IHARF
INDIAN HEAD AGRICULTURAL RESEARCH FOUNDATION

2020 Annual Report




IHARF

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Contents

Introduction

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

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

IHARF Mandate

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

IHARF Board of Directors

IHARF is led by a nine-member Board of Directors consisting of producers and industry stakeholders who volunteer their time and provide guidance to the organization. Residing all across southeastern Saskatchewan, IHARF Directors are dedicated to the betterment of the agricultural community as a whole. The 2020 IHARF Directors included:

- Cameron Gibson - President *(Indian Head)*
- Rick Procyk - Vice President *(Filmore)*
- Kyle Heggie - Secretary / Treasurer *(Leross)*
- Curtis Russell *(Indian Head)*
- Heather Haus *(Glenavon)*
- Janel Delage *(Indian Head)*
- Dean Douhaniuk *(Killaly)*
- Thom Weir *(Yorkton)*
- Winston van Staveren *(Creelman)*

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 2020 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
- Dylan Sebastian - Research Technician
- Dan Walker - Seasonal Technician
- Vlad Sheshnev - 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 2020 was Amanda Fedorchuk. Amanda was working towards her master's degree at the University of Saskatchewan, looking at pre-emergent herbicide and integrated weed management.

Extension Events

Indian Head Crop Management Field Day

Indian Head Crop Management Field Day in 2020 was cancelled due to COVID-19 restrictions.

AgriARM Research Update

IHARF, along with Agriculture Applied Research Management (AgriARM) sites from across the province, jointly hosted the virtual AgriARM Research Update in late winter 2021. The event highlighted components of each organizations applied research and demonstration programs.

IHARF Soil and Crop Management Seminar

On February 3, 2021, IHARF hosted its annual winter seminar in online platform, highlighting the results of 2020 season and current industry issues. 203 registrations took in including 175 viewers plus 40 post webinar views. Presentations were delivered by:

- Bill May (AAFC Indian Head)
- Chris Holzapfel (IHARF)
- Christiane Catellier (IHARF)
- Clark Brenzil (Saskatchewan Ministry of Agriculture)

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

2020 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 2020:

Platinum

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

Gold

- Agriculture Development Fund
- Alberta Agriculture Funding Consortium
- Alberta Wheat Commission
- Anuvia Plant Nutrients
- Koch Agronomic Services
- Manitoba Pulse & Soybean Growers
- Mosaic
- Saskatchewan Pulse Growers
- Saskatchewan Strategic Field Program
- Saskatchewan Barley Development Commission
- Syngenta

Silver

- Albaugh
- Belchim
- Crop Intelligence by South Country
- Fertilizer Canada
- NorthStar Genetics
- Novozymes BioAg
- Saskatchewan Oat Development Commission
- York Potash

Bronze

- Ag Action Manitoba
- CanMar Farms Indian Head
- Corteva Agriscience
- Delage Farms
- FP Genetics
- GrainShark.com
- Koch Agronomic Services
- LL Seeds
- Manitoba Crop Alliance
- Northland Seeds
- Nutrien Ag Solutions
- Richardson Pioneer
- 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

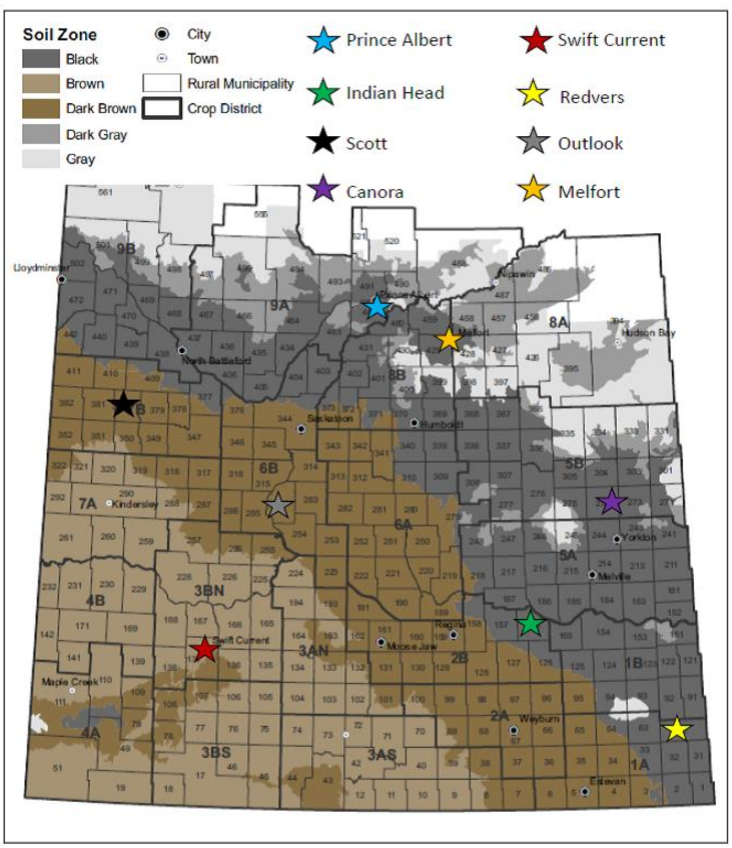

Figure 1. Locations of organizations comprising the Saskatchewan AgriARM Network.

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].

Weather data for May through September 2020 is presented relative to the long-term (1981-2010) normal in Tables 1 and 2. Overall growing season temperatures were near normal at Indian Head, Scott, and Swift Current (Table 1). At Melfort, June was cooler than normal while July and August were warmer than normal. All locations except Scott were drier than average when the full growing season was considered (Table 2). Indian Head was the driest location with only 113 mm from May-August, or 46% of average. Scott was the exception receiving 118% of its long-term average precipitation, or 258 mm, over the four-month period. July was the wettest month at Scott with 123 mm of precipitation during that month alone while August was the driest with approximately 25 mm, slightly below half of the long-term average.

Table 1. Mean monthly temperatures for the 2020 growing season and long-term normals (1981-2010).

		May	June	July	August	September	Average
				˚C			
Indian Head	2020	10.7	15.6	18.4	17.9	11.5	14.8
	Normal	10.8	15.8	18.2	17.4	11.5	14.7
Melfort	2020	10.1	14.3	18.8	17.6	10.8	14.3
	Normal	10.7	15.9	17.5	16.8	10.8	14.3
Scott	2020	9.9	14.8	17.2	16.3	10.8	13.8
	Normal	10.8	14.8	17.3	16.3	10.4	13.9
Swift Current	2020	10.4	15.5	18.1	19.4	13.0	15.3
	Normal	11.0	15.7	18.4	17.9	12.0	15.0

Table 2. Total monthly precipitation for the 2020 growing season and long-term normals (1981-2010).

		May	June	July	August	September	Total
				mm			
Indian Head	2020	27.3	23.5	37.7	24.9	15.0	128.4
	Normal	51.7	77.4	63.8	51.2	35.3	279.4
Melfort	2020	26.7	103.7	52.4	18.5	21.2	222.5
	Normal	42.9	54.3	76.7	52.4	38.7	265.0
Scott	2020	51.9	55.9	123.0	27.0	31.3	289.1
	Normal	36.3	61.8	72.1	45.7	36.0	251.9
Swift Current	2020	30.0	70.9	52.6	3.3	23.5	180.3
	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.

Winter Wheat Response to Contrasting Nitrogen Fertilizer Placement and Timing Options

Holzapfel, C. (IHARF)

Description

The objective of this project was to demonstrate winter wheat responses to N rate when all the N was applied as urea either in a sideband, early-spring broadcast, or a split-application with 50% of the N side-banded, and the remainder as an early season broadcast application. A field trial with winter wheat was initiated in 2018-2019 at Indian Head and repeated for the following season (2019-2020). The treatments were a factorial combination of three N fertilizer placement/timing strategies and five N fertilizer rates (Table 5). A control treatment where N fertilizer was applied at the rate of 7 kg N/ha from seed-placed monoammonium phosphate (11-52-0) was also included. The treatments were arranged in a RCBD with four replicates.

Table 5. Winter wheat nitrogen fertilizer management by rate treatments.

#	Timing / Placement	Total N Rate [Z]
1	N/A	7 kg N/ha [Y] + residual
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] Includes Residual NO_3-N (0-60 cm) based on fall composite soil samples

[Y] Provided by seed-placed 11-52-0 for all treatments

Results

The response variables measured were 1) normalized difference vegetation index (NDVI), 2) flag-leaf chlorophyll (SPAD) measurements at the milk stage, 3) grain yield, and 4) grain protein. Both NDVI and SPAD measurements increased with N fertilization and were reasonably good in-season indicators of the overall N status of the crops. Compared to the SPAD values, NDVI appeared to be more sensitive and consistent with yield when it came to timing/placement effects. Winter wheat yields were optimized with 120-150 kg N/ha (soil plus fertilizer; Table 6) while protein responded similarly but continued increasing with slightly higher N rates compared to yield. Regarding timing/placement effects, environmental conditions were not especially conducive to leaching or denitrification losses of fall-applied N and timely spring precipitation events reduced volatile losses and increased availability of the spring applied N. Yields tended to be highest with side-banded N while protein was higher with spring broadcast applications (Table 7). Results with the split applications were intermediate but generally more like the fall side-band applications.

Table 6. Main effect means and orthogonal contrast results for average N rate (NR) effects on winter wheat grain yield. Means within a group (Yr x NR; NR) followed by the same letter do not significantly differ (Tukey-Kramer, P ≤ 0.05).

Treatment	2019	2020	Average
	-------------------------------------- *Grain Yield (kg/ha)* --------------------------------------		
Control	2570	2171	2370
60 kg N/ha	3467 e	3240 e	3353 D
90 kg N/ha	3708 d	3894 cd	3801 C
120 kg N/ha	3869 bcd	4219 b	4044 B
150 kg N/ha	3978 bc	4599 a	4288 A
180 kg N/ha	4038 bc	4731 a	4385 A

Table 7. Main effect means for average N timing/placement (TP) effects on winter wheat grain yield and protein. Means within a group (Yr x TP; TP) followed by the same letter do not significantly differ (Tukey-Kramer, P ≤ 0.05).

Treatment	2019	2020	Average
	-------------------------------------- *Grain Yield (kg/ha)* --------------------------------------		
Control	2570	2171	2370
Side-Banded	3817 b	4287 a	4052 A
Spr. Broadcast	3793 b	3952 b	3873 A
50:50 Split App.	3825 b	4171 a	3998 A
	-------------------------------------- *Grain Protein (%)* --------------------------------------		
Control	10.40	9.86	10.13
Side-Banded	12.63 a	11.24 c	11.93 B
Spr. Broadcast	12.93 a	11.72 b	12.33 A
50:50 Split App.	12.75 a	11.36 c	12.06 B

Conclusions

All factors considered, each of the N timing/placement strategies performed reasonably well; however, the results supported our initial hypotheses that split applications will provide the most flexibility in terms of allowing crop establishment to be assessed before committing the full N requirements while also buffering against potential losses of fall applied N and early season N deficiencies. That said, the added cost of two-pass seeding/fertilization systems must also be considered. Side-banded N is safest when later seeding is combined with relatively dry/cool climates and well drained fields. Deferring at least some of the crop's N requirements is increasingly recommended if seeding occurs early or in regions that are warmer and wetter on average. Deferring all of a winter cereal crop's N fertilizer requirement until spring is not recommended unless, perhaps, residual soil N levels are particularly high or relatively large quantities of N are provided with the phosphorus and/or sulphur fertilizer products.

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 and Fertilizer Canada.

Crop Response to Shallow vs Deep Banded N Fertilizer Formulations Relative to Other Benchmark Management Practices

Holzapfel, C. (IHARF)

Description
The objectives of this project were 1) to demonstrate the potential benefits, under field conditions, of banding urea at depths of at least 5 cm relative to the shallower banding depths commonly achieved when side-banding is combined with shallow seeding depths and other benchmark practices and 2) to demonstrate the potential benefits, under field conditions, of utilizing a commercially available volatilization/nitrification inhibitor to mitigate the risk of N losses for contrasting placement/timing options. A field trial with CWRS wheat was initiated at Indian Head with the first N treatments applied in the fall of 2019 followed by subsequent applications and seeding in the early spring of 2020. The treatments were a combination of six N fertilizer rate, placement, and timing strategies and two formulations, plus a control where no supplemental N was applied (Table 8). The treatments were arranged in a four replicate RCBD.

Table 8. Nitrogen management treatments evaluated for CWRS wheat at Indian Head in 2020.

