IHARF
INDIAN HEAD AGRICULTURAL RESEARCH FOUNDATION

2018 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 2018 IHARF Directors included:

- Janel Delage - President *(Indian Head)*
- Chris Brown - Vice President *(Indian Head)*
- Kyle Heggie - Secretary / Treasurer *(Leross)*
- Fred Stilborn *(Balcarres)*
- Rick Procyk *(Fillmore)*
- Dean Douhaniuk *(Killaly)*
- Heather Haus *(Glenavon)*
- Travis Wiens *(Milestone)*
- 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:

- Bruce McArthur - Associate Director, RDT
- Bill May - Research Scientist
- Chris Omoth - Research Assistant

IHARF Staff

The 2018 team of IHARF staff included:

- Danny Petty - Executive Manager
- Chris Holzapfel - Research Manager
- Christiane Catellier - Research Associate
- Jared Solomon - Farm Technician
- Marissa Glofcheskie - Agronomy Research Intern
- Dan Walker - Seasonal Technician
- Vladislav Sheshnev - Summer Student
- 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 2018 was Anique Josuttes. Anique is completing her Masters in Plant Sciences at the University of Saskatchewan, studying plant phenomics and high-throughput phenotyping.

Extension Events

Indian Head Crop Management Field Day

On July 17, 2018, IHARF and AAFC hosted the annual Indian Head Crop Management Field Day. 183 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)
- Anique Josuttes (University of Saskatchewan)
- Dan Heaney (Fertilizer Canada)
- Melissa Higgins (Saskatchewan Crop Insurance Corporation)
- Gord Finlay (AAFC Brandon)
- Dr. Raju Soolanayakanahally (AAFC Saskatoon)
- Dr. Fardausi (Shathi) Akhter (AAFC Indian Head)

AgriARM Research Update

On January 17, 2019, IHARF, along with Agriculture Applied Research Management (AgriARM) sites 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)
- Jessica Pratchler (Northeast Agriculture Research Foundation)
- Garry Hnatowich (Irrigation Crop Diversification Corporation)
- Chris Baan (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 6, 2019, IHARF hosted its annual winter seminar in Melville, SK, highlighting results of the 2018 season and current industry issues. 125 guests took in presentations delivered by:

- Chris Holzapfel (IHARF)
- Bill May (AAFC Indian Head)
- Dr. Alan Moulin (AAFC Saskatoon)
- Mike Hall (East Central Research Foundation)
- Jason Fradette (AAFC Winnipeg)
- Warren Ward (Canola Council of Canada)

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

2018 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 2018:

Platinum

- Agriculture & Agri-Food Canada - Indian Head Research Farm
- Agriculture Development Fund
- Bayer CropScience
- Canada/Saskatchewan ADOPT Program
- Koch Agronomic Services
- Saskatchewan Canola Development Commission
- Saskatchewan Ministry of Agriculture
- Saskatchewan Wheat Development Commission
- Western Grains Research Foundation

Gold

- Agriculture & Agri-Food Canada - Career Focus Program
- Anuvia Plant Nutrition
- BASF
- DSW Enterprises
- Engage Agro
- Manitoba Pulse & Soybean Growers
- Mosaic

Silver

- Albaugh
- Canola Council of Canada
- Crop Production Services
- FP Genetics
- Manitoba Canola Growers
- McCarthy Seed Farm
- NorthStar Genetics
- Pioneer Hi-Bred
- Saskatchewan Barley Development Commission
- Saskatchewan Flax Development Commission
- Saskatchewan Oat Development Commission
- Saskatchewan Pulse Growers
- Syngenta
- University of Saskatchewan

Bronze

- Arysta LifeScience
- CanMar Farms Indian Head
- Delage Farms
- Dow AgroSciences
- Eskdale Seed Farm
- FenderXtender
- GrainShark.com
- IntraGrain Technologies
- Markusson New Holland
- Monsanto BioAg
- SeedMaster
- TD Canada Trust
- 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 organized as a non-profit organization, and is led by volunteer Boards of Directors, generally comprised of producers in their respective areas.

Each site 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

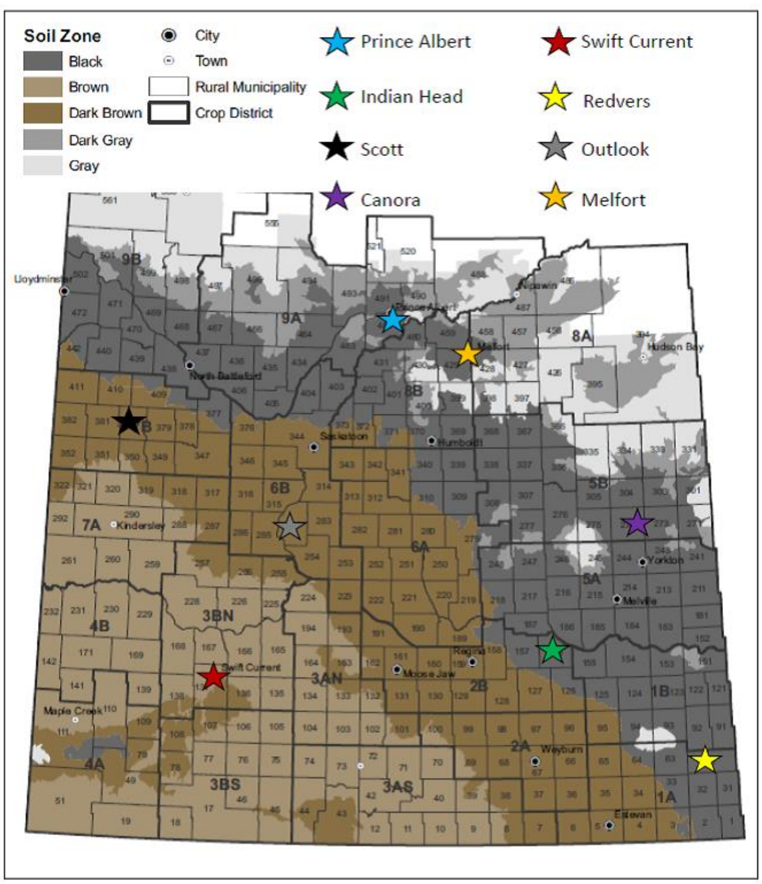

Figure 1. Locations of organizations comprising the Saskatchewan AgriARM Network.

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].

It was initially considered drier than normal in the spring of 2018, but with adequate soil moisture for germination and seeding conditions were considered excellent overall. While there was essentially no precipitation early in May, 24 mm was received towards the end of the month leading to excellent emergence and total precipitation in June was 116% of the long-term (1981-2010) average with 90 mm received over the course of the month. The remainder of the season was very dry with less than 50% of the long-term average in July and essentially no precipitation in August. Averaged over the four months (May-August), a total of 148 mm of rainfall was received, or 61% of the long-term average. Temperatures were well above average in May and, to a lesser extent, June but below average in July and approximately average in August. Averaged over the four months the mean temperature in 2018 was 16.4°C compared to long-term average of 15.6°C.

Table 1. Mean monthly temperatures for the 2018 growing season and long-term normals (1981-2010).

		Apr	May	Jun	Jul	Aug	Sep	Oct
					°C			
Indian Head	2018	-2.1	13.9	16.5	17.5*	17.6	7.6*	1.3
	normal	4.2	10.8	15.8	18.2	17.4	11.5	4.0
Melfort	2018	-3.4 *	13.9	16.8	17.5	15.9*	6.9*	0.9*
	normal	2.8	10.7	15.9	17.5	16.8	10.8	3.3
Scott	2018	-2.2	13.6	16.1*	17.4*	16.2	6.5	2.1
	normal	3.8	10.8	15.3	17.1	16.5	10.4	3.3
Swift Current	2018	-0.8*	15.2*	17.1*	18.7*	19.0*	10.4*	4.5*
	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 2018 growing season and long-term normals (1981-2010).

		Apr	May	Jun	Jul	Aug	Sep	Oct	Total
						mm			
Indian Head	2018	8.5	23.7	90.0	30.4*	3.9	39.6*	25.5	221.6*
	normal	22.6	51.7	77.4	63.8	51.2	35.3	24.9	326.9
Melfort	2018	5.0*	38.5*	46.6	69.5	43.2*	42.0*	8.9*	253.7*
	normal	26.7	42.9	54.3	76.7	52.4	38.7	27.9	319.6
Scott	2018	8.5	29.6	29.6*	48.2*	23.3	52.1	9.1	200.4*
	normal	21.6	36.3	61.8	72.1	45.7	36.0	17.9	291.4
Swift Current	2018	4.8*	8.8*	23.6*	15.1*	28.3*	45.4*	7.9*	133.9*
	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.

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

Holzapfel, C. (IHARF), Schoenau, J. (UofS), Pratchler, J. (NARF), Hall, M. (ECRF), Weber, J. (WARC), Nybo, B. (WCA), Shaw, L. (SERF), and Slaski, J. (InnoTech).

Description

Flax fertility trials were conducted over a three-year period at eight locations, primarily in Saskatchewan but also in Alberta and Manitoba. Residual NO3-N was variable across locations while P levels were relatively low with a maximum of 24 ppm (Olsen P) and less than 10 ppm at 63% of the sites. All fertilizer was side-banded and the treatments were a factorial combination of four nitrogen fertilizer rates (13, 50, 100, and 150 kg N/ha) and four phosphorus fertilizer rates (0, 20, 40, and 60 kg P_2O_5/ha). This study measured plant density, days to maturity, seed yield, and test weight.

Results

Flax emergence was somewhat sensitive to side-banded urea with stand reductions associated with increasing N rate observed at 74% of the sites. At affected sites the response was linear with a 28% reduction in plant densities when the N rate was increased from 13 kg N/ha to 150 kg N/ha. Side-banded MAP did not affect plant density, regardless of rate. Increasing N rate delayed maturity 71% of the time averaging 2.4 days amongst the affected sites. Phosphorus rate did not have a noticeable effect on flax maturity. Flax yields were increased with both N and P fertilizer as shown in Table 5.There was a site by N rate interaction with a relatively strong response at 83% of the sites, increasing yields by 39% on average with maximum yields achieved at approximately 100 kg N/ha. At the remaining sites, the response was weak with an 11% yield increase on average and optimal rates closer to 50 kg N/ha. For phosphorus, although there was variation, no site by phosphorus interaction was detected. The average response was linear but relatively shallow (7%); therefore, more modest rates of 20-40 kg P_2O_5/ha are likely to be optimal. At 50% of the sites, the maximum yield increase with P was 5-10% while the response was below 5% at 28% of the sites and greater than 10% at 22% of the sites. Test weight was not affected by P fertilizer rate but there was a very slight linear increase at 41% of the sites.

Table 5. Main effect means for flax seed yield when averaged across all sites (n=18), for sites where a significant N effect was detected (n=15), and for sites where there was no N effect (n=3).

Treatment	All Sites (n=18)	N Responsive Sites (n=15)	Non-N Responsive Sites (n=3)
Nitrogen Rate		kg/ha	
13 kg N/ha	1679 c	1669 c	1526 b
50 kg N/ha	2073 b	2094 b	1638 a
100 kg N/ha	2251 a	2288 a	1661 a
150 kg N/ha	2271 a	2313 a	1690 a
Phosphorus Rate		kg/ha	
0 kg P_2O_5/ha	1929 c	2017 c	1500 b
20 kg P_2O_5/ha	2006 b	2080 b	1667 a
40 kg P_2O_5/ha	2039 ab	2124 a	1645 a
60 kg P_2O_5/ha	2064 a	2143 a	1704 a

Conclusions

In conclusion, these results show that adequate N and P fertility are both important for achieving higher flax yields. However, the responses were modest with respect to both magnitude of the yield increase and the rates at which maximum yield was achieved. Site-to-site variability was much higher than the variability within sites due to N and P fertilizer rate. This potentially suggests that fertility is not likely the most limiting factor for majority of western Canadian flax acres; however, this will vary on a farm-to-farm basis.

Acknowledgements

This project was jointly funded through the Agriculture Development Fund, the Saskatchewan Flax Development Commission, and the Western Grains Research Foundation.

Input Study: Intensive Wheat Management

Brandt, S. (NARF), Pratchler, J. (NARF), Catellier, C. (IHARF), Hall, M. (ECRF), Holzapfel, C. (IHARF), Nybo, B. (WCA) and Weber, J. (WARC).

Description

This project was conducted at Melfort, Indian Head, Scott, Swift Current, and Yorkton in 2017 and 2018 for a total of 10 site-years. 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 6. Each cultivar was grown under 3 progressively intensified management levels as shown in Table 7. Together the six cultivars under three management levels were combined to develop an 18 treatment study. The overall objective of this research project was to enhance wheat profitability.

Table 6. 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]
					Area 1&2	Area 3&4	
Carberry	CWRS	Marginally Resistant	Very Good	99	100	100	14.6
AAC Cameron VB	CWRS	Intermediate	Fair	-2	108	118	-0.7
CDC Utmost VB	CWRS	Marginally Susceptible	Fair	-3	108	112	-0.4
AC Andrew	CWSWS	Intermediate	Very Good	+2	130	137	NA
SY Rowyn	CPSR	Marginally Resistant	Fair	0	101	106	-1.1
AAC Ryley	CPSR	Marginally Susceptible	Poor	-1	103	110	-1.2

[z] In relationship to Carberry

Table 7. Management level descriptions for the Intensive Wheat Management study at five locations in 2017.

	Seed Treat ment	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

Plant density

Management had a significant effect on plant populations at all 10-site years, with increasing plant density as management level intensified due to the increased seeding rates. In 2017, AAC Cameron VB had the highest plant density at four of the five locations. In 2018, at the locations where there was a significant difference between varieties, AC Ryley tended to have the highest plant density.

Grain Yield

In 2017 and 2018, both cultivar and management had a significant effect on grain yield at all locations, except Swift Current where only cultivar was significant. At Indian Head in 2017 & 2018, Scott 2017 & 2018, and Yorkton 2017, the CWRS cultivars tended to yield less than the CPSR and CWSWS cultivars (Table 8). At Melfort 2018, the opposite trend occurred with the CWRS cultivars yielding greater than the CPSRs. At Melfort 2017, Swift Current 2017 & 2018, and Yorkton 2018 there was no significant difference between the CWRS and CPSR cultivars. As expected, yield increased with increasing management intensity (Figure 2). Averaged over the two study years, the Conventional management treatments averaged 68 bu/ac across varieties at 4 of 5 locations. Increasing management to the Enhanced level resulted in an average 6 bu/ac yield increase. Intensifying management to the highest level (Intensive) resulted in a further 6 bu/ac average yield increase. It was only in 2018, at two locations, that there was a significant cultivar by management interaction. At both Indian Head and Scott, AC Andrew under Enhanced and Intensive management were the highest yielding treatments and were statistically similar.

Table 8. Influence of cultivar on grain yield (bu/ac) for the Input Study: Intensive Wheat Management at five locations in 2017 & 2018.

