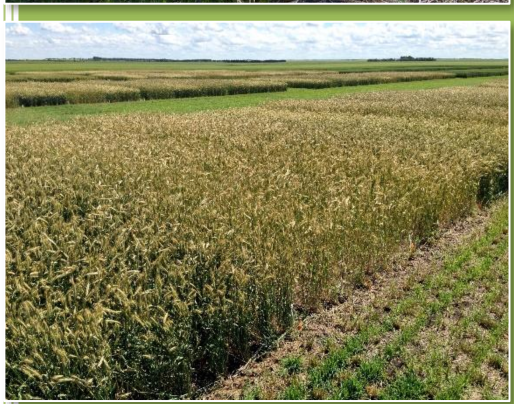
IHARF

INDIAN HEAD AGRICULTURAL RESEARCH FOUNDATION

2019 Annual Report



IHARF

Box 156

Indian Head, SK

S0G 2K0

Ph: (306) 695-4200

www.iharf.ca

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 southeastern Saskatchewan, IHARF Directors are dedicated to the betterment of the agricultural community as a whole. The 2019 IHARF Directors included:

- Janel Delage - President *(Indian Head)*
- Rick Procyk - Vice President *(Filmore)*
- Kyle Heggie - Secretary / Treasurer *(Leross)*
- Doug Hannah *(Foam Lake)*
- Heather Haus *(Glenavon)*
- Fred Stilborn *(Balcarres)*
- Dean Douhaniuk *(Killaly)*
- Thom Weir *(Yorkton)*
- Travis Wiens *(Milestone)*

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 2019 team of IHARF staff included:

- Danny Petty - Executive Manager
- Chris Holzapfel - Research Manager
- Christiane Catellier - Research Associate
- Michelle Ross - Agronomy Research Associate
- Jared Solomon - Farm Technician
- Evan Sebastian - Seasonal Technician
- Dan Walker - Seasonal Technician
- Vlad Sheshnev - Summer Student
- Logan Fahlman - Summer Student

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 2019 was Surendra Bhattarai. Surendra was working towards his PhD at the University of Saskatchewan, looking at the salt resistance of alfalfa.

Extension Events

Indian Head Crop Management Field Day

On July 16, 2019, IHARF and AAFC hosted the annual Indian Head Crop Management Field Day. 125 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)
- Dan Heaney (Fertilizer Canada)
- Lana Shaw (South East Research Farm)
- Derek Flad (Norther Quinoa)
- Bill May (AAFC Indian Head)
- Cory Jacobs (Saskatchewan Ministry of Agriculture)
- Dr. Tyler Wist (AAFC Saskatoon)
- Dr. Fardausi (Shathi) Akhter (AAFC Indian Head)
- Surendra Bhattarai (University of Saskatchewan)
- Jeff Kostuik (Hemp Genetics International)
- Dr. Kelly Turkington (AAFC Lacombe)
- Dr. Brian Beres (AAFC Lethbridge)

AgriARM Research Update

On January 16, 2020, 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 at Prairieland Park, Saskatoon, SK. The event highlighted components of each organizations applied research and demonstration programs. Presenters for the day included:

- Mike Hall (East Central Research Foundation)
- Brianne McInnes (Northeast Agriculture Research Foundation)
- Amber Wall (Wheatland Conservation Area)
- Chris Holzapfel (IHARF)
- Jessica Weber (Western Applied Research Corporation)
- Garry Hnatowich (Irrigation Crop Diversification Corporation)
- Lana Shaw (South East Research Farm)
- Brooke Howat (Conservation Learning Centre)
- Joel Peru (Ministry of Agriculture/ Irrigation Crop Diversification Corporation)

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

IHARF Soil and Crop Management Seminar

On February 5, 2020, IHARF hosted its annual winter seminar in Balgonie, SK, highlighting results of the 2019 season and current industry issues. 138 guests took in presentations delivered by:

- Bill May (AAFC Indian Head)
- Dr. Paul Tracy (Soil Health Institute)
- Dr. Tyler Wist (AAFC Saskatoon)
- Dr. Stuart Smyth (University of Saskatchewan)
- Dr. Tom Wolf (Agrimetrix Research & Training)
- Chris Holzapfel (IHARF)

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

2019 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 2019:

Platinum

- Agriculture & Agri-Food Canada - Indian Head Research Farm
- BASF
- Bayer CropScience
- Saskatchewan ADOPT Program
- Saskatchewan AgriARM Program
- Saskatchewan Agriculture Development Fund
- Saskatchewan Canola Development Commission

- Saskatchewan Wheat Development Commission
- Western Grains Research Foundation

Gold

- Alberta Agriculture Funding Consortium
- Alberta Wheat Commission
- Anuvia Plant Nutrients
- Belchim
- DSW Enterprises
- FMC
- Koch Agronomic Services
- Manitoba Pulse & Soybean Growers
- Mosaic
- Nutrien Ag Solutions
- Saskatchewan Pulse Growers
- Saskatchewan Strategic Field Program

Silver

- Acceleron BioAg
- Ag Action Manitoba
- Fertilizer Canada
- Northern Quinoa
- Saskatchewan Barley Development Commission
- Saskatchewan Flax Development Commission
- Saskatchewan Oat Development Commission
- Syngenta
- University of Saskatchewan

Bronze

- CanMar Farms Indian Head
- Corteva Agriscience
- Crop Intelligence by South Country
- Delage Farms
- FenderXtender
- FP Genetics
- GrainShark.com
- Mazergroup Regina
- NorthStar Genetics
- TD Canada Trust
- Town of Indian Head
- Whispering Pine Farms

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

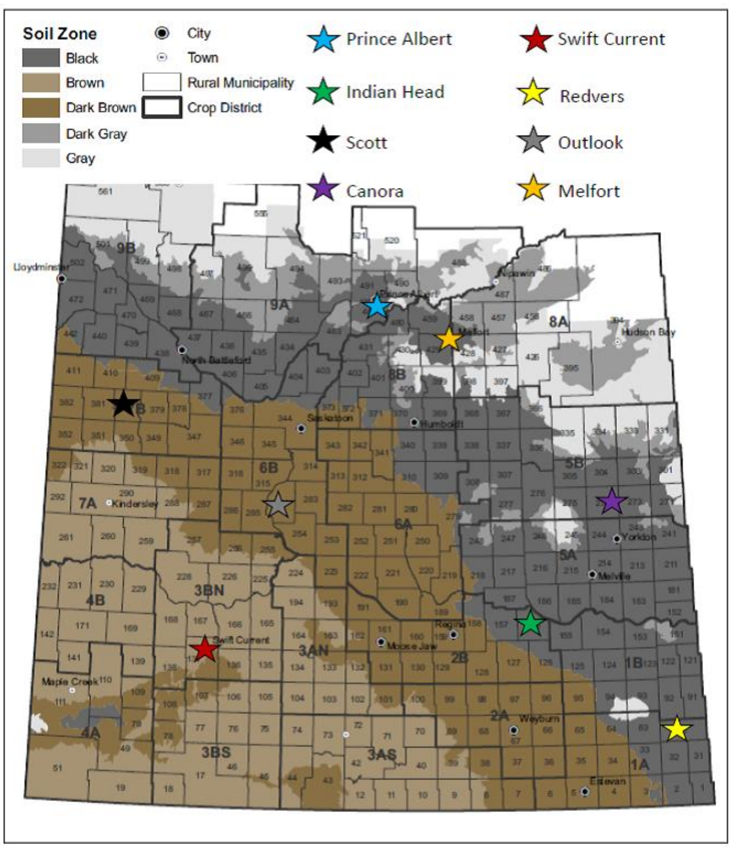


Figure 1. Locations of organizations comprising the Saskatchewan AgriARM Network.

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].

Overall moisture reserves going into the 2019 growing season were low and conditions were drier than normal for much of the spring with relatively little moisture left over from the 2018 crop and less than 60% of normal precipitation received from October 2018 through April 2019. Weather data for May through September 2019 is presented relative to the long-term (1981-2010) normal in Tables 1 and 2. The dry weather continued through May and early June at which point soil moisture conditions began to improve, and precipitation amounts were above normal for the month of August at Indian Head. Averaged over the five months at all locations, mean monthly temperature was at least 0.6 ˚C lower compared to the long-term average.

Table 1. Mean monthly temperatures for the 2019 growing season and long-term normals (1981-2010).

		May	June	July	August	September	Average
		˚C					
Indian Head	2019	8.9	15.7	17.4	15.8	11.9	13.9
	Normal	10.8	15.8	18.2	17.4	11.5	14.7
Melfort	2019	8.8	15.3	16.9	14.9	11.2	13.4
	Normal	10.7	15.9	17.5	16.8	10.8	14.3
Scott	2019	9.1	14.9	16.1	14.4	11.2	13.1
	Normal	10.8	15.3	17.1	16.5	10.4	14.0
Swift Current	2019	9.5	15.8	17.7	16.8	12.1	14.4
	Normal	10.9	15.4	18.5	18.2	12.0	15.0

Table 2. Total monthly precipitation for the 2019 growing season and long-term normals (1981-2010).

		May	June	July	August	September	Total
		mm					
Indian Head	2019	13.3	50.4	53.1	96.0	120.8	333.6
	Normal	51.7	77.4	63.8	51.2	35.3	279.4
Melfort	2019	18.8	87.4	72.7	30.7	43.0	252.6
	Normal	42.9	54.3	76.7	52.4	38.7	265.0
Scott	2019	12.7	97.7	107.8	18	41.8	278.0
	Normal	36.3	61.8	72.1	45.7	36.0	251.9
Swift Current	2019	21	13.3	156	11.1	106.3	307.7
	Normal	48.5	72.8	52.6	41.5	34.1	249.5

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 in Table 4. 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.

Demonstrating 4R Nitrogen Management Principles in Spring Wheat

Holzapfel, C. (IHARF)

Description

The objective of this trial was to demonstrate the feasibility of various N management strategies and overall N rate response on spring wheat. Two trials were conducted at Indian Head. Trial #1 focused on the right rate and included rates of N at 0, 0.5, 0.75, 1, 1.25, 1.5 and 1.75x of a baseline soil-test recommendation rate of 125 kg N/ha (residual NO_3-N plus fertilizer N). Trial #2 focused on the right time, right place, right form and included treatments of side-banding at seeding, fall broadcast and spring broadcast applications while the forms included untreated urea, Agrotain (volatilization inhibitor), SuperUrea (volatilization plus denitrification inhibitors) and ESN (polymer coated urea). The treatments were arranged in a RCBD with four replicates. A treatment list is shown in **Error! Reference source not found.**.

Table 5. Wheat 4R N management treatments evaluated at Indian Head in 2019.

Trial #1: Right Rate*	Trial #2: Right Time, Right Place, Right Form***
1) 0x (39 kg total N/ha) **	1) Fall Broadcast – untreated urea
2) 0.5x (68 kg total N/ha)	2) Fall Broadcast – ESN®
3) 0.75x (94 kg total N/ha)	3) Fall Broadcast – Agrotain® treated urea
4) 1.0x (125 kg total N/ha)	4) Fall Broadcast – SuperU®
5) 1.25x (156 kg total N/ha)	5) Side-band – untreated urea
6) 1.50x (188 kg total N/ha)	6) Side-band – ESN®
7) 1.75x (219 kg total N/ha)	7) Side-band – Agrotain® treated urea
	8) Side-band – SuperU®
*Side-banded urea in all trts, specified rates include residual N and N from 11-52-0	9) Spring Broadcast – untreated urea
	10) Spring Broadcast – ESN®
**Background levels of 39 kg N/ha from residual NO_3-N and seed-placed 11-52-0	11) Spring Broadcast – Agrotain® treated urea
	12) Spring Broadcast – SuperU®
	***1.0x rate (soil + fertilizer = 125 kg N/ha) in all trts

Results

Trial #1: Right rate of nitrogen.

As expected, NDVI increased with N rate (NR) with the greatest increases associated with the first 68 kg N/ha and smaller increases continuing to approximately 125 kg N/ha at which point NDVI no longer significantly increased with further additions of N. Chlorophyll meter readings (SPAD) also increased with N fertilization but were somewhat less sensitive than NDVI with no further significant increases in SPAD values as fertility levels were increased past 94 kg N/ha. A strong overall yield response to N fertilization was observed with all fertilized treatments yielding significantly higher than the control and increases of nearly 50% observed at the highest N rates (Figure 2). Spring wheat yields increased with increasing N right up to 156 kg N/ha (soil plus fertilizer) at which point further additions of N no longer significantly increased yield. Grain protein concentrations in wheat are normally even more sensitive to N fertility than yield and this was true in the current demonstration. Protein increased from a low of 11.5% in the control to a peak of 16.1% at the second highest N level of 188 kg N/ha.

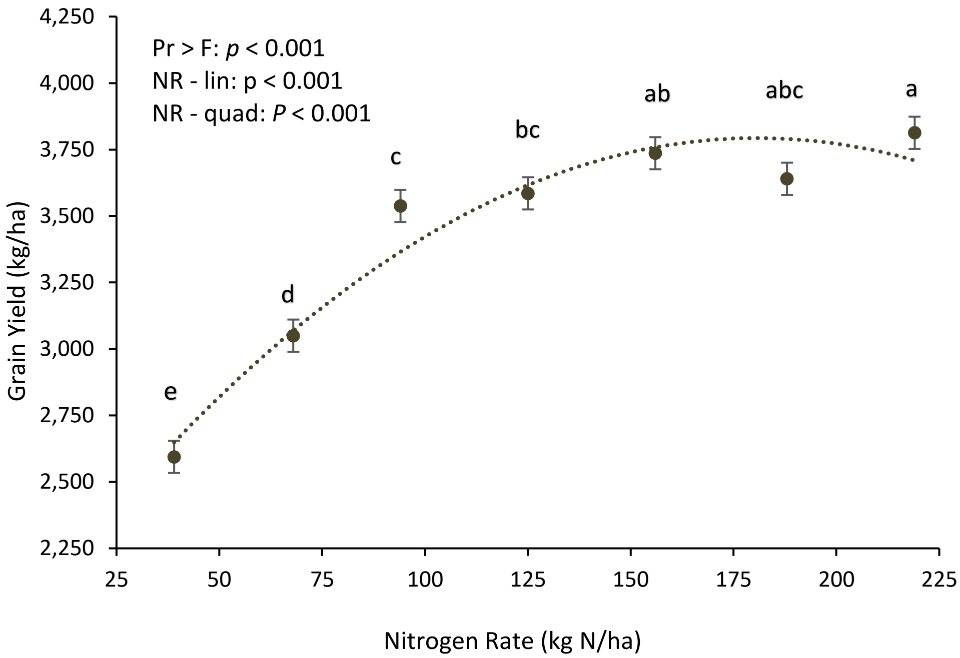


Figure 2. Nitrogen fertilizer rate effects on wheat grain yield at Indian Head (2019). Nitrogen rates are residual soil NO3-N plus fertilizer and the primary N source was side-banded urea. Error bars are S.E.M.

Trial #2: Right source, timing and placement of nitrogen.

Normalized difference vegetation index (NDVI) was affected by both N source and timing/placement along with the S x TP interaction. The main effect means showed an overall advantage to side-banding over both fall and spring applications. The interaction appeared to be due to certain inconsistencies in source effects depending on the application method whereby NDVI with ESN tended to be lower when broadcast while the values with fall broadcast SuperU® was as high any side-banded treatments. The leaf chlorophyll (SPAD) measurements were affected by N timing/placement but not source and there was no TP x S interaction. Similar to NDVI, the average SPAD values were highest with side-banding; however, the values did not differ between spring and fall broadcast applications. Spring wheat grain yield was affected by N timing/placement but not source and there was no TP x S interaction. The TP effect was such that yields were highest with side-banding (3619 kg/ha) but did not significantly differ between the fall (3397 kg/ha) and spring (3417 kg/ha) surface broadcast applications. Averaged across TP options, yields for the various N sources were consistent ranging from 3409-3529 kg/ha and the lack of an interaction suggests that this was true regardless of how the N was managed. Grain protein concentrations were also affected by N timing/placement but not source and there was no TP x S interaction detected. Again, the TP effect was such that grain protein was highest with side-band (15.0%) but there was further separation between the fall (13.3%) and spring (14.4%) broadcast applications. Observed protein concentrations for the various sources ranged from 14.1-14.4% and, again, the lack of an interaction suggests that protein concentrations were similar across N sources regardless of timing/placement option. The effects of N timing/placement are shown in

Table 6.