#	N Form	Treatment Name	Depth	Total N Rate [Z]
1	N/A	Control	n/a	7 kg N/ha [Y] + residual
2	Untreated urea	High N side-band	≈3.5 cm (1.5”)	1.5x – 165 kg N/ha
3	Untreated urea	Side-band	≈3.5 cm (1.5”)	1.0x – 110 kg N/ha
4	Untreated urea	Fall surface broadcast	0 cm (0”)	1.0x – 110 kg N/ha
5	Untreated urea	Spring surface broadcast	0 cm (0”)	1.0x – 110 kg N/ha
6	Untreated urea	Fall deep band	≈5.6 cm (2.3”)	1.0x – 110 kg N/ha
7	Untreated urea	Fall shallow band	≈2.5 cm (1”)	1.0x – 110 kg N/ha
8	SUPERU®	High N side-band	≈3.5 cm (1.5”)	1.5x – 165 kg N/ha
9	SUPERU®	Side-band	≈3.5 cm (1.5”)	1.0x – 110 kg N/ha
10	SUPERU®	Fall surface broadcast	0 cm (0”)	1.0x – 110 kg N/ha
11	SUPERU®	Spring surface broadcast	0 cm (0”)	1.0x – 110 kg N/ha
12	SUPERU®	Fall deep band	≈5.6 cm (2.3”)	1.0x – 110 kg N/ha
13	SUPERU®	Fall shallow band	≈2.5 cm (1”)	1.0x – 110 kg N/ha

[Z] Includes residual NO_3-N (0-60 cm) estimated from fall composite soil samples

[Y] Provided by seed-placed 11-52-0 for all treatments

Results

The response variables measured were 1) normalized difference vegetation index (NDVI) at the flag-leaf stage, 2) flag-leaf chlorophyll (SPAD) measurements at the milk stage, 3) yield, and 4) grain protein. All the response variables indicated strong responses to N when the fertilized treatments were compared to the unfertilized control treatment while comparisons to the 1.5x rate confirmed that the 1x rate was below optimal and, therefore, should allow for differences between strategies to be readily detected. The two N formulations performed similarly to one another but there was considerable variation amongst the timing/placement strategies. Both NDVI and SPAD measurements were good indicators of the response to N, but the relative rankings of the treatments were not always consistent with the yield and protein results, particularly for NDVI which favoured fall-banding. Consistent with previous work at this location, side-banding performed well and simultaneously resulted in both the highest yields (Figure 2) and grain protein (Figure 3) concentrations. Surface broadcast applications were the least efficient placement option with fall applications favouring yield and spring applications favouring protein accumulation. Fall banding, regardless of depth, performed better than the surface applications but not as well as side-banding. When both yield and protein were considered, deep banding performed better than shallow banding, particularly with untreated urea.

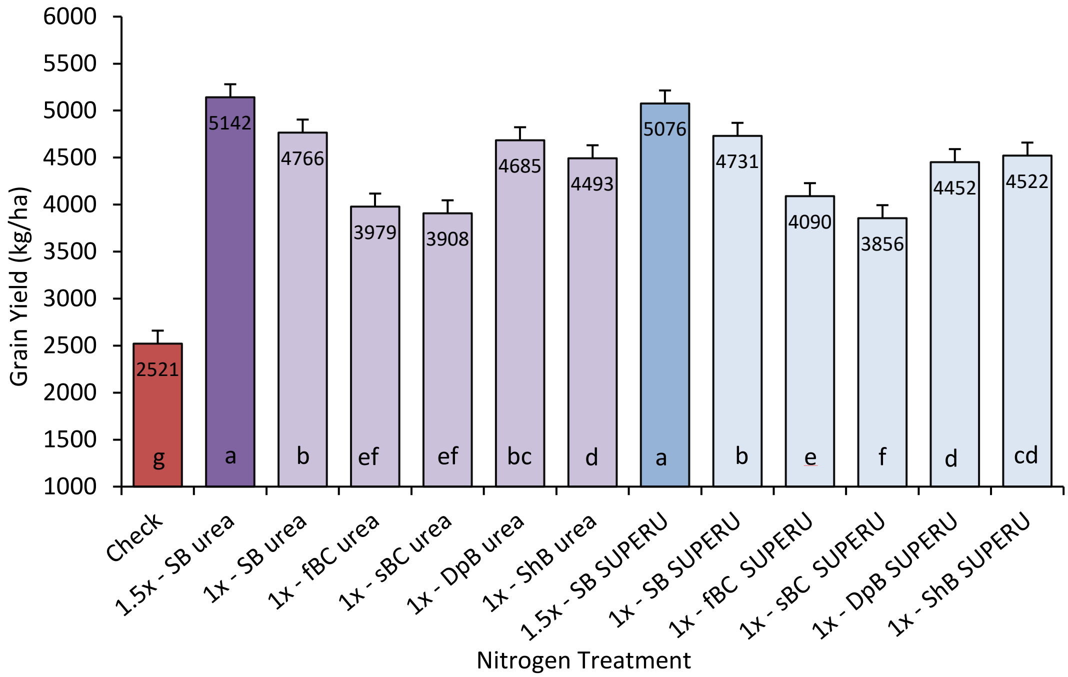

Figure 2. Individual nitrogen treatment means for spring wheat grain yield at Indian Head in 2020. Error bars are the standard error of the treatment means. The 1x rate is 110 kg N/ha (soil + fertilizer) and the 1.5x rate is 165 kg N/ha. SB is side-band, fBC is fall broadcast, sBC is spring broadcast, DpB is fall Deep Band, ShB is fall shallow band.

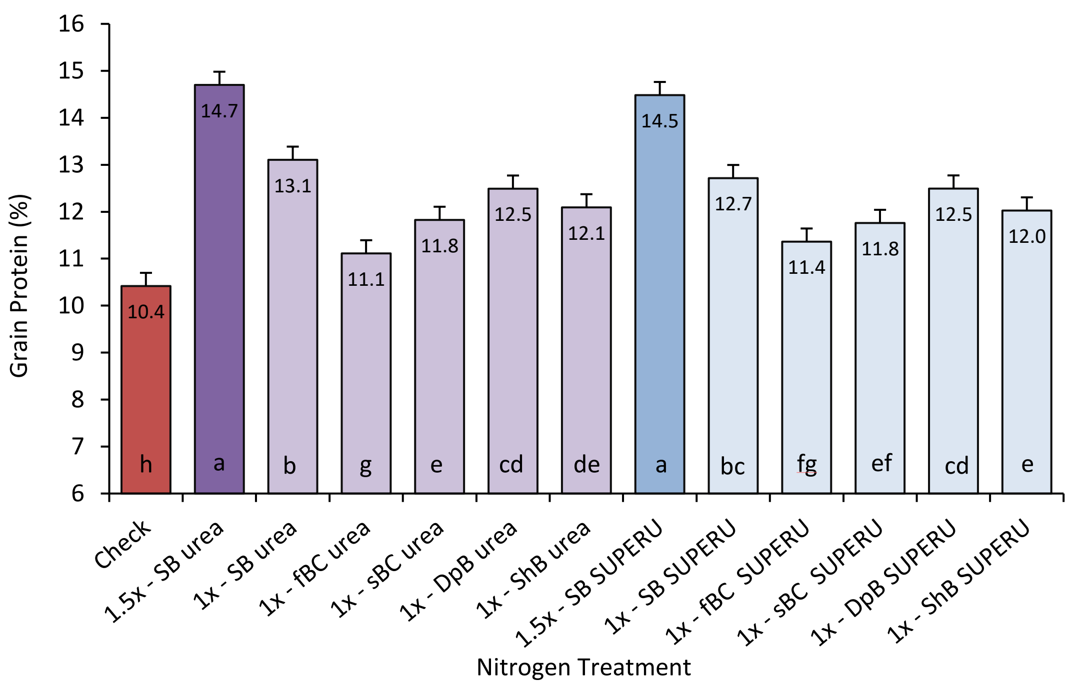

Figure 3. Individual nitrogen treatment means for spring wheat grain protein concentrations at Indian Head in 2020. Error bars are the standard error of the treatment means. The 1x rate is 110 kg N/ha (soil + fertilizer) and the 1.5x rate is 165 kg N/ha. SB is side-band, fBC is fall broadcast, sBC is spring broadcast, DpB is fall Deep Band, ShB is fall shallow band.

Conclusions

In this single site-year, side-banding proved to be the most effective N management strategy of the options evaluated for both formulations (untreated urea and SUPERU®), simultaneously resulting in the highest yields and grain protein concentrations. Side-banding places the N beneath the soil surface where it is relatively protected from NH_3 volatilization, and in concentrated bands which slows both urea hydrolyses and nitrification. Side-banding aims to place the N far enough away from the seed that it will not negatively impact emergence but close enough that it will still be readily accessible to the crop but less available to shallow rooted weeds growing between crop rows. Broadcasting N without incorporation is never ideal but can perform well if timely precipitation moves it into the rooting zone before environmental losses or yield reductions can occur. With the dry weather during 2019-2020 study period, broadcasting without incorporation was the poorest performing option regardless of the formulation or specific timing. Among the broadcast treatments, fall application resulted in higher yields but lower protein concentrations compared to spring application; however, neither performed as well as the fall in-soil bands or side-banding. Fall-banding provides the benefits of concentrating the N in a location that is relatively protected from loss and available to crops; however, is less optimal than side- or mid-row banding with respect to timing.

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 and Fertilizer Canada.

Canola Seed Safety and Yield Response to Novel Phosphorus Sources in Saskatchewan Soils

Holzapfel, C. (IHARF), Weber, J. (WARC), Nybo, B. (WCA), and Hall, M. (ECRF)

Description

The objective of this project was to demonstrate canola response to increasing rates of seed-placed phosphorus (P) fertilizer for various formulations. The formulations were monoammonium phosphate (MAP), MicroEssentials® S15, and struvite (CrystalGreen®) applied alone or in a blend. Field trials were conducted at Swift Current, Scott, Indian Head, and Yorkton in 2020. All P fertilizer was seed-placed while urea and ammonium sulfate were side-banded. Detailed treatment information is provided in Table 9, and they were arranged in a four replicate RCBD.

Table 9. Treatment descriptions for novel Phosphorus demonstrations completed at Swift Current, Scott, Indian Head, and Yorkton in 2020.

#	Phosphorus Form [Z]	Nutrient Analyses	Phosphorus Rate
1	Control	Not applicable	0 kg P_2O_5/ha
2	Monoammonium phosphate	11-52-0	25 kg P_2O_5/ha
3	Monoammonium phosphate	11-52-0	45 kg P_2O_5/ha
4	Monoammonium phosphate	11-52-0	65 kg P_2O_5/ha
5	MicroEssentials® S15	13-33-0-15	25 kg P_2O_5/ha
6	MicroEssentials® S15	13-33-0-15	45 kg P_2O_5/ha
7	MicroEssentials® S15	13-33-0-15	65 kg P_2O_5/ha
8	CrystalGreen®[Y]	5-28-0 + 10% Mg	25 kg P_2O_5/ha
9	CrystalGreen®	5-28-0 + 10% Mg	45 kg P_2O_5/ha
10	CrystalGreen®	5-28-0 + 10% Mg	65 kg P_2O_5/ha
11	50:50 MAP:CrystalGreen®[Z]	8-40-0 + 5% Mg	25 kg P_2O_5/ha
12	50:50 MAP:CrystalGreen®	8-40-0 + 5% Mg	45 kg P_2O_5/ha
13	50:50 MAP:CrystalGreen®	8-40-0 + 5% Mg	65 kg P_2O_5/ha

[Y] Struvite is marketed under the trade name CrystalGreen®

[Z] Expressed as actual P_2O_5 the ratio is 65:35 MAP:CrystalGreen®

Results

The response data included spring and fall plant densities, maturity, and yield. Treatment effects on plant densities were mostly small or not significant but, where responses occurred, S15 and MAP were the most likely to negatively affect emergence compared to CrystalGreen (Table 10). The most prominent reductions occurred at Swift Current and Scott, the latter where increasing rates of both seed-placed MAP and S15 reduced canola plant densities linearly. At Indian Head, only S15 at the highest application rate reduced plant populations while, at Yorkton, emergence was variable but not significantly affected by the treatments. Differences in plant densities tended to be less when the counts were repeated in the fall. Treatment effects on maturity were either not significant or too small to be of practical importance. The magnitude and consistency of yield responses varied with location (Table 11). Scott was, by far, the most responsive location with linear yield increase detected for all formulations, by up to 19% at the highest P rate. At Swift Current, the average increase was at 11% at the highest P rate and, while there were subtle differences between forms, yields were statistically similar for all when averaged across rates. At Yorkton, the average yield increase was 8% and the best responses occurred with MAP and the MAP:CrystalGreen blend compared to CrystalGreen applied alone. The weakest response occurred at Indian Head despite high yields and low residual P. At this location, the average increase was less than 5% and, while the response was most consistent with S15, yields were statistically similar for all forms when averaged across rates.