	IH17[z]	IH18	ME17	ME18	ST17	ST18	SC17	SC18	YK17	YK18	Avg.
Carberry	69c	59bc	66b	70c	87c	39c	45a	34b	69c	83c	62.1
AAC Cameron	68c	57c	68b	80b	86c	45b	43ab	35b	70c	89b	64.1
CDC Utmost	68c	60b	73b	84b	88c	40c	44ab	37ab	68c	89bc	65.3
AC Andrew	81a	69a	84a	104a	108a	57a	48a	43a	96a	106a	79.7
SY Rowyn	72b	60b	68b	72c	95b	45b	40b	39ab	81b	89bc	66.0
AC Ryley	69bc	61b	71b	72c	96b	43b	47a	42a	80b	91b	67.1

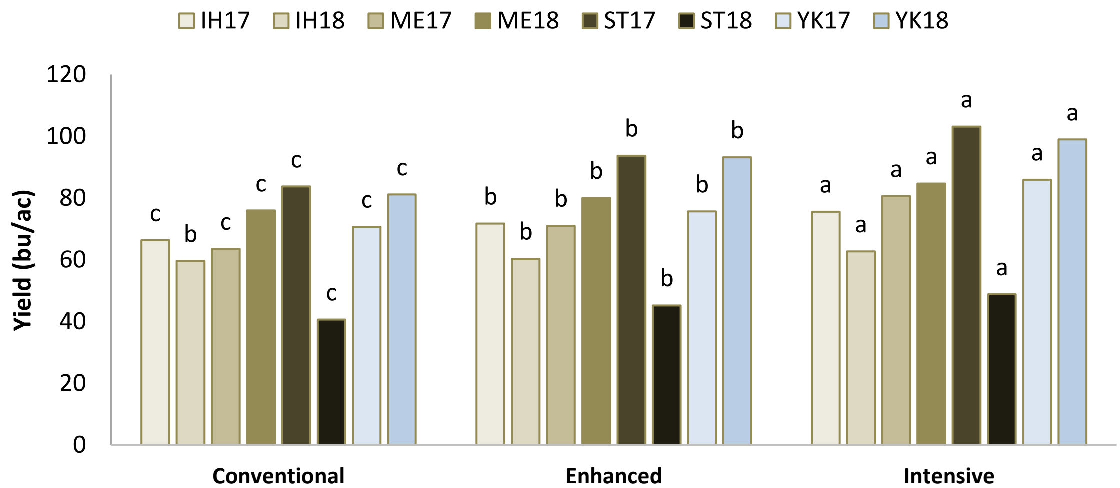

Figure 2. Management level effect on grain yield (bu/ac) at four Saskatchewan locations in 2017 & 2018).

Grain Quality

Across all 10 site-years, Carberry consistently provided some of the highest protein levels of the cultivars tested. As expected, AC Andrew the CWSWS cultivar, produced the lowest protein levels on average across all locations. Protein increases between the management levels were minimal ranging from 0.6 to 1% point, respectively. Fusarium infection levels were low in both 2017 and 2018, therefore %FDK was minimal at less than 1%. Despite minimal fusarium levels, there continued to be a significant difference in the FDK levels between cultivars. AC Ryley had the highest %FDK levels both years tested.

Economic Analysis

Economic returns were highly variable across locations and treatments, ranging from losses of $176/ac to profits of $269/ac. Averaged across the two growing seasons, Yorkton had the highest average returns due to higher yields while Swift Current had the lowest average return due to drought. Melfort and Scott had relatively high average returns as well, while Indian Head more or less break-even due to lower yields in 2018. Carberry, under Enhanced management, provided the largest net return at Indian Head, while AC Ryley under Intensive management resulted in a significant net loss. At Indian Head the three CWRS cultivars resulted in positive net returns at any management level, whereas the CSWSW and CPSR wheat had increasingly negative returns as management level intensified. It appears that CWRS cultivars are good candidates for Intensive management. However, due to the high yields of the two CPSR cultivars, they too can be good candidates providing they are priced similar to CWRS wheat. This may be the case for producers living closer to ethanol processing centers.

Conclusions

Based on the two years of study, results indicate that wheat should be managed differently between soil zones and climatic conditions. From an agronomic perspective, there is some evidence that wheat should be managed differently between classes and varieties, although results are not conclusive. There still continues to be significant differences between cultivars and management, and less frequently between the interaction of these two factors. Based on agronomic and economic results, intensive management is supported by all wheat classes and varieties when growing conditions are conducive to high yielding conditions. The level of intensive management is largely dependent on the price/costs and economic risk the producer is willing to take. These results do suggest that when varietal testing occurs, it should be conducted under both conventional and intensified management systems to identify varieties that are more responsive to intensive management. The project will be conducted for a third season in 2019.

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, Alliance Seeds and Engage Agro.

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 and Swift Current in 2017 and 2018, at Yorkton in 2017 and Saskatoon in 2018, for a total of 10 site-years. 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

The pre-seed residual herbicides tended to reduce early season weed populations and overall weed growth by > 50% in comparison to the traditional pre-seed burn-off strategy. A seeding rate effect was detected throughout the entirety of the disease rating period. Days to maturity were extended with increased seeding rates. The seeding rate of 190 seeds m^{-2} resulted in the highest yield as shown in Figure 3 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. Seed size had a slight, but not significant, reduction when seeding rates exceeded 130 seeds m^{-2}. During year two of the study, disease levels were relatively low due to the drier conditions at some sites; however, a fungicide and seeding rate response was detected at 14 and 21 days after initial application. It was found the highest seeding rates of 260 seeds m^{-2} required multiple fungicide applications to reduce disease pressure as shown in Figure 4. The economic analysis demonstrated that the best management practice was the single fungicide application strategy with a seeding rate of 190 seeds m^{-2}. A high price market scenario indicated a net profit increase for the single fungicide application compared to no fungicide applied.

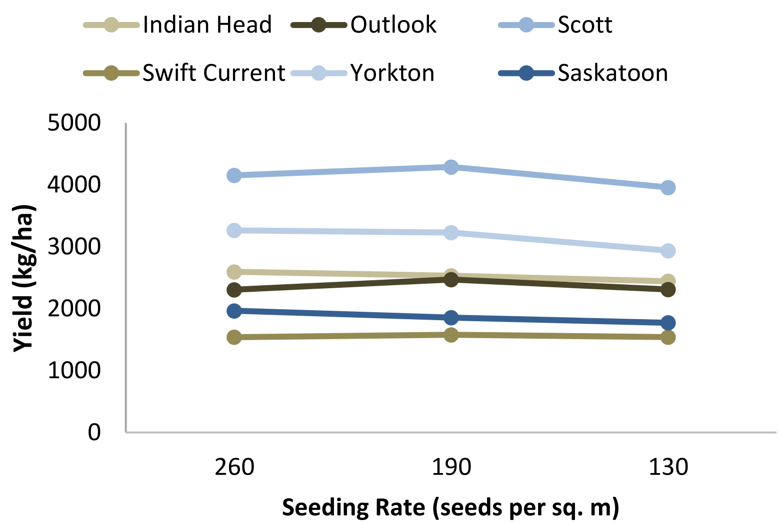

Figure 3. Lentil seed yield response to seeding rate (seeds per sq m^{-2}) at five locations across Saskatchewan (2017 & 2018).

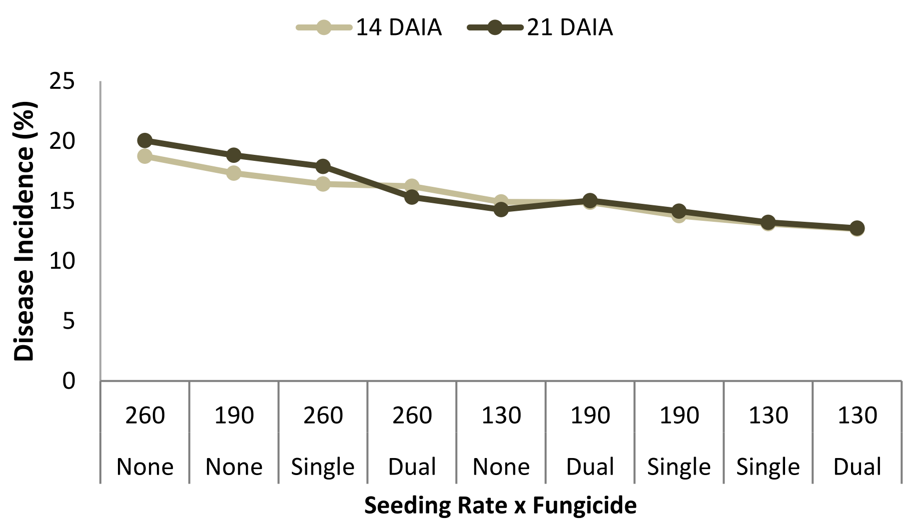

Figure 4. Disease response ratings at 14 DAIA and 21DAIA to fungicide applications at three locations across Saskatchewan(2017 &2018).

Conclusions

Early season weed growth was significantly reduced with a pre-seed residual application compared to the pre-seed burn-off. The preliminary results indicate that if seeding rates are to increase to 190 seeds m^{-2} then fungicide applications are likely required, particularly under moist conditions. It was found that a seeding rate of 190 seeds m^{-2} with a single fungicide application resulted in the highest gross profit. As disease pressure was relatively low amongst all locations, the impact of multiple fungicide applications at high seeding rates on disease pressure and overall yield requires further investigation. The high input costs associated with the dual fungicide application strategy could be justified if a severe high disease pressure is present. This project is being ran again in 2019, which will be the final year of the study.

Acknowledgements

This project was funded by the Agriculture Development Fund, the Saskatchewan Pulse Growers and the Western Grains Research Foundation.

Seed Treatment and Foliar Fungicide Options for Flax

Holzapfel, C. (IHARF), Shaw, L. (SERF), Nybo, B. (WCA), Weber, J. (WARC) and Brown, R. (CLC).

Description

This study was conducted in 2018 at Indian Head, Redvers, Swift Current, Scott and Prince Albert. The treatments were a factorial combination of three seed-applied fungicide treatments (untreated, Vitaflo-280, and Insure Pulse) and three foliar-applied fungicide treatments (untreated, Headline EC, and Priaxor). All products were used as per label recommendations and the foliar fungicide applications were targeted for 7-10 days after the first flowers were observed. The objective of this project was to demonstrate the response of flax to various seed-applied and foliar fungicide options with a focus on establishment, maturity, and yield.

Results

There were no treatment effects on days to emergence, lodging, or maturity at any locations. Under the dry conditions, yields were modest ranging from 1102 kg/ha at Swift Current to 2053 kg/ha at Indian Head when averaged across treatments. At Indian Head, Redvers, Swift Current, and Scott there was no effect of either seed treatment or foliar fungicide on flax yield as shown in Table 9. At Prince Albert, plant populations were increased with both Insure Pulse and, to a lesser extent, Vitaflo-280. At Prince Albert, Insure Pulse increased yield by 12% over both the control and Vitaflo-280. Despite a trend for slightly higher yields with foliar fungicide at Prince Albert, the response was not significant and, although this was the wettest site, the lack of response was not necessarily unexpected given the low disease levels reported. Very little pasmo was observed overall, with no symptoms whatsoever recorded at three out of five sites. At Indian Head, the average pasmo rating was 2.8/9 with a small reduction in visible symptoms with fungicide; however, conditions went from wet to dry at this location and disease never progressed past the lower leaves. Under these conditions, foliar fungicides did not result in significant yield benefits at any locations.

Table 9. Main effect means for treatment effects on flax seed yield ($P \leq 0.05$).

	Indian Head	Redvers	Swift Current	Scott	Prince Albert
	------------------------------------ Seed Yield (kg/ha) ------------------------------------				
Seed Treatment					
Control	2056 a	1481 a	1097 a	1449 a	1830 b
Vitaflo-280	2075 a	1608 a	1054 a	1434 a	1848 b
Insure Pulse	2027 a	1629 a	1156 a	1453 a	2063 a
Fungicide					
Control	2047 a	1480 a	1063 a	1452 a	1834 a
Headline EC	2081 a	1496 a	1156 a	1438 a	1936 a
Priaxor	2031 a	1741 a	1033 a	1445 a	1973 a

Conclusions

The dry conditions were not conducive for demonstrating the potential benefits of seed-applied and foliar fungicide options. These results reinforce the importance of crop scouting and that benefits to crop protection products are unlikely in the absence of the pests that they are registered to control. Previous field trials with seed treatments have produced results ranging from no benefit to higher plant populations with a tendency for higher yields. The current results reinforce the recommendation that benefits of seed treatments under field conditions are variable and presumably less likely when using high quality seed and good seeding practices. While past field trials have shown potentially strong yield responses and effects on maturity with foliar fungicide applications under higher disease pressure, the current results are consistent with other previous cases where disease pressure was low.

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 additional sites funded by the Saskatchewan Flax Development Commission. As an additional in-kind contribution, Michelle Beaith (SFDC) assisted with protocol development, seed sourcing, and reporting. Crop protection products were provided in-kind by BASF, Bayer CropScience, Arysta, and FMC.

Seed-placed Phosphorus Fertilizer Forms and P. bilaii Effects on Canola Emergence, Phosphorus Uptake, and Yield

Holzapfel, C. (IHARF).

Description

A field trial was established near Indian Head to demonstrate canola response to varying application rates of contrasting P fertilizer products with and without *P. bilaii* inoculation. The treatments were a factorial combination of seed placed rates of 0, 25, or 50 kg P_2O_5/ha, fertilizer forms of (MAP (11-52-0) or MES15 (13-33-0-15), and with and without in-furrow granular JumpStart. The soil at this location was low in residual P at 7 ppm (Olsen-P).

Results

There was a significant overall stand reduction with increasing P fertilizer rates, particularly for MES15 presumably due to the higher product rates and additional nutrients with this form. Plant populations were 13.5% lower with seed-placed P on average but up to 23% lower at the 50 kg P_2O_5/ha rate of MES15. Despite these effects, populations were sufficiently high to not limit yields in all treatments. Both P forms resulted in modest but significant increases in early-season biomass yield, P tissue concentrations, and P-uptake as shown in Table 10. Contrast results for canola response variables (P ≤ 0.05).. There was evidence that *P. bilaii* inoculation increased biomass yields in the absence of P fertilizer but this did not translate into higher tissue concentrations, uptake or seed yield. The response was relatively small at only 4% when averaged across all fertilized treatments and less than 7% in the highest yielding treatments; however, canola yields increased linearly with P rate in a similar manner regardless of form or *P. bilaii* inoculation. Maturity was similar regardless of treatment with only 0.6 days between the earliest and latest treatments and there was essentially no green seed.

Table 10. Contrast results for canola response variables (P ≤ 0.05).