Table 6. N timing/placement effects on NDVI, SPAD values (leaf chlorophyll), grain yield, and grain protein. Means for each main effect within a column followed by the same letter do not significantly differ (Fisher's protected LSD test, P ≤ 0.05).

Source / Main Effect	NDVI	SPAD	Grain Yield	Grain Protein
	---------------------------------- (p-value)	----------------------------------		
N Source (S)	0.012	0.129	0.392	0.232
N Timing/Placement (TP)	<0.001	<0.001	0.003	<0.001
S x TP	0.004	0.179	0.719	0.750
N Source	----- (0-1) -----	------------------	---- (kg/ha) ----	------ (%)------
1) Untreated Urea	0.667 a	44.7 a	3463 a	14.05 a
2) ESN®	0.648 b	43.9 a	3409 a	14.33 a
3) Agrotain®	0.658 ab	45.3 a	3510 a	14.35 a
4) SuperUrea®	0.663 a	44.8 a	3529 a	14.11 a
N Timing/Placement (TP)				
1) Side-band	0.686 a	46.4 a	3619 a	14.99 a
2) Fall Broadcast	0.661 b	43.4 b	3397 b	13.25 c
3) Spring Broadcast	0.630 c	44.1 b	3417 b	14.39 b

Conclusions

This project demonstrated the overall spring wheat response to a wide range of application rates and a selection of fundamentally different N management strategies where the fertilizer sources, timing of application, and placement method were varied. While both the NDVI and SPAD values increased with N fertilization, neither measurement predicted the extent of the response as both peaked at lower N rates than either yield or protein. There was a distinct advantage to side-banding N fertilizer as opposed to the broadcast applications for all response variables. Differences between fall and spring broadcast applications were somewhat inconsistent whereby the fall applications resulted in higher NDVI but no difference in SPAD or yield and lower protein concentrations relative to the spring broadcast applications. Focussing on the broadcast treatments, it is possible that the fall applications resulted in better early season N availability (and subsequent vegetative growth), but the spring applications resulted in increased N availability later in the season and a small protein advantage. The N source effects were never statistically significant and there were no interactions for either yield or protein to suggest that the EEF products were more advantageous with the fall and/or surface broadcast applications. It is important to acknowledge that the results of field trials such as this can vary widely depending on the specific conditions encountered.

Acknowledgements
Funding for this project was provided by Fertilizer Canada and 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 Corteva Agriscience and Bayer CropScience.

Winter Wheat Response to Contrasting Nitrogen Fertilizer Placement/Timing Options

Holzapfel, C. (IHARF)

Description
The objective of this trial was to demonstrate the relative winter wheat responses to varying N fertilizer rates when all of the fertilizer is applied either as side-banded urea, early spring broadcast urea, or a split application where 50% of the supplemental N fertilizer is side-banded and the remainder is applied in an early season broadcast application. Treatments are shown in

Table 7 and were arranged in an RCBD with four replicates.

Table 7. Treatment list for winter wheat response to N fertilizer rate/placement/timing options.

#	Timing / Placement	Total N Rate [Z]
1	N/A	18 kg N/ha [Y]
2	Side-Band	60 kg N/ha
3	Side-Band	90 kg N/ha
4	Side-Band	120 kg N/ha
5	Side-Band	150 kg N/ha
6	Side-Band	180 kg N/ha
7	Spring Broadcast	60 kg N/ha
8	Spring Broadcast	90 kg N/ha
9	Spring Broadcast	120 kg N/ha
10	Spring Broadcast	150 kg N/ha
11	Spring Broadcast	180 kg N/ha
12	Split Application (50/50)	60 kg N/ha
13	Split Application	90 kg N/ha
14	Split Application	120 kg N/ha
15	Split Application	150 kg N/ha
16	Split Application	180 kg N/ha

[Z] Residual NO_3-N (0-60 cm) plus fertilizer N

[Y] Provided from residual NO_3-N and seed-applied 11-52-0

Results

When averaged across N timing/placement options, NDVI increased with N rate (NR) with the greatest increases with the first 60 kg N/ha and a diminishing response beyond 120 kg N/ha. Chlorophyll meter (SPAD) readings also increased with N fertilization; however, there were no significant differences amongst the fertilized treatments or N timing/placement effects detected (P = 0.866). A strong overall yield response to N fertilization was observed with all fertilized treatments yielding significantly higher than the control and increases of nearly 60% observed in certain cases (Figure 3). When averaged across timing/placement options, winter wheat yields increased significantly right up to 150 kg N/ha (soil plus fertilizer) at which point further increases in N rate no longer significantly increased yield. Neither timing/placement (P = 0.832) nor the TP x NR interaction (P = 0.659) were significant indicating that that the yield response to N was similar regardless of how the fertilizer was managed.

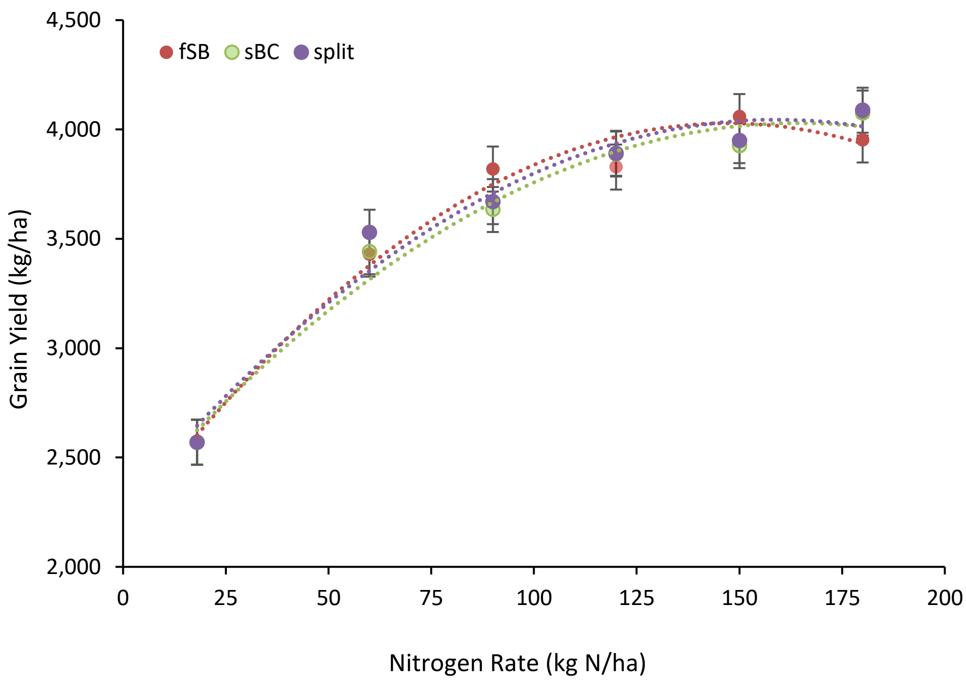


Figure 3. N fertilizer rate by timing/placement effects on winter wheat grain yield at Indian Head (2018-19). N rates are residual soil NO3-N plus fertilizer and the timing/placement options were 1) fall side band (fSB), 2) spring surface broadcast (sBC), and 3) a 50/50 split application (split). Error bars are S.E.M.

There was a strong protein response associated with N fertilization and grain protein concentrations were also affected by N timing/placement (P = 0.018) in addition to N rate (P < 0.001) as shown in (Figure 4). The lack of a TP x NR interaction indicates that responses to N rate were reasonably consistent regardless of how the N was managed and vice versa. Although the differences were fairly small, the protein concentrations were highest with the spring broadcast applications (12.9%), lowest with fall side-banding (12.6%) and intermediate with the split applications (12.75%). Averaged across timing/placement methods, the highest protein occurred at 180 kg N/ha (13.8%), but this was not significantly higher than at the 150 kg N/ha rate (13.5%) and the quadratic response (P = 0.005) indicated that the increases were diminishing at higher rates. For individual timing/placement options, the linear responses were always highly significant (P < 0.001) while the quadratic response was highly significant with side banding (P = 0.002), marginally significant with split applications (P = 0.059), and not significant for spring broadcast N (P = 0.194). However, with no TP x NR interaction we cannot say with confidence that the response differed depending on timing/placement method. Inspection of individual treatment means, and the multiple comparisons test results suggest that the advantage to spring applied N was most evident at the highest rates.

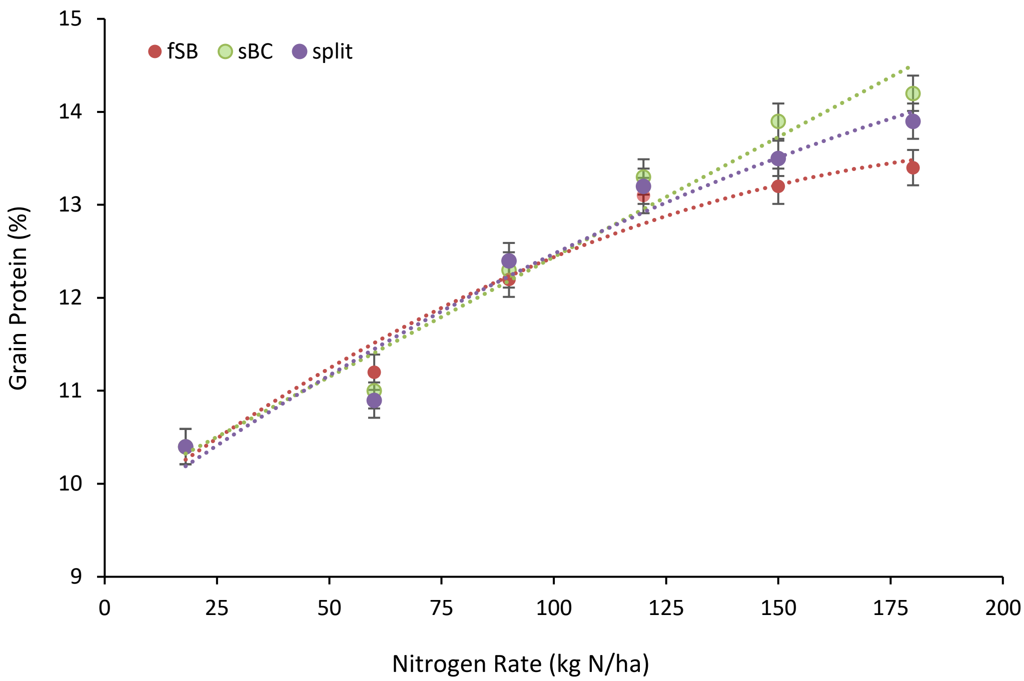


Figure 4. N fertilizer rate by timing/placement effects on winter wheat grain yield at Indian Head (2018-19). N rates are residual soil NO3-N plus fertilizer and the timing/placement options were 1) fall side band (fSB), 2) spring surface broadcast (sBC), and 3) a 50/50 split application (split). Error bars are S.E.M.

Conclusions

This project demonstrated winter wheat response to fundamentally different N management strategies and a wide range of application rates. All of the N timing/placement options (side-band, spring broadcast, and split-application) worked reasonably well under the specific conditions encountered; the protein responses revealed a slight advantage to the spring broadcast applications. Past research has suggested that, while side-banding the crops entire N requirements can be feasible in dry environments, it is risky under wet conditions and saturated soils can frequently occur during the early spring thaw period even in relatively dry years/regions. In contrast, there can also be a risk of nutrient deficiency associated with deferring too much N until the following spring. This can be the case if dry conditions result in reduced availability of the spring broadcast N or if spring broadcast applications are delayed (i.e. wet weather). To alleviate the risk of N losses in the fall/early spring while also minimizing the potential for N deficiencies, split applications are commonly recommended as an ideal option for a wide range of environmental conditions and the results from the current project support this recommendation.

Acknowledgements
Funding for this project was provided by Fertilizer Canada and 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 Corteva Agriscience and Bayer CropScience.

A Field-scale Assessment of Fungicide Application Practices for FHB Management in Spring Wheat

Catellier, C. (IHARF)

Description
The objective of this study was to demonstrate the effect of fungicide nozzle configuration and ground speed on spray quality and efficacy of Fusarium Head Blight (FHB) management in spring wheat on a field-scale. The study was conducted at Indian Head in 2019, and four treatments were evaluated which varied in fungicide nozzle type, nozzle size and ground speed/pressure (Table 8). Treatment 3 demonstrates the recommended practice (double flat-fan Turbo TwinJet, grey nozzle at 10 km/h and 275-310 KPa) which all other treatments were compared to. Treatment 1 utilized a single nozzle. Treatment 2 consisted of a finer nozzle size (red) at a slower speed to maintain the recommended pressure. Treatment 4 increased ground speed/pressure. A treatment list is shown in Table 8. Spray quality was assessed with water sensitive paper that was placed in the field at the time of spray application with droplet density, droplet size, and % coverage were assessed using the DepositScan software. In-field FHB was assessed at four locations per plot and harvested grain was graded and the level of Fusarium and DON infection was determined.

Table 8. Treatments evaluated for a field-scale assessment of fungicide application practices for FHB management in spring wheat at Indian Head in 2019.

Trt #	Nozzle	Travel Speed	Pressure
1	Single flat-fan (Turbo TeeJet, grey)	16 km/hr (10 mph)	275-310 KPa (40-45 psi)
2	Double flat-fan (Turbo TwinJet, red)	10 km/hr (6 mph)	275-310 KPa (40-45 psi)
3	Double flat-fan (Turbo TwinJet, grey)	16 km/hr (10 mph)	275-310 KPa (40-45 psi)
4	Double flat-fan (Turbo TwinJet, grey)	23 km/hr (14 mph)	620 KPa (90 psi)

Results
The use of single nozzles, finer spray and higher speed/pressure reduced uniformity of droplet size deposition and had more variable coverage relative to the recommended practice. The reduced uniformity of droplet size indicates the spray pattern and angle of spray were more vulnerable to turbulence and wind disturbance. The increased variability of coverage potentially led to inadequate

doses of fungicide on sides of the wheat heads that had lower coverage. The grain yield, FHB severity and FHB index was not affected by treatment and DON and %FDK were very low overall. This was not unexpected as the environmental conditions for FHB infection and development were only marginally favourable. Even in a year with low FHB prevalence overall, there was a significant increase in FHB incidence with the use of a finer nozzle size and higher speed/pressure relative to the recommended treatment. This demonstrates that the appropriate nozzle configuration and ground speed/pressure is essential to maximize producer's investment in fungicide.

Conclusions
This has implications from both an economic and a disease resistance management standpoint. Producers need to optimize the efficacy of their fungicide application to get the greatest return on their investment and also to prevent the application of a sub-lethal dose that may potentially accelerate the development of fungicide resistance. Using an appropriate nozzle configuration and ground speed/pressure in conjunction with adequate water volume and optimal boom height is essential to have adequate spray coverage and maximize the efficacy of a fungicide application.

Acknowledgements
Funding for this project was provided 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 BASF.

Input Contributions to Spring Wheat Yield, Quality and Profits

Holzapfel, C. (IHARF)

Description
A field trial was established near Indian Head, Saskatchewan to demonstrate wheat response to low versus high input management systems. The objective of this trial was to demonstrate the agronomic and economic responses of CWRS wheat to numerous crop inputs both individually and in various combinations. Treatments were arranged in an RCBD with four replications. A treatments list is shown in Table 9.