Table 10. Mean final plant densities and F-test results for phosphorus fertilizer formulation and rate treatments for canola at four Saskatchewan locations in 2020. Means within a column followed by the same letter do not significantly differ (Tukey-Kramer, P ≤ 0.05).

Treatment [Z]	Swift Current	Scott	Indian Head	Yorkton
	---------------------------- Fall Plant Densities (plants/m^2) ----------------------------			
Control	31.4 a	65.4 a	53.8 a	103.0 a
MAP – 25[Y]	34.7 a	55.9 a	62.6 a	106.6 a
MAP – 45	34.1 a	59.8 a	58.4 a	103.7 a
MAP – 65	33.5 a	51.9 a	56.2 a	89.4 a
S15 – 25	33.8 a	54.9 a	52.1 a	–
S15 – 45	25.4 a	49.2 a	54.8 a	–
S15 – 65	26.0 a	50.2 a	49.2 a	–
CG – 25	34.4 a	60.8 a	57.0 a	123.0 a
CG – 45	34.1 a	63.5 a	60.7 a	128.8 a
CG – 65	35.0 a	62.8 a	59.7 a	116.9 a
MAP:CG – 25	33.8 a	64.2 a	54.7 a	125.5 a
MAP:CG – 45	25.4 a	59.1 a	54.8 a	105.0 a
MAP:CG – 65	29.3 a	57.4 a	52.5 a	92.7 a

[Z] MAP – monoammonium phosphate (11-52-0); S15 – MicroEssentials® S15 (13-33-0-15); CG – CrystalGreen® (5-28-0 + 10 Mg); MAP:CG – 50:50 blend (by mass of product) of MAP:CG (8-40-0 + 5 Mg), [Y] Application rates are 25, 45, or 65 kg P_2O_5/ha

Table 11. Mean seed yields and F-test results for phosphorus fertilizer formulation and rate treatments for canola at four Saskatchewan locations in 2020. Means within a column followed by the same letter do not significantly differ (Tukey-Kramer, P ≤ 0.05).

Treatment [Z]	Swift Current	Scott	Indian Head	Yorkton
	------------------------------------- Seed Yield (kg/ha) -------------------------------------			
Control	1996 a	2973 b	3236 a	2951 b
MAP – 25[Y]	2147 a	3191 ab	3324 a	3020 ab
MAP – 45	2180 a	3556 a	3179 a	3143 ab
MAP – 65	2257 a	3516 a	3449 a	3269 a
S15 – 25	2133 a	3299 ab	3279 a	–
S15 – 45	2167 a	3379 ab	3374 a	–
S15 – 65	2153 a	3429 ab	3447 a	–
CG – 25	2247 a	3346 ab	3186 a	3093 ab
CG – 45	2229 a	3354 ab	3332 a	3056 ab
CG – 65	2162 a	3649 a	3252 a	3041 ab
MAP:CG – 25	2020 a	3266 ab	3248 a	3150 ab
MAP:CG – 45	2201 a	3347 ab	3260 a	3235 a
MAP:CG – 65	2268 a	3582 a	3407 a	3223 ab

[Z] MAP – monoammonium phosphate (11-52-0); S15 – MicroEssentials® S15 (13-33-0-15); CG – CrystalGreen® (5-28-0 + 10 Mg); MAP:CG – 50:50 blend (by mass of product) of MAP:CG (8-40-0 + 5 Mg), [Y] Application rates are 25, 45, or 65 kg P_2O_5/ha

Conclusions

When choosing appropriate P rates, considering removal rates with realistic yield targets continues be a reasonable strategy. In terms of choosing formulations, cost is important to consider but seed safety, equipment configurations, and overall product availability may also play into this decision.

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 and Fertilizer Canada.

Seeding Rates to Reduce Tillering and Flowering Duration for FHB Management in Durum Wheat

Holzapfel, C. (IHARF), Weber, J. (WARC), and Nybo, B. (WCA)

Description

The objectives of this project were (1) to demonstrate the potential for higher seeding rates to reduce tillering, duration of flowering, fusarium head blight (FHB) infection, and quality loss in durum wheat, (2) to demonstrate the ability of foliar fungicide applications to increase grain yield and reduce FHB infection, and subsequent quality loss in durum wheat, and (3) to demonstrate the combined ability of higher seeding rates and foliar fungicide to optimize both yield and quality of durum wheat. Field trials were conducted near Swift Current, Scott, and Indian Head in 2020. The treatments were a factorial combination of four seeding rates and two fungicide treatments. Each treatment was replicated four times and arranged in an RCBD at Indian Head and Swift Current and a split plot design (with fungicide as the main plot) at Scott. Treatment information is provided in Table 12.

Table 12. Individual treatment descriptions for fusarium head blight management demonstrations completed at Swift Current, Scott, and Indian Head in 2020.

#	Foliar Fungicide [Z]	Seeding Rate [Y]
1	No foliar fungicide applied	125 seeds/m^2
2	No foliar fungicide applied	250 seeds/m^2
3	No fungicide applied	375 seeds/m^2
4	No fungicide applied	500 seeds/m^2
5	0.803 ml Prosaro XTR/ha	125 seeds/m^2
6	0.803 ml Prosaro XTR/ha	250 seeds/m^2
7	0.803 ml Prosaro XTR/ha	375 seeds/m^2
8	0.803 ml Prosaro XTR/ha	500 seeds/m^2

[Z] Applied at 50% anthesis in at least 187 l/ha solution; [Y] Adjusted for seed size and germination

Results

Data collection included assessments of plant and head density, tillering, visible FHB infection, yield, test weight, fusarium damaged kernels (FDK), and deoxynivalenol (DON). The weather was drier than normal at Swift Current and Indian Head but wetter than normal at Scott, especially in July. As expected, higher seeding rates resulted in higher plant and head densities, but reduced tillering for individual plants. With the dry weather, there was relatively little visible FHB infection at Swift Current and Indian Head, but these values were higher at Scott and were reduced by fungicide (Table 13). The fungicide application at Scott appeared to be less effective at reducing visible FHB infection at the lowest seeding rate, presumably due to increasing tillering and more variable crop stage. Yield gains with the fungicide application were always small and never statistically significant. This was a reasonable response at Swift Current and Indian Head given the lack of disease but was somewhat unexpected at Scott. Higher seeding rates were more beneficial for improving yield at Swift Current and Scott than they were at Indian Head, but these locations also had higher seedling mortality and/or less tillering. Seeding rate effects on test weight were like those observed for yield. Fungicide tended to have a positive effect on test weight, although not always significantly so. Higher seeding rates appeared to have a greater impact on FDK and DON than fungicide. The combination of higher seeding rates and fungicide resulted in the least visible disease, FDK, and DON. This would likely be more apparent under heavier disease pressure.

Table 13. Fungicide treatment and seeding rate effects on fusarium head blight (FHB) index in durum. FHB index is the overall average infected spike area, including spikes where no infection was observed. Main effect means within a column followed by the same letter do not significantly differ (Tukey-Kramer, $P \le 0.05$).

Main Effect	Swift Current	Scott [Y]	Indian Head
	---------------------------------------	FHB Index (%)	---------------------------------------
Fungicide [Z]			
Untreated	2.3 a	14.2 a	4.2 a
Treated	2.3 a	8.3 b	3.5 a
Seeding Rate			
125 seeds/m^2	1.4 b	10.3 a	4.0 a
250 seeds/m^2	1.3 b	11.3 a	4.2 a
375 seeds/m^2	2.7 a	12.4 a	4.6 a
500 seeds/m^2	3.2 a	10.9 a	2.7 a

[Z] The fungicide was Prosaro XTR applied at 50% anthesis

[Y] Fung x Seed interaction was significant for FHB index at Scott

Conclusions

Higher seeding rates combined with foliar fungicide applications can be an effective strategy for managing FHB in durum wheat; however, producers should consider expected seedling mortality and disease pressure (i.e., weather and experience) when choosing seeding rates and deciding whether to invest in a fungicide application.

Acknowledgements

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Dry Bean Response to Nitrogen Fertilizer Rates in Dryland, Solid-Seeded Production

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

Description

The objective of this project was to demonstrate the response of dryland, solid-seeded black beans to varying rates of nitrogen (N) fertilizer across a range of environments in Saskatchewan. Field demonstrations with CDC Blackstrap dry bean were initiated at Indian Head, Melfort, Redvers, and Yorkton in 2020. The treatments were six N rates which included an unfertilized control, 45, 75, 105, 135, and 165 kg N/ha (soil residual plus fertilizer) with side-banded urea as the primary N source. For the control, the only N available to the crop was provided by the soil and any monoammonium phosphate (11-52-0) that was applied. The treatments were arranged in a four replicate RCBD.

Results

All locations were drier than average which was neither ideal for dry bean production nor likely to represent the potential at these locations over the longer term. Looking at crop establishment, we saw the poorest emergence at Indian Head and Melfort, the locations with the heaviest soil texture and highest organic matter. Maturity also tended to be later at these locations and, although maturity varied widely with location only Indian Head and, to a lesser extent, Redvers, observed any delays with increasing N fertilizer rates. Plant height increased with N rate at two of four locations, but the average height was consistent. Seed yields were extremely low at Indian Head, Melfort, and Yorkton but higher at Redvers (Table 14). All locations saw strong yield increases with N fertilizer rate, but the specific responses varied. At Indian Head, yields peaked at a modest rate of 75 kg N/ha before levelling off and even declining slightly at the highest N rate. For all other locations, the response was linear with yields increasing right up to 165 kg N/ha. This was somewhat unexpected considering the low yields, especially at Melfort and Yorkton. Although we did not measure all the yield components (i.e., pods per plant, seeds per pod, etc.), the observed yield increases were at least partly due to increasing seed size as more N was applied.

Table 14. Nitrogen fertilizer rate effects on dry bean seed yield at four Saskatchewan locations in 2020. Means within a column followed by the same letter do not significantly differ (Tukey-Kramer, $P \leq 0.05$).

Treatment	Indian Head [Z]	Melfort [Y]	Redvers [Y]	Yorkton [Z]
	------------- *Seed Yield (kg/ha)* -------------			
Control	408.0 d	347.4 b	1046.6 a	400.0 d
45 kg N/ha	513.0 cd	–	–	330.5 d
75 kg N/ha	711.6 a	513.3 b	1170.4 a	548.4 c
105 kg N/ha	637.6 ab	651.0 ab	1277.5 a	647.6 b
135 kg N/ha	672.6 ab	872.6 a	1507.1 a	660.5 b
165 kg N/ha	576.3 bc	945.7 a	1615.4 a	810.2 a

[Z] Residual NO_3-N plus the N provided by 11-52 was 25 kg N/ha at Indian Head and Yorkton, [Y] Residual NO_3-N plus the N provided by 11-52 was 50 kg N/ha at Melfort and Redvers; therefore the 45 kg N/ha treatment was excluded at these locations

Conclusions

To improve our understanding of dry bean response to N rate and adaption to dryland, solid-seeded production in Saskatchewan, it would be beneficial to repeat these trials under a wider range of conditions. Furthermore, when the objective is to maximize profits, the optimum N rate will vary depending on the relative prices of both the fertilizer and the harvested commodity. Reporting the marginal economic returns for the different N rates is beyond the scope of this project; however, this is important to keep in mind.

Acknowledgements

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Input Contributions to Spring Wheat Yield, Quality, and Profits

Holzapfel, C. (IHARF)

Description

The objective of this project was to demonstrate the agronomic and economic responses of CWRS wheat to numerous crop inputs individually and in various combinations. A field demonstration with CWRS wheat was initiated near Indian Head in 2019 and repeated in 2020. The project was designed to show the contributions of individual crop inputs when either added to low input systems or removed from high input systems. The inputs that were varied included seed-applied fungicide, seeding rate, fertility, PGR, and foliar fungicide. The treatments are described in detail in Table 15, and they were arranged in a four replicate RCBD.

Table 55. Treatments evaluated in wheat input demonstration at Indian Head in 2019-2020.