Response Variable	No P Fertilizer	P Fertilizer
Plant Density (plants/m^2)	72.5 a	62.7 b
Early Season Biomass (kg dry matter/ha)	1006 b	1280 a
Tissue P (% P)	0.39 b	0.42 a
P Uptake (kg P_2O_5/ha)	9.1 b	12.1 a
Seed Yield (kg/ha)	3002 b	3113 a

Response Variable	MAP	MES15
Plant Density (plants/m^2)	66.5 a	58.9 b
Early Season Biomass (kg dry matter/ha)	1306 a	1254 a
Tissue P (% P)	0.42 a	0.42 a
P Uptake (kg P_2O_5/ha)	12.4 a	11.9 a
Seed Yield (kg/ha)	3085 a	3140 a

Conclusions

Overall, producers are advised to consider soil tests, crop removal and long-term fertility objectives when deciding on appropriate P rates. Caution should be exercised when considering higher rates of seed-placed fertilizer, especially with multi-nutrient products like MES15 or similar blends. Regarding *P. bilaii* inoculation, growers are advised to utilize check strips to determine whether economic benefits are being realized and to utilize this input in combination with adequate fertilizer as opposed to a substitute.

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. In-kind support was provided by Bayer CropScience, BASF, and Acceleron BioAg.

Demonstrating 4R Nitrogen Management Principles in Canola

Holzapfel, C. (IHARF).

Description

A field trial was conducted at Indian Head to promote 4R N stewardship and to demonstrate the overall canola response to N fertilization rates. The nitrogen fertilizer forms, timing of application and placement were varied. The demonstration included four forms (untreated urea, Agrotain, SuperUrea, and ESN) and three timing/placement options (fall surface-broadcast, fall in-soil band, and side-band). Treatments of 0x, 0.5x, 1.0x, and 1.5x of a baseline rate of 145 kg N/ha (soil residual plus fertilizer) was supplied as side-banded urea. Data collection included NDVI, leaf chlorophyll (SPAD) measurements, and yield.

Results

Despite the dry weather, this project demonstrated strong canola responses to N fertilization along with the relative responses associated with several contrasting N management strategies. The in-season NDVI and SPAD measurements were both reasonably good indicators of the potential yield response to N. The yield increase with N was 133% over the control with similar yields between the 1-1.5x rates as shown in Figure 5. Focussing on timing/placement, all of the options resulted in a strong N response and significant differences amongst individual treatments were relatively rare. However, there was an overall advantage to both side-banding and fall in-soil banding over the fall surface broadcast applications as shown in Figure 6. Averaged across forms, yields with fall surface-broadcast applications were 9% lower than with either fall in-soil or side-banded N. Yields were similar for fall banded versus side-banded N. Regarding forms, all performed similarly under the conditions encountered when averaged across timing and placement methods. The greatest exception to this was specifically for fall surface-broadcasting where canola yields with SuperUrea tended to be higher than with untreated urea and Agrotain and did not significantly differ from 88% of the individual treatments where N fertilizer was banded beneath the soil surface.

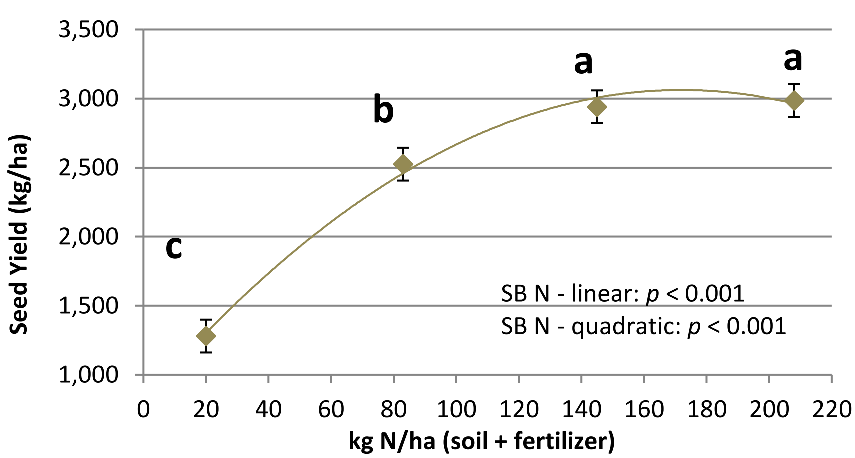

Figure 5. Side-banded urea rate effects on canola seed yield at Indian Head (2018).

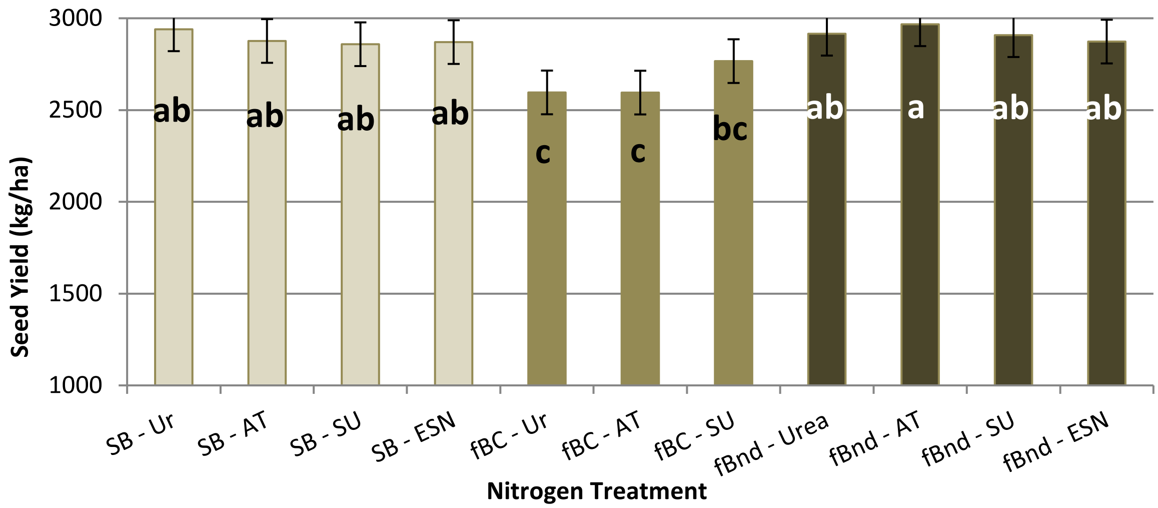

Figure 6. Nitrogen form/placement/timing effects on canola seed yield at Indian Head (2018). SB – side-band, fBC – fall surface broadcast, fBnd – fall in-soil band, Ur - untreated urea, AT– Agrotain treated urea, SU – SuperUrea, ESN – polymer coated urea.

Conclusion

Nitrogen fertilizer management is sensitive to environmental conditions and therefore the actual results that producers might experience with these strategies can vary greatly. Soil testing is advised to account for the inherent fertility of the soil and better determine appropriate fertilizer rates. Side-banding continues to be recommended as a safe and effective practice that will provide consistent results over a broad range of environmental conditions. In the current demonstration, fall in-soil banding was also highly effective and, although the benefits can vary depending on the specific conditions encountered, enhanced efficiency fertilizer products can improve performance particularly with potentially risky practices such as fall-surface broadcasting.

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 Bayer CropScience, BASF, Koch Agronomic Services and Nutrien.

Seeding Rate and Row Spacing Effects on Faba bean Establishment, Competitiveness with Weeds, Maturity & Yield

Holzapfel, C. (IHARF).

Description

A field trial was established at Indian Head to demonstrate faba bean response to row spacing and seeding rate and to assess whether the response to seeding rate is affected by row spacing. The treatments, replicated four times, were a combination of four row spacing levels (25, 30, 36, 41 cm) and three seed rates (25, 45, 65 seeds/m^2) and the variables evaluated included plant density, late-season weed pressure, maturity, yield and seed size.

Results

There were no interactions between row spacing and seeding rate detected. Plant density increased linearly with seeding rate but the effect of row spacing was minor with only subtle evidence of slightly higher plant populations at the narrowest spacing. Weeds were controlled well with pre-emergent and in-crop herbicides and there was a slight increase in late-season weed pressure at the lowest seeding rate but no row spacing effect. Maturity was not affected by row spacing but decreased linearly with increasing seed rate. Grain yields were below average overall but similar across row spacing treatments and numerically highest at 41 cm spacing as shown in Figure 7. Yield increased linearly with seeding rate but modestly with only a 138 kg/ha (2 bu/ac) difference between the 25-65 seeds/m^2 rates as shown in Figure 8. Seed size was not affected by row spacing but was inversely related to seeding rate with the largest seeds observed at 25 seeds/m2.

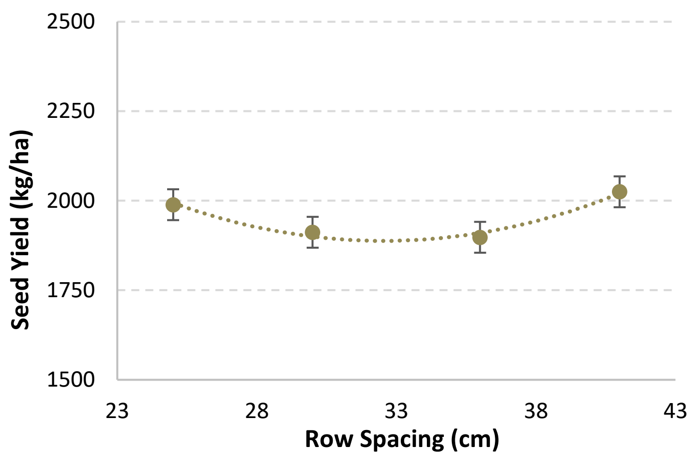

Figure 7. Row spacing effects on faba bean seed yield when averaged across seeding rates. While the overall F-test was not quite significant at the desired probability (P = 0.066), the quadratic orthogonal contrast was significant (P = 0.010).

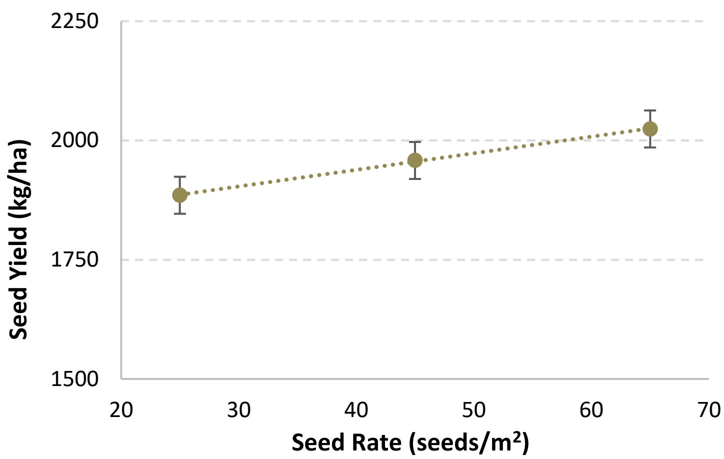

Figure 8. Seed rate effects on faba bean seed yield when averaged across row spacing treatments. Both the overall F-test (P = 0.018) and linear responses (P = 0.005) were significant.

Conclusions

In conclusion, this project demonstrated that faba beans performed similarly across the full range of row spacing treatments evaluated but benefited from higher than expected seed rates under drought conditions. It would be beneficial to repeat this work under more typical, higher yielding conditions in order to increase confidence in the results and develop more robust faba bean row spacing recommendations.

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 FMC, Bayer CropScience and BASF and certain design aspects and components of the drill were provided in-kind by SeedMaster.

Control of Glyphosate Resistant Canola in Glyphosate Resistant Soybeans

Hall,M. (ECRF), Catellier, C. (IHARF), Pratchler, J. (NARF) and Hnatowich, G. (ICDC).

Description

This trial was established at Yorkton, Indian Head, Melfort and Outlook to demonstrate the benefit of layering herbicide for the control of glyphosate resistant (GR) canola volunteers in a GR soybean crop. The trials were established as a factorial design with 4 replicates. The first factor compared an in-crop application of glyphosate alone against glyphosate + Viper ADV. The second factor contrasted pre-seed applications of glyphosate alone and glyphosate tank mixed with either Blackhawk, Authority Charge, Express SG or Heat LQ.

Results

An in-crop application of Viper ADV alone was sufficient to maximize control of RR canola volunteers and maximize yield at Yorkton, Indian Head and Melfort. Viper ADV was very effective at these locations, providing over 85% control as shown in Figure 9. Viper ADV alone reduced canola dockage from 8.8% down to 1.2% at Yorkton and from 11.2% down to 0.6% at Melfort. Layering with pre-seed tank mixes did little to further improve control of volunteers or increase soybean yield as canola populations were low at Indian Head and the initial flush at Melfort and Yorkton emerged after the pre-seed herbicides had been applied.

The situation was different at Outlook under irrigation, as a healthy population of volunteers was present when pre-seed herbicides were applied and canola continued to flush throughout the year. The best control of volunteer canola at Outlook was achieved by layering Viper ADV with a pre-seed herbicide tank mix. The check, sprayed pre-seed and in-crop with glyphosate alone, provided no control of canola, resulted in 44.8% dockage and produced a soybean yield of only 1524 kg/ha Table 11. On average, a pre-seed tank mix without an in-crop application of Viper ADV provided 60% control of volunteers, reduced canola dockage down to 24.3% and increased yield to 2075 kg/ha. Layering Viper ADV with a pre-seed tank mix improved control of volunteers to 90%, further reduced dockage to 11.5% and maximized yield at 2570 kg/ha. Layering herbicide at Outlook increased soybean yield by 68%.

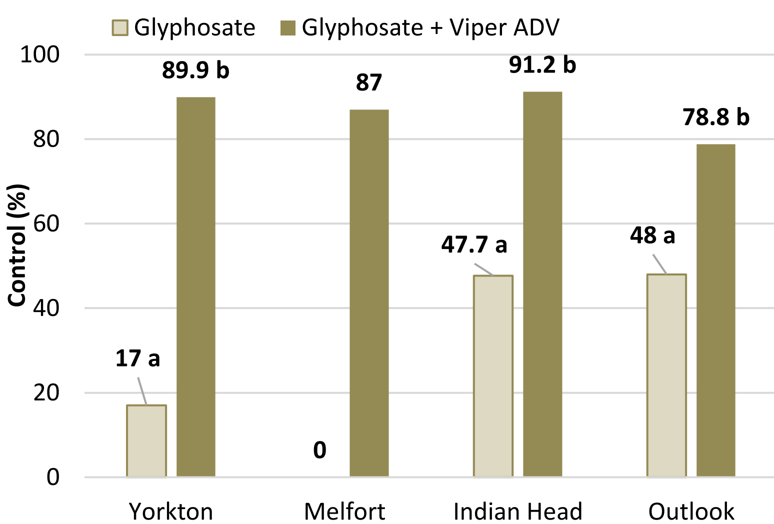

Figure 9. Main effects of in-crop herbicide on the control of volunteer canola 56 days after post-emergent herbicide application.

Table 11. Means for the Interaction between In-crop control and Pre-seed control on percent control 56 days after post-emergent herbicide application, dockage and yield at Outlook 2018 site.