Table 9. Treatment list for wheat input demonstration at Indian Head in 2019.

#	Name	Seed Trt (no/yes)	Seed Rate (seeds/m^2)	Fertility (kg/ha $N-P_2O_5-K_2O-S$)	PGR (no/yes)	Foliar Fungicide (no/yes)
1	Low Input	No	250	90-20-10-10	No	No
2	Low + Seed Treatment	Yes	250	90-20-10-10	No	No
3	Low + Seed Rate	No	400	90-20-10-10	No	No
4	Low + Fertility	No	250	135-40-20-20	No	No
5	Low + PGR	No	250	90-20-10-10	Yes	No
6	Low + Fungicide	No	250	90-20-10-10	No	Yes
7	High - Seed Treatment	No	400	135-40-20-20	Yes	Yes
8	High - Seed Rate	Yes	250	135-40-20-20	Yes	Yes
9	High - Fertility	Yes	400	90-20-10-10	Yes	Yes
10	High - PGR	Yes	400	135-40-20-20	No	Yes
11	High - Fungicide	Yes	400	135-40-20-20	Yes	No
12	High Input	Yes	400	135-40-20-20	Yes	Yes

Results

Increasing seeding rate had the greatest effect on plant populations while seed treatments appeared to have a slight positive effect and the opposite occurred with higher fertility. Plant height was only affected by the PGR which reduced height by 9% on average. Lodging was not observed in any plots. FHB pressure was low and the only input to significantly affect disease levels was the foliar fungicide. Although there were a few significant yield differences amongst individual treatments, the intensively managed wheat only yielded 7% more than the low input treatment (Figure 5). None of the inputs significantly increased grain yield when added to the low input treatment individually; however, reducing fertilizer rates in the high input package led to a small but significant reduction. When averaged across treatments, all of the inputs except seed-applied fungicide had a positive impact on yield but the increases were always small. Impacts on test weight or TKW were small and of little agronomic importance, but these parameters tended to be better in the lower input treatments. Protein was increased from 15.1% to 15.6% when fertility was increased in the low input treatment and fell from 15.5% to 15.0% when fertility was reduced in the high input treatment. A basic economic analysis showed intensively managed wheat to be the least profitable while the most profitable was the low input system.

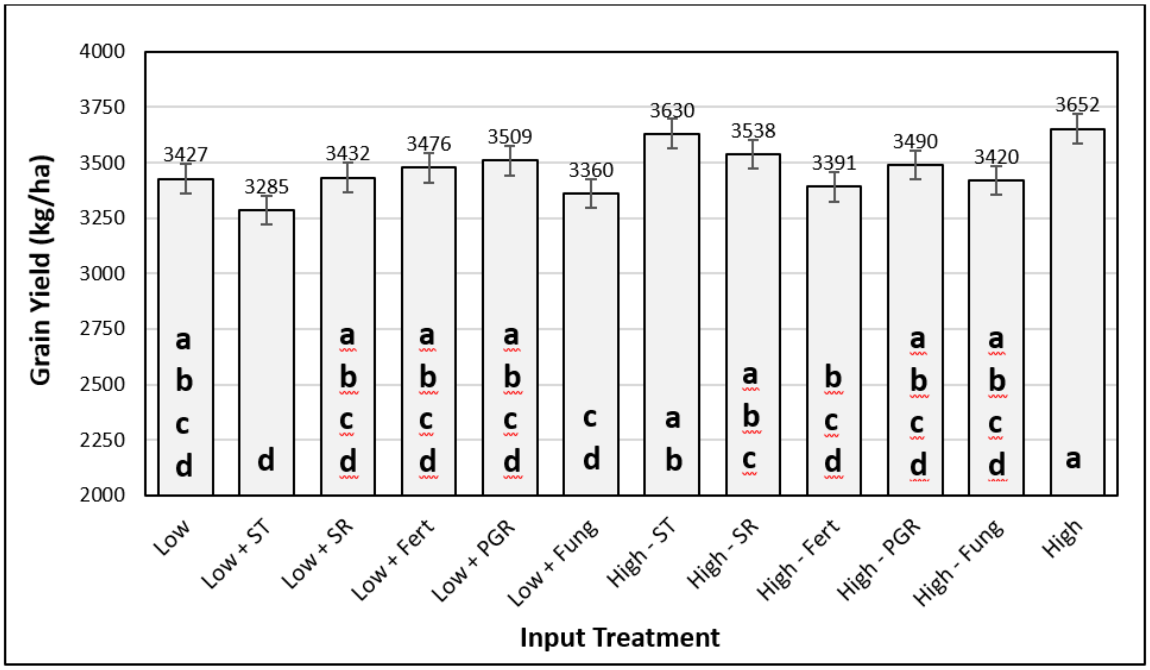


Figure 5. Individual input effects on wheat grain yield when either added to a low input package or removed from a high input package at Indian Head in 2019.

Conclusions

This project demonstrated the contributions of various crop inputs on wheat establishment, yield, quality, and profitability under somewhat below average yield conditions with relatively low lodging and/or disease pressure. One broad comparison that can be made throughout is looking at the agronomic and economic performance of intensive management versus a lower input, less intensive approach to growing wheat. Bear in mind that the low input wheat was still reasonably well managed (i.e. midge tolerant variety/certified seed, timely seeding and weed removal, modest but balanced fertility) and that the results are specific to the conditions encountered. It is important to consider that these results were considered somewhat atypical for the region and actual responses may vary dramatically with environment. Nonetheless, with relatively low yield potential, lodging, and disease pressure combined with moderately high residual nutrient levels the observed responses are not necessarily unexpected. That being said, the results also show that it is important to carefully manage input costs in order to maximize profitability in wheat production. As a general recommendation, soil testing to determine fertility requirements and choosing crop protection products based on knowledge of past pest problems combined with frequent crop scouting will provide the best opportunity to optimize yields and quality while managing costs and maximizing economic returns.

Acknowledgements

Funding for this project was provided 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 Corteva Agriscience, Belchim Canada, and Bayer CropScience.

Dry Bean Inoculation and Fertilizer Strategies for Soil Seeded Production

Hnatowhich, G. (ICDC), Weber, J. (WARC), Shaw, L. (SERF), Hall, M. (ECRF), and Holzapfel, C. (IHARF)

Description

A study was initiated to evaluate the efficacy of a peat and granular dry bean inoculant, manufactured and retailed in the USA, with and without fertilizer nitrogen (N) additions. An additional aspect of the study was to evaluate the potential of CDC Blackstrap as a suitable variety for dry land, solid seeded production. The trial was conducted under natural rainfed conditions at Scott, Redvers, Yorkton and Indian Head. An additional trial was conducted under irrigation at Outlook to serve as a production reference. Peat formulation inoculant was seed applied at 3.1 gm/kg of seed either by itself, with a dilute molasses as a sticking agent or with a commercially applied polymer coating. The granular inoculant was applied at either 4.8 kg/ha or 4.0 kg/ha depending upon the row spacing used. All trials were seeded to establish a plant population of 35 plants/m^2 in a solid seeded system using 25cm (10”) or 30cm (12”) row spacing. Nitrogen fertilizer treatments were applied at rates so that total available N (soil N plus fertilizer N) equaled 80 lb N/ac. A treatment list is shown in Table 10.

Table 10. Treatment list for dry bean inoculation and fertilization strategies for soil seeded production.

#	Inoculant / N Fertilizer Treatment ^{z}	
1	Control – unfertilized	(no inoculant)
2	N Charge	(peat on seed)
3	N Charge + molasses	(peat on seed + molasses)
4	N Charge polymer	(pretreated polymer)
5	PRIMO GX2	(granular)
6	N Charge + PRIMO GX2	(peat on seed + granular)
7	Control + 80N	(no inoculant plus fertilizer)
8	N Charge + 80N	(peat on seed + fertilizer)
9	N Charge + molasses + 80N	(peat on seed + molasses + fertilizer)
10	N Charge polymer + 80N	(pretreated polymer + fertilizer)
11	PRIMO GX2 + 80N	(granular + fertilizer)
12	N Charge + PRIMO GX2 + 80N	(peat on seed + granular + fertilizer)

^{Z} 80 kg N/ha (soil residual plus fertilizer) side-banded

Results

Inoculation failed to provide a yield advantage over un-inoculated dry bean at 4 of 5 locations (Figure 6). At the Indian Head, yields were very low and variable, with inoculant treatment inconsistences. No inoculant response was obtained when data were combined across locations. However, all trial locations obtained significantly higher yields when fertilizer N was applied. The un-inoculated treatment at the irrigated site was high yielding compared to dry land sites, this is partly attributed to high levels of indigenous rhizobia populations from numerous preceding dry bean productions. In general, the observed dry land production of CDC Blackstrap was encouraging. Fertilized treatments resulted in an average of 690 kg/ha (614 lb/ac) greater seed yield than unfertilized treatments under dry land conditions.

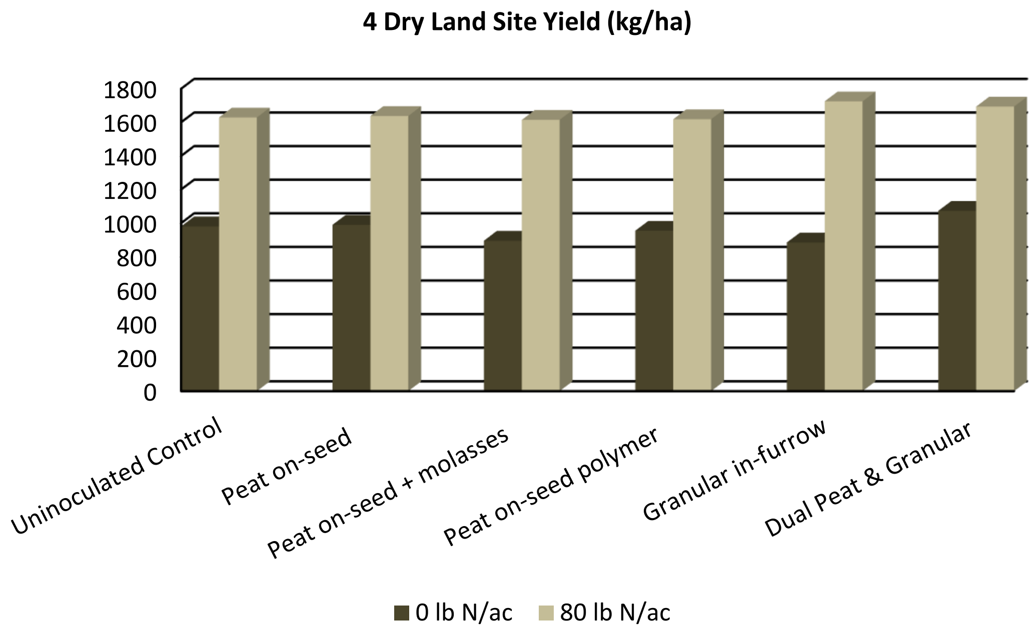


Figure 6. Combined 4 dry land site dry bean yield, effect of inoculation and N fertilization in 2019.

Conclusions

Inoculation failed to provide yield or agronomic benefits to dry beans in this trial. It is suspected that the strain of *Rhizobium leguminosarum bv. Phaseoli* provided in the inoculant formulations used in the study were either inefficient in forming an effective symbiotic relationship with the CDC Blackstrap variety used in the study or the strain was unable to thrive and multiply under Saskatchewan soil/climatic conditions. Application of fertilizer N, such that the combination of soil available N (0-60cm depth) plus fertilizer N (nutrient) equaled 80 lb N/ac significantly increased grain yield and tended to produce taller plants which may facilitate harvest management. It is recommended that producers view N fertilizer as their primary nutrient source for dry bean production. An inoculant, if available, can be used as an insurance but is unlikely to provide optimal N-fixation to optimize yield goals. This study demonstrated the feasibility of producing CDC Blackstrap dry bean under dry land conditions utilizing a solid seeded production system. Should further investigations also demonstrate this potential then dry bean production could expand considerably beyond the present acreage. This pulse could be an alternative for the moister regions of the province where root diseases have impacted other pulse crops.

Acknowledgements

Funding for this project was provided by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement. Inoculant products were provided in-kind by Verdesian Life Sciences.

Maintaining Acceptable Test Weights for Milling Oats

Hall, M. (ECRF), Sorestad, H. (ECRF), Pratchler, J. (NARF), and Holzapfel, C. (IHARF)

Description

The purpose of this study was to demonstrate the seeding date and nitrogen fertility effects on yield and quality of oats. This trial was conducted at Yorkton, Indian Head and Melfort locations. A treatment list is shown in

Table 11 and were arranged in a split plot design with four replicates.

Table 11. Treatment list for maintaining acceptable test weights for milling oats trial.

#	Seeding Date (main plots)	Variety (sub-plots)	N Fertilizer Rate (sub-plots)
1	Early (May 3-14)	CS Camden	40 kg N/ha
2	Early	CS Camden	80 kg N/ha
3	Early	CS Camden	120 kg N/ha
4	Early	Summit	40 kg N/ha
5	Early	Summit	80 kg N/ha
6	Early	Summit	120 kg N/ha
7	Late (May 29-Jun 12)	CS Camden	40 kg N/ha
8	Late	CS Camden	80 kg N/ha
9	Late	CS Camden	120 kg N/ha
10	Late	Summit	40 kg N/ha
11	Late	Summit	80 kg N/ha
12	Late	Summit	120 kg N/ha

Results

Increasing N was anticipated to increase oat yield and reduce test weights. On average, raising N rate from 40 to 120 kg N/ha significantly increased yield by 18 and 34% at Yorkton and Melfort, respectively (Tables 12). At Indian Head, yield response to added N was a little unusual as a significant interaction between seeding date and nitrogen rate were detected. For the early seeding date, yield peaked at 80 Kg N/ha and declined with 120 Kg N/ha. When seeded late, oat yield increased with added N but at a modest and insignificant rate. Yield potential was moderate at Indian Head and soil N levels were moderate with 44 lb N/ac in the top 24 inches of soil. This may account for the low yield response to added N. As anticipated, test weights were significantly reduced by increasing N at Indian Head and Yorkton (Tables 13). However, test weights were unaffected by rate of N at Melfort. Moreover, Summit clearly maintained higher test weights than CS Camden at equivalent rates of N at all sites.

Table 12. Main effects of seeding date, variety, and nitrogen fertilizer rate on oat yield at multiple locations in 2019.

Main effect	Yield		
	Indian Head	Melfort	Yorkton
Seeding Date		kg/ha	
Early May (early)	4477 a	7073 a	6439 a
Early June (late)	4563 a	6876 a	6859 a
Variety			
CS Camden	4474 a	6950 a	6531 b
Summit	4566 a	6999 a	6767 a
N Fertilizer Rate (kg N/ha)			
40	4391 b	5821 c	5999 c
80	4607 a	7277 b	6854 b
120	4562 a	7826 a	7094 a

Table 13. Main effects of seeding date, variety, and nitrogen fertilizer rate on oat test weight at multiple locations in 2019.

Main effect	Test Weight		
	Indian Head	Melfort	Yorkton
Seeding Date		g/0.5L	
Early May (early)	241.2 a	259.3 b	253.7 a
Early June (late)	234.4 b	267.6 a	259.1 a
Variety			
CS Camden	231.9 b	261.0 b	251.9 b
Summit	243.7 a	265.9 a	260.8 a
N Fertilizer Rate (kg N/ha)			
40	240.3 a	264.0 a	259.5 a
80	236.9 b	262.8 a	255.5 b
120	236.1 b	263.6 a	254.1 b

Conclusions

Early seeding is recommended for milling oats to help maximize yield and test weights. However, yields and test weights were not always higher with early seeding in this study. This would indicate that seeding early does not guarantee and, environmental conditions will always be conducive for greater yield and test weight. It is hard to recommend an N rate that would be appropriate for every producer. However, 80 kg N/ha (71 lb N/ac) generally did not result in rejection for milling and often produced economic returns which were close to the maximum possible. To minimize the risk of rejection due to low test weight, a higher test weight variety (Summit) should be grown instead of a lower test weight variety (CS Camden). However, if lodging had been an issue in this study CS Camden may have performed relatively better as its lodging resistance is higher compared to Summit. While seeding earlier did not guarantee higher test weights, it is still a good practice as early seeding will likely favor harvest under ideal conditions.