#	Name	Seed Trt (no/yes)	Seed Rate (seeds/m^2)	Fertility (kg/ha N-P_2O_5-K_2O-S)	PGR (no/yes)	Foliar Fung (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

€Seed Treatment -1 g tebuconazole + 5 g prothioconazole + 2 g metalaxyl per 100 kg seed, ¥PGR - 1118 g chlormequat chloride/ha, £Foliar fungicide - 100 g prothioconazole/ha + 100 g tebuconazole/ha

Results

Increasing seeding rate had the greatest effect on plant populations while seed treatments had a slight positive effect in 2019 but not 2020. Plant height was primarily affected by the PGR which reduced height by 7% on average. Lodging was always negligible under the dry conditions. Fusarium head blight (FHB) pressure was low and the only input to consistently affect FHB incidence was foliar fungicide, but higher seeding rates also reduced infection in 2020. Yields were lower in 2019 compared to 2020 and there was also greater separation between treatments in 2020 (Table 16). For example, there was a 7% yield advantage to the high input treatment over the low input treatment in 2019 compared to 18% in 2020. Extra fertility was the input that most consistently increased yield, resulting in an average yield increase of 8% compared to 5% for foliar fungicide and 2.5% for PGR. Seed treatments and higher seeding rates did not increase yield. Impacts on test weight were small and of little agronomic importance while seed weight was not affected. Extra fertility was the only input that increased grain protein, from 13.7% to 14.7% when averaged across years. Fungicide slightly reduced protein due to its positive effect on yield. Basic economic analyses showed the most intensively managed wheat to be less profitable than the low input package, but results varied depending on the specific inputs and the growing season. Extra fertility generally paid with the most profitable treatment (on average) being low input plus enhanced fertility and the least profitable being high input with reduced fertility.

Table 16. Mean spring wheat grain yields for individual years and averaged across years. Means within a column followed by the same letter do not significantly differ (Tukey's range test, P ≤ 0.05).

Treatment	2019	2020	Average
	Grain Yield (kg/ha)		
Low Input	3427 abcd	4366 ef	3897 EF
Low + Seed Treatment	3285 d	4389 ef	3837 F
Low + Seed Rate	3432 abcd	4312 f	3872 EF
Low + Fertility	3476 abcd	4812 bc	4144 BC
Low + PGR	3509 abcd	4415 def	3962 DEF
Low + Fungicide	3360 cd	4641 cd	4001 CDE
High - Seed Treatment	3630 ab	5038 ab	4334 A
High - Seed Rate	3538 abc	5136 a	4337 A
High - Fertility	3391 cd	4589 cde	3990 DE
High - PGR	3490 abcd	5029 ab	4259 AB
High - Fungicide	3420 bcd	4739 c	4079 CD
High Input	3652 a	5140 a	4396 A

Conclusions

Products such as seeds and fertilizers are generally known to build yield potential while crop protection products and plant growth regulators are for protecting yield potential and preventing losses due to factors such as disease or lodging. With that in mind, it makes sense that products intended to prevent yield loss often provide the greatest benefit when combined with adequate levels of the inputs that build yield potential up in the first place. 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.

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Oat and Pea Intercrop Demonstration

Shaw, L. (SERF), McInnes, B. (NARF), and Holzapfel, C. (IHARF)

Description

The objective of this trial was to demonstrate the effect of varying oat seeding rates when intercropped with pea on forage and grain yields along with oat milling quality relative to monocrops. This demonstration was conducted at Redvers, Melfort, and Indian Head in 2020. A treatment list is shown in Table 17 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 the location.

Table 17. Treatment list for oat and pea intercrop demonstration in 2020.

Trt #	Crop	Oat Seed Rate (plants per m^2)	Oat Seed Rate (approx. lb/ac)	Pea Seed Rate (plants per m^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

Pea densities were relatively high at Redvers and Indian Head and did not vary by treatment. Establishment of peas was not as good at Melfort, particularly for the intercrop treatments. Oat densities were close to or slightly exceeded the targeted plant densities at Redvers. At Indian Head, the oat densities were lower than the targeted amount, likely due to dry spring conditions there. There was no lodging at Redvers or Indian Head due to dry conditions. At Melfort, intercropping at the 100 and 125 pl/m^2 oat density resulted in significantly reduced lodging compared with lower oat intercrop densities and pea monocrops. Pea biomass generally went down in the intercrops as oat seeding density was increased. Furthermore, the intercrop pea biomass was lower compared to both monoculture pea treatments. Oat biomass was low when oat seeding density in the intercrops was low. When the pea and oat biomass are combined, the total biomass was quite similar across treatments. Pea yield decreased as the seeding density of oat increased in the intercrops and was generally lower than the monocrops (Table 18). Oat yield increased as oat density increased in the intercrop mixture treatments but was lower than the monocrop oat. Total yield, as an indication of total productive capacity, was generally better for the higher oat intercrop densities and poor for the low oat intercrop densities. Bulked oat samples from all three sites were analysed for quality parameters such as plumps and thins. When sites were used as replications, there was a statistically significant increase in percentage of plump groats with intercropping. Furthermore, the intercropped samples had 7% more plump groats than the monocrop samples.

Table 18. Pea, oat, and total grain yield at Redvers (RV), Indian Head (IH), and Melfort (MF) in 2020.

Treatment	RV	IH	MF	RV	IH	MF	RV	IH	MF
	Pea yield (t/ha)			Oat yield (t/ha)			Total yield (t/ha)		
Pea + 25 Oat	1.73	2.58	1.89	0.66	1.06	1.77	2.39	3.64	3.18
Pea + 50 Oat	1.10	2.36	1.30	1.29	1.38	3.17	2.39	3.74	3.71
Pea + 75 Oat	1.25	1.91	1.17	2.06	2.24	4.00	3.31	4.15	3.61
Pea + 100 Oat	0.78	1.54	1.00	2.05	2.49	4.86	2.82	4.04	4.27
Pea + 125 Oat	0.76	1.52	0.80	2.48	2.55	4.93	3.28	4.07	3.90
Oat	-	-	-	3.32	4.37	6.67	3.32	4.37	4.44
Pea (hand-weeded)	3.10	3.83	3.31	-	-	-	3.10	3.83	3.31
Pea	1.88	3.38	2.68	-	-	-	1.88	3.38	2.68

Units: 1 t/ha = 1,000 kg/ha

Conclusions

All three sites experienced drier than normal conditions during the field season. Some of the benefits of pea oat intercropping come from wetter conditions. There were some signs of detrimental interspecies competition at the low oat densities. This may not occur on wet years.

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.

Pre-harvest Weed Control and Desiccation Options for Flax

Holzapfel, C. (IHARF), Thompson, W. (Sask Flax), Hall, M. (ECRF), and Nybo, B. (WCA)

Description

The objectives of this project were (1) to demonstrate the effects of pre-harvest herbicide and desiccant options for flax on seed and straw dry-down and (2) to provide a forum for discussion on the potential advantages and disadvantages of the pre-harvest options evaluated with respect to both weed control and efficacy as a harvest aid. The field trials were initiated at Indian Head, Swift Current, and Yorkton locations in 2020. The treatments were a factorial combination of two varieties (CDC Bethune and CDC Glas) and four pre-harvest herbicide/desiccation options for a total of eight treatments. The treatments were arranged in a four replicate RCBD and are described in Table 19.

Table 69. Variety by pre-harvest herbicide/desiccant options evaluated for flax at Indian Head, Swift Current, and Yorkton in 2020.

#	Variety	Pre-harvest Application [Z]
1	CDC Bethune	Untreated
2	CDC Bethune	894 g glyphosate/ha
3	CDC Bethune	894 g glyphosate/ha plus 50 g saflufenacil
4	CDC Bethune	400 g diquat/ha
5	CDC Glas	Untreated
6	CDC Glas	894 g glyphosate/ha
7	CDC Glas	894 g glyphosate/ha plus 50 g saflufenacil
8	CDC Glas	400 g diquat/ha

[Z] Applied in a minimum solution volume of 185 l/ha when 75% of bolls had turned brown

Results

Pre-harvest treatments were applied when 75% of the bolls had turned brown and the variables of greatest importance were visual stem colour change along with actual seed and stem moisture content at harvest. Harvest was completed 14-17 days after the treatment applications. At Swift Current, August was extremely dry and warmer than normal. Under these conditions, the crop dried down well regardless of the treatments and there were no differences in either stem colour change or actual stem moisture content at harvest (Figure 4). At Indian Head and Yorkton, all pre-harvest options were beneficial. Diquat consistently provided the most rapid and thorough dry-down (Figures 5 and 6). Glyphosate applied alone was the slowest option and did not dry the crop to the extent of diquat but was still beneficial. Tank-mixing glyphosate with saflufenacil resulted in more rapid stem colour change at both locations and, at Indian Head, more thorough stem dry-down after 14 days. Besides cost, another factor to consider is weed control and there are trade-offs in this regard. While diquat was, by far, the most effective crop desiccant, it is limited in its ability to control weeds, especially perennials, and can make weed control more difficult by burning of top-growth and reducing opportunities to spray post-harvest. Glyphosate is the least effective as a desiccant but is also the least expensive and ideal for controlling difficult weeds. Tank-mixing glyphosate with saflufenacil aims to bridge this gap, combining both powerful weed control and more rapid and complete crop dry-down; however, this is the most expensive option and still not as effective as diquat for drying down the crop.

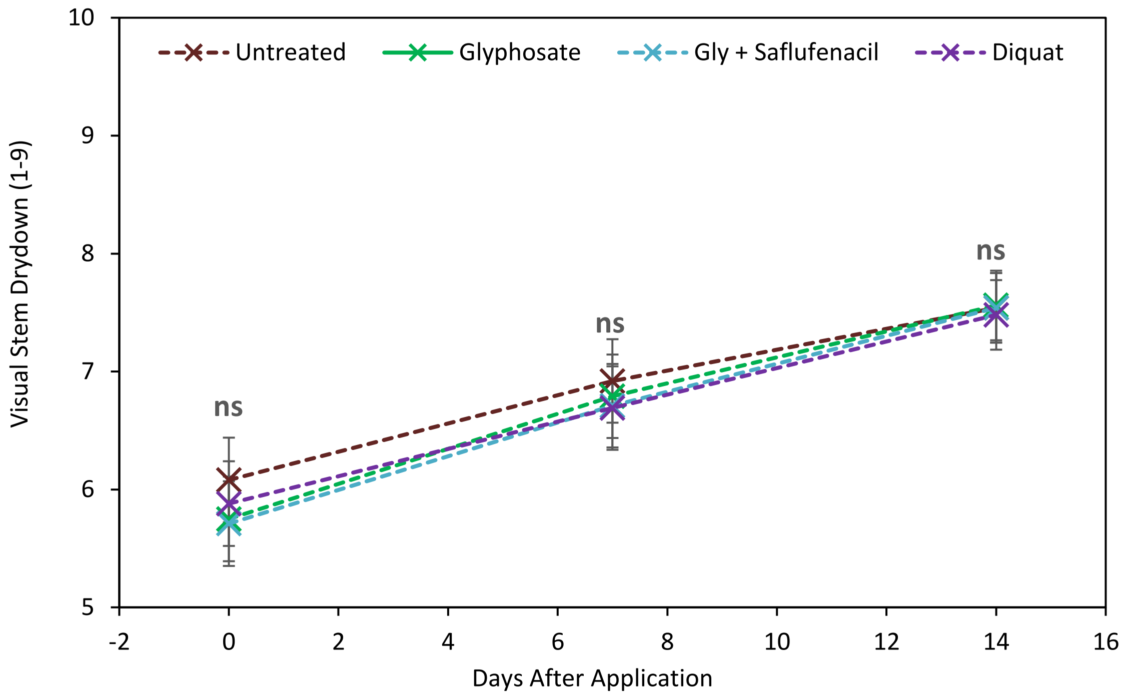

Figure 4. Visual stem dry-down ratings at 0, 7, and 14 days after application for various pre-harvest treatments at Swift Current, Saskatchewan (2020).