Treatment	% Control	% Dockage	Yield Kg/ha²
Glyphosate – Glyphosate	0.0	44.8	1524 a
Glyphosate – Glyphosate + Blackhawk	70.0	26.7	2231 c
Glyphosate – Glyphosate + Authority Charge	70.0	15.0	2388 cd
Glyphosate – Glyphosate + Express SG	50.0	27.0	1974 bc
Glyphosate – Glyphosate + Heat LQ	50.0	28.5	1890 b
Glyphosate + Viper ADV– Glyphosate	22.5	39.5	1436 a
Glyphosate + Viper ADV – Glyphosate + Blackhawk	96.3	14.6	2886 e
Glyphosate + Viper ADV – Glyphosate + Authority Charge	93.8	12.2	2901 e
Glyphosate + Viper ADV – Glyphosate + Express SG	88.8	10.4	2614 d
Glyphosate + Viper ADV – Glyphosate + Heat LQ	92.5	8.9	2479 cd

Conclusions

An in-crop application of Viper ADV without a pre-seed tank mix provided sufficient control of GR canola volunteers and maximized yield at Yorkton, Melfort and Indian Head because volunteers flushed late at Yorkton and Melfort and populations were low at Indian Head. In contrast, layering pre-seed herbicide tank mixes with an in-crop application of Viper ADV was extremely beneficial at Outlook under irrigation as populations of canola volunteers were very heavy and there were multiple flushes. Layering of herbicides with different application timings and modes of action can increase control of canola volunteers and increase soybean yield. While differences between pre-seed tank mixes were significant at times, no consistent conclusion can be made regarding the relative efficacy of the products

Acknowledgements

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

Malt versus Feed Barley Management

Hall, M. (ECRF), Brown, R. (CLC), Holzapfel, C. (IHARF), Pratchler, J. (NARF), Shaw, L. (SERF), Hnatowich, G. (ICDC) and Weber, J. (WARC).

Description

A study was conducted at Indian Head, Yorkton, Prince Albert, Melfort, Redvers, Outlook and Scott to determine the effect of seeding rate (200 vs 300 seeds/m^2) and nitrogen rate (50, 75 and 100 lbs N/ac) on the yield of the malt barley variety CDC Bow and the feed barley variety CDC Austenson. Treatment effects on grain quality for malt were also measured.

Results

Increasing seeding rate increased inter-plant competition for moisture and reduced yield at the dryland sites since precipitation was well below average at all locations; however, the effects on yield were rarely significant at individual sites. Increasing seeding rate only resulted in more yield at Outlook under irrigation. When averaged across locations, increasing seeding rate decreased thousand kernel weight. However, it did not decrease kernel plumpness which is of more concern to maltsters. No other quality parameters were influenced by seeding rate. While the yield response to added nitrogen was similar between the varieties, CDC Austenson was 8% higher yielding than CDC Bow when averaged over treatments and location as shown in Figure 10. The yield difference between varieties varied from as low as 1.9% at Prince Albert to as high as 11% at Redvers. Increasing nitrogen significantly increased protein. For most sites, protein stayed below the maximum limit even at the highest nitrogen rate of 100 lbs N/ac. The exception to this was at Scott where acceptable protein levels for malt were exceeded even with 50 lbs N/ac. As a result, the economic analysis for growing CDC Bow for malt or feed against CDC Austenson for feed were made at 100 lbs N/ac for all locations except Scott where comparisons were made at 50 lbs N/ac.

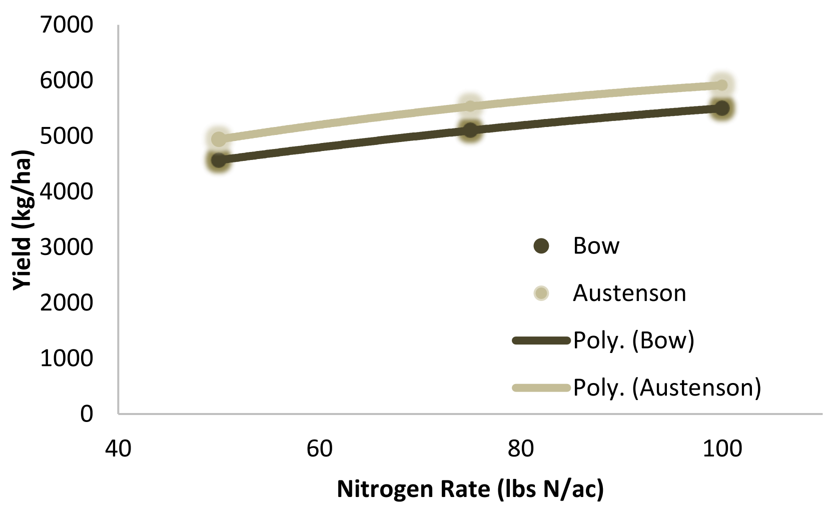

Figure 10. Yield response of CDC Bow and CDC Austenson to added nitrogen rate, averaged over seeding rate and Location.

Conclusions

The economic analysis was based on yields obtained for these nitrogen rates and pricing obtained from Saskatchewan Crop Planning Guide. The 2017 values were $5.44 and $3.22/bu for malt and feed barley, respectively. In 2018, the prices narrowed to $4.68 and $3.70/bu for malt and feed barley, respectively. Based on 2017 and the narrower 2018 pricing, the likelihood of achieving malt with CDC Bow has to be greater than 10 or 27%, to justify growing it instead of CDC Austenson for feed. The values would be a little higher if one considers the yield of the feed variety CDC Austenson could have been pushed higher with increasing N beyond 100 lbs/ac at most sites. While the chance of obtaining malt may be high for some producers, one must recognize that only 20% of malting barley is actually selected according to the Canadian Grain Commission. As even higher yielding malt varieties such as AAC Synergy gain acceptance in the market place, there may be little reason to grow feed varieties in the future.

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

Oats: Busting Bins & Making the Grade with Agronomy Basics

Holzapfel, C. (IHARF).

Description
A field trial was established near Indian Head to demonstrate the response of milling oats to contrasting seeding dates (May 4 versus May 28), a range of seed rates (200, 300, or 400 seeds/m^2) and two distinct N fertility levels (70 or 120 kg N/ha). The variety CDC Ruffian was direct seeded into canola stubble, while weeds and disease were managed using registered crop protection products, no harvest aids were used and the plots were straight-combined when mature and dry. Various data was collected with a focus on yield and grain quality characteristics.

Results
The oats got off to a strong start with good initial seeding conditions and adequate early-season precipitation; however, the dry weather for the latter half of the season was a yield limiting factor for both seeding dates in the end. There was essentially no lodging and wild oat pressure was negligible as shown in Table 12. Establishment and overall yields were similar for both seeding dates but early seeding resulted in higher test weights and a tendency for more plump/fewer thin kernels. Seeding rate effects were somewhat inconsistent, especially depending on seeding date as there were numerous seeding date by seed rate interactions. In general, late seeded oats benefitted more from higher seeding rates than early seeded oats. Unexpectedly, and presumably due to the dry and weed free conditions, early seeded oats performed better at the lower seeding rates. Nitrogen fertility generally had a positive effect on both yield and quality, regardless of seeding date or seed rate.

Table 12. Main effect means for seeding date, seed rate and N rate effects on oat emergence, lodging, wild oat ratings and grain yield.

Main Effect	Plant Density	Lodging	Wild Oat Ratings	Grain Yield
Seeding Date	---- plants/m^2 ----	------ 0-9 ------	-------- 0-9 --------	------- kg/ha -------
Early May	290 a	0.35 a	0.5 a	4789 a
Late May	305 a	0.00 b	0.4 a	4724 a
Seed Rate				
200 seeds/m^2	214 c	0.06 b	0.5 a	4671 b
300 seeds/m^2	299 b	0.25 a	0.3 a	4815 a
400 seeds/m^2	380 a	0.22 a	0.4 a	4783 ab
Nitrogen Rate				
70 kg N/ha	305 a	0.17 a	0.4 a	4637 b
120 kg N/ha	291 a	0.19 a	0.5 a	4875 a

Conclusions

All factors considered, the most consistent yields and quality were achieved with early seeding, moderate seeding rates (i.e. 300 seeds/m^2) and higher N fertility. Caution and soil testing is advised when determining appropriate N rates as previous work has shown that excessive N fertility can reduce oat quality.

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. Crop protection products were provided in-kind by Bayer CropScience and Syngenta.

Oat Vigour Improves with Larger Seed Size

Hall, M. (ECRF) and Holzapfel, C. (IHARF).

Description

The objective of this study was to demonstrate the benefit of screening out the small seed from an oat seed lot. Small seed tends to be less vigorous and the removal of small seed before planting can increase crop competition and yield. A seed lot of CS Camden was screened to remove the small seed constituting 8% of the original mass. This created three seed lots of large (42 mg/seed), small (26 mg/seed) and unscreened (41 mg/seed) seed sizes. These three different seed size lots were planted shallow at 100, 200 and 300 seeds/m^2 near Yorkton and Indian Head. In addition, each lot was also seeded deep at 200 seed/m^2.

Results

While the vigor of the seed lots all tested over 98%, the oats grown from small seed were found to be less vigorous than oats from large seed under these field conditions. Plants grown from the small seed lot had reduced emergence and less early-season above ground biomass (Figure 11) at both locations. Oats grown from the large seed yielded 8% higher than with the small seed lot at Yorkton but seed size did not significantly affect yields at Indian Head. In the field, large seed size oats did not statistically outperform the unscreened seed by any measure at either location. Increasing seeding rates from 100 to 300 seeds m^{-2} did not improve yield at either location in this study; however, the high seeding rate hastened maturity by four days and reduced wild oat pressure at Indian Head.

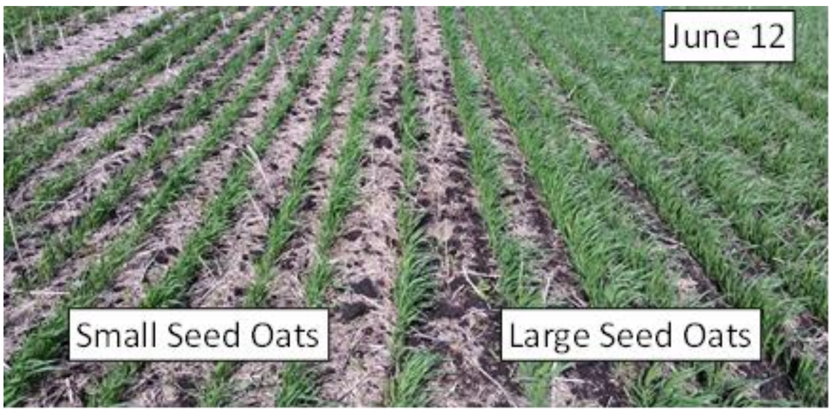

Figure 11. Small versus large seed oats seeded deep (3") at Yorkton on June 12th.

Conclusion

The small seed size oats were found to be less vigorous and oats grown from this seed produced lower yield at Yorkton. However, removing these seeds from the original seed lot did little to improve overall seed vigor or increase crop yield as they only constituted 8% of the original unscreened seed lot. The quality of the small seed in this seed lot was still good and tested 98% vigor. This may not always be the case and it still may be a good practice for producers to remove thin seed from seed lots they intend to plant. The high seeding rate of 300 seeds/m^2 should still be recommended as it hastened maturity and reduced wild oat pressure at Indian Head.

Acknowledgement

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

Input Contributions to Spring Wheat Yield Components, Quality, and Profits

Holzapfel, C. (IHARF).

Description

A field trial was established near Indian Head to demonstrate wheat response to low versus high input management. The inputs evaluated were seed-applied fungicides, seeding rates, fertility, PGR and foliar fungicide. In addition to the low versus high-input treatments, each input was added to the low-input system individually. A treatment list is shown in Table 13.

Table 13. Treatments evaluated in the wheat input demo at Indian Head, Saskatchewan (2018).

Treatment	Seed-Applied Fungicide	Seed Rate (seeds/m^2)	Fertility (kg/ha N-P_2O_5-K_2O-S)	Manipulator PGR (no/yes)	Foliar-Applied Fungicide
Low Input	No	250	90-20-10-10	No	No
Seed-Treatment	Yes	250	90-20-10-10	No	No
Seed Rate	No	400	90-20-10-10	No	No
Fertility	No	250	135-40-20-20	No	No
PGR	No	250	90-20-10-10	Yes	No
Fungicide	No	250	90-20-10-10	No	Yes
High Input	Yes	400	135-40-20-20	Yes	Yes

Results

Increasing seeding rate and, to a lesser extent, fertility, increased plant density. However, there were few differences in the final observed head densities and head size was not affected. The PGR substantially reduced wheat height as shown in Table 14. There was an 11% yield difference between the low versus high input wheat and the individual inputs to increase grain yield were fertility (5%), PGR (8%), and foliar fungicide applications (8%). Test weight and TKW were lower in the high input system than any other treatments but the differences were small and unlikely to impact marketability of the grain. Grain protein increased from 13.3% to 14.3% with higher fertility but fell to 12.9% when PGR or fungicides were applied in the low input system. Overall, fusarium pressure was low and FDK was not high enough to be a grading factor in any treatments. FDK tended to be lowest with foliar fungicide and highest when only seeding rate was increased in an otherwise low input system.

Table 14. Treatment means for wheat height, lodging, grain yield, and harvest index.

Treatment	Plant Height (cm)	Dry Matter Yield	Lodging Rating (0-9)	Harvest Index	Grain Yield (kg/ha)
Low Input	96.3 a	---- kg/ha ----	0.5 c	grain/total	3502 c
Seed Treatment	95.5 a	8182 c	0.5 c	0.408 b	3510 c
Seed Rate	96.7 a	8263 bc	1.1 a	0.403 b	3494 c
Higher Fertility	97.0 a	7834 c	0.8 b	0.421 ab	3680 b
PGR Application	81.9 b	9307 a	0.0 d	0.404 b	3789 ab
Foliar Fungicide	96.3 a	8253 bc	0.5 c	0.430 a	3768 ab
High Input	80.2 b	9149 ab	0.5 c	0.403 b	3896 a

Conclusion

Economically, the intensively managed wheat was the least profitable by a substantial margin and considerably less profitable than the low input treatment. The PGR application and, to a lesser extent, foliar fungicide, were the only inputs to increase profits but this does not take into account any quality considerations (i.e. protein, FDK). Producer experiences will vary dramatically under different environmental conditions but this clearly demonstrates that wheat growers must choose their inputs carefully for maximum profit. Soil testing, knowledge of past pest problems, and thorough and frequent crop scouting will provide the best opportunity to optimize yields and quality while managing costs and maximizing economic returns.

Acknowledgments

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 Bayer CropScience, Corteva Agriscience and Engage Agro.

Increasing Wheat Protein with a Post Emergent Application of UAN

Hall, M. (ECRF), Holzapfel, C. (IHARF), Pratchler, J. (NARF), Shaw, L. (SERF), Hnatowich, G. (ICDC), Weber, J. (WARC) and Nybo, B. (WCA).

Description

A study was conducted at seven locations across Saskatchewan to determine if wheat yield and/or protein could be increased by applying 30 lbs N/ac of UAN at pre-boot or post-anthesis. UAN was subsequently applied in addition to base rates of 70 or 100 lbs N/ac of side-banded urea. The in-crop N was either dribble banded pre-boot or post-anthesis or foliar sprayed post-anthesis.