Acknowledgements
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Oat/Pea Intercrop Demonstration

Shaw, L. (SERF), Hnatowich, G. (ICDC), Pratchler, J (NARF), Brown, R. (CLC), Holzapfel, C. (IHARF), and Nybo, B. (WCA)

Description
The objective of this trial was to demonstrate the effect of varying oat seeding rate when intercropped with pea on forage and grain yields along with oat milling quality relative to monocrops. This trial was conducted at Redvers, Melfort, Indian Head, Swift Current, Outlook and Prince Albert. A treatment list is shown in Table 14 and was arranged in an RCBD with four replicates. Five seeding rates of oats were evaluated as a companion crop with yellow or marrowfat peas, depending on location.

Table 14. Treatment list for oat/pea intercrop demonstration.

Trt #	Crop	Oat Seed Rate (plants meter $^{-2}$)	Oat Seed Rate (approx. lb/ac)	Pea Seed Rate (plants meter^{-2})
1	Pea + Oat	25	11	80
2	Pea + Oat	50	21	80
3	Pea + Oat	75	32	80
4	Pea + Oat	100	43	80
5	Pea + Oat	125	53	80
6	Oat	200	85	0
7	Pea (hand-weeded)	0	0	80
8	Pea	0	0	80

Results
Land Equivalency Ratio (LER) for grain yield was close to one at Indian Head, Outlook, and Swift Current and was lower than one at Redvers. Biomass LER tended to be close to one with small effects of oat seeding rate on that ratio. The site at Indian Head was the most successful for intercrop establishment. The ICDC irrigated site at Outlook had the highest yields but poor establishment and growth of the peas. At Redvers, bird damage and possibly dry conditions resulted in lower land equivalency ratio. There were some indications that intercropping reduced lodging and improved weed competition. Oat quality

was determined for the seed samples collected at Indian Head and Redvers. Samples from Indian Head showed bushel weights of 39.4 for intercrop treatments vs 37.42 for the monocrop oats. Redvers samples did not show the same trends but had high unthreshed grain percentage for some reason, possibly high moisture at combining or incorrect combine setting. Estimated cost of basic separation using rotary screens based on $0.25/bu (industry source) is $15-25/acre depending on yield. In this demonstration, about half the normal rate of N was applied to the intercrops, resulting in a cost savings of about $18/ac compared to monocrop oats. The cost of the pea seed is estimated at $22/ac and ranged from $1 to $5 per acre for oat seed. The costs of intercrop relative to monocrop are shown in Table 15.

Table 15. Costs of intercrop relative to monocrop oats.

	Intercrop
Seed cost	$9 higher
N fertilizer	$17.50 lower
Separation	$18 higher
Pesticides	Unknown differences
Total	$9.5 higher (minus differential in pesticide use)

Conclusions

There are some promising indications for oat quality and weed suppression, but there is no indication of a yield advantage to intercropping pea and oat. With the separation costs included, production of yellow peas and milling oats is not attractive compared to the monocrops from a profitability standpoint. This trial did not determine whether there are any reductions in pesticide use possible which might offset the separation costs of the pea and oats. These results suggest there is potential for intercropping to improve competitive ability of pea, particularly at the higher rates of oat inclusion (75, 100, 125 oat plants/m^2) as well as reduce lodging relative to the pea monocrop. This intercrop shows some positive functionality, but separation costs and lack of broad-spectrum suitable herbicides would be an obstacle to adoption. The improvement in weed competition may be more relevant for organic farmers than conventional farmers.

Acknowledgements

Funding for this project was provided by Sask Oats and Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement.

Optimum Seed Rate for New Hybrid Brown Mustard Compared to Standard Recommendations of Other Varieties

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

Description

The objective of this project was to demonstrate the seeding rate response of hybrid brown mustard variety (AAC Brown 18) compared to a traditional open pollinated variety (Centennial). This study was conducted at Swift Current, Indian Head, and Redvers locations in 2019. Treatment list is shown in Table 16, and they were arranged in a RCBD with four replicates. Mustard seeding rate calculations are based on a target plant population per m^2. All fertilizer applications were side-banded at seeding to avoid any negative effects of in row fertilizer application and seeds were treated with Helix Vibrance.

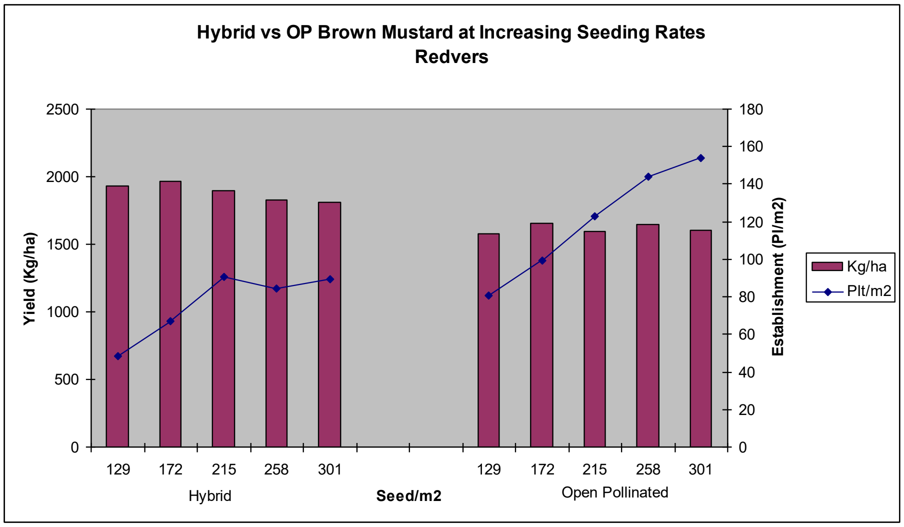
Table 16. Treatment list of optimal seed rate for new hybrid brown mustard compared to standard recommendations of other varieties.

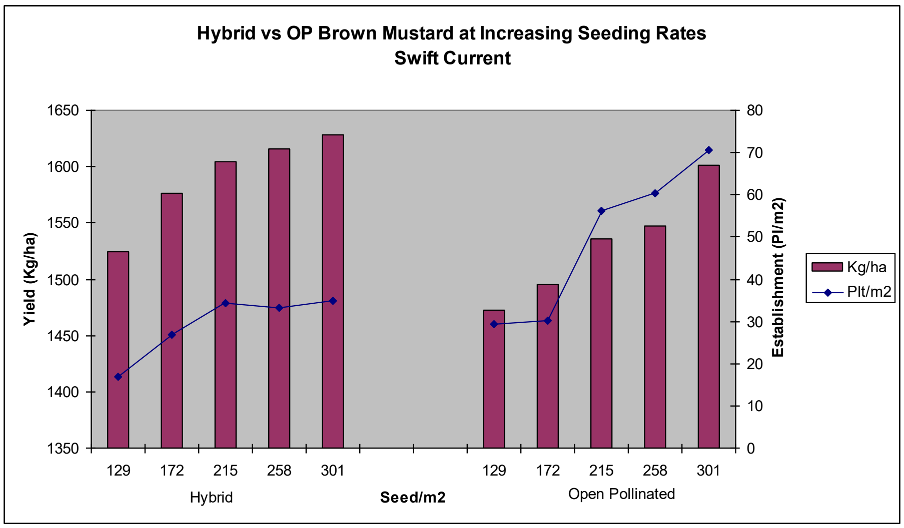
#	Variety	Seed Rate	kg/ha
1	AAC Brown 18 (hybrid)	129 seeds/m^2 (12 seeds/ft^2)	4.0
2	AAC Brown 18	172 seeds/m^2 (16 seeds/ft^2)	5.4
3	AAC Brown 18	215 seeds/m^2 (20 seeds/ft^2)	6.7
4	AAC Brown 18	258 seeds/m^2 (24 seeds/ft^2)	8.1
5	AAC Brown 18	301 seeds/m^2 (28 seeds/ft^2)	9.3
6	Centennial Brown (OP)	129 seeds/m^2 (12 seeds/ft^2)	3.7
7	Centennial Brown	172 seeds/m^2 (16 seeds/ft^2)	4.9
8	Centennial Brown	215 seeds/m^2 (20 seeds/ft^2)	6.2
9	Centennial Brown	258 seeds/m^2 (24 seeds/ft^2)	7.4
10	Centennial Brown	301 seeds/m^2 (28 seeds/ft^2)	8.6

[Z] AAC Brown 18 – 3.1 g/1000 seeds, 100% germ; Centennial Brown – 2.8 g/1000 seeds, 98% germ

Results

The lack of early spring moisture, cool temperatures, and late spring frosts affected crop emergence, which negatively impacted crop production in 2019 and limited any treatment effects studied in this trial. There were no significant treatment effects on yield, height, lodging, or days to maturity at all sites. When looking at the hybrid mustard compared to the open pollinated mustard averaged over all seeding rates, we can pick out positively higher yields in the hybrid mustard at Redvers and Indian Head compared to Swift Current (Figure 7), and lower establishment rates in the hybrid mustard at all three sites. The current recommended target plant stand for mustard is 70-120 plants/m^2. Plant establishment in this trial was well below this recommended target window at Swift Current and Indian Head, and clearly demonstrated the negative effects of the extreme dry soil moisture conditions. The hybrid brown took the biggest hit in 2019, which may be due to the smaller seed size of the hybrid (TKW = 2.8 g) compared to the Centennial (TKW = 3.1 g). In fact, the only treatment that reached the minimum target plant stand at Swift Current and Indian Head was the highest seeding rate of Centennial brown mustard. Hybrid mustard yields were higher at all three sites even though establishment rates were much lower. This demonstrates the vigorous elasticity of the hybrid and its ability to branch out and compensate for thin plant stands to produce yield when moisture conditions improve. In 2019, despite poor establishment of the hybrid brown mustard, mid-season rains promoted branching, flowering and pod development producing higher yields than the corresponding Centennial brown mustard at each seeding rate treatment.





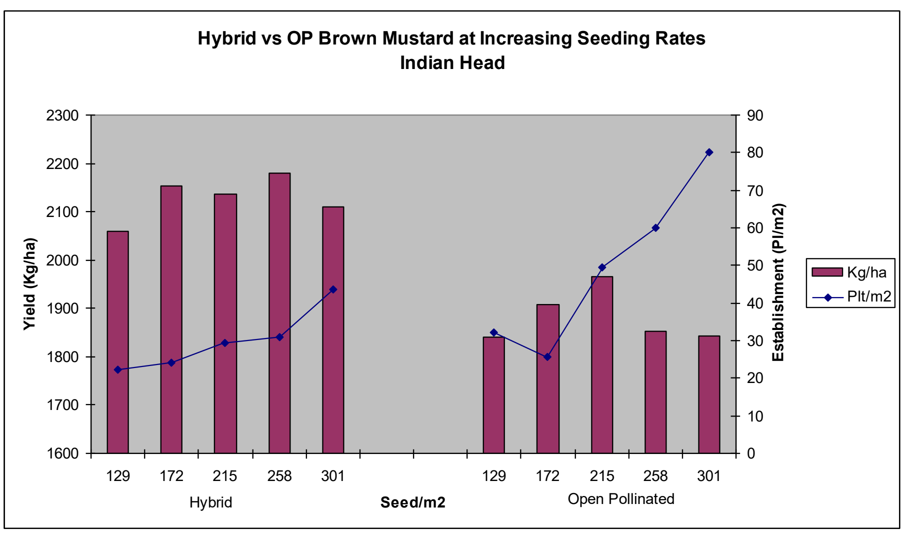


Figure 7. Establishment and yield of Hybrid Brown Mustard vs. Centennial Brown Mustard with increased seeding rate for each individual site (Redvers, Swift Current, and Indian Head) in 2019.

Conclusions

Emergence rates for mustard generally range from 50-80% when soil moisture is not limiting. With the poor spring soil moisture conditions experienced in the province in 2019, we saw emergence rates on average of 21% from the hybrid brown mustard and 34% emergence from the Centennial brown mustard, therefore, we were unable to consistently achieve the desired plant populations designed for this project. With the excessively low plant populations at this site, we were not able reach an optimal seeding rate and no recommendations or economic analysis could be made based on the data from this site. What this trial does demonstrate is the vigor and the impressive elasticity built into the hybrid brown mustard giving it the potential to branch out and compensate for thin plant stands to produce yield.

Acknowledgements

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

Enhanced Fertilizer Management for Optimizing Yield and Protein in Pea

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

Description

The objective of this study was to evaluate, across a range of Saskatchewan environments, the yield and protein response of yellow field pea to various rates and combinations of nitrogen, phosphorus and sulphur fertilizer. The trial was conducted at Indian Head, Yorkton, Melfort, Scott, Swift Current and Outlook. A treatment list is shown in Table 17 which were arranged in a RCBD with four replicates.

Table 17. Treatment list for enhanced fertilizer management for optimizing pea yield and protein.

#	kg N-P_2O_5-K_2O-S/ha
1	0-0-0-0 (no fertilizer)
2	17-0-0-10 (0 P)
3	17-20-0-10 (20 P)
4	17-40-0-10 (40 P / 10 S)
5	21-60-0-10 (60 P)
6	26-80-0-10 (80 P)
7	17-40-0-0 (0 S)
8	17-40-0-5 (5 S)
9	22-40-0-15 (15 S)
10	40-40-0-10 (40 N as MAP/AS/urea)
11[Z]	17.2-40-0-10 + 40 N in-crop broadcast urea
12	40-40-0-10 * (40 N as MAP/AS/ESN)
13	40-80-0-15 * (ultra high fertility / ESN)

[Z] In-crop N broadcast approximately 4-5 weeks after emergence, prior to canopy closure and 1st flowers

*All fertilizer side-banded

Results

Overall, the locations provided a range of yield potentials and were representative of the major field pea producing regions of Saskatchewan while the observed fertilizer responses were largely consistent with past research and current recommendations for western Canada. Soil test P levels for all sites were considered low (≤ 11 ppm, Olsen) and there was evidence of a statistically significant response at 4/6 locations, or 67% of the time. For the responsive sites, the yield increase with P ranged from 11-31% and, when averaged across all six locations, yields were increased by up to 12% with P fertilization and the optimal rate was 40 kg P_2O_5/ha. While responses were occasionally linear with top yields realized at the highest P rate, yield increases beyond the 20 kg P_2O_5/ha rate were never statistically significant and it is unlikely that rates exceeding approximately 40 kg P_2O_5/ha would be justified under most conditions. An important exception could be when the objective of the producer is for long-term building of residual P levels.

Conclusions

Some of the literature cited earlier indicated yield increases of approximately 15% at responsive sites and suggested that responses were likely when soil test levels were below 10 ppm (modified Kelowna extractable P). Sulphur responses have been elusive in past research and this was also true in the current project. Past work has also shown that responses to S are poorly correlated with soil test results. Consequently, if deficiencies have been observed in the past for either field peas or other crops, applying a small amount of S may be justifiable; however, it is unlikely that S deficiency has been an important yield limiting factor for many field pea producers in Saskatchewan. Focussing on N, past research has found that N fertilization can frequently increase vegetative growth in field peas, but positive yield responses are less likely, especially when combined with adequate rhizobial inoculation. Negative protein responses to N fertilization are at least as probable as positive responses. Our results did not show any benefits to N fertilization and, unless residual levels are extremely low or a nodulation failure is suspected, Saskatchewan field pea producers are advised to avoid applying any more N fertilizer than what is provided by any P or S fertilizer products being utilized.