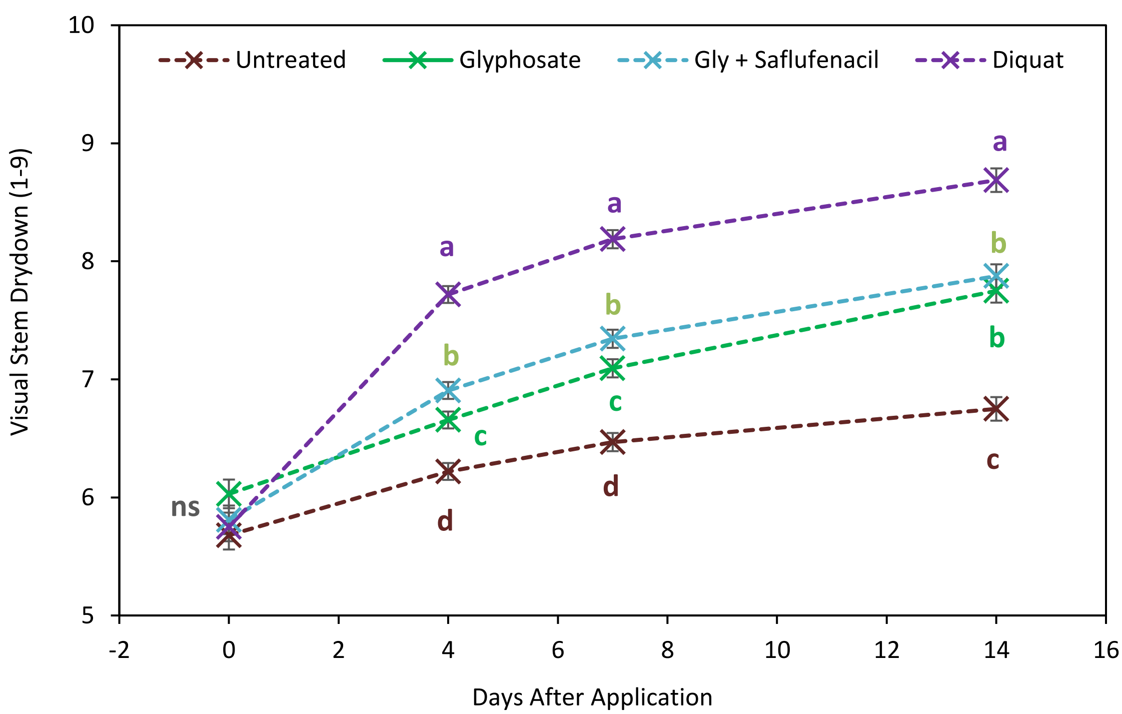

Figure 5. Visual stem dry-down ratings at 0, 4, 7, and 14 days after application for various pre-harvest treatments at Indian Head, Saskatchewan (2020).

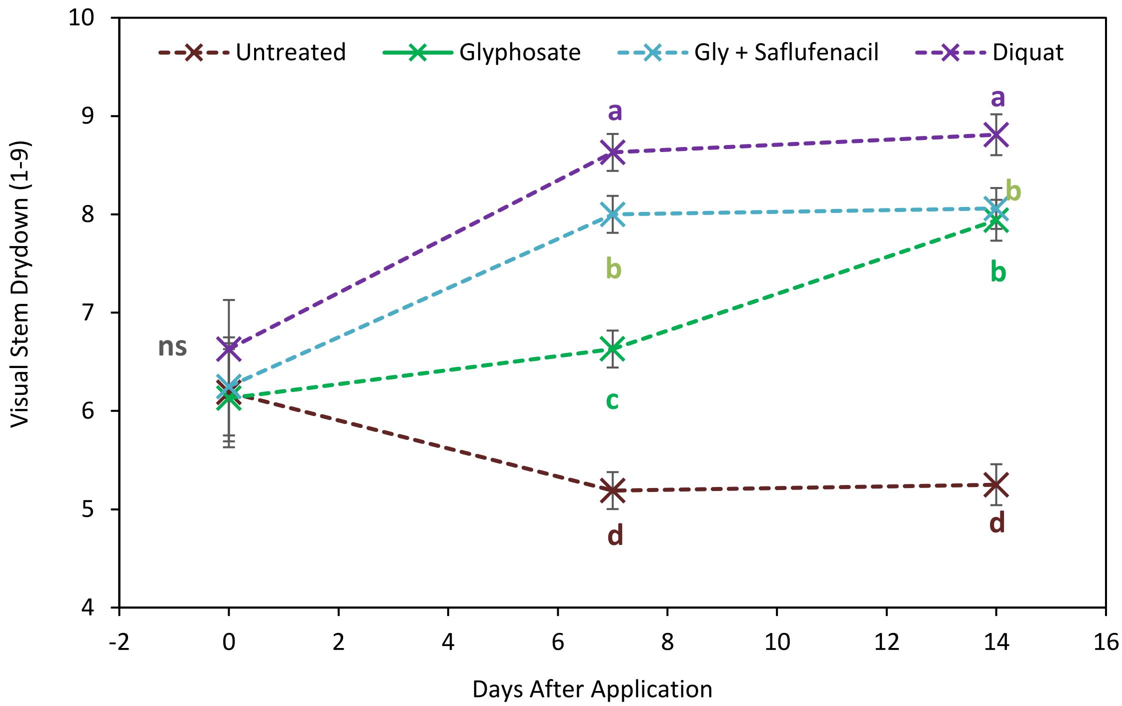

Figure 6. Visual stem dry-down ratings at 0, 7, and 14 days after application for various pre-harvest treatments at Yorkton, Saskatchewan (2020).

Conclusions

All of the options evaluated can potentially allow for earlier harvest, easier threshing, and perhaps an improved ability to chop straw if doing so is desired. The ideal product choice will depend on factors such as crop stage, location, specific environmental conditions, and the number and type of weeds that are present in the field. However, growers who require both perennial weed control and the most rapid and thorough crop dry-down possible might consider applying glyphosate at 75% boll colour change and following up with a diquat application after the glyphosate has been given sufficient time to be taken up by target weeds.

Acknowledgements

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Enhanced Fertilizer Management for Optimizing Yield and Protein in Pea

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

Description

The project objective was to evaluate the yield and protein response of yellow field pea to various rates and combinations of nitrogen (N), phosphorus (P) and sulfur (S) fertilizer. The field trials were conducted at Indian Head, Yorkton, Melfort, Scott, Swift Current, and Outlook during 2019 and 2020 growing seasons. The fertilizer treatments shown in Table 20 were arranged in a RCBD with four replicates. All treatments received the full, label-recommended rate of a granular (*Rhizobium leguminosarum*) inoculant.

Table 20. Field pea fertilizer treatment descriptions.

#	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[Y]	40-40-0-10 * (40 N as MAP/AS/ESN)
13[Y]	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

[Y] ESN (44-0-0) instead of urea as the supplemental N source in Trt #12 and 13

*All fertilizer side-banded except for the 40 kg N/ha as in-crop urea in Trt #11

Results

The overall F-test for seed yield was highly significant while mean yields for the individual treatments were lowest in the unfertilized control (4016 kg/ha) and, numerically, highest with a combination of 60 kg P_2O_5/ha and 10 kg S/ha but no extra N (Trt #4; 4536 kg/ha). Yields from essentially all of the treatments that received modest rates of P were statistically similar (Table 21). The contrast comparisons showed an overall yield advantage of 378 kg/ha, or 9% for the combined fertilized treatments relative to the control. Yields with normal versus extra N were statistically similar but, numerically, favoured the treatments that did not receive the additional N (4468 kg/ha versus 4393 kg/ha). Consistent with many of the sites individually, yields increased quadratically with P rate, levelling off at roughly 40 kg P_2O_5/ha which is approximately what is required to match removal in a 3360 kg/ha (50 bu/ac) crop. There was no yield increase associated with S fertilization.

For protein, the overall F-test was significant when all locations were combined but there was only a 0.5% range and few significant differences amongst individual treatments (Table 21). The contrast comparisons did not detect any difference between the control and combined fertilized treatments or any benefit to extra N fertilizer. Although there was a significant linear increase in protein with P rate, the magnitude of the response was small with a spread of only 0.4% between 0 kg P_2O_5/ha and 80 kg P_2O_5/ha. This effect might be attributable to generally healthier plants and root systems as the protein increase also came with a yield increase which was considerably larger in magnitude. Sulfur fertilization did not impact seed protein.

Table 21. Results for tests of fertilizer effects on field pea seed yield and protein concentrations along with individual treatment means when averaged over 12 location-years in Saskatchewan. Means within a column followed by the same letter do not significantly differ from one another (Tukey-Kramer; $P \leq 0.05$).

Source / Treatment	Seed Yield	Seed Protein
kg N-P_2O_5-K_2O-S/ha	------------- kg/ha -------------	--------------- % ---------------
1) 0-0-0-0 (no fertilizer)	4016 c	22.3 ab
2) 17-0-0-10 (0 P)	4155 bc	22.4 ab
3) 17-20-0-10 (20 P)	4303 ab	22.2 b
4) 17-40-0-10 (40 P / 10 S)	4468 a	22.6 ab
5) 21-60-0-10 (60 P)	4536 a	22.5 ab
6) 26-80-0-10 (80 P)	4456 a	22.6 ab
7) 17-40-0-0 (0 S)	4397 a	22.4 ab
8) 17-40-0-5 (5 S)	4310 ab	22.5 ab
9) 22-40-0-15 (15 S)	4405 a	22.5 ab
10) 40-40-0-10 (urea)	4367 ab	22.5 ab
11) 17-40-0-10 + 40 N in-crop	4431 a	22.7 a
12) 40-40-0-10 (ESN)	4382 ab	22.5 ab
13) 40-80-0-15 (ultra high fertility)	4512 a	22.7 ab

Conclusions

When averaged across all twelve location-years, yields were increased by over 9% with P fertilization and the optimal rate was approximately 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 rarely statistically significant. 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 the P and/or S fertilizer products being utilized. In most cases, this will be sufficient; however, in rare cases where neither P or S fertilizer is being applied and residual N is extremely low, side-banding a small amount of urea (or similar) might be beneficial.

Acknowledgments
This project was funded by Sask Pulse Growers.

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), McInnes, B. (NARF), Pratchler, J. (NARF), Shaw, L. (SERF), Hnatowich, G. (ICDC), Weber, J. (WARC), Wall, A. (WCA), and Nybo, B. (WCA)

Description
The overall objective of this project was to demonstrate the potential of an additional 30 lb N/ac applied late season to increase either wheat yield or grain protein compared to applying all nitrogen (N) at seeding. Trials were initiated in 2019 and 2020 at Swift Current, Outlook, Scott, Indian Head, Yorkton, Melfort, Prince Albert, and Redvers. Treatments were designed to compare boot stage and post-anthesis timings of split N relative to side-banding all the N at seeding. Dribble band and broadcast applications of UAN and dissolved urea were compared. Treatments are listed in Table 22, and they were arranged in a four replicate RCBD.

Table 22. Treatment list for the increasing wheat protein with post emergent applications of UAN vs dissolved urea

Trt #	Seeding	Post emergence application				
	Side-banded Urea (lb/ac)	N (lb/ac)	Product	%N	Method	Stage
1	70	N/A	N/A	N/A	N/A	N/A
2	100	N/A	N/A	N/A	N/A	N/A
3	70	30	UAN	15.7	Dribble[1]	Boot
4	70	30	UAN	28	Dribble[2]	Boot
5	70	30	UAN	15.7	Dribble[1]	Post-anthesis
6	70	30	UAN	28	Dribble[2]	Post-anthesis
7	70	25	Urea Sol'n	14	Dribble [3]	Post-anthesis
8	70	30	UAN	15.7	Broadcast[4]	Post-anthesis
9	70	25	Urea Sol'n	14	Broadcast[5]	Post-anthesis

[1] Sprayed with dribble band nozzle at 20 US gal/ac to deliver 30 lb N/ac (10 gal/ac UAN + 10 gal/ac water = 15.7% N solution by weight)

[2] Sprayed with dribble band nozzle at 10 US gal/ac to deliver 30 lb N/ac (undiluted UAN = 28% N solution by weight)

[3] Sprayed with dribble band nozzle at 20 gal/ac to deliver 25 lb N/ac (1.66 Kg of urea dissolved in 1 US gallon of water = 14% N solution)

[4] Sprayed with 02 flat fan nozzles at 20 gal/ac to deliver 30 lb N/ac (10 gal/ac UAN + 10 gal/ac water = 15.7% N solution by weight)

[5] Spray with 02 flat fan nozzles at 20 gal/ac to deliver 25 lb N/ac (1.66 Kg of urea dissolved in 1 US gallon of water = 14% N solution)

Results

When averaged across all 16 site-years, increasing the rate of side-banded urea from 70 to 100 lb N/ac significantly increased yield from 4261 to 4476 kg/ha (63.4 to 66.6 bu/ac) and significantly increased grain protein from 13.3 to 13.8%, respectively (Figure 7). Split applications of N (trts 5-9) resulted in higher grain protein compared to side-banding all the N at seeding (trt 2) however, it also reduced yield. The greatest increases in grain protein and decreases in yield resulted when split applications occurred post-anthesis compared to the boot stage. For example, dribble banding UAN (28% N) post-anthesis at 30 lb N/ac to a base rate of 70 lb N/ac (trt 6) significantly increased grain protein by 0.32% but significantly resulted in 322 kg/ha (4.8 bu/ac) less yield, compared to the side-banded check of 100 lb N/ac (trt 2). In contrast, dribble banding UAN (28% N) earlier at the boot stage (trt 4), resulted in a more modest grain protein increase of 0.15% but with a relatively lower yield loss of only 55 kg/ha (0.8 bu/ac). The reason for the grain yield and protein differences between boot stage and post-anthesis applications may be related to differences in flag leaf burn. Dribble banding UAN post-anthesis caused more flag leaf damage compared to the boot stage timing, which may have reduced yield and in turn increased grain protein (Figure 7). However, it is also possible, more of the N from the boot stage application favored yield over protein because it was earlier than the post-anthesis application. Overall, grain protein increases to split N applied post-anthesis tended to be a little lower (0.1%) when using dissolved urea compared to UAN, but this was likely the result of applying a little less N with dissolved urea (i.e. 25 vs 30 lb N/ac).