Results

Leaf burning was most severe with the foliar spray application and dribble banding pre-boot resulted in the least amount of crop damage. Reduced yield may account for some of the observed increase in protein from late season UAN applications as foliar spray applications with higher levels of leaf burn also had somewhat higher protein; however, there was one site where, at the post-anthesis stage, foliar applied UAN did appear to be more effective for increasing protein than dribble banding. The effect of total N rate on wheat protein (%) averaged over method of applying supplemental N is shown in Figure 12. On average, the supplemental application of 30 lbs N/ac increased grain protein by 0.8% and 0.6% when applied to base rates of 70 and 100 lbs N/ac. This supports the hypothesis that supplemental N can increase grain protein when N deficiency is greater. While applying supplemental N increased protein it did not increase either yield or protein compared to side banding the additional 30 lbs N/ac at seeding and in some instances split applications resulted in less yield and/or protein. In this study, nitrogen use efficiency was better when all the nitrogen was side-banded at seeding. Nitrogen from split applications was less efficient as it was likely stranded at the soil surface due to dry conditions or lost to volatilization.

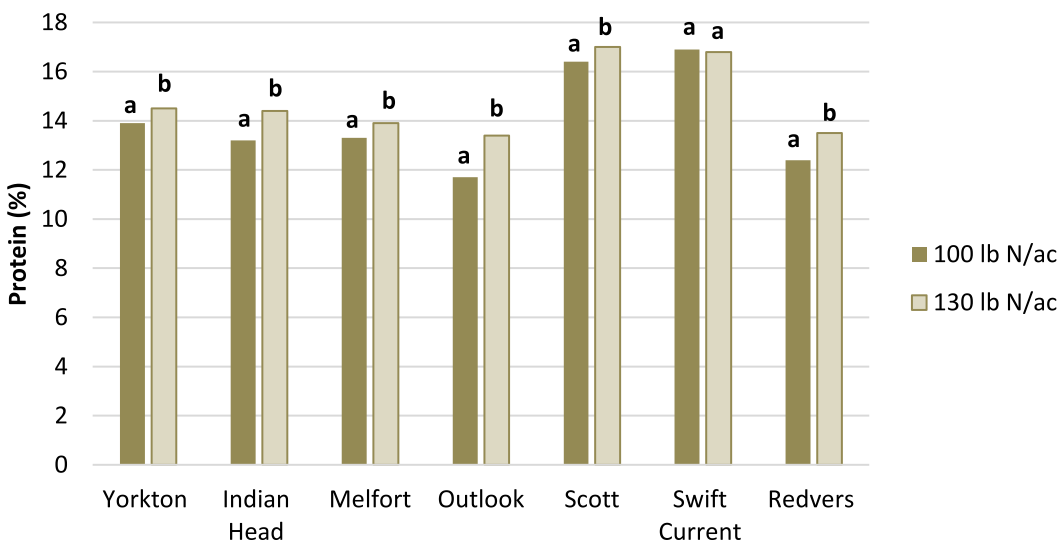

Figure 12. Effect of total N rate on wheat grain protein (%) averaged over method of applying supplemental N.

Conclusions

This study concludes that late season nitrogen can be used to increase protein, but doing so was never advantageous over simply side-banding the extra nitrogen at seeding under the conditions encountered. However, if a crop has been under fertilized for its potential, late season supplemental N can provide a protein boost of 0.8%. This will increase net returns, but only when protein spreads are at historical highs, therefore the need for N should be identified early enough that yield can also be increased. If increasing protein with a late season application of N is desired, every effort should be made to reduce leaf burn. As expected, pre-boot dribble banding UAN was safer on the crop than foliar sprays post anthesis. Spraying should not occur at temperatures above 20°C. Diluting 50:50 with water may reduce leaf burn with foliar applications but the effects of dilution with dribble-banding are uncertain. For example, dilution also doubles the total solution application volume required and reduces surface tension of the UAN which could result in greater potential for leaf burn in dribble-band applications. With foliar applications the objective is to get as much product as possible retained on the leaves while, dribble-band applications are specifically targeting the soil surface.

Acknowledgements

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

Demonstrating 4R Nitrogen Management Principles for Wheat

Holzapfel, C. (IHARF).

Description

A field trial was established near Indian Head to promote 4R nitrogen stewardship and to demonstrate the overall wheat response to N fertilization along with the relative performance of N fertilizer management strategies where the forms, timing of application and placement were varied. The rates of N were 0, 0.5, 1 and 1.5x of a baseline soil-test recommendation rate of 130 kg N/ha (residual NO3-N plus fertilizer N). The placement/timing options were side-banding at seeding, fall surface application and fall in-soil band while the forms included untreated urea, Agrotain (volatilization inhibitor), SuperUrea (volatilization plus denitrification inhibitors) and ESN (polymer coated urea). A treatment list is shown in Table 15.

Table 15. Wheat 4R N Management treatments evaluated at Indian Head in 2018.

#	Rate (soil + fertilizer)	Form	Time	Placement
1	0x (10 kg N/ha)	Urea	At Seeding	Side-band
2	0.5x (70 kg N/ha)	Urea	At Seeding	Side-band
3	1.0x (130 kg N/ha)	Urea	At Seeding	Side-band
4	1.5x (190 kg N/ha)	Urea	At Seeding	Side-band
5	1.0x (130 kg N/ha)	Agrotain	At Seeding	Side-band
6	1.0x (130 kg N/ha)	Super Urea	At Seeding	Side-band
7	1.0x (130 kg N/ha)	ESN	At Seeding	Side-band
8	1.0x (130 kg N/ha)	Urea	Late Fall	Surface Broadcast
9	1.0x (130 kg N/ha)	Agrotain	Late Fall	Surface Broadcast
10	1.0x (130 kg N/ha)	Super Urea	Late Fall	Surface Broadcast
11	1.0x (130 kg N/ha)	Urea	Late Fall	In-soil Band
12	1.0x (130 kg N/ha)	Agrotain	Late Fall	In-soil Band
13	1.0x (130 kg N/ha)	Super Urea	Late Fall	In-soil Band
14	1.0x (130 kg N/ha)	ESN	Late Fall	In-soil Band

Results

The maximum yield increase was 87% over the control with similar yields between the 1-1.5x rates while protein ranged from 10.1% in the control to 14.4% at the highest N rate. Focussing on N management strategies, the demonstration included four forms (untreated urea, Agrotain, SuperUrea, and ESN) and three timing/placement options (fall surface-broadcast, fall in-soil band, and side-band). Averaged across forms, yields did not significantly differ between timing/placement options. However, grain protein was highest with side-banding (14.3%), followed by fall in-soil banding (14.1%), and finally fall surface-broadcast applications (13.5%). All N forms performed similarly under the conditions encountered when averaged across timing/placement methods. Specifically for fall-surface broadcast N, grain protein concentrations with SuperUrea tended to be higher than for urea or Agrotain and did not differ from 75% of the individual treatments where N was in-soil banded as shown in Figure 14.

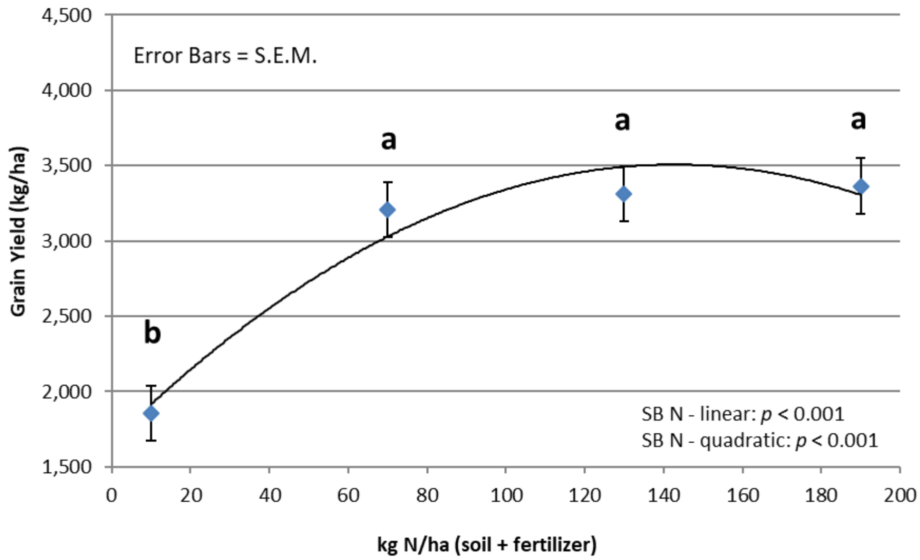

Figure 13. Side-banded urea rate effects on wheat grain yield at Indian Head 2018.

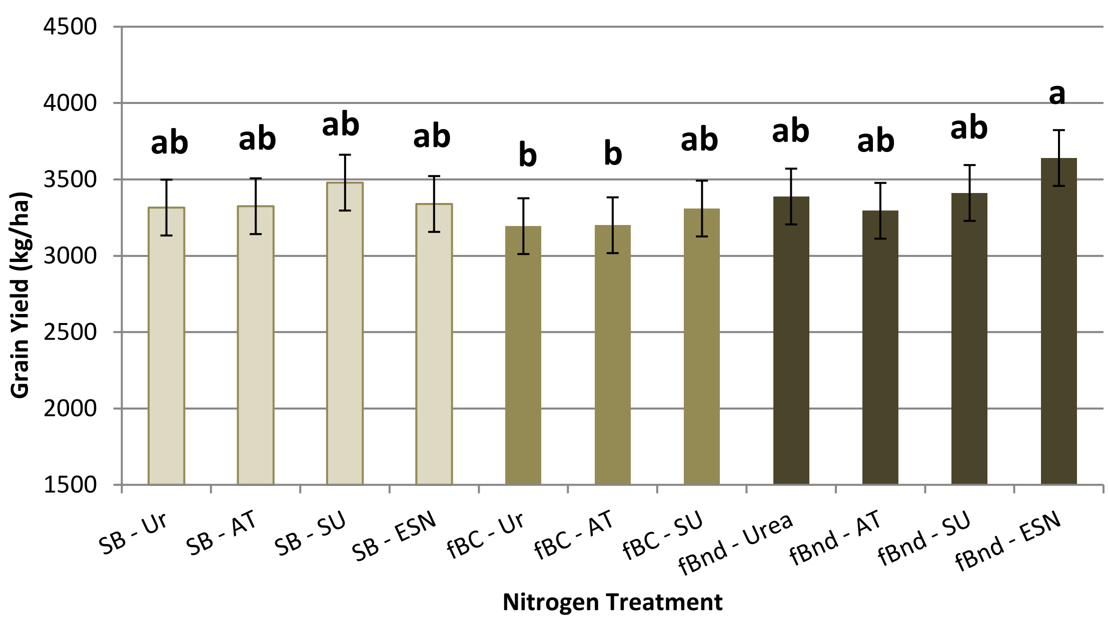

Figure 14. Nitrogen form/placement/timing effects on wheat grain yield at Indian Head (2018). SB – side-band, fBC – fall surface broadcast, fBnd – fall in-soil band, Ur - untreated urea, AT– Agrotain (NBPT) treated urea, SU – SuperUrea (NBPT + DCD), ESN – polymer coated urea.

Conclusions

Nitrogen fertilizer management is sensitive to weather and environmental conditions; therefore, the actual results that producers might experience with these strategies may vary greatly. Broadly speaking, soil testing is advised to account for the inherent fertility of the soil and better determine appropriate rates. Side-banding continues to be recommended as a safe and effective practice that will perform consistently across a broad range of environmental conditions. In the current demonstration, fall in-soil banding was also reasonably effective and, although the benefits can vary depending on the specific conditions encountered, enhanced efficiency fertilizer products can improve performance particularly with potentially risky practices such as fall-surface broadcasting.

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. Inputs and crop protection products used for both plot maintenance and treatments were provided in-kind by Bayer CropScience, Corteva Agriscience, Koch Agronomic Services, and Nutrien.

Demonstrating the Nitrogen Rate Response of Contrasting Winter Wheat Classes

Holzapfel, C. (IHARF).

Description
A field trial was established near Indian Head to demonstrate the response of contrasting winter wheat classes to a wide range of N fertilizer rates. The classes were CWRW (Moats), a milling type where high protein is desirable, and CWSP (Accipiter), a utility type that is usually grown as ethanol feedstock. The N rates were 7, 50, 100, 150, 200, and 250 kg N/ha with 7 kg/ha provided by MAP and the remainder as side-banded urea.

Results
Despite dry conditions at seeding, timely precipitation events allowed for excellent initial emergence with an estimated 93% of the planted seeds emerging in the fall. There was a slight but significant decline in fall plant populations with increasing N rates; however, even at 250 kg N/ha approximately 90% of the planted seeds emerged with mean populations of 358 seeds/m^2. Despite the initially high populations, dry conditions, lack of snow cover and cold temperatures resulted in substantial winter-kill and spring plant populations were only 52% of those recorded in the fall, averaging 195 plants/m^2. Over-winter mortality was similar regardless of variety or N rate and, combined with the dry spring, was a major yield limiting factor. Despite challenging conditions, there was still a strong yield response to N with the fertilized plots yielding 34% higher than the control. For both classes, yields peaked at 100 kg N/ha and levelled off or declined slightly with further increases in N rate as shown in Figure 15. The was a slight difference between the two classes but test weight was not affected by N rate. Protein was affected by N rate but not between varieties and there was no interaction between the two factors. Averaged across varieties, grain protein concentrations ranged from 9.2% in the control where no urea was applied to 12.0-12.4% for the N rates ranging from 100-250 kg N/ha.

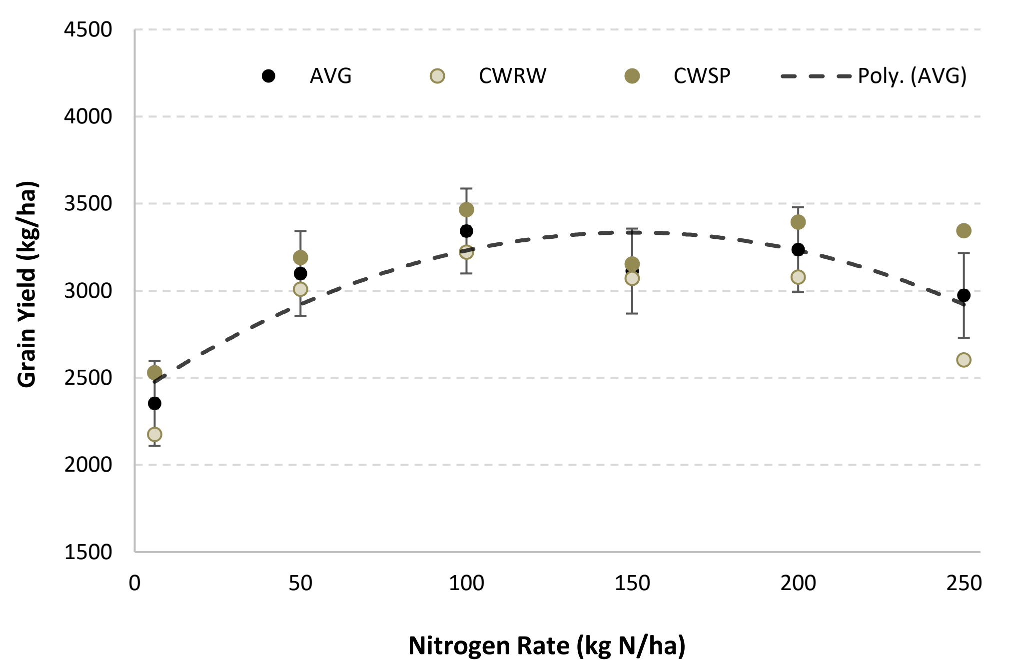

Figure 15. Side-banded N rate effects on winter wheat grain yield at Indian Head (2017-18). The mean yields of the two classes differed slightly in favour of the CWSP variety (P = 0.002).