Acknowledgments
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Malt vs Feed Barley Management

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

Description

The objective of this trial was to demonstrate that newer malt varieties can provide comparable yield to the best feed varieties and to demonstrate management practices for the contrasting varieties. The trials were conducted at Yorkton, Redvers, Indian Head, Swift Current, Scott, Outlook, Prince Albert, and Melfort in 2019. The treatment consisted of the two varieties AAC Synergy (malt) and CDC Austenson (feed), seeding rates, and nitrogen rates. A treatment list is shown in Table 18 and were arranged in RCBD with four replicates.

Table 18. Treatment list for malt versus feed barley management.

Trt#	Variety	Seeds/m^2	Lb N/ac soil + Fertilizer
1	AAC Synergy (Malt)	200	80
2	AAC Synergy (Malt)	200	120
3	AAC Synergy (Malt)	200	160
4	AAC Synergy (Malt)	300	80
5	AAC Synergy (Malt)	300	120
6	AAC Synergy (Malt)	300	160
7	CDC Austenson	200	80
8	CDC Austenson	200	120
9	CDC Austenson	200	160
10	CDC Austenson	300	80
11	CDC Austenson	300	120
12	CDC Austenson	300	160

Results

The yield difference between the malt variety AAC Synergy and feed variety CDC Austenson did vary between locations. However, when averaged across location, there was little yield difference between the varieties. There may be little reason to grow a feed variety over AAC Synergy which has a similar yield to the best feed varieties and is gaining acceptance with maltsters. Increasing seeding rate did not increase yield, decrease protein or improve any quality factors for malt barley (Figure 8). However, increasing N did increase protein and tended to decrease % plump. In many cases it was not possible to compare the optimum level of N between the feed and malt varieties. At 5 locations, the yield of both varieties was unresponsive to increasing N levels above 80 lb/ac (soil + applied N). This means the economic level of N for these sites was below 80 lb/ac for both the feed and malt barley varieties. At Yorkton, the most economic level of N for both varieties would have been above 160 lb/ac as yield was highly responsive to added N and protein levels remained relatively low.

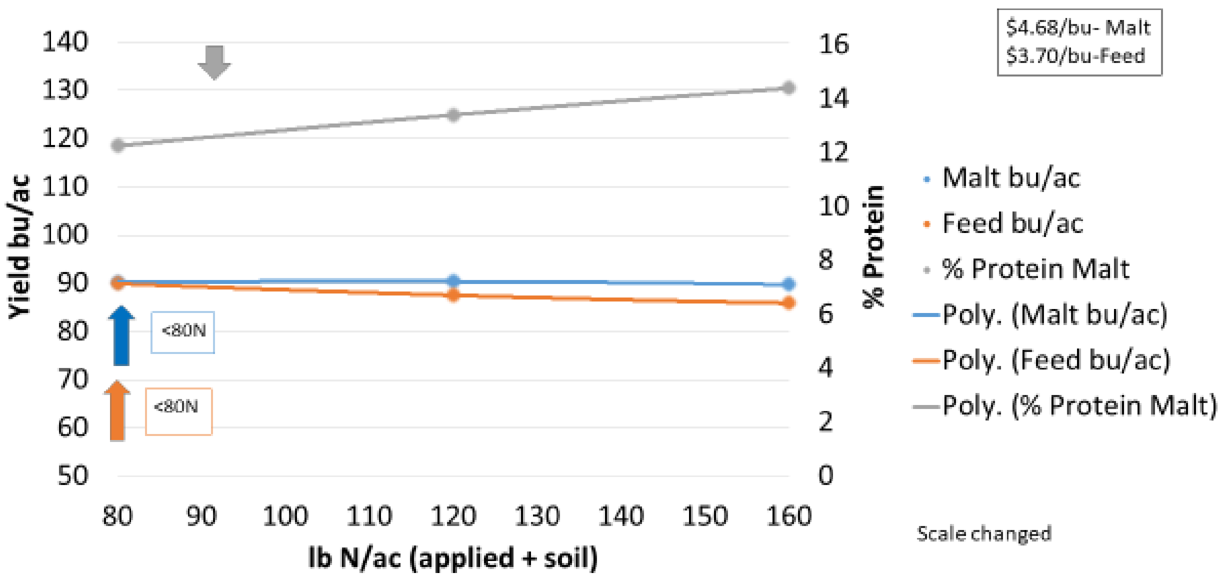

Figure 8. Indian Head yield/protein of AAC Synergy vs Yield of CDC Austenson in 2019.

Conclusions

A fair comparison of the most economic rate of N was only possible at Scott, where the most economic N rate for the malt and feed varieties were 155 and 123 lb/ac, respectively. While there is more risk associated with applying too much N to malt barley, there was little evidence to suggest the most economic rate of N is higher for feed than malt.

Acknowledgements

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Increasing Wheat Protein with a Post Emergent Applications of UAN vs. Dissolved Urea

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

Description

The objective of this trial was to demonstrate the effects of post-emergent nitrogen timing, formulation, and placement method on CWRS wheat grain yield and protein concentrations. This trial was conducted at Yorkton, Swift Current, Indian Head, Melfort, Redvers, Outlook, Scott, and Prince Albert. The treatment list is shown in Table 12 which were arranged in a RCBD with four replicates.

Table 12. Treatment list for Increasing Wheat Protein with Post Emergent Applications of UAN vs. Dissolved Urea.

Treatment #	Seeding	Post emergence application				
	Lb N/ac of Side-banded Urea	N (lb/ac)	Product	%N	method	Stage
1	70	na	na	na	na	na
2	100	na	na	na	na	na
3	70	30	UAN	14	dribble	boot
4	70	30	UAN	28	dribble	boot
5	70	30	UAN	14	dribble	post-anthesis
6	70	30	UAN	28	dribble	post-anthesis
7	70	30	Urea Sol'n	14	dribble	post-anthesis
8	70	30	UAN	14	foliar	post-anthesis
9	70	30	Urea Sol'n	14	foliar	post-anthesis

Results

Wheat yields were highest at Outlook under irrigation, averaging 7507 kg/ha (111 bu/ac) with a grain protein of 12.5%. At Yorkton, Redvers and Melfort yields were relatively high averaging 5780, 5041 and 5179 kg/ha with grain proteins of 12.4, 14.9, and 11.5%, respectively. Swift Current, Scott, Prince Albert and Indian Head had lower yields averaging 3185, 3938, 3753 and 3316 kg/ha and relatively higher proteins averaging 16.9, 14.6, 14.4, and 16.0%, respectively. Increasing side-banded N from 70 to 100 lb/ac increased yield and grain protein at all locations except Redvers, where yield decreased by 8.3% and Swift Current, where protein dropped by 0.9%. Both the loss in yield and protein were unexpected and can only be attributed to experimental variation. However, when averaged across locations, increasing the rate of side-banded urea from 70 to 100 lb N/ac increased yield and protein by 199 kg/ha (2.96 bu/ac) and 0.2%, respectively.

On average, split applications of N at the boot stage did not tend to effect grain yield or protein relative to placing all the N down at seeding (treatment 2 -100 lb N/ac side-banded urea). However, a latter application post-anthesis produced 0.29% more protein and resulted in 2.7% less yield compared to treatment 2 where all N was applied at seeding (Figure 9). Dribble banding UAN at the earlier boot stage did not cause damage to the flag leaf because it did not fully emerge at the time of application. Flag leaf burn from split applications of N post-anthesis were worse with UAN compared to dissolved urea, particularly when applied as a broadcast foliar spray compared to dribble banding. However, differences in yield or protein were not usually detected between applications of UAN compared dissolved urea. In contrast, grain protein tended to be higher with broadcast applications compared to dribble band applications and this difference was large and statistically significant at Indian Head.

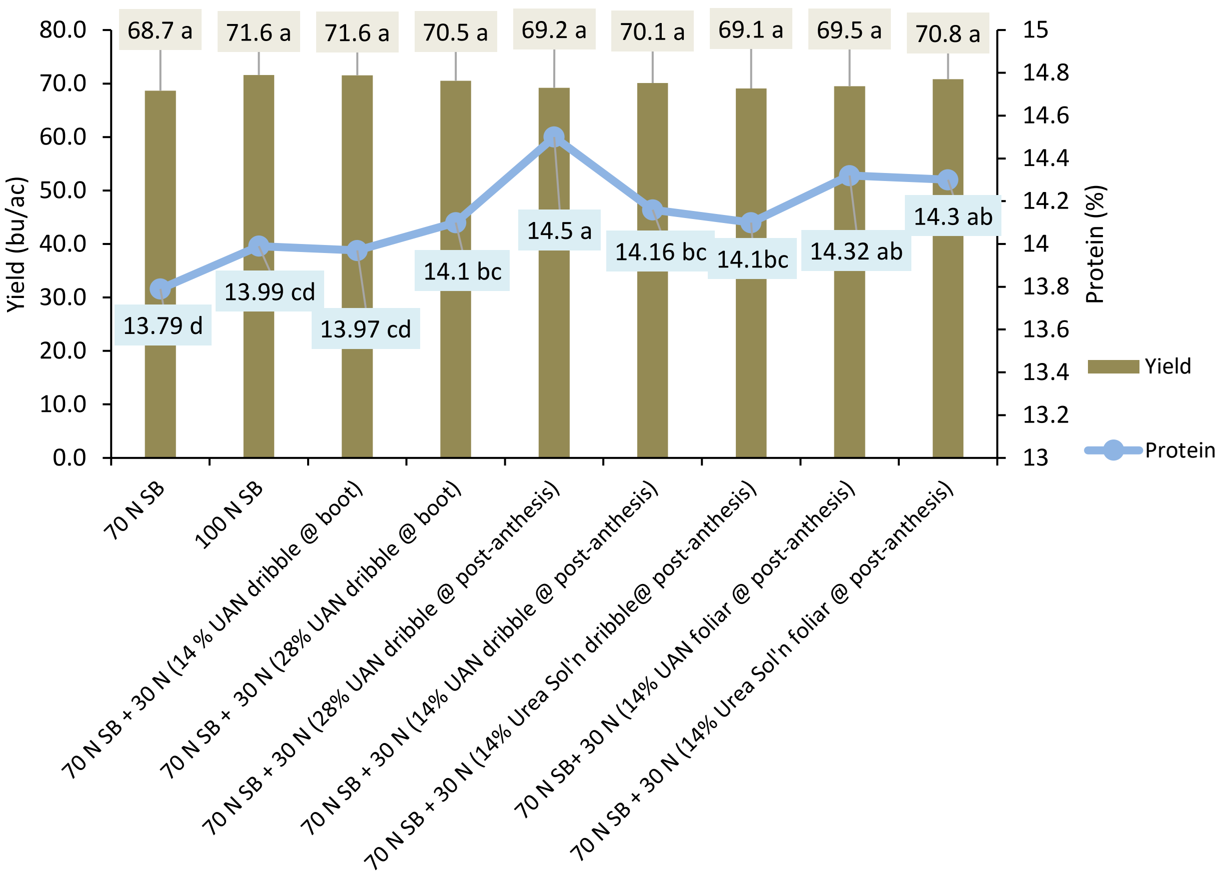

Figure 9. Impact of late season nitrogen on wheat yield and protein.

Conclusions

Split applications of N at the boot stage did not tend to affect yield or protein but a latter application post-anthesis tended to increase protein and decrease yield relative to applying all the N at seeding. While there were many cases were split N resulted in greater grain protein, the lower yield and extra cost of application meant few cases proved economical compared to applying all the N at seeding, even assuming a wide protein spread of 66 cents/%/bu.

Acknowledgements

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Input Study: Intensive Wheat Management

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

Description

The objective of this study was to demonstrate the agronomic and economic responses of CWRS wheat to numerous crop inputs both individually and in various combinations. This small plot research study was conducted at Indian Head, Melfort, Scott, Swift Current, and Yorkton, SK from 2017 to 2019. The study consisted of six wheat varieties from three wheat classes: Canada Western Red Spring (CWRS), Canada Western Soft White Spring (CWSWS), and Canada Prairie Spring Red (CPSR). The varieties from these classes differ in Fusarium Head Blight (FHB) resistance, lodging resistance, maturity, yield, and protein content (Table 20). Each variety was grown under three progressively intensified management levels (Table 21). Together, the six varieties and three management levels were combined to develop a 6 by 3 factorial study with a total of 18 treatments (Table 22).

Table 20. Variety attributes for the Input Study: Intensive Wheat Management at five locations from 2017 to 2019. Source: Saskatchewan Varieties of Grain Crops Guide 2019.

Variety	Class	FHB Resistance	Lodging Resistance	Maturity (days to) [a]	Yield (%) [a]		Protein (%) [a]
					Area 1 & 2	Area 3 & 4	
Carberry	CWRS	Moderately Resistant	Very Good	99	100	100	14.6
AAC Cameron VB	CWRS	Intermediate Resistance	Fair	-2	108	118	-0.6
CDC Utmost VB	CWRS	Moderately Susceptible	Fair	-3	108	112	-0.4
AC Andrew	CWSWS	Intermediate Resistance	Very Good	+2	130	137	NA
SY Rowyn	CPSR	Moderately Resistant	Fair	0	101	106	-0.9
AAC Ryley	CPSR	Moderately Susceptible	Poor	-1	103	110	-1.2

[a] Relative to Carberry

Table 21. Management level descriptions for the Input Study: Intensive Wheat Management at five locations from 2017 to 2019.

Management Level	Seed Treatment	Seeding Rate (seeds/m^2)	Nitrogen Rate (lb N/ac)	Phosphorus Rate (lb P_2O_5/ac)	Fungicide at Flag Leaf	Fungicide at Anthesis	PGR Application
Conventional	No	200	75	25	No	No	No
Enhanced	No	300	98	33	No	Yes	No
Intensive	Yes	360	120	40	Yes	Yes	Yes

Table 22. Six varieties by three management levels for a total 18-treatments in the Input Study: Intensive Wheat Management at five locations from 2017 to 2019.

Treatment #	Variety	Management
1	Carberry	Conventional
2	AAC Cameron VB	
3	CDC Utmost VB	
4	AC Andrew	
5	SY Rowyn	
6	AAC Ryley	
7	Carberry	Enhanced
8	AAC Cameron VB	
9	CDC Utmost VB	
10	AC Andrew	
11	SY Rowyn	
12	AAC Ryley	
13	Carberry	Intensive
14	AAC Cameron VB	
15	CDC Utmost VB	
16	AC Andrew	
17	SY Rowyn	
18	AAC Ryley	

Results

Results indicate that CWRS varieties tended to be more responsive to Intensive management, on the count of a larger response to seed treatment, than CPSR or CSWSW varieties. Enhanced management often led to hastened maturity across all varieties, while varietal selection is also important in order to prevent delayed maturity with Conventional and Intensive management. Intensive management resulted in maximum yield for CWRS and CPSR varieties, while CWSWS were less responsive to this management level (Figure 10). Conversely, CWRS and CPSR varieties were less responsive to management level, while CWSWS benefited the most from Intensive management for building protein.

Conversely, protein levels of CWRS and CPSR varieties were less responsive to management, while CWSWS benefited the greatest from Intensive management. Test weight and seed size differences were largely attributed to genetic differences and any responses to management were of little practical agronomic importance. Fusarium Damaged Kernel (FDK) values were largely reflective of genetic differences, with Enhanced management providing increased control. In the end, CWRS varieties tended to be more profitable than CWSWS and CPSR varieties, with Conventional management providing the best net returns (Table 23). Overall, CWRS varieties tend to be more responsive to changes in management intensity. Although intensive management resulted in the largest yields, Enhanced management hastened maturity and reduced FDK more consistently. However, Enhanced management did not always outperform Conventional economically. Therefore, the results of this experiment indicate that Conventional management of wheat in Saskatchewan continues to provide the best return on investment. Although under some circumstances, Enhanced management can be beneficial and profitable.