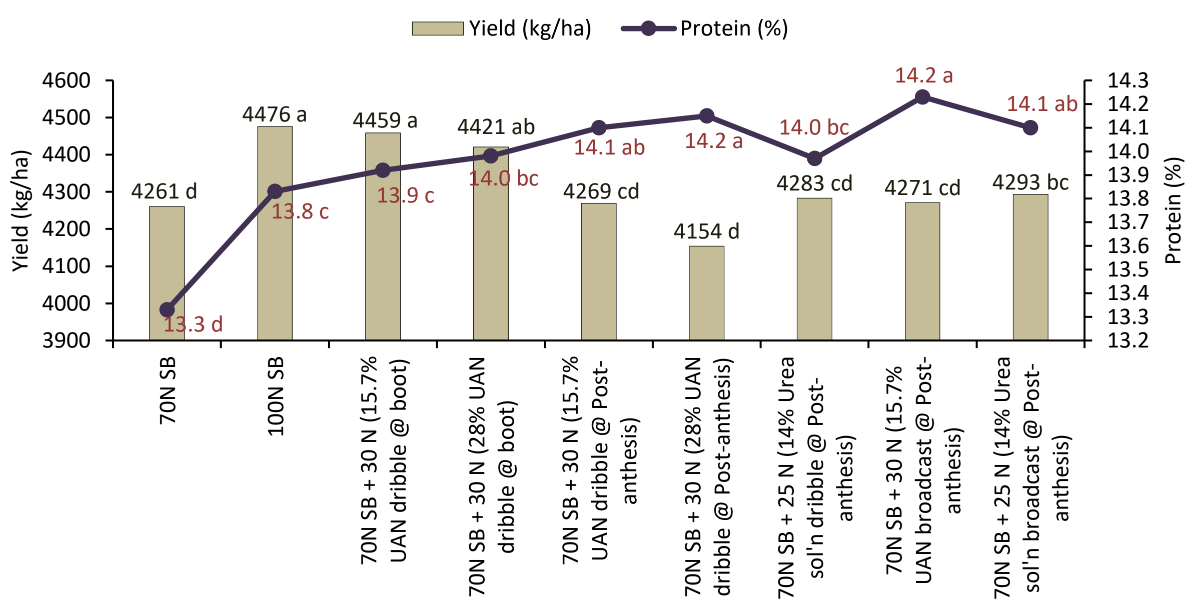

Figure 7. Effect of treatment on wheat yield and grain protein averaged across all 16 site-years

Conclusions

Split applications of N were able to raise the grain protein relative to applying all the N at seeding, but they also tended to result in less yield. Protein increases and yield decreases were less pronounced with the boot stage timing compared to the post-anthesis timing. Economically, split applications did not prove to be economic because the value of the protein increases were negated by the associated yield losses even when assuming a healthy protein spread of $0.6/%/bu.

Acknowledgements
This project was supported by the Saskatchewan Wheat Development Commission.

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

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 objectives of this project were (1) to compare the vigor and yield performance of various lots of farm-saved wheat seed (FSS) relative to the same varieties of certified seed and (2) to determine the degree to which seed treatment can improve the vigor and yield potential of farm-saved and certified seed lots of wheat. This is a three-year study (2019-2021), with 2020 being the second season of the trials which were conducted at Yorkton, Indian Head, Redvers, Swift Current, Outlook, Scott, Melfort and Prince Albert. The treatments were a three-way factorial RCBD with four replicates. The treatment list is shown in Table 23.

Table 23. Treatment list for farmer-saved seed wheat trial in 2020.

Trt #	Seed treatment	Variety pairing	Seed type
1	Untreated	A	Certified
2	Untreated	A	Farm-saved Seed
3	Untreated	B	Certified
4	Untreated	B	Farm-saved Seed
5	Untreated	C	Certified
6	Untreated	C	Farm-saved Seed
7	Treated	A	Certified
8	Treated	A	Farm-saved Seed
9	Treated	B	Certified
10	Treated	B	Farm-saved Seed
11	Treated	C	Certified
12	Treated	C	Farm-saved Seed

Results

Overall, the quality of FSS and certified seed used in this study was comparable. In 2019, the seed vigor of certified seed was 93.1%, which did not differ significantly from the vigor of FSS at 93.3%. In 2020, the vigor of certified seed at 93.7% was a little higher than FSS at 91.1%. While not significantly different in either year, seed-borne levels of total fusarium species in 2019 were on average 1.6% and 2.4% on FSS and certified seed, respectively. In 2020, levels of seed-borne fusarium species were a little higher at 3.7% for certified seed and 4.8% for FSS. However, these average levels would be considered low and of little concern in either year.

The affect of seed treatment on seedling vigor and crop yield was inconsistent. In the majority of cases seedling vigor and yield were unaffected by seed treatment. However, seed treatment did increase seedling vigor at four site-years and in two of these cases this led to significantly higher yields and a numerically higher yield in another. In contrast, seed treatment significantly reduced seedling vigor at one site-year and significantly reduced yield. At two more site-years, seed treatment also significantly reduced yield. Averaged across all site-years, seed treatment had no affect on yield (Table 24).
For most of the site-years, seedling vigor did not differ between certified or FSS. Where differences were detected, the response was inconsistent. While two site-years found better seedling vigor with certified seed, another three site-years found FSS had better seedling vigor. Furthermore, yield did not differ significantly between certified and FSS whether all site-years were analyzed collectively or individually (Table 24). Moreover, effects of seed type and seed treatment on grain protein were usually insignificant and where they were significant the trends were inconsistent.

Table 24. Main effect means and significance of seed treatment and seed type and their interaction on seedling vigor, grain yield, and protein across all 16 site-years.

Main Effect	Seedling Vigor (1-10)	Yield (kg/ha)	Protein (%)
Seed Treatment (S)			
Untreated	8.10 b	4445 a	13.52 a
Treated	8.29 a	4435 a	13.43 a
Seed Type (T)			
Certified	8.24 a	4453 a	13.44 a
Farm-saved	8.14 a	4428 a	13.51 a
(S by T)			
Untreated Certified	8.20 a	4458 a	13.50 a
Untreated Farm-saved	8.00 a	4433 a	13.53 a
Treated Certified	8.28 a	4448 a	13.37 a
Treated Farm-saved	8.30 a	4423 a	13.48 a

Conclusions

Growing FSS was more economical in this study, because doing so incurred no yield or protein disadvantage, and certified seed is typically more expensive. However, certified seed has value as it is "true to type" which is of growing importance to the end user. Purchasing certified seed introduces improved genetics to the farm and supports a breeding system that keeps Canadian wheat producers globally competitive. This study does not discount the importance of certified seed. However, the popular approach of many farmers to grow farm saved seed for a couple of years between purchases of new certified seed appears economically sound.

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 assess the integration of genetic disease resistance, seeding rates, and fungicide application timing for disease control in oats. The study was conducted at Indian Head, Melfort, Redvers, and Yorkton, Saskatchewan in 2018, 2019, and 2020. The treatment list is shown in Table 25 and were arranged in a split plot design with fungicide timing as the main plot and variety and seeding rate fully randomized within the sub-plots. Each treatment was replicated four times at each location in each year.

Table 25. Treatment list for improved integrated disease management for oats trial.

Treatment	Fungicide[¥] Timing	Variety	Seeding Rate (seeds m^{-2})
1	Untreated	CS Camden	300
2			450
3		Summit	300
4			450
5	Flag Leaf	CS Camden	300
6			450
7		Summit	300
8			450
9	Heading	CS Camden	300
10			450
11		Summit	300
12			450

[¥]Caramba foliar fungicide (metconazole) was applied either at the flag leaf stage (Zadoks 39) at the recommended rate (280 mL/ac), or at the heading stage (Zadoks 59) at the recommended rate (400 mL/ac), with a water volume of 40 L/ac.

Results

Conditions were not highly conducive to disease development at any of the locations or years of the study. Effects of variety, seeding rate, and fungicide were all very dependent on environments. Plant population, tillering, and panicle development were generally affected by variety and seeding rate (Table 26), and these effects, in turn, may have contributed to varietal and seeding rate differences in lodging, leaf disease development, maturity, yield, and seed quality. There were often variety by seeding rate interactions but, seeding rate and variety effects were nearly always independent of fungicide treatments. Effects of fungicide application were inconsistent and often inconclusive, as untreated treatments performed as well as either of the fungicide application timings, even when there were significant differences between the treatments. Fungicide effects would likely have been more frequent and consistent if environmental conditions had been conducive to disease development.

Table 26. F-test results of mixed-effects model analysis of the crop response variables, with site-year included as a random effect, to assess the overall effect of each treatment and interactions of the treatments across site-years. Effects are considered statistically significant if P ≤ 0.05.

	Plant density	Tillers per plant	Panicles per plant	Lodging	Maturity	Yield	TKW
Variety (V)	0.310	**0.017**	**<0.001**	**<0.001**	**<0.001**	0.852	**<0.001**
Seeding Rate (R)	**<0.001**	**<0.001**	**<0.001**	**0.004**	0.095	**0.002**	0.431
Fungicide (F)	-	-	**0.008**	0.182	**0.032**	**0.013**	0.377
V X R	0.221	**0.006**	0.190	**0.039**	0.641	0.806	0.449
V X F	-	-	0.439	0.174	0.956	0.533	0.820
R X F	-	-	0.986	0.735	0.796	0.535	0.688
V X R X F	-	-	0.846	0.519	0.231	0.343	0.326

Conclusions

It is recommended that producers continue to combine several practices to manage disease in oats, as the effects can be additive, if not interactive. The effectiveness of applying fungicide for disease management did not appear to vary with varieties or seeding rates in this study. Thus, the decision to apply fungicide, and at what timing, should be based on environmental conditions being conducive to disease development.

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 study is to examine the additive and interactive effects of management and environment on stand establishment and disease development in canola. The study design consisted of an observational, or survey-style approach, with a multivariate and nested/hierarchical data structure. The study was conducted on commercial farms, in collaboration with local producers in the Indian Head area for three growing seasons, from 2018-2020. Producers were contacted ahead of seeding in the spring to identify fields which would be planted to canola. There were no treatments or experimental manipulation; producers managed their fields as usual. The fields chosen for the study were approximately 160 acres in area but could be part of larger management units. The replicates were arranged hierarchically, in that sample sites were nested within fields, fields were nested within operations, and the same operations were included over the three years of the study. The number of replicates at each level over the three years of the study is summarized in Table 27.

Table 27. Replication at the sample site, field, and operation level in each growing season over the duration of the study.

	2018		2019		2020	
Operation ID	Fields	Sample Sites	Fields	Sample Sites	Fields	Sample Sites
001	5	17	3	10	3	9
002	4	13	3	11	4	12
003	5	18	3	9	5	15
004	4	12	3	10	-	-
005	3	11	3	10	3	9
006	-	-	3	9	3	9
Total	21	71	18	59	18	54

Results

The additive and interactive effects of management and environment on the speed, temporal uniformity, and spatial uniformity of canola emergence were examined. Several management variables were found to be significantly influencing the emergence response at the location and in the years studied. Canola cultivar was the most influential management variable (Figure 8) and had a consistent and surprisingly large effect on all emergence response variables. Seeding date was also consistently and significantly influential on emergence (Figure 8), however the effect was not additive when combined with environmental variables. This indicates that the effect of seeding date was mainly a function of environmental conditions. Nearly all the environmental variables measured consistently influenced the emergence response and had additive and sometimes interactive effects with the management variables. Temperature and heat units were consistently more influential on emergence than precipitation and moisture.