Conclusions

With the compromised stand and dry weather, conditions were not ideal for assessing the potential winter wheat yield and protein response to a wide range of N fertilizer rates. However, the conditions encountered did provide a unique opportunity to discuss assessing winter cereal establishment in the spring and investigate potential differences in winter-kill across classes and N fertility levels. Although winter kill was relatively severe, it did not appear to be affected by side-banded N rate and was similar for both varieties; however, it would still generally not be recommended to apply the extremely high rates evaluated in the current project during seeding with winter cereals. Overall, producers are advised to consider soil test information, soil/environmental conditions, past yield potential and protein requirements when deciding upon appropriate winter wheat N rates. Depending on the rates, environmental conditions, and field characteristics (i.e. drainage), it may be preferable to defer a portion of the N requirements until early spring in order to reduce potential N losses prior to peak crop uptake. The economic optimum rate is typically lower than that required to maximize yield; however, profits are generally reasonably well buffered between these two rates.

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 Dow Agrosciences and Bayer CropScience.

Pre-harvest Herbicide and Desiccation Options for Straight-combining Canola: Effects on Plant and Seed Dry-down, Yield and Seed quality

Holzapfel, C. (IHARF), Pratchler, J. (NARF), Weber, J. (WARC) and Chalmers, S. (WADO).

Description

Field trials were completed at Indian Head, Melfort, Scott and Melita in the 2017 and 2018 growing season. The varieties 233P (Liberty Link® - LL - glufosinate ammonium tolerant) and 45M35 (Roundup Ready® - RR - glyphosate tolerant) were used in 2017 while in 2018, 233P was replaced with 255PC under the expectation that this would result in more similar maturity between the two hybrids. The canola was seeded into cereal stubble in mid-May at a rate of 120 seeds/m2. Pre-harvest herbicide treatments were targeted for 60-75% seed colour change (glyphosate and saflufenacil) or 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

Yield

After the second year of study, it was found that with low weed populations, dry late season weather, and early maturity (i.e. LL canola at Indian Head and Melita 2017, Melita 2018) there was little benefit to pre-harvest applications. While seed yields varied with environment across location-years and, occasionally, between hybrids, there were no cases where any of the pre-harvest treatments significantly impacted yield.

Diquat

Diquat performed consistently well for both herbicide systems with respect to reducing seed and whole plant moisture content. With some exceptions (i.e. Scott 2017), diquat resulted in equal to or greater reductions in whole plant moisture content compared to other options, regardless of herbicide system as shown in Figure 16 and Figure 17. Averaged across hybrids, diquat reduced seed moisture content at harvest 75% of the time (6/8 site-years) and whole plant moisture 63% of the time (5/8 location-years). Waiting for the appropriate application stage of diquat is extremely important as illustrated at multiple locations where percent green seed was significantly higher with diquat compared to the other options, most notably for the RR hybrid at Indian Head 2017.

Glyphosate, Saflufenacil, Glufosinate-ammonium

While glyphosate is not registered for this specific purpose, pre-harvest glyphosate reduced seed moisture content in LL canola 50% of the time (4/8 location-years) and reduced whole plant moisture content 75% of time (6/8 location-years). Reductions in seed and crop moisture with saflufenacil have been somewhat less consistent and/or smaller than with diquat and, in certain cases with LL canola (i.e. seed moisture at Indian Head 2018, seed and whole plant moisture at Scott both years), it appeared that the glyphosate was having a greater impact on crop dry down than the saflufenacil in the tank mix. Overall, saflufenacil appeared to reduce seed moisture content 25% of the time (2/8 location-years) and whole plant moisture 38% of the time (3/8 location-years). The performance of glufosinate-ammonium was somewhat inconsistent with reductions in seed moisture 38% of the time (3/8 location-years) and whole plant moisture content 25% of the time (50% of the time at $P \leq 0.10$).

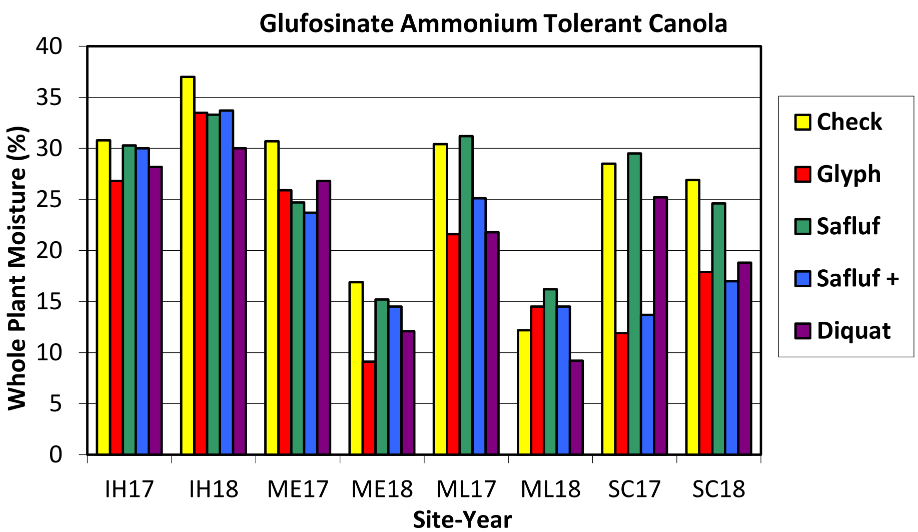

Figure 16. Pre-harvest treatment effects on whole plant moisture content for glufosinate ammonium resistant canola at four locations over two years. Individual pre-harvest treatment differences were significant at IH18, ME17, SC17, and SC18.

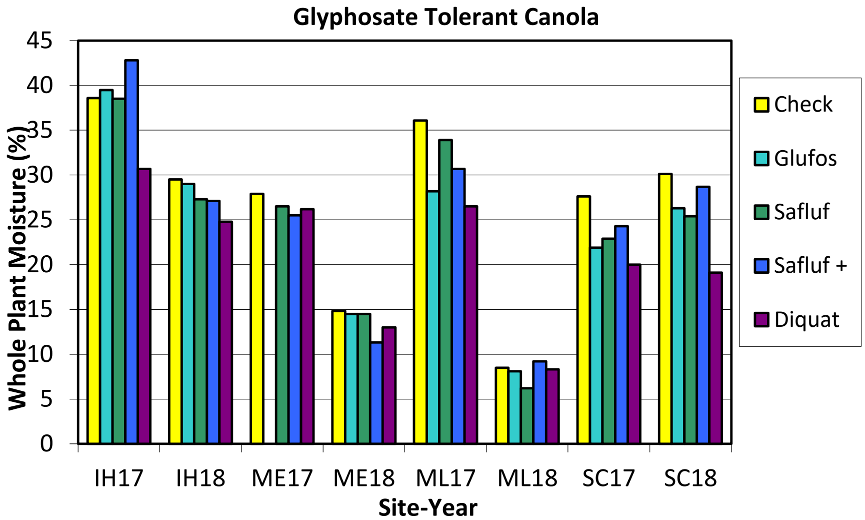

Figure 17. Pre-harvest treatment effects on whole plant moisture content for glyphosate resistant canola at 8 locations. Individual pre-harvest treatment differences were significant ($P < 0.001$) at IH17, IH18, ME17, ML17, SC17, and SC18.

Conclusions

Diquat performed well with respect to reducing seed and whole plant moisture content. Glyphosate frequently resulted in observations of final reductions in seed and plant moisture. However, glyphosate is initially slow and less likely to improve harvestability in dry falls or when applied at later crop stages. However, our results show that such benefits can frequently occur with LL canola provided that the herbicide is given sufficient time to work. While it appears that diquat is more effective than saflufenacil from a strictly crop dry down perspective, a scenario where saflufenacil plus glyphosate tank mixes may be particularly beneficial in the presence of substantial perennial weed populations for which the producer requires both long-term control and reasonably fast desiccation. Glufosinate-ammonium is not a registered pre-harvest option for canola and, to our knowledge, there is no indication that it will become one; however, it was registered for this purpose in the 1990s. It is probable that the relatively poor performance observed for Glufosinate-ammonium is due in part to the late application stage that was implemented for this project.

After the second year of study, it was found that with low weed populations, dry late season weather, and early maturity, there was little benefit to pre-harvest applications. The risks associated with later harvest are arguably much lower with modern shatter tolerant canola hybrids than previous straight-combining research that mostly preceded this trait have suggested. With this in mind, growers planning to straight-combine shatter tolerant canola hybrids who have seeded early, achieved uniform stands, kept things reasonably free of weeds, and have no reason to expect unusual harvest delays, they should consider not spraying as a viable and preferable option. These are preliminary findings as this project is going into the third year of study in 2019.

Acknowledgements
This project was supported by the Canola Agronomic Research Program (CARP), with in-kind support provided by Bayer CropScience and Pioneer Hi-Bred.

Management Practices to Optimize Establishment and Early Growth of Soybean

Mohr, R. (AAFC). Glenn, A. (AAFC). Linde,C. (Manitoba Ag), Holzapfel, C. (IHARF) and Tomasiewicz, D. (AFFC).

Description
A small-plot trial was initiated to better understand the effect of management practices on temperature and moisture conditions and, in turn, the effect on soybean establishment, growth, yield and quality. This was a four-year study initiated in 2017 near Brandon, Carberry, and Indian Head to assess the effect of residue management practices on the following soybean crop. Treatments consisted of a factorial combination of six residue management treatments [fall-tilled; fall-burned; short stubble (+straw); tall stubble (+straw); short stubble (-straw); tall stubble (-straw)], and two soybean planting dates. Residue treatments were imposed on wheat (Brandon, Carberry) or canaryseed (Indian Head) stubble in fall 2017, and these plots were planted to soybean in 2018. Immediately after residue treatments were imposed, self-logging temperature sensors were installed at a 5 cm depth in each plot to monitor soil temperature until spring.

Results
In 2018, soybean (R2, 00.3, 2375 CHU) was planted into residue treatments in early or late May (May 8-10 or 24-26). Yields varied considerably among sites as a function of growing season conditions (Figure 18). Soil temperature at soybean planting was higher for later seeding dates at all sites, and varied with residue management. Soil temperatures were higher for burned than all other treatments at Indian Head; for burned, tilled and short stubble (-straw) treatments than for short or tall stubble (+straw) at Carberry; and for burned and short and tall stubble (-straw) than for short stubble (+straw) at Brandon (Figure 18). Soil moisture at planting was higher for tall stubble (+straw) than burned treatments at Carberry, and for tall stubble (+/- straw) than tilled treatments at Indian Head (Figure 18). Treatments had no effect on final plant density which ranged from an average of 35 to 41 plants/m^2 across sites. Despite soil temperature and moisture differences observed at planting, neither seeding date nor residue treatments affected soybean yield except at Indian Head where the tall stubble treatments that had been associated with higher moisture at seeding resulted in higher yields than the burned and short stubble (-straw) treatments (Figure 18). Treatments had limited effects on test weight, seed weight, and % protein. Early planting increased % oil at 2 of 3 sites, while residue management effects appeared to vary among sites in 2018.

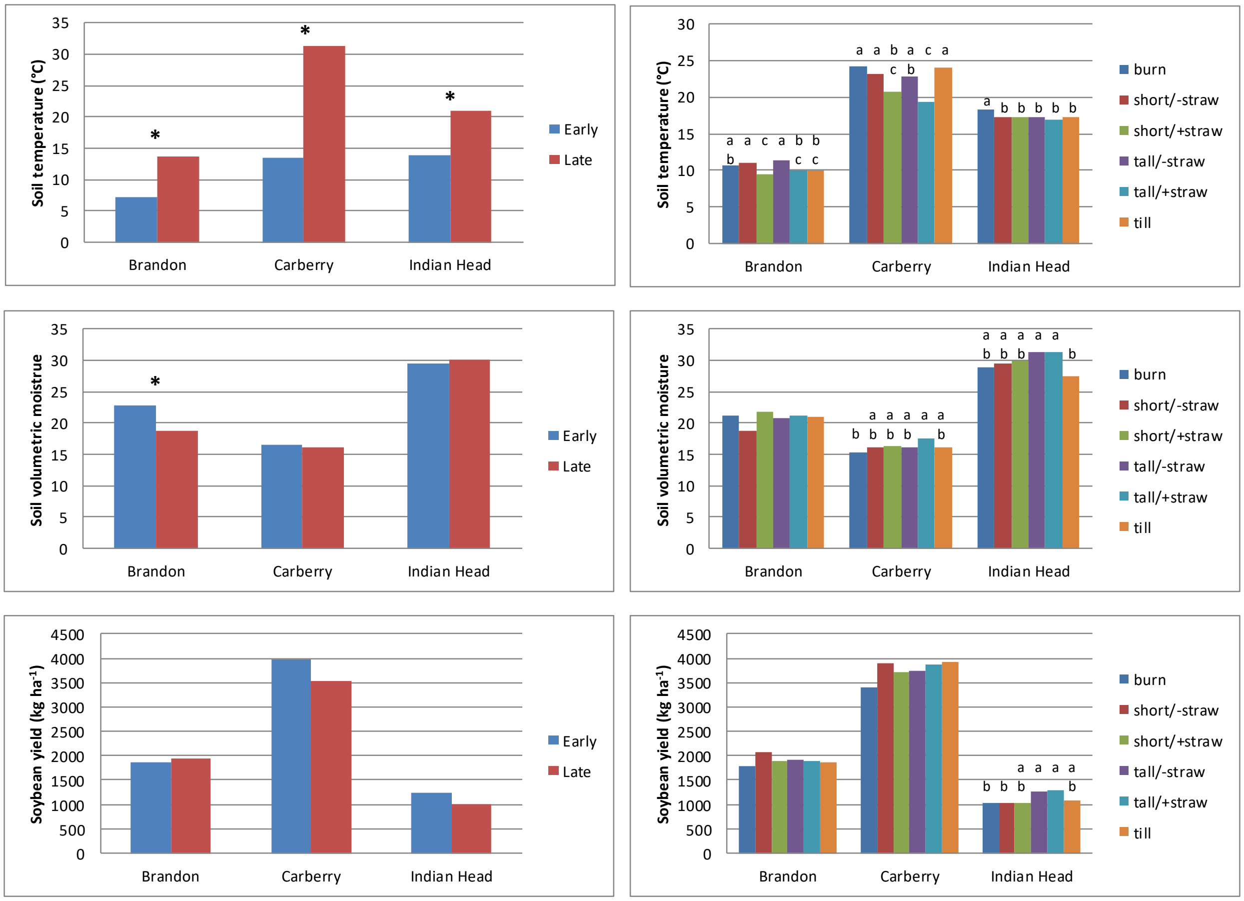

Figure 18. Effect of planting date (early vs late May) and preceding residue management (fall burn, short stubble with and without straw, tall stubble with and without straw, fall tillage) on soil temperature and moisture at soybean planting, and on soybean yield, at Brandon, Carberry, and Indian Head in 2018. Reported values for planting date are averaged across residue management practices, and for residue management practices are averaged across planting dates (*indicates that planting dates are significantly different within a given site. Residue management practices within a site that are denoted by the same letter are not significantly different from one another).