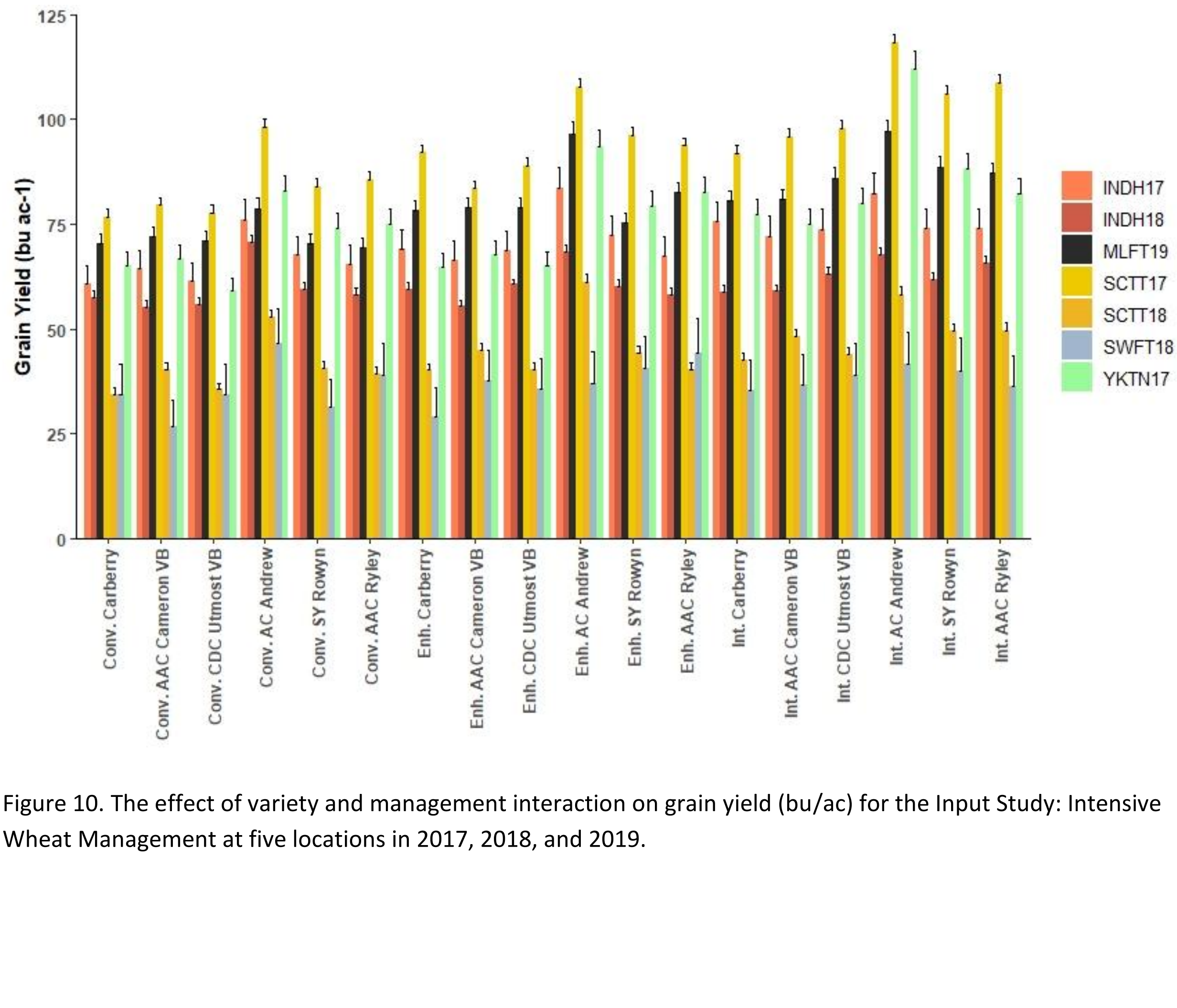

Figure 10. The effect of variety and management interaction on grain yield (bu/ac) for the Input Study: Intensive Wheat Management at five locations in 2017, 2018, and 2019.

Table 23. Influence of variety and management on the 3-year average net return ($/ac) above variable and fixed costs for the Input Study: Intensive Wheat Management at five locations from 2017 to 2019.

Variety	Management	Indian Head	Melfort	Scott	Swift Current	Yorkton	3 Year Avg.
Carberry	Conventional	57.22	108.66	100.60	17.82	175.14	86.52
AAC Cameron VB		46.73	112.49	126.36	-15.80	190.87	85.99
CDC Utmost VB		51.68	145.98	110.79	12.64	174.94	91.44
AC Andrew		2.71	66.21	61.96	-61.68	139.21	32.71
SY Rowyn		-12.07	4.63	37.63	-84.40	97.34	0.13
AAC Ryley		-22.75	12.11	21.96	-54.01	106.98	85.93
Carberry	Enhanced	38.72	77.19	129.08	-31.68	183.74	67.28
AAC Cameron VB		9.45	112.34	113.36	-23.66	179.05	64.45
CDC Utmost VB		41.45	126.28	125.78	-25.03	189.63	76.75
AC Andrew		-35.86	75.64	64.89	-116.70	135.64	9.14
SY Rowyn		-50.26	-7.99	34.28	-93.34	93.98	-17.02
AAC Ryley		-61.15	1.10	19.63	-61.50	102.29	-14.43
Carberry	Intensive	-12.45	48.69	86.40	-84.72	153.61	20.93
AAC Cameron VB		-19.95	67.41	121.62	-98.92	163.19	24.43
CDC Utmost VB		-2.55	88.91	116.94	-67.60	177.35	43.11
AC Andrew		-116.16	48.84	36.09	-173.45	113.84	-41.16
SY Rowyn		-111.45	-25.41	18.94	-144.38	69.20	-57.74
AAC Ryley		-102.70	-40.96	17.46	-162.79	64.08	-66.35
Carberry	Average	27.83	78.18	105.36	-32.86	170.83	58.24
AAC Cameron VB		12.08	97.41	120.45	-46.13	177.70	58.29
CDC Utmost VB		30.19	120.39	117.84	-26.66	180.64	70.43
AC Andrew		-49.77	63.56	54.31	-117.28	129.56	0.23
SY Rowyn		-57.93	-9.59	30.28	-107.37	86.84	-24.88
AAC Ryley		-62.20	-9.25	19.68	-92.77	91.12	1.72
Average	Conventional	20.59	75.01	76.55	-30.91	147.41	63.79
	Enhanced	-9.61	64.09	81.17	-58.65	147.39	31.03
	Intensive	-60.88	31.25	66.24	-121.98	123.55	-12.80
Total	Average	-16.63	56.78	74.65	-70.51	139.45	27.34

Conclusions

Enhanced and Intensive management practices can provide significant benefits for increasing wheat yields. However, the intensity of increased management needs to be considered for each individual operation. In this experiment, many assumptions were made regarding the price and costs associated with wheat production, across various growing areas. Yet each individual farming operation has its own expenses and sale prices. Therefore, it is recommended that each producer uses their own price and cost matrix, using the yields and protein levels for each variety. This will allow producers to develop an expectation as to how varieties and management levels may perform at their operation. Then for the most profitable scenario, use the practices listed in this experiment, to test on farm. Every year continue to do a quick economic analysis to what improvements are made over the producers' typical practices.

Acknowledgements
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Lentil Input Study

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

Description
The purpose of this trial was to provide lentil producers with improved weed control, seeding rate and fungicide recommendations and determine which combination(s) of inputs are most economically feasible. This trial was conducted at Scott, Yorkton, Indian Head, Swift Current and Outlook. The study included three seeding rates (130, 190 and 260 seeds/m^2), three fungicide treatments (none, single, dual application) and two herbicide management practices (pre-seed burn-off vs. pre-seed residual) to total 18 treatments. The pre-seed burn off consisted of glyphosate and the pre-seed residual included glyphosate and Focus® co-formulated. A treatment list is shown in Table 24 which were arranged in a factorial RCBD with four replicates.

Table 24. Treatment list for lentil input study.

#	Seed Rate (seeds/m^2)	Fungicide	Herbicide (Pre)
1	130	No Fungicide	Glyphosate + Focus
2	130	No Fungicide	Glyphosate
3	130	Priaxor	Glyphosate + Focus
4	130	Priaxor	Glyphosate
5	130	Priaxor & Lance WDG	Glyphosate + Focus
6	130	Priaxor & Lance WDG	Glyphosate
7	190	No Fungicide	Glyphosate + Focus
8	190	No Fungicide	Glyphosate
9	190	Priaxor	Glyphosate + Focus
10	190	Priaxor	Glyphosate
11	190	Priaxor & Lance WDG	Glyphosate + Focus
12	190	Priaxor & Lance WDG	Glyphosate
13	260	No Fungicide	Glyphosate + Focus
14	260	No Fungicide	Glyphosate
15	260	Priaxor	Glyphosate + Focus
16	260	Priaxor	Glyphosate
17	260	Priaxor & Lance WDG	Glyphosate + Focus
18	260	Priaxor & Lance WDG	Glyphosate

Results

The results indicated that a pre-seed residual herbicide reduced early season annual weed populations by 66% compared to the traditional pre-seed burn-off strategy. Weed growth was largely influenced by both seeding rate and herbicide application. The least effective weed management strategy was utilizing the current seeding rate recommendation of 130 seeds/m^2 with glyphosate applied alone (Figure 11). If a burn-off strategy is to be used, the seeding rate must exceed 130 seeds/m^2 to reduce weed interference. A residual herbicide application was more effective than glyphosate applied alone at all three seeding rates. The most effective weed management strategy utilized a seeding rate of 190 seeds/m^2 combined with a residual herbicide to reduce weed biomass by 76%. Seeding rate also influenced disease severity throughout the growing season. Disease severity tended to increase with seeding rate (260 seeds/m^2 > 190 seeds/m^2 > 130 seeds/m^2). Seeding rates of 190 seeds/m^2 resulted in disease levels similar to unsprayed lentil at the current seeding rate recommendation (130 seeds/m^2). This indicates that if seeding rates are to increase to 190 seeds/m^2 then fungicide applications are likely required, particularly under moist conditions. Furthermore, dual fungicide applications tended to have the least amount of disease pressure compared to single applications and unsprayed. Yield was also largely influenced by seeding rate with 190 seeds/m^2 resulting in the highest yield compared to seeding rates of 130 and 260 seeds/m^2. A seeding rate of 190 seeds/m^2 also provided the best economic returns, regardless of management strategy. The highest net returns occurred with a seeding rate of 190 seeds/m^2, unsprayed fungicide and a residual herbicide application (Table 25). Although the cost of a fungicide typically reduced net returns compared to the unsprayed, the fungicides should be viewed as a form of insurance rather than an input cost, as disease management is essential for proper lentil production.

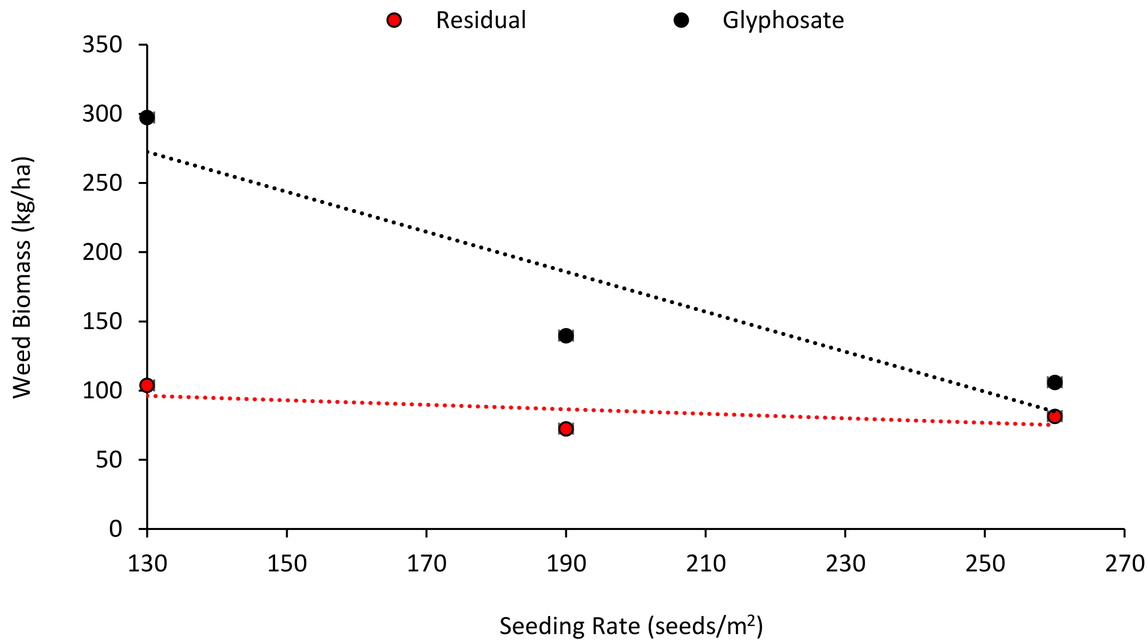

Figure 11. Effect of seeding rate and herbicide applications on weed biomass at physiological maturity. Points represent 11 responsive site years. Line equation for the glyphosate applied alone: $y= -1.445x +460.32$; $R^2= 0.8469$. Line equation for the residual herbicide is $y= -0.1627 x + 117.41$; $R^2= 0.4324$

Table 25. Economic analysis of the production management strategies with yields based on the 15 site-year yield means (kg/ha) with market price fixed at $0.44/kg.

Seeds/m^2	Fungicide & Herbicide Application	Yield (kg/ha)	$/kg	Gross Revenue	Production Expenses	Net Revenue
130	Unsprayed & Glyphosate	2444.7	$ 0.44	$ 1,078	$ 178	$ 900
	Unsprayed & Residual	2500.0	$ 0.44	$ 1,102	$ 215	$ 887
	Single & Glyphosate	2532.3	$ 0.44	$ 1,116	$ 246	$ 870
	Single & Residual	2575.6	$ 0.44	$ 1,136	$ 283	$ 852
	Dual & Glyphosate	2516.3	$ 0.44	$ 1,109	$ 312	$ 797
	Dual & Residual	2527.6	$ 0.44	$ 1,114	$ 349	$ 765
190	Unsprayed & Glyphosate	2604.8	$ 0.44	$ 1,148	$ 203	$ 945
	Unsprayed & Residual	2708.2	$ 0.44	$ 1,194	$ 240	$ 954
	Single & Glyphosate	2715.5	$ 0.44	$ 1,197	$271	$ 926
	Single & Residual	2718.9	$ 0.44	$ 1,199	$ 308	$ 890
	Dual & Glyphosate	2636.6	$ 0.44	$ 1,162	$ 337	$ 825
	Dual & Residual	2673.8	$ 0.44	$ 1,179	$ 375	$ 804
260	Unsprayed & Glyphosate	2651.9	$ 0.44	$ 1,169	$ 229	$ 941
	Unsprayed & Residual	2666.0	$ 0.44	$ 1,175	$ 266	$ 910
	Single & Glyphosate	2615.7	$ 0.44	$ 1,153	$ 296	$ 857
	Single & Residual	2695.8	$ 0.44	$ 1,189	$ 334	$ 855
	Dual & Glyphosate	2609.0	$ 0.44	$ 1,150	$ 363	$ 788
	Dual & Residual	2648.0	$ 0.44	$ 1,167	$ 400	$ 768

Conclusions

The lentils grown in the 15 site- years were generally under drought conditions with limited disease pressure and therefore our results may not reflect the potential economic benefits associated with fungicide applications under a wider range of conditions. Producers can also reduce their risk of yield loss from plant diseases by choosing a cultivar with excellent disease resistance. A second factor to consider is the use of a residual herbicide over a burn-down weed control method like glyphosate applied alone. In this study, there was limited weed pressure (< 58 plants/m^2) and therefore under weedy conditions there would likely be a significant profit associated with a residual herbicide. Furthermore, residual herbicides and herbicide layering are often part of a longer-term weed management strategy, and the benefits of this application may continue to be realized in subsequent years.