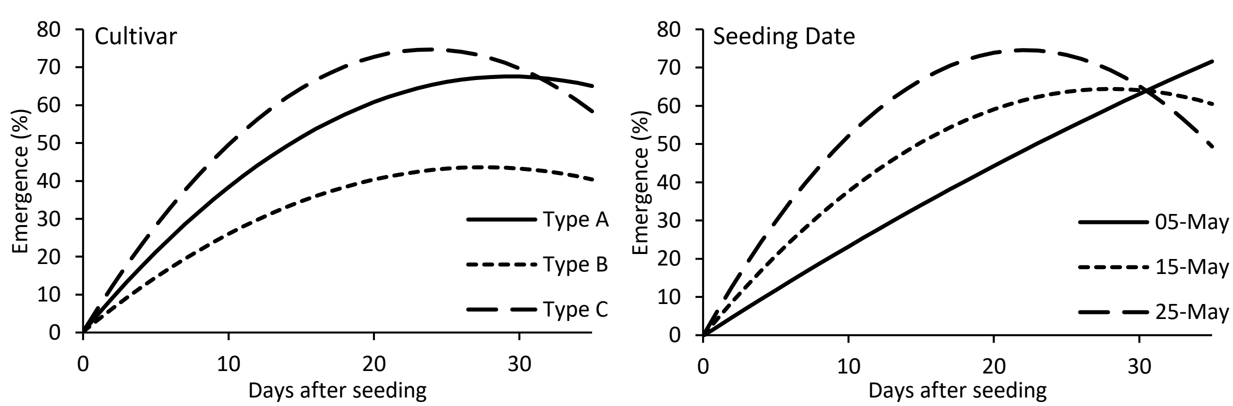

Figure 8. Cultivar and seeding date effect on canola emergence across all site-years.

Conclusions
The analysis and findings of the study were limited by the level of replication. Conducting the study in a single location limited the range of certain environmental conditions represented in the study. An extension of the study to provide additional replication at several locations would be insightful and would allow for the interpolation of the results to different agricultural production regions. Yet, the study was useful in demonstrating the potential of on-farm observational studies in agronomic research. An extension of the study could focus on variables of interest, as identified by canola industry stakeholders.

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.

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. For the purpose of this study, SCIC provided non-aggregated data, reported by quarter section over 10 years (2009-2018). The variables included in the data set included the year, land location, crop and variety, seeding date, fertility rates, and yield. Every entry included an anonymous customer ID number to distinguish management under different operations. A separate data set was created for each of the two components of this study, seeding date and crop rotation. The total number of entries for each of the major crops is shown in Table 28. The SCIC also provided weather data for 131 weather stations located throughout Saskatchewan. The data included daily rainfall and minimum, maximum, and mean temperatures for each station from April to October from 2006-2018. Several new variables were calculated from the raw weather data, including cumulative GDD, frost dates, and cumulative rainfall, both by year and averaged over all years.

Table 28. Number of entries for each of the crops in the seeding date data set.

Crop	Number of entries
Barley	88,998
Canaryseed	14,369
Canola	403,007
Chickpeas	3,988
Durum Wheat	151,737
Faba beans	1,230
Field Peas	83,089
Flax	36,784
Fall Seeded Crops	10,815
Grain Corn	390
Hard Red Spring Wheat	268,542
Lentils	108,964
Minor Cereals	28,396
Mustard	10,376
Oats	50,634
Soybeans	9,736

Results

Statistical analysis of the seeding date component of the study was undertaken during this reporting period. A sample of what can be expected is provided below using barley as an example crop.

The barley yield response to seeding date was quadratic and varied significantly by soil zone, by average seasonal rainfall, and by average seasonal GDD. In the thick black, dark grey and grey soil zones, there is a nearly linear decrease in yield with any delay in seeding, while in the black and dark brown soil zones there is less of a yield loss with delayed seeding at early seeding dates, but the penalty increases with later seeding dates (Figure 9). Consistent with the response by soil zone, there was a nearly linear decrease in yield with a delay in seeding in higher seasonal rainfall areas, and less of a yield penalty with delayed seeding at early seeding dates but an increasingly greater penalty with later seeding dates in lower rainfall areas (Figure 10). Furthermore, similar to the response by soil zone, there was a nearly linear decrease in yield with a delay in seeding in cooler areas, and less of a yield penalty with delayed seeding at early seeding dates but an increasingly greater penalty with later seeding dates in warmer areas (Figure 11). Furthermore, in wetter environments, regardless of temperature, there was a nearly linear decline in yield with any delay in seeding date, while in drier environments, regardless of temperature, there was little effect of a delayed seeding date earlier in the season, but the yield penalty increased with later seeding dates.

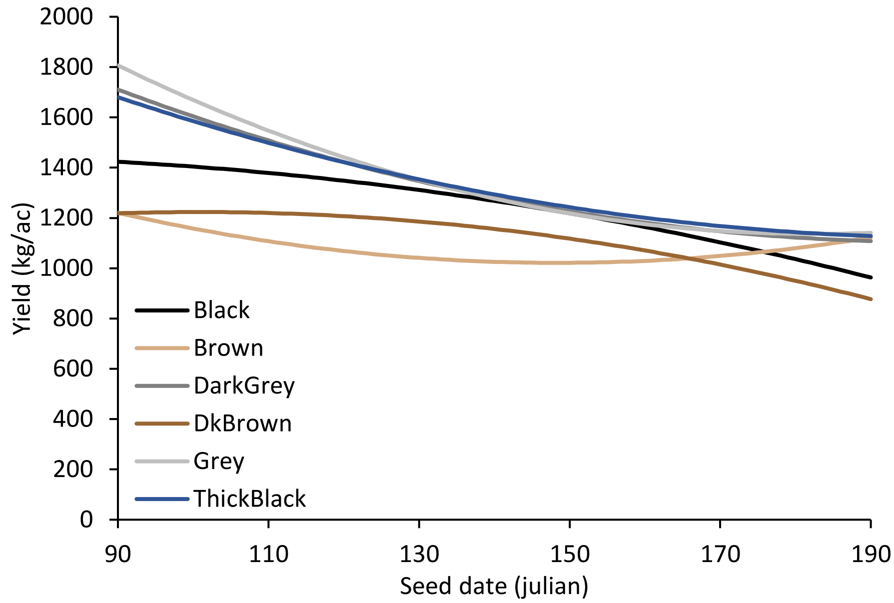

Figure 9. The effect of seeding date on barley yield, by soil zone. The range of seeding dates is inclusive of all seeding dates observed in the data set.

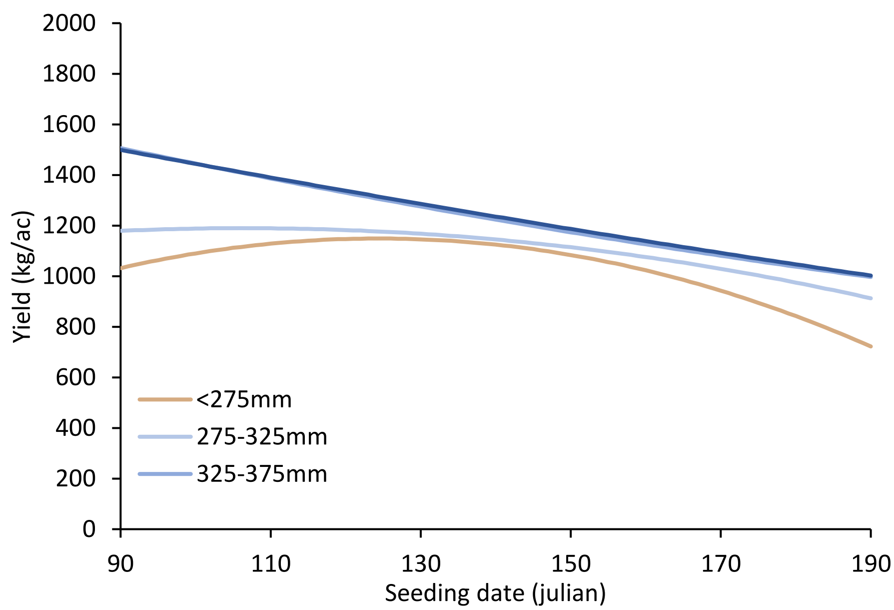

Figure 10. The effect of seeding date on barley yield, by average seasonal rainfall. The range of seeding dates is inclusive of all seeding dates observed in the data set.

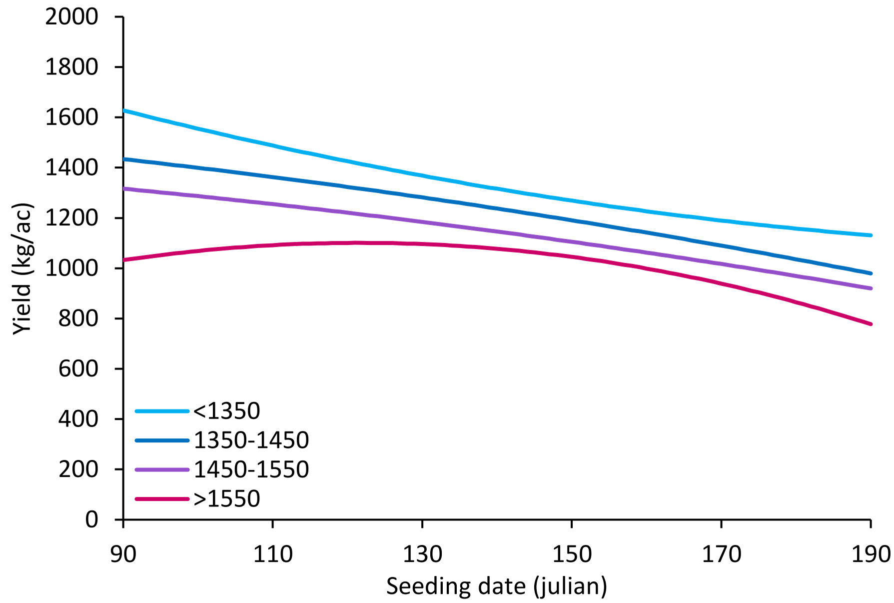

Figure 11. The effect of seeding date on barley yield, by average seasonal GDD. The range of seeding dates is inclusive of all seeding dates observed in the data set.

Conclusions

Due to the extensive nature of the data set, data management, manipulation, and exploration comprised a greater effort than was expected and has been the major activity completed to date. The analytical process is repeated for all major crops, but the geographical and environmental variables of interest may differ and are still being explored for some crops.

Acknowledgements

This project was funded by WGRF.

Contrasting Fungicide Applications and Genetic Fusarium Head Blight Resistance for Enhanced Yield and Quality of Barley

Holzapfel, C. (IHARF), Turkington, K. (AAFC), Mohr, R. (AAFC), Hall, M. (ECRF), and McInnes, B. (NARF)

Description

The objective of this project was to investigate the potential merits of contrasting foliar fungicide strategies in barley production and the potential for foliar fungicide applications combined with genetic fusarium head blight (FHB) resistance to enhance yield and quality of barley. The field trials were conducted at Indian Head, Melfort, and Yorkton from 2019-2020. The treatments were a factorial combination of three varieties and four fungicide treatments, arranged in a four replicate RCBD (Table 29). Seeding rate was 300 viable seeds/m^2 at all the locations.

Table 29. Treatment list of barley varieties and fungicide treatments.

#	Variety [Z]	Fungicide [Y]
1	CDC Bow (MS)	Untreated (no foliar fungicide)
2	CDC Bow (MS)	Flag (0.4 l/ac Trivapro A + 0.12 l/ac Trivapro B)
3	CDC Bow (MS)	Head (0.325 l/ac Prosaro XTR)
4	CDC Bow (MS)	Dual (Trt 2 and 3 combined – plots receive both applications)
5	AAC Synergy (I)	Untreated (no foliar fungicide)
6	AAC Synergy (I)	Flag (0.4 l/ac Trivapro A + 0.12 l/ac Trivapro B)
7	AAC Synergy (I)	Head (0.325 l/ac Prosaro XTR)
8	AAC Synergy (I)	Dual (Trt 2 and 3 combined – plots receive both applications)
9	AAC Connect (MR)	Untreated (no foliar fungicide)
10	AAC Connect (MR)	Flag (0.4 l/ac Trivapro A + 0.12 l/ac Trivapro B)
11	AAC Connect (MR)	Head (0.325 l/ac Prosaro XTR)
12	AAC Connect (MR)	Dual (Trt 2 and 3 combined – plots receive both applications)

[Z] All locations will use the same seed source on a year-to-year basis. Ratings are for FHB (MS – moderately susceptible; I – intermediate; MR – moderately resistant)

[Y] Fungicides should be applied in ~20 U.S. gal/ac at either the flag-leaf stage (Trt 2, 4, 6, 8, 10, & 12) or between 80% head emergence and 3 days after heading is complete (Trt 3, 4, 7, 8, 11, & 12). If necessary, application dates may vary with variety.