Conclusions

Based on preliminary results from the first year of field studies, planting date and previous residue management often influenced soil temperature and moisture at soybean planting. However, residue management influenced soybean yield at only 1 of 3 sites, while planting date (early vs late May) had no effect on yield in 2018. Seeding date and residue management had limited effects on soybean seed quality in 2018. These are preliminary results only from the first year of ongoing field experiments.

Acknowledgements

This research was supported by the Manitoba Pulse and Soybean Growers, Agriculture and Agri-Food Canada, the Canada Manitoba Crop Diversification Centre, and the Indian Head Agricultural Research Foundation.

Enhancing Canola Production with Improved Phosphorus Fertilizer Management

Brandt, S. (NARF), Pratchler, J. (NARF), Weber, J. (WARC) Holzapfel, C. (IHARF) and Catellier, C. (IHARF).

Description

Current canola hybrids can readily yield more than 3500 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 2016-2018 in Melfort, Indian Head and Scott. The treatments are shown in Table 17.

Table 17. Fertilizer P rate and placement methods used to evaluate improved phosphorus management for canola production.

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 and Biomass

In general, plant populations declined significantly as P rates increased with both seed-placed and SP + 15S treatments, but not with the side-band placement. The level of damage from the seed-placed treatments varied across location and years, from rather extensive damage in Scott 2016 to limited or no damage at other locations. Damage from these two placement methods were noted at 2, 4, and 6 weeks after seeding, as well as post-harvest. There was some indication that damage was less severe with later evaluation timings, particularly where the SP + 15AS treatments were in combination with high rates of fertilizer P. It was also apparent that the damaging effects of seed placed P and S were additive when significant at Indian Head and Melfort. At Scott, the effect was still damaging but to a lesser extent. This may have been due to the location being responsive to sulphur, which somewhat offset the damaging effect of increasing P rate. Biomass production increased with phosphorus fertilizer application and was greatest when side-band applied. There also was an indication that biomass production may decline when high rates of phosphorus are seed-placed alone or with sulphur, likely due to reductions in plant population. Overall, there was also a trend for biomass to reflect the final in-crop plant population assessment. As expected, tissue P levels increased with all fertilizer P application rates. This indicates that the P levels used in this trial were not excessive or toxic to plant growth.

Maturity and Yield

In general, treatment effects on maturity were variable between treatments and no trends clearly emerged. In most cases, treatment effects were less than one day. Overall, any effects on maturity are of little practical significance as effects are associated with decreases in plant density rather than nutrition. Yield was affected by phosphorus rate and in some cases, the interaction between rate and placement. On average, side-banded P resulted in yield increases of up to 263 kg/ha as shown in Figure 19. Canola yields generally increased with increasing P rate and optimal yields were reached between 70 and 80 kg/ha of fertilizer P. Quality parameters (TKW and Green Seed) were largely affected by fertilizer P rate alone, and very seldom placement. Higher rates tended to increase % green seed and mean seed weight, particularly when seed-placed. This further suggests that maturity delays are associated with reduced plant populations. Albeit the response in TKW and green seed were of little agronomic significance.

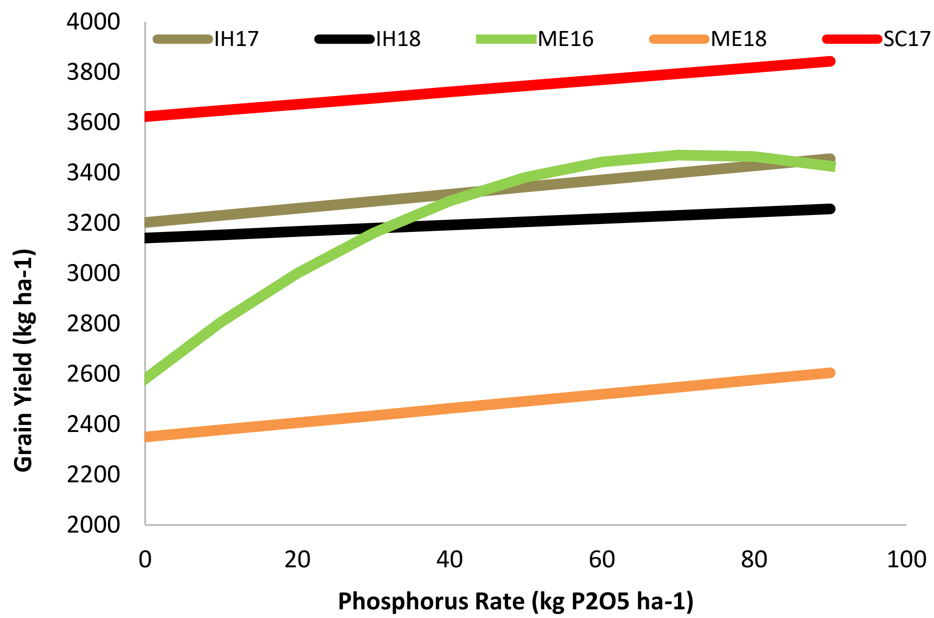

Figure 19. Phosphorus Rate (kg P2O5 ha-1) Effect on Canola Grain Yield (kg ha-1) at Indian Head two years, Melfort two years, and Scott one year.

Conclusions

Results suggest that damage from seed-placed phosphorus may not be as severe as suggested by the initial studies used to determine safe rates. This may reflect the greater seedbed utilization of hoe type openers compared to the disc type openers used in earlier trials. Slinkard and Henry (1977) found plant density reductions of 40 to 50% when the safe rate of seed-placed P was exceeded, and upwards of 70 to 80% when fertilizer P was increased to 60 kg/ha. The results of our study suggest that when significant, there is only a maximum of 40% decline in plant populations when fertilizer P was increased to 80 kg/ha. Our results are similar to those of Grant (2012), Karamanos et al. (2014), and Mohr et al. (2013), who found reductions of 10 to 30% with rates of 60 kg/ha of fertilizer P. Our results also suggest that side-banded fertilizer P can be as or more efficient than seed-placed P even at lower rates, for canola establishment.

Overall, the optimal phosphorus management practices have changed for growing canola in Saskatchewan. All or most of the phosphorus fertilizer applied should be side-banded, especially when higher rates are needed. No rate of seed-placed P was found to be safe, as damaged occurred at very low rates, although damage may be deemed acceptable at low rates. Also, at low rates, there was no evidence that seed-placed P provided better responses, as they were always equal to or less than side-banded P. Furthermore, the degree of damage from seed-placed P fertilizer is very difficult to predict due to soil characteristics and spring moisture, and thus the degree of damage is likely to change across the landscape. The sites-years were there were very low to moderate levels of soil available P, all showed a yield benefit from side-banded P. This effect was also seen at fertilizer P rates above soil test recommendations. At site-years that were high in soil available P, there was no negative consequences to added fertilizer P, suggesting that this practice can be used as a method to build or maintain soil P reserves. The effects of applying sulphur in the seed-row is detrimental to crop establishment and can have a negative additive effect to seed-placed P. Therefore, the practice of P and S in the seed-row should be discouraged. Consequently, if logistics allow, P and S fertilizer should all be side-banded to maintain plant populations and yield potential. The results of this research also suggest that the current phosphorus fertilizer recommendations should be reconsidered for the high yielding cultivars currently used.

Acknowledgements
This project was funded by the Saskatchewan Canola Development Commission.

Optimal Seeding Rate Based on Seed Size in Canola

Catellier, C. (IHARF), Pratchler, J. (NARF), Weber, J. (WARC) Hall, M. (ECRF) and Hnatowich, G. (ICDC).

Description

The objectives of this trial were to: 1) determine optimal seeding rate to achieve adequate plant populations and optimize yield under various environmental conditions in Saskatchewan; and 2) determine if optimal seeding rate varies with seed size and/or hybrid. A small-plot field trial was conducted at five locations (Indian Head, Yorkton, Melfort, Scott, and Outlook) in 2018. The treatments were a full factorial combination of two canola hybrids (InVigor L233P and Pioneer 45M35), two seed sizes of each hybrid ("Small" and "Large"), and three different seeding densities (5, 10, and 15 seeds ft^{-2}) as shown in Table 18.

Table 18. List of treatments evaluated in 2018 field trial.

Hybrid	Entry	Seed size (g 1000 $seeds^{-1}$)	Seeding rate (density) (seeds ft^{-2} / seeds m^{-2})	Seeding rate (lb ac^{-1} / kg ha^{-1})
L233P	1	Small (4.3 g)	5 (54)	2.1 (2.3)
	2	Small (4.3 g)	10 (108)	4.1 (4.6)
	3	Small (4.3 g)	15 (161)	6.2 (6.9)
	4	Large (5.5 g)	5 (54)	2.6 (3.0)
	5	Large (5.5 g)	10 (108)	5.3 (5.9)
	6	Large (5.5 g)	15 (161)	7.9 (8.9)
45M35	7	Small (4.8 g)	5 (54)	2.3 (2.6)
	8	Small (4.8 g)	10 (108)	4.6 (5.2)
	9	Small (4.8 g)	15 (161)	6.9 (7.7)
	10	Large (5.9 g)	5 (54)	2.8 (3.2)
	11	Large (5.9 g)	10 (108)	5.7 (6.3)
	12	Large (5.9 g)	15 (161)	8.5 (9.5)

Results

There was an effect of seeding rate on all crop response variables that were measured, and the response varied with seed size and/or hybrid. Emergence rates were very high at all locations in 2018, and in-season mortality was minimal. Thus, seeding rates required to achieve adequate plant populations and optimize yield were likely lower than would be expected. Seeding at the lowest seeding rate resulted in adequate plant population (>4 plants ft^{-2}) for the two larger-seeded lots, but lower emergence and survival rates for smaller seed lots resulted in marginally adequate final plant populations for small-seeded L233P and less than adequate plant population for small-seeded 45M35 at the lowest seeding rate as shown in Figure 20. The moderate seeding rate of 10 plants ft^{-2} achieved more than adequate plant populations for all combinations of hybrid and seed size. Maturity was delayed with lower seeding rates. The yield response was quite different between hybrids as shown in Table 18. Yield of hybrid L233P did not respond to seeding rate or resulting plant population, and was not affected by seed size, whereas yield of 45M35 yield was significantly lower with a smaller seed lot, and the yield was optimized at the moderate seeding rate. If emergence and survival rates had been lower, we might have expected a greater yield penalty resulting from less than adequate plant population at the lowest seeding rate.

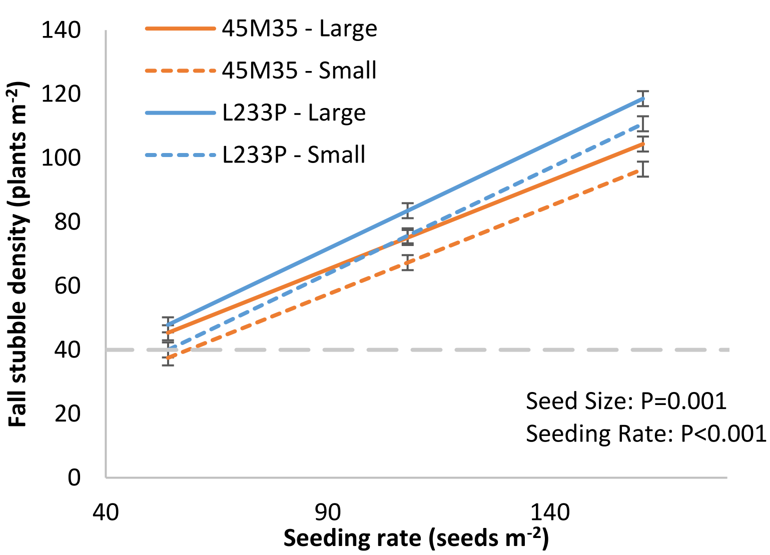

Figure 20. The effect of hybrid, seed size, and seeding rate on fall stubble density in canola, averaged over multiple environments in 2018. The error bars indicate the standard error within treatments. The grey dashed line indicates the minimum plant density required to achieve maximum yield potential in canola.

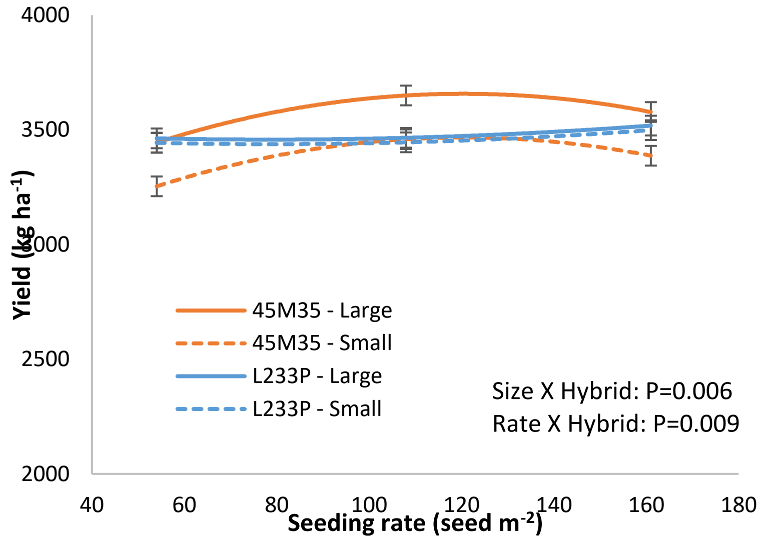

Figure 21. The effect of hybrid, seed size, and seeding rate on canola seed yield, averaged over multiple environments in 2018. The error bars indicate the standard error within treatments.

Conclusions

It was concluded that the seeding rate that is the most economical with the least amount of risk to achieve adequate plant population would be close to the moderate 10 seeds ft^{-2}. However, the minimum or adequate plant population required to optimize yield differs among hybrids, and the effect of seed size may or may not be important depending on the hybrid.

Acknowledgements

We would like to thank BASF and Pioneer for sourcing and supplying the canola seed and supporting the concept. We thank the Saskatchewan Canola Development Commission for funding support.

An On-Farm Approach to Monitor and Evaluate the Interaction of Management and Environment on Canola Stand Establishment and Disease Development

Catellier, C. (IHARF).