Acknowledgements

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Pre-Harvest Options for Straight-Cut Canola

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

Description

The objective of this trial was to demonstrate differences in crop dry-down and fall weed control amongst registered pre-harvest herbicide / desiccant options for straight-combining LL versus RR canola (Liberty Link® - LL and Roundup Ready® - RR). This trial was conducted at Indian Head, Melfort, Scott and Melita from 2017-2019. A treatment list is shown in Table 26 and were arranged in a four replicated RCBD. The intent was to give the earlier pre-harvest applications (glyphosate and saflufenacil) a minimum of 14 days to affect crop dry-down while also harvesting within 14 days of the later applications (i.e. diquat and glufosinate ammonium); however, actual timings of operations varied. The challenge was to find the right balance between giving the pre-harvest applications enough time to work while also harvesting the plots early enough that treatment effects (i.e. differences in whole plant and seed moisture content) would still be evident. In many cases, this meant harvesting when some plots were still relatively tough/green; however, in some, the canola dried down rapidly, and harvest was completed relatively early after the treatment applications (i.e. 10 days at Melita 2019). In other cases, cold, wet late-season weather delayed maturity, treatment applications and harvest; thus, diminishing our ability to detect treatment differences (i.e. Melfort 2019).

Table 26. Treatment list for pre-harvest options for straight-combining canola trial.

Entry	Hybrid	Treatments	Rate	Volume
1	LL (L255PC)	Control	—	—
2 [Z]	LL (L255PC)	Roundup Transorb HC (glyphosate) [Z]	0.67 l/ac (890 g ai/ha)	96 l/ha (minimum)
3 [Z]	LL (L255PC)	Heat LQ (saflufenacil) + Merge [Z]	59 ml/ac (50 g ai/ha) + 0.4 l/ac	192 l/ha (minimum)
4 [Z]	LL (L255PC)	Roundup Transorb HC (glyphosate) + Heat LQ (saflufenacil) + Merge [Z]	0.67 l/ac (890 g ai/ha) + 59 ml/ac (50 g ai/ha) + 0.2 l/ac	192 l/ha (minimum)
5 [Y]	LL (L255PC)	Reglone Ion (diquat) [Y]	0.81 l/ac (400 g ai/ha)	192 l/ha (minimum)
6	RR (45M35)	Control	—	—
7	RR (45M35)	Good Harvest (glufosinate ammonium) [Y]	1.1 l/ac (408 g ai/ha)	192 l/ha (minimum)
8	RR (45M35)	Heat LQ (saflufenacil) + Merge [Z]	59 ml/ac (50 g ai/ha) + 0.4 l/ac	192 l/ha (minimum)
9	RR (45M35)	Roundup Transorb HC (glyphosate) + Heat LQ (saflufenacil) + Merge [Z]	0.67 l/ac (890 g ai/ha) + 59 ml/ac (50 g ai/ha) + 0.2 l/ac	192 l/ha (minimum)
10	RR (45M35)	Reglone Ion (diquat) [Y]	0.81 l/ac (400 g ai/ha)	192 l/ha (minimum)

[Z] Target 60-70% seed colour change (if hybrids are reasonably similar apply treatments 2, 3, 4, 8 and 9 same day)

[Y] Target 80-90% seed colour change (if hybrids are reasonably similar apply treatments 5, 7 and 10 same day)

Results

Glyphosate is registered as a pre-harvest herbicide, not specifically as a crop desiccant; therefore, growers should not expect any support if this product fails to meet expectations for canola plant and seed dry-down. That being said, pre-harvest glyphosate at least marginally reduced whole plant moisture content in LL canola 67% of the time (8/12 site-years) and reduced seed moisture content 50% of time (6/12 site-years). When averaged across all locations, whole plant moisture was reduced from 29% to 24% while seed moisture was reduced from 9.9% to 8.7%.

Glufosinate-ammonium is not a registered pre-harvest option for canola, and to our knowledge, there is no indication that it will become one in the foreseeable future; however, it was registered for this purpose in the 1990s (i.e. Harvest, 1995 Saskatchewan Crop Protection Guide). The performance of this product was somewhat variable with at least marginally significant reductions in whole plant moisture content 45% of the time (5/11 site-years) and seed moisture 36% of the time (4/11 site-years).

Saflufenacil is a registered harvest aid for canola with potential to provide crop dry-down benefits for all canola herbicide systems. Saflufenacil is usually tank-mixed with glyphosate, providing excellent weed control benefits and, for non-glyphosate tolerant canola, dual modes of action to assist in crop dry-down. In order to distinguish between the effects of glyphosate and saflufenacil in LL canola, it was applied both alone and as a tank-mix. When evaluated in this manner, saflufenacil at least marginally reduced whole plant moisture 33% of the time (4/12 site-years) and seed moisture 25% of the time. Averaged across all site-years and both canola herbicide systems (regardless of whether the response was significant), saflufenacil (applied alone) reduced whole plant moisture content from 29% to 27% and seed moisture content from 10.0% to 9.3%.

Of the pre-harvest options for straight combined canola that were evaluated, diquat is a desiccant in the truest form working purely on contact and taking effect rapidly but with limited weed-control benefits, especially for perennials. With respect to whole plant and seed dry-down, diquat performed consistently well for both canola herbicide systems and generally better than any of other options evaluated, especially when considered across the broad range of environmental conditions encountered. Averaged across hybrids, diquat reduced whole plant moisture content 83% of the time (10/12 site-years) and seed moisture 67% of the time (8/12 site-years). When averaged across hybrids and site-years, diquat reduced whole plant moisture content from 29% to 22% and seed moisture content from 10.0% to 8.2%.

Conclusions

Overall, this project has improved our understanding of how straight-combined canola responds to various pre-harvest herbicide/desiccation options with a focus on whole plant and seed dry-down. Despite the reductions in seed and plant moisture that were frequently observed, glyphosate is initially slow and less likely to improve harvestability in drier falls or when applied at later crop stages. When saflufenacil was tank-mixed with glyphosate, the effects on crop dry-down were similar to when saflufenacil was applied alone with glyphosate tolerant canola and usually similar to glyphosate applied alone in glufosinate ammonium tolerant canola. While there appears to be some potential for enhanced crop-down with glyphosate plus saflufenacil versus glyphosate alone for LL canola, the benefits (relative to glyphosate applied alone) were inconsistent and may not always justify the higher cost of the tank-mix. For RR canola, saflufenacil effects on crop dry-down were also variable (particularly compared to diquat); however, glyphosate plus saflufenacil is the best available option for RR canola growers who prioritize both fall weed control benefits and potential for accelerated crop dry-down. With regard to seed quality, diquat was unique compared to the other products in that it frequently resulted in elevated green seed levels relative to the other treatments. In any of the cases where green seed levels were high enough to result in downgrading it could, however, be attributed to the diquat being applied too early. Nonetheless, this is an indication of how important proper staging is and how sensitive canola can be to down-grading if diquat is applied before the recommended crop stage. While no other products had the impact on green seed that we saw with diquat, various options did occasionally result in reduced seed size; however, such effects tended to be infrequent and inconsistent.

Acknowledgements
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Improved Integrated Disease Management for Oats

Pratchler, J. (NARF), Hall, M. (ECRF), Holzapfel, C. (IHARF), McInnes, B. (NARF), Shaw, L. (SERF), Catellier, C. (IHARF)

Description

The objective of this study was to understand the effectiveness of fungicide application in addition to genetic resistance to control foliar disease in contrasting oat varieties at varying seeding rates. The trial was conducted at Melfort, Indian Head, Revers and Yorkton. A treatment list is shown in Table 27 and were arranged in a split plot design with four replicates.

Table 27. Treatment list for improved integrated disease management for oats trial.

#	Fungicide (main plots)	Variety [Z] (sub-plots)	Seeding Rate (sub-plots)
1	Untreated	CS Camden	300 seeds/m^2
2	Untreated	CS Camden	450 seeds/m^2
3	Untreated	Summit	300 seeds/m^2
4	Untreated	Summit	450 seeds/m^2
5	0.28 l Caramba/ac at Flag Leaf	CS Camden	300 seeds/m^2
6	0.28 l Caramba/ac at Flag Leaf	CS Camden	450 seeds/m^2
7	0.28 l Caramba/ac at Flag Leaf	Summit	300 seeds/m^2
8	0.28 l Caramba/ac at Flag Leaf	Summit	450 seeds/m^2
9	0.40 l Caramaba/ac at Heading	CS Camden	300 seeds/m^2
10	0.40 l Caramaba/ac at Heading	CS Camden	450 seeds/m^2
11	0.40 l Caramaba/ac at Heading	Summit	300 seeds/m^2
12	0.40 l Caramaba/ac at Heading	Summit	450 seeds/m^2

[Z] Camden - higher yield potential but poorer disease resistance; Summit – lower yield potential but better disease resistance

Results

Generally, fungicide application and timing, variety, seeding rate, and their interactions resulted in mixed outcomes across site-years. Averaged over the two years, the varietal differences were not significant on plant population. As expected, increasing the seeding rate by 150 seeds/m^2 resulted in significant increases in plant population. On average, the difference between the two seeding rates was 100 plants/m^2. Overall, plant populations were significantly different between the two seeding rate treatments but similar between the two varieties. Therefore, it is anticipated that any effect plant population will have on subsequently measured variables, will solely be due to differences in plant population caused by seeding rate.

Plant populations themselves tended to influence tiller and panicle development more than variety or seeding rate. At some site-years, there were more tillers and panicles due to lower plant populations that were established due to dry early season growing conditions. Therefore, any influence on tillering and panicle development is largely a function of the initial plant population developed by the growing environment of the individual location. For example, if conditions were such that the plant population was lower than anticipated, there will be a large number of tillers and panicles that develop. Tillers and panicle densities were largely unaffected by variety and seeding rate.

Fungicide application did not have a consistent effect on leaf spot diseases in oats, with results being mixed where significant effects were found (Table 28). When disease pressure was lower and in initial stages, both varieties had similar disease levels. However, as time progressed and disease pressure increased, CS Camden tended to have 3 to 7% greater disease than Summit. The agronomical impact of this difference can vary and will depend on the total disease severity and growing conditions. However, this does suggest that both varieties have reasonably similar resistance to leaf spot diseases. In some cases, increasing the seeding rate to 450 seeds/m^2 resulted in 5 to 12% increases in disease compared to the lower seeding rate.

Table 28. Statistical summary of treatment effects on final leaf spot diseases (%) at the milk stage of development for the improved integrated disease management for Oats (*Avena sativa* L.) in Saskatchewan study at four locations from 2018 to 2019.

	Indian Head (IH) [z]	Melfort (ME) [z]	Redvers (RD) [z]	Yorkton (YK) [z]
	---------- *2018* ----------			
Fungicide (F)	0.2598	0.3164	NA	NA
Variety (V)	<0.0001***	0.4160	NA	NA
Seeding Rate (R)	<0.0001***	0.0184*	NA	NA
F X V	0.0492*	0.0606	NA	NA
F X S	0.0723	0.2850	NA	NA
V X S	0.3099	0.6245	NA	NA
F X V X S	0.3407	0.3869	NA	NA
	---------- *2019* ----------			
Fungicide (F)	0.0316*	0.0370*	NA	0.3022
Variety (V)	<0.0001***	0.0411*	NA	0.1994
Seeding Rate (R)	0.0541	0.1597	NA	<0.0001***
F X V	0.2293	0.6192	NA	0.8299
F X S	0.5331	0.1703	NA	0.0519
V X S	0.0012**	0.1504	NA	0.0015**
F X V X S	0.9750	0.1256	NA	0.5585

[z] ***p<0.0001; **0.001<p>0.01; *p<0.05

Conclusions

Generally, responses to the integrated disease management practices tested were minimal and likely of little agronomic or economic importance. Response to fungicide was not consistent and fungicide applications were often not effective. However, fungicide did not present any negative consequences to lodging, maturity, TKW, or most milling qualities. There is some suggestion that fungicide application at heading can be effective for increasing groat, and decreasing seed borne *Fusarium* poae and *Cochliobolus sativus.* Variety selection and seeding rates continue to be important integrated disease management factors.

Acknowledgments

This project was funded by Agricultural Development Fund supported by the Saskatchewan Ministry of Agriculture and the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement, Saskatchewan Oat Development Commission, and the Western Grains Research Foundation.

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 was conducted in the Indian Head area for three growing seasons. There are no treatments or experimental manipulation; producers manage their fields as usual. The 2019 season was the second year of study and included 59 sample sites, within 18 different fields, managed by six different producers in the Indian Head area. The fields should be approximately 160 acres in area but can be part of larger management units. The precise location of representative sample sites was identified and recorded for each field, usually 3 or 4 samples sites per 160 ac field. As each producer had 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.

Results

The purpose of the data exploration was to identify trends, correlations and potential relationships in the data that could be pursued in future analyses. An example of the trends and correlations explored is shown in Figures 12 and 13. In Figure 1 we see contrasting canola emergence patterns in response to seeding date in different years. In 2018, both early- and late-seeded fields emerge quickly, but late-seeded fields end up with a greater percent emergence. In 2019, early seeded crops were slower to emerge but final percent emergence was similar between early- and late-seeded. In Figure 2, we see that regardless of final percent emergence in any year, canola seeded on cereal stubble is quicker to emerge, but levels off quicker than canola seeded on pea stubble. We can see how the two factors examined here, seeding date and stubble type, could interact with each other and with environmental conditions to influence canola emergence. It is important to remember that this is a simple data exploration exercise and is not statistically valid, as the data are unbalanced, and replication is low at this stage.

In regard to disease development in canola, relationships were less apparent with univariate data exploration approaches, indicating that there are likely many variables at play. We did observe that there was a significant difference in visual blackleg symptoms between different operations, indicating a strong management influence.

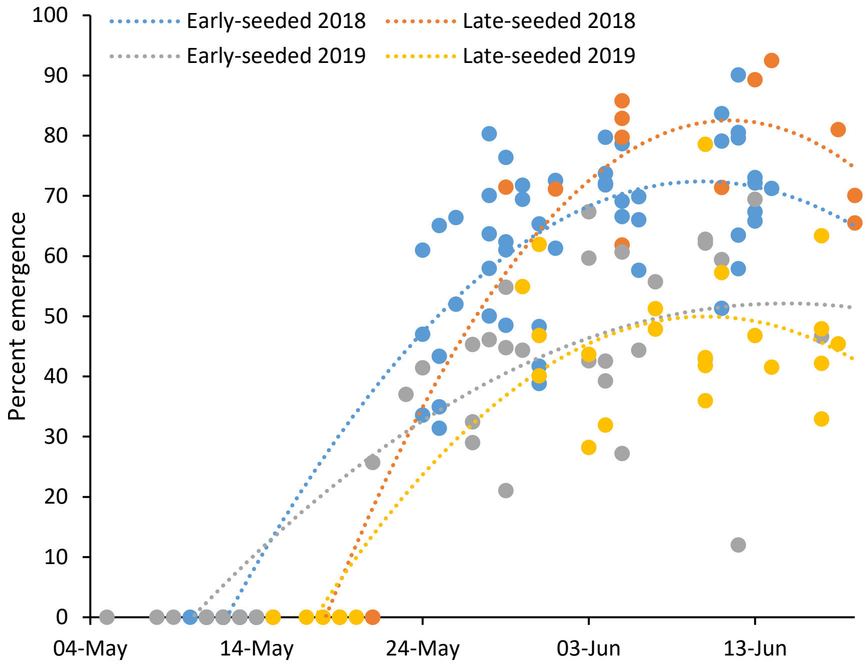

Figure 12. The relationship between seeding date and canola emergence over time in the Indian Head area in 2018 and 2019.