Results

Barley yields were highest at Indian Head, intermediate at Melfort, and lowest at Yorkton. Barley yields were affected by variety but not fungicide at both Indian Head and Yorkton (Table 30). At Melfort, neither variety nor fungicide effects were significant. At Indian Head, yields were higher with Synergy and Connect versus Bow while, at Yorkton, yields were higher with Synergy than for either Bow or Connect. At Melfort, the trend was for lower yields with Bow compared to the other two varieties. While fungicide effects were never significant, the tendency was usually for slightly higher yields in the treatments that received a flag leaf application. Test weight was affected by variety at all three locations but never by fungicide treatment. Numerically, AAC Synergy had the highest test weight at all three locations while CDC Bow consistently had amongst the lowest test weight. Thousand kernel weight (TKW) was affected by variety at all locations and by fungicide treatment at Yorkton. The variety effect was consistent with lower TKW for CDC Bow at all three locations compared to the other two varieties. Although differences between fungicide treatments were too small to be declared significant individually, the trend was for higher TKW when a flag leaf fungicide was applied. Deoxynivalenol (DON) accumulation was not affected by either variety or fungicide treatment on their own for any individual location. Under the dry conditions, DON was low for all treatments at all locations, averaging 0.005 ppm at Yorkton, 0.047 ppm at Indian Head, and 0.096 ppm at Melfort.

Table 30. Main effect (variety and fungicide treatment) means for barley grain yield at three locations in 2020. Main effect means within a location followed by the same letter do not significantly differ at P < 0.05.

Main Effect	Indian Head	Yorkton	Melfort
Variety	--------------------------------	Grain Yield (kg/ha)	--------------------------------
Bow (MS)	4986 b	2610 b	3394 a
Synergy (I)	5609 a	3074 a	3691 a
Connect (MR)	5429 a	2624 b	3630 a
Fungicide			
Untreated Control	5378 a	2744 a	3487 a
Flag	5444 a	2998 a	3691 a
Head	5258 a	2647 a	3604 a
Dual	5286 a	2688 a	3505 a

Conclusions

Overall, the FHB pressure was too low for us to detect either meaningful variety differences or consistent fungicide benefits. It simply means that, in the absence of the disease, fungicides are much less likely to provide measurable benefits for yield or quality and genetic resistance may be less important than other agronomic considerations. We are hopeful that we will acquire results for a wider range of conditions, including heavier disease pressure, as we move forward with the project.

Acknowledgements

This project was funded by WGRF, Sask Barley, and Manitoba Crop Alliance.

Establishing Nitrogen and Seeding Rate Recommendations for Hybrid Brown Mustard Production in SK

Nybo, B. (WCA), Wall, A. (WCA), Holzapfel, C. (IHARF), Shaw, L. (SERF), Jacob, C. (SK Ministry of Ag.), Chant, S. (SK Ministry of Ag.), and Bernard, M. (SK Ministry of Ag.)

Description

The objectives of this project were (1) to demonstrate the nitrogen (N) response of hybrid brown mustard compared to a traditional open pollinated variety and (2) to demonstrate the seeding rate response of hybrid brown mustard compared to a traditional open pollinated variety. The demonstration trials were conducted at Swift Current, Indian Head, and Redvers in 2020. Trial one consisted of seven nitrogen rates applied to both Centennial brown mustard and hybrid brown mustard (Table 31). Trial two consisted of five seeding rates of both Centennial brown mustard and hybrid brown mustard (Table 32). The treatments in both trials were arranged in a four replicate RCBD.

Table 31. Treatments list for nitrogen fertility trial.

#	Variety	N Fertility (fertilizer + soil) [Z]	Urea Rate
1	AAC Brown 18 (Hybrid)	check (soil N plus N from MAP)	nil
2	AAC Brown 18	67 kg N/ha	65 kg/ha
3	AAC Brown 18	90 kg N/ha	115 kg/ha
4	AAC Brown 18	112 kg N/ha	163 kg/ha
5	AAC Brown 18	134 kg N/ha	211 kg/ha
6	AAC Brown 18	157 kg N/ha	261 kg/ha
7	AAC Brown 18	179 kg N/ha	309 kg/ha
8	Centennial Brown (OP)	check (soil N plus N from MAP)	nil
9	Centennial Brown	67 kg N/ha	65 kg/ha
10	Centennial Brown	90 kg N/ha	115 kg/ha
11	Centennial Brown	112 kg N/ha	163 kg/ha
12	Centennial Brown	134 kg N/ha	211 kg/ha
13	Centennial Brown	157 kg N/ha	261 kg/ha
14	Centennial Brown	179 kg N/ha	309 kg/ha

[Z] Assumes 37 kg NO_3-N/ha soil residual plus N from MAP and AMS

Table 32. Treatments list for seeding rate trial.

#	Variety	Seed Rate	kg/ha
1	AAC Brown 18 (Hybrid)	108 seeds/m^2 (10 seeds/ft^2)	3.0
2	AAC Brown 18	150 seeds/m^2 (14 seeds/ft^2)	4.0
3	AAC Brown 18	194 seeds/m^2 (18 seeds/ft^2)	5.4
4	AAC Brown 18	237 seeds/m^2 (22 seeds/ft^2)	6.6
5	AAC Brown 18	280 seeds/m^2 (26 seeds/ft^2)	7.7
6	Centennial Brown (OP)	108 seeds/m^2 (10 seeds/ft^2)	4.3
7	Centennial Brown	150 seeds/m^2 (14 seeds/ft^2)	5.9
8	Centennial Brown	194 seeds/m^2 (18 seeds/ft^2)	7.6
9	Centennial Brown	237 seeds/m^2 (22 seeds/ft^2)	9.4
10	Centennial Brown	280 seeds/m^2 (26 seeds/ft^2)	11.0

[Z] AAC Brown 18 – 2.68 g/1000 seeds, 96% germ; Centennial Brown – 3.84 g/1000 seeds, 96% germ

Results

(1) Nitrogen Fertility Trial

Overall, yields for the nitrogen trial were around the provincial average (923 kg/ha). Indian Head resulted in the highest yields of all sites and for the hybrid brown increased with nitrogen up to 140N (2812 kg/ga) before leveling off at 160N (1350 kg/ha), but not significantly different from one another (Figure 12). Centennial brown yields increased up to 160N (2341 kg/ha), a 6% increase over 140N available (2208 kg/ha) at Indian Head. In Swift Current hybrid brown yield increased with nitrogen up to 120N (1807 kg/ha) followed by a decline at 140N and 160N. Centennial brown had yields increasing up to the 140N (1493 kg/ha) followed by a slight decline at 160N. At Redvers, hybrid yields increased up to 160N (1918 kg/ha) with a 17% increase over 120N (1593 kg/ha). Centennial brown yields at Redvers increased with nitrogen up to 140N (1580 kg/ha) and showed a slight decline with 160N (1511 kg/ha). When all locations were averaged together, hybrid mustard with available nitrogen from 120N to 160N out yielded Centennial with 140N by 11% to 18%. Overall, hybrid brown yield ranged from 1000kg/ha to 1807kg/ha at Swift Current, 1241kg/ha to 2812kg/ha at Indian Head, and 1067kg/ha to 1918kg/ha at Redvers. Centennial brown yield ranged from 717 kg/ha to 1493 kg/ha at Swift Current, 1059 kg/ha to 2341 kg/ha at Indian Head, and 953 kg/ha to 1580 kg/ha at Redvers.

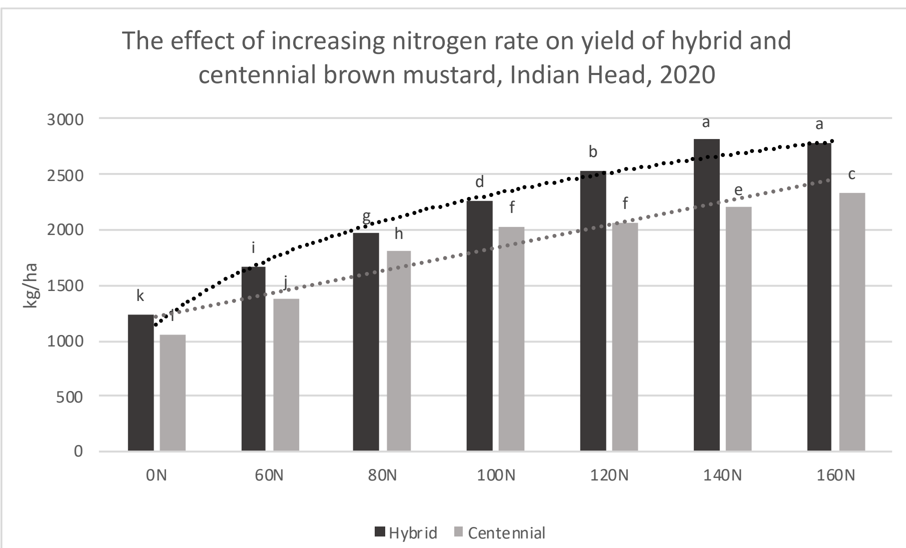

Figure 12. Grain yield of hybrid brown and Centennial brown mustard for increasing nitrogen rates at Indian Head in 2020.

(2) Seeding Rate Trial

Except for Centennial brown yield at Swift Current, mustard yields for the seed rate trial were at least that of the provincial average (923 kg/ha). Results from Swift Current showed that hybrid brown yield increased with seed rates up to 22 seeds/ft^2 (1081 kg/ha) before levelling off at 26 seeds/ft^2 (1092 kg/ha). Centennial brown yield increased up to 26 seeds/ft^2 (875 kg/ha) except for 22 seeds/ft^2 that showed a slight decline. Indian Head had the highest yields of all the sites (Figure 13). Hybrid brown yield increased with seed rate up to 18 seeds/ft^2 (2912 kg/ha) followed by a statistically significant decline. Centennial brown yield at Indian Head increased up to 14 seeds/ft^2 and was not significantly different than 22 seeds/ft^2. At Redvers there was no significant difference in the highest hybrid yields when seeding 10-18 seeds/ft^2, which resulted in a slight downward trend for the effect of increasing seeding rate on yield. The highest yielding Centennial brown treatment at Redvers resulted from 14 seeds/ft^2 (1025 kg/ha). For both varieties at Redvers, seeding 26 seeds/ft^2 resulted in the lowest yield of 1050 kg/ha for the hybrid, and 827 kg/ha for Centennial.

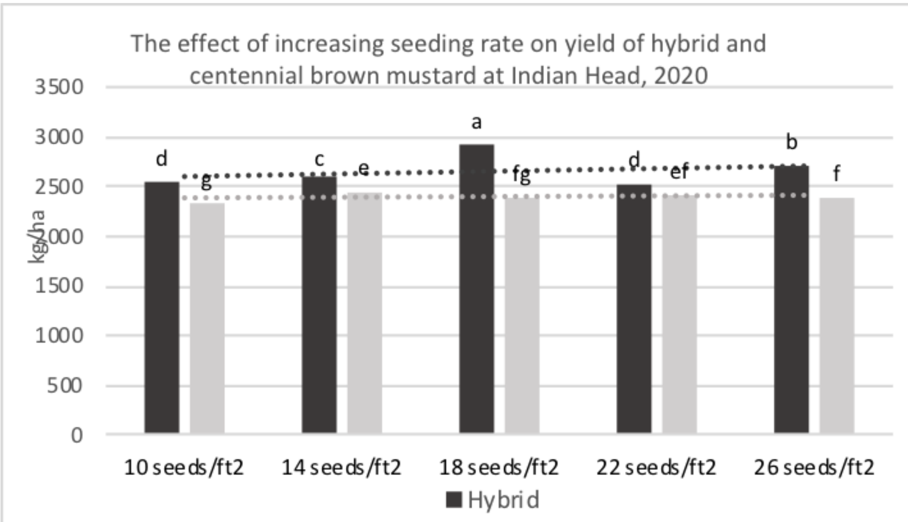

Figure 13. Grain yield of hybrid brown and Centennial brown mustard for increasing seeding rates at Indian Head in 2020.

Conclusions

After year one of this study, more robust multi-site, multi-year data is essential to perform meaningful statistical analyses and acceptable recommendation changes for the optimum seeding rate and nitrogen fertilizer requirements for hybrid brown mustard. Many growers in the province are opting out of growing mustard acres as it has not kept up with technological advances driving the competitiveness of other Canadian crops. Double digit increases to yield can keep mustard competitive with domestic crops and global export by remaining a valuable business option as a rotational crop for our mustard growers. In the coming years, further research is required to develop optimal fertilizer rates for other nutrients such as phosphorus, potassium, sulphur, zinc and will help to further explore the vigor and elasticity of hybrid mustards and their ability to compensate for a reduced plant stand to produce yield.

Acknowledgements

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