Description

The objective of this project is to conduct an observational, multivariate study utilizing data collected directly from producers' fields, to examine how management decisions and environmental conditions interact with each other to affect 1) canola emergence and seedling development, and 2) disease (sclerotinia and blackleg) development in canola. This study was initiated in the spring of 2018 and will be conducted in the Indian Head area for three growing seasons. There are no treatments or experimental manipulation; producers manage their fields as usual. For the 2018 season, the study included 71 sample sites, within 21 different fields, managed by 5 different producers in the Indian Head area. As each producer has multiple fields of canola that they seeded successively in the spring, this provided a range of environmental conditions at time of seeding, during seedling establishment, and throughout the growth stages of the crop.

Conclusions

Results from year one of this study are preliminary. This study will be repeated in the 2019 and 2020 growing season after which data from all three years will be compiled and analyzed.

Acknowledgments

We would like to acknowledge the Saskatchewan Canola Development Commission for funding this project and the local producers who have agreed to collaborate on this study and have been very accommodating and cooperative.

An On-Farm Approach to Evaluate the Interaction of Management and Environment On FHB Development in Wheat

Catellier, C. (IHARF), Weber, J. (WARC), Pratchler, J. (NARF).

Description

The objective of this project is to conduct an observational, multivariate study utilizing data collected directly from producers' fields, to examine how management decisions and environmental conditions interact with each other to affect Fusarium Head Blight (FHB) development in all classes of wheat. There are no treatments or experimental manipulation; producers manage their fields as usual. The study will be conducted in three regions, near Indian Head, Melfort, and Scott, for three growing seasons, and was initiated in the spring of 2018. For the 2018 season, the study included 106 sample sites, within 32 different fields, managed by 10 different producers in the three regions.

Conclusions

Results from year one of this study are preliminary. This study will be repeated in the 2019 and 2020 growing season after which data from all three years will be compiled and analyzed.

Acknowledgements

We would like to acknowledge the Saskatchewan Wheat Development Commission for funding this project and the local producers who have agreed to collaborate on this study and have been very accommodating and cooperative.

New Insights Into Natural Aeration Grain Drying

Palmer, R. (IHARF).

Description

This research project started over a decade ago in 2007 and was concluded in 2018. The overall objective of this project originally was to find a control strategy that would efficiently dry grain. During the course of this research, the objective of just getting the grain dry was questioned. It was learned that spoilage was a function of grain temperature and moisture content. The revised objective, for the best grain storage, with the least spoilage must include the grain temperature: keep the grain as cold as possible. The following is a summary of the results found throughout the duration of this project.

Results

Diurnal Cycle

A daily pattern of drying was discovered called the diurnal drying cycle and it clearly showed that the most drying occurred at night and the least during the day as shown in Figure 22. The diurnal drying cycle averaged across 19 trials. The best drying occurs a couple of hours after midnight and the least drying occurs in the afternoon circa 2:00 PM. Typically there is significant wetting of the grain in the afternoon. The cold dry night air is warmed by the grain as it flows through the bin absorbing moisture from the grain.

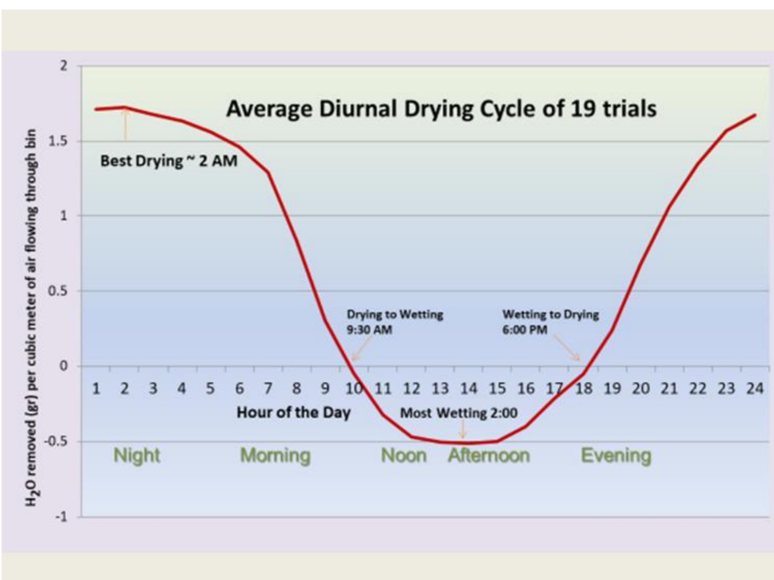

Figure 22. The diurnal drying cycle averaged across 19 trials.

Differential Temperature Control

The hourly drying graphs (Figure 23) demonstrated a strong correlation between drying and cooling of the grain. It was observed that: "Cooling is Drying" or "Drying results in Cooling". This became the basis for a fan control strategy. If cooling the grain resulted in drying, then it would be logical to only run the fan when cooling occurs. To cool the grain, one requires air that is colder than the grain. Consequently, the following control strategy was established: only run the fan if the outside air temperature is less than the grain temperature. This is called Differential Temperature Control and it is the best control for keeping the grain cold. This controller was built and tested, with the duty cycle of the run-time of the fan approximately 50% but, quickly dropping to 20% or less as the grain cooled.

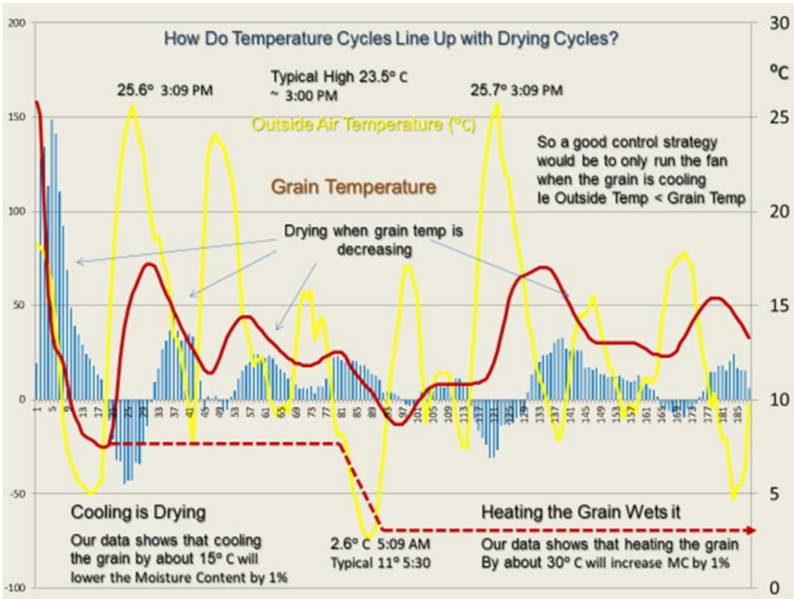

Figure 23. How do Temperature Cycles Line up With Drying Cycles? Demonstrating the relationship of grain cooling and grain drying: cooling is drying.

Absolute Humidity

When the grain is cold, it possesses little heat energy to expel and evaporate more of its moisture. Even if grain is loaded into the bin at a high temperature, one should expect only modest drying with moisture content reduction of a couple of percentage points. The grain will need to be re-energized to expel more moisture. Night drying only worked while the grain had some heat in it; once cold, there was no more drying. Being cold, the grain was safe from spoilage, even though it might be tough. If the objective was to dry the grain, therefore the fan should run whenever a drying condition exists. Drying conditions exist when the absolute humidity of the air leaving the bin is greater than the absolute humidity of the air entering the bin through the fan. By measuring the absolute humidity of the air entering and leaving the bin, it would be possible to determine drying conditions and when to turn the fan on. This is called Absolute Humidity Control and it is the best control strategy for optimum drying: only run the fan if the absolute humidity of the air leaving the bin is greater than the absolute humidity of the air entering the bin. This controller was built and tested. This method of measuring drying was instrumental in the subsequent research to measure and observe drying in real time. The duty cycle of the run-time of the fan was initially about 50% but it quickly dropped to 20% or less as the grain cooled and dried.

Relative Humidity Calculator and Condensation

To determine drying conditions by hand with a calculator is complicated and tedious. A calculator was designed and installed on www.planetcalc.com to do the difficult calculations. One simply inputs the grain temperature, its moisture content, and the temperature of the outside air. The calculator returns the threshold Relative Humidity, RHthres. If the outside relative humidity is below this threshold, one has drying conditions. The calculator has another purpose: it can be used to determine if condensation would form under the roof of the bin, the cause of which is explained in Figure 24. Conditions for condensation exist if the calculated threshold relative humidity is greater than 100%. It would not be advisable to run the fan under these conditions as condensed moisture would literally be raining down onto the grain.

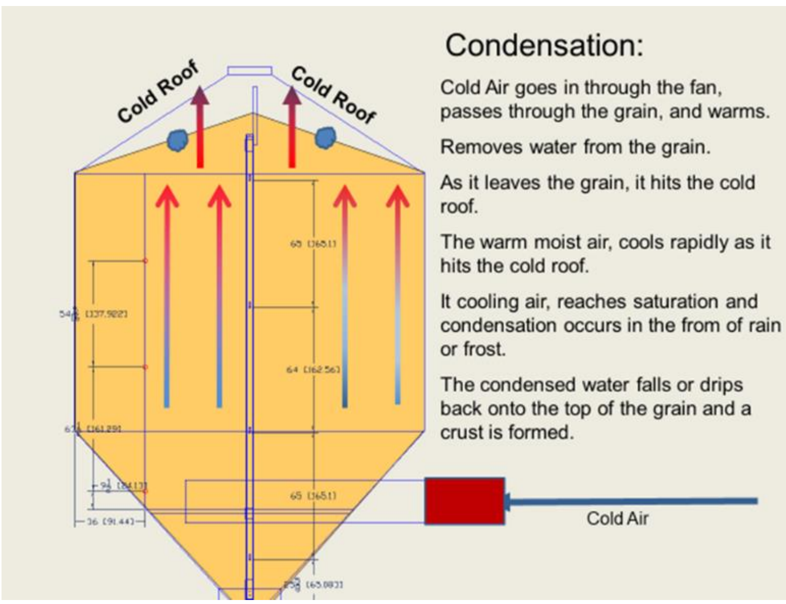

Figure 24. Condensation forming on the roof explained.

Bottom Dries First

It has been noticed by many that the bottom of the bin dries first and often over-dries by the time the top dries. The air at the bottom of the bin is slightly warmer from compression. The compression was enough to result in warming the air by a few degrees. The warmer air has more capacity to hold water, and thus dries the bottom more. If one uses a bigger fan, one will get more compression, more of a temperature difference from top to bottom and more over drying the bottom. Using a bigger fan with more compression can be counter productive in over-drying the bottom. The best flow was found to be about 0.4 CFM/bu to cool and dry the grain and to mitigate the top/bottom drying discrepancy.

Conclusions

Through this project, two control strategies have been developed, one for best storage and one for best drying. And a better understanding of what is happening in the bin has been found and made available to farmers. There has been one common parameter throughout all aspects of this research, and that is grain temperature. Grain temperature is the dominant parameter in determining absolute humidity as well as securing the grain from spoilage. On the one hand, hot grain is good because heat energy is required to push moisture out of the grain, but on the other hand, it is hot grain that spoils. We want to get that heat energy into the grain for drying, but once hot, we want to cool it immediately to mitigate the spoilage. It is a paradigm shift: we always thought that dry grain was paramount, and perhaps this would be the case if there was no control over temperature. With NAD aeration, the temperature of the grain can be controlled, the grain can be cooled in a matter of hours and thus cool grain becomes more of an important ideal than dry grain. This research project has resulted in the design and testing of controllers and many bonus findings, such as the cause of condensation on the roof, the calculator, and the reason the bottom dries first.

Acknowledgements

This research would not have been possible without the generous support from Western Grains Research Foundation (WGRF) and the in-kind support from Advancing Canada's Agriculture and Agri-Food Saskatchewan (ACAAFS). Instrumentation of the bins was first provided by Great West Controls of Saskatoon, and later by IntraGrain of Regina. PAMI did the tests for air flow, absolute humidity controller, and warming trends of canola, winter to spring. Many farmers participated with feedback and results from experiments they conducted on their own. Credit must be given posthumously to the person with the insight and curiosity that initiated this project in 2007, Guy Lafond.

Root Growth Promoter Field Scale Trials

Description

A total of 12 field scale trials were conducted from 2016-2018 with wheat (3), canola (2) soybeans (3), field peas (1), oats (1), barley (1) and canaryseed (1) as test crops. Crops were managed using normal recommended management practices with the intent of keeping all factors within our control (i.e. plant populations, fertility, weeds, disease, insects, etc.) non-limiting. For all trials, the treatments were simply an 'untreated check' versus 63 ml/ac Radiate plant growth promotor (3-indolebutric acid (IBA) and kinetin; Loveland Products) tank-mixed with the in-crop herbicide(s) for each crop. Each treatment was replicated four times with the exception of the 2017 oats and canary seed trials, where only three replicates were retained. Treatments were applied using an 80' field sprayer and two 30' combine passes were harvested out of the centre of each plot. Yields were determined by either manually weighing the contents of each plot or using the combines yield monitor.

Results

Treatment means and p-values are presented in Table 19, Table 20, Table 21 and Table 22. Statistically significant impacts on yield were detected in 8% of the trials (1/12) at the 5% probability level and 17% of the trials (2/12) at the 10% probability level. In both of these cases the yield response was positive but small, ranging from 2.5-3%. For the crop types where the trial was repeated over multiple years the overall average yield increase was 0.6 bu/ac (1%) for wheat (3 years), -1.1 bu/ac (-2%) for canola (2 years) and 0.1 bu/ac (0.4%) for soybeans (3 years). Regardless of crop type, there was no evidence of an impact on yield for 83% of the individual trials completed (10/12). Furthermore, when averaged across all years and crop types, yields for the two treatments were similar at 60.1 bu/ac for the control and 59.8 bu/ac for the treated plots.

Table 19. Field-scale Radiate trial yield results for spring wheat (2016, 2017, and 2018) in bu/ac.

Treatment	2016	2017	2018	Average
1) Check	67.5	65.1	59.2	63.9
2) Radiate	69.2	64.9	59.5	64.5
Pr > *F*	0.042	0.813	0.828	–

Table 20. Field-scale Radiate trial yield results for canola (2017 and 2018) in bu/ac.

Treatment	2017	2018	Average
1) Check	55.0	63.8	59.4
2) Radiate	53.5	63.5	58.3
Pr > *F*	0.167	0.904	–

Table 21. Field-scale Radiate trial yield results for soybean (2016, 2017, and 2018) in bu/ac.

Treatment	2016	2017	2018	Average
1) Check	37.0	23.2	19.1	26.4
2) Radiate	37.1	23.9	18.6	26.5
Pr > *F*	0.930	0.078	0.108	–

Table 22. Field-scale Radiate trial yield results for pea, barley, oat and canaryseed in bu/ac.

Treatment	Pea (2018)	Barley (2017)	Oat (2017)	Canaryseed (2017)
1) Check	45.5	90.0	146.7	48.7
2) Radiate	45.2	87.6	146.6	48.2
Pr > *F*	0.780	0.381	0.634	0.628

Acknowledgements
In-kind support for this project was provided by Crop Production Services.