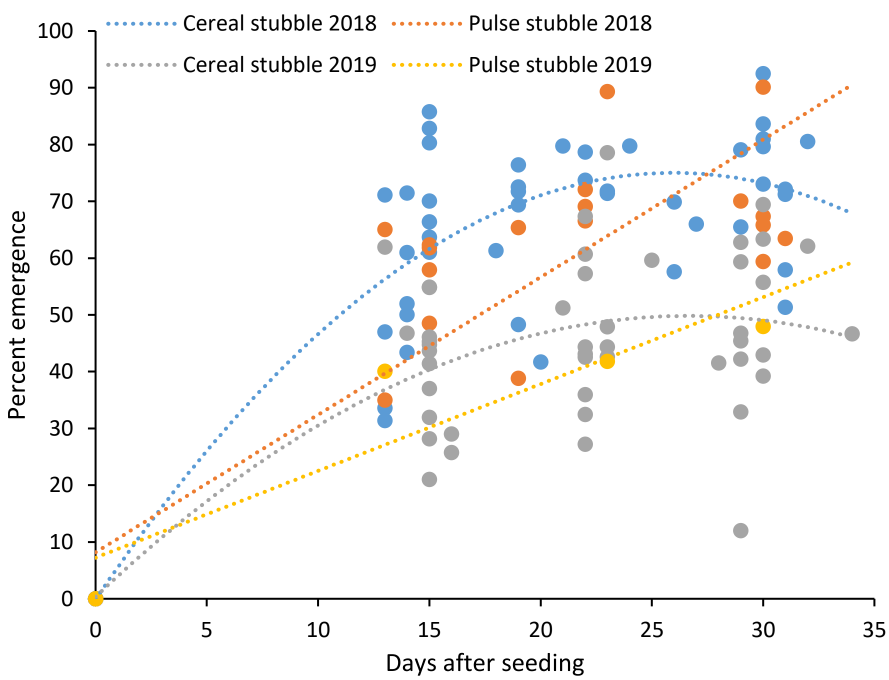

Figure 13. The relationship between stubble type and canola emergence over time in the Indian Head area in 2018 and 2019.

Conclusions
Results from year one of this study are preliminary. This study will be repeated in the 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), and 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. This study consists of a nested/hierarchical design using multivariate observational data. 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. The 2019 season was the second year of study and included 105 sample sites, within 30 different fields, managed by 10 different producers in the three regions. The fields should be approximately 160 acres in area but can be part of larger management units. The precise location of representative sample sites was identified and recorded for each field, usually 3 or 4 samples sites per 160 ac field, where successive measurements were taken throughout the growing season. As each producer or operation had multiple fields of wheat that they seed successively in the spring, this provided a range of environmental conditions for each replicate (operation, field, sample site) at time of seeding, during seedling establishment, and throughout the growth stages of the crop.

Results
FHB symptoms and % FDK varies among producers within sites, between sites, and between years, indicating both a management and an environmental influence (Figure 14). Within locations, % FDK did not appear to be affected by the number of FHB-susceptible crops in the rotation. Both within year and within location, % FDK tended to be lower in farm-saved seed compared to certified seed. Percent FDK was similar between row spacings in 2018 but tended to be lower with 12” spacing in 2019. FDK level also differed between row spacings within locations, but not consistently. Furthermore, the data exploration revealed a low level of variability within other categorical variables, for example CWRS variety, seed treatment, and fungicide product. It is important to note that this is a simple data visualization and exploration exercise, and these results are not confirmatory. The relationships may

differ when nesting and unbalanced data are considered, and when several variables are examined simultaneously.

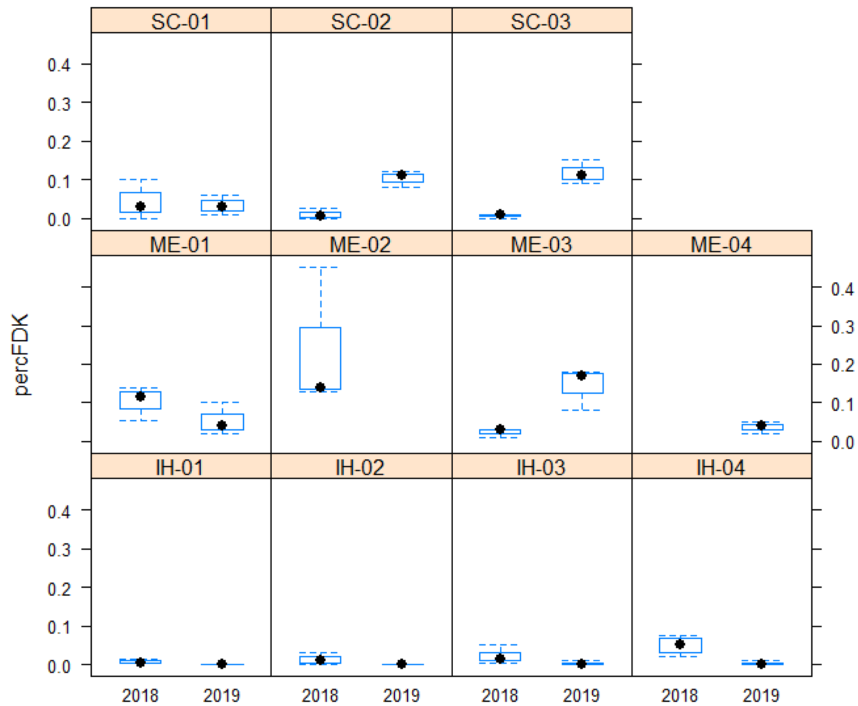

Figure 14. The distribution of % Fusarium damaged kernels (FDK) by year and producer. 'SC' indicates producers located in Scott, 'ME' in Melfort, and 'IH' in Indian Head.

Conclusions

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

Acknowledgements

Funding was provided by 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.

Can Farmer Saved Seed of Wheat Perform as Well as Certified Seed?

Hall, M. (ECRF), Sorestad, H. (ECRF), Lokken, R. (CLC), Catellier, C. (IHARF), Pratchler, J. (NARF), Shaw, L. (SERF), Hnatowich, G. (ICDC), Weber, J. (WARC) and Nybo, B. (WCA)

Description

The objective of this project was to evaluate the performance of a farm-saved seed compared to certified seeds of different wheat varieties, with or without seed treatments. This is a three-year study, with 2019 being the first season of trials which were conducted at Yorkton, Indian Head, Redvers, Swift Current, Outlook, Scott, Melfort and Prince Albert. The treatments were a 3-way factorial RCBD with four replicates. A treatment list is shown in Table 29.

Table 29. Treatment list for farmer-saved seed wheat trial.

Trt #	Seed treatment	Variety pairing & Seed lot	Seed type
1	Untreated	A – Brandon (LL Seeds)	Certified
2	Untreated	A – Brandon (Brand)	FSS
3	Untreated	B – Brandon (Sandercock)	Certified
4	Untreated	B – Brandon (Stillborn)	FSS
5	Untreated	C – Elie (Blenkin)	Certified
6	Untreated	C – Elie (Gray)	FSS
7	Treated	A – Brandon (LL Seeds)	Certified
8	Treated	A – Brandon (Brand)	FSS
9	Treated	B – Brandon (Sandercock)	Certified
10	Treated	B – Brandon (Stillborn)	FSS
11	Treated	C – Elie (Blenkin)	Certified
12	Treated	C – Elie (Gray)	FSS

Results

Positive effects of seed treatment on emergence, seedling vigor and grain protein were observed at Swift Current. However, there were a couple instances at Yorkton and Indian Head where seed treatment adversely affected yield. In most instances seed treatment did not affect emergence, seedling vigor, yield or grain protein of wheat. Overall, seed quality was very good for both farmer saved seed and certified seed lots. However, levels of seed borne disease tended to be more variable on farmer saved seed. One seed lot of farmer saved seed had total Fusarium levels beyond acceptable levels. Despite this, the overall vigor of farmer saved seed lots were no different from certified seed. Few significant differences in emergence, seedling vigor, yield or grain protein were observed between planting farmer saved seed and certified seed. As a result, growing farmer saved seed would have been more economical because of the added cost of purchasing certified seed.

Conclusions

Growing FSS was more economical in this study because there was no yield or protein increase compared to growing certified seed and there is usually an added cost to purchasing certified seed.

However, there is value in purchasing certified seed, to assure quality (true to type) for end users and to introduce better genetics to the farm to stay competitive. This study does not conclude that there is no value in purchasing certified seed only that there were no production risks to growing FSS during 2019. Growing FSS for a couple years between purchasing new certified varieties with better genetics may prove to have little risk to production. This would appear to be the approach of many producers as approximately 70 to 80% of cereal acres in western Canada were seeded with FSS in 2004 based on a phone survey of 800 producers. Initial results would indicate that wheat producers who use quality control measures similar to those required for certified seed can produce grain yield and protein comparable to that of certified seed.

Acknowledgements
This project was funded through the Saskatchewan Wheat Development Commission.

Effect of Increased Seeding Density on Weed Competition and Late Season Regrowth in Spring Wheat and Durum

Benzil, C. and Jacob, C. (SK Ministry of Ag.), Holzapfel, C. (IHARF)

Description

The objective of this trial was to collect current data on seeding rates and row spacing in spring wheat or durum (where durum is realistically grown) to demonstrate the impact that this can have on weed management and as well as yield and quality parameters. A treatment list is shown in Table 30 which were arranged in a RCBD with four replicates. Tame oats (non-dwarfing) and yellow mustard were cross seeded through all plots at a target rate of 20 seeds/m^2 prior to seeding wheat.

Table 30. Treatment list for row spacing and seed rate effects on weed competition and late season regrowth in spring wheat and durum.

Trt #	Row Spacing (main plots)	Seed Rate (sub-plots)
1	10” (25.4 cm)	75% (203 seeds/m^2)
2	12” (30.5 cm)	100% (270 seeds/m^2)
3	14” (35.6 cm)	150% (405 seeds/m^2)
4	16” (40.6 cm)	200% (540 seeds/m^2)

Results

Early season weed biomass increased slightly with row spacing but was unaffected by seeding rate. Overall weed dry matter yields were relatively low, due in part to timing of the measurements and also the dry weather. The visual weed assessments showed a slight increase in weeds with increasing row spacing and the opposite with increasing seeding rate (Figure 15). Plant density slightly declined with increasing row spacing and as expected, a strong linear increase in populations with increasing seeding rate. Averaged across row spacing levels, the actual plant densities ranged from 204 seeds/m^2 (at 203 seeds/m^2) to 412 seeds/m^2 (at 540 seeds/m^2). Head densities were largely unaffected by row spacing but increased linearly with seeding rate. There was an interaction between row spacing and seeding rate for head density; however, the nature of the interaction was inconsistent with no readily apparent or logical explanation. The number of tillers per plant was not affected by row spacing but as expected, decreased linearly as seeding rate was increased. Averaged across row spacing levels, the number of spikes per plant fell from 2.5 to 1.6 when seeding rate was increased from the lowest to the highest rate. Maturity increased quadratically with increasing row spacing and decreased quadratically with increasing seeding rate, but the overall effects were fairly minor and of little practical importance. A slight decline in grain yield with increasing row spacing was detected but seeding rate had no effect. While the observed row spacing effects are somewhat inconsistent with other recent studies, they were not entirely unexpected given the heavy weed pressure in this particular field trial. The observed yield loss at 36 cm spacing relative to 25 cm was 180 kg/ha (2.7 bu/ac) or 5%. Head length was not affected by row spacing but decreased linearly with increasing seeding rate. This result may have been due in part to the drier conditions and also helped to explain the lack of seeding rate effects on seed yield. Ability to compete (ATC) values (100% - Dockage%) were calculated as an indicator of how the treatments affect the ability to wheat to out-compete weeds. The observed dockage consisted primarily of tame oats and ATC decreased linearly with increasing row spacing and increased quadratically with increasing seeding rate. The quadratic seeding rate effect indicated that ATC improved with seeding rates up to 405 seeds/m^2 but there was little benefit to further increases to 540 seeds/m^2. Seed weight was 34.6 g/1000 seeds on average and not affected by either row spacing or seeding rate. The effects on test weight were small and of relatively little practical importance but there was a slight linear decline in test weight as row spacing increased and an increase in test weight with increasing seeding rate.

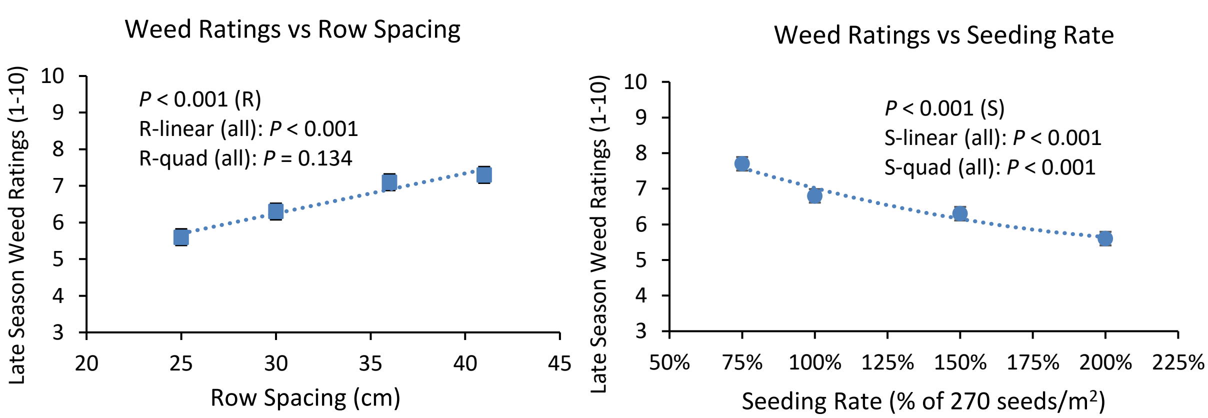

Figure 15. Wheat row spacing and seeding rate effects on visual weed assessments at maturity at Indian Head in 2019. Higher values indicate more weeds. Error bars are the standard errors of the treatment mean (S.E.M.).

Conclusions

The results indicated that the combination of narrower row spacing and higher seeding rates allowed wheat to best compete under heavy weed pressure. While most producers would use in-crop herbicides and there are many good options for wheat, these results support the hypothesis that narrow row spacing and higher seeding rates can help to reduce our reliance on these products, potentially slowing the development of herbicide resistance when combined with other recommended practices.

Acknowledgements
This project was supported by the Strategic Field Program initiative under the Canadian Agricultural Partnership bi-lateral agreement between the federal government and the Saskatchewan Ministry of Agriculture.

Evaluating the Interaction of Management and Environment on Crop Production in Western Canada using Producer-Reported Data for Various Crops

Catellier, C. (IHARF)

Description

The objective of this project was to conduct an analysis of producer-reported management data obtained from the Saskatchewan Crop Insurance Corporation (SCIC), in conjunction with environmental (soil and weather) data to examine: 1) the interacting effects of seeding date and environmental conditions on crop yields in Saskatchewan; and 2) the interacting effects of crop rotation and environmental conditions on crop yields in Saskatchewan.

Producer-reported data was obtained from SCIC upon signing a data-sharing agreement. The data set encompassed data on all insured crops grown in Saskatchewan from 2009-2018, reported by quarter section. The reported variables included the year, RM, land location, producer ID number, crop and variety, seeding date, and yield.

An in-depth literature review was conducted to identify potentially influential environmental variables. Environmental data were gathered from other third-party sources (SCIC weather data, Environment Canada, SKSIS). Data from all sources were aggregated into a single database such that new variables could be calculated (e.g. GDD, rainfall evenness, frequency of broadleaf crops in 4-year rotation, etc.), based on findings from the literature review.

Results

To date, most of the data has been compiled and organized, and literature is being reviewed to determine which new variables should be calculated. The full data set will need to be aggregated into a database prior to data exploration and statistical analysis. There are no results to report at this time.

Conclusions

Progress on the project was delayed as a result of reasons both related and unrelated to covid-19.

Acknowledgements
This project was funded by WGRF.