2018 Annual Report
for the

Agricultural Demonstration of Practices and Technologies (ADOPT) Program

Project Title: Input Contributions to Spring Wheat Yield Components, Quality, and Profits

(Project #20170419)

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Project Identification

1. **Project Title:** Input Contributions to Spring Wheat Yield Components, Grain Quality, and Profits
2. **Project Number:** 20170419
3. **Producer Group Sponsoring the Project:** Indian Head Agricultural Research Foundation
4. **Project Location(s):** Indian Head, Saskatchewan, R.M. #156
5. **Project start and end dates (month & year):** April-2018 to February-2019
6. **Project contact person & contact details:**

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Objectives and Rationale

7. **Project objectives:**

The objective of this project was to demonstrate agronomic and economic responses of CWRS wheat to various crop inputs both individually and collectively with consideration given to individual yield components (i.e. number of plants, spikes per plant, kernels per spike and kernel size) along with other important variables such as grain yield, protein concentration and overall profitability.

8. **Project Rationale:**

Wheat is an important rotational crop for farmers and a major contributor to the provincial economy. Provided that top grades and protein can be achieved, wheat can also be quite profitable; however, consistently achieving high quality and yield is a challenge that can greatly affect the profitability of the crop and be a deterrent for many growers. The current project was initiated to demonstrate both the economic costs/benefits associated with seed treatments, higher seeding rates, extra fertility, PGR applications and foliar fungicide along with their respective contributions to individual yield components, grain yield, quality and subsequent revenues. The project was designed to demonstrate the individual contributions of several major inputs when brought into a low input system relative to the effects of applying all of the inputs together in a single, intensively managed system. A brief background discussion of the individual inputs evaluated follows.

<u>Seed Applied Fungicide</u>

Seed-applied fungicides are registered to protect plants against soil borne pathogens and root diseases. Replicated, third party research showing yield benefits to seed-applied fungicides under field conditions is limited but generally shows they are most likely to be beneficial when using lower quality (i.e. diseased) seed or in highly stressful environments (i.e. cold wet soils, dry conditions with winter cereals). That said, a large percentage of producers see these products as a form of insurance and, given that wheat tends to be one of the earliest seeded crops, applying seed-applied fungicides has become a common practice for many growers.

<u>Seeding Rate</u>

The traditional recommended range of plant populations to target for spring wheat is 215-270 plants/m^2; however, especially in wetter environments where drought is less likely to be limiting and disease issues are more common, many growers and agronomists are targeting populations in excess of 300 plants/m^2. The primary rationale for higher populations is to reduce the infection window for fusarium head blight and make fungicide applications easier to time. That said, under dry conditions higher seeding rates can lead to premature maturity and reduced yield while, under wet conditions, dense plant populations frequently increase the risk of lodging.

Fertility

Spring wheat response to major crop nutrient applications has been well researched and all nutrients can potentially be limiting depending on yield potential and the soil's capacity to provide the required nutrients. Spring wheat has a total uptake of 1.9-2.3 lb N/bu, 0.73-0.88 lb P_2O_5/bu, 1.63-2.00 lb K_2O/bu and 0.2 lb S/bu. While responses to K and S are less likely in most Saskatchewan soils, N and P are much more commonly limiting. Nitrogen fertility is also one of the most important factors affecting grain protein concentration, an important quality parameter for the CWRS and CWAD classes which are the dominant classes grown in Saskatchewan.

Plant Growth Regulators

After several years of limited and restricted use due to MRL issues, the plant growth regulator (PGR) chlormequat chloride (Manipulator™ 620) became available to western Canadian wheat growers in 2018. This product has been locally evaluated in numerous industry and publicly funded trials dating back to 2013 and has performed consistently well with average yield increases at Indian Head of 12 bu/ac in 2013 (16%), 9 bu/ac in 2014 (12%), 7 bu/ac in 2015 (10%), 9 bu/ac (15%) in 2016 and 7 bu/ac (10%) in 2017. While yield benefits are frequently observed, chlormequat chloride is not registered for increasing yield, but rather, for reducing plant height and lodging. Shorter, more upright plants can increase harvest efficiency and, in many cases, grain yield. Past research and demonstrations have shown that PGR applications are most likely to be beneficial under intensive management where yield potential along with the risk of lodging are higher.

Foliar Fungicide

Fusarium head blight (FHB) is one of the most important factors reducing yield and quality of wheat in western Canada, particularly in wetter years and/or regions. While improved genetic resistance is vital for managing fusarium on both a short- and long-term basis, foliar fungicides are the most commonly used option for minimizing the impact of this disease on wheat yield and quality. While disease severity and subsequent responses to fungicide vary with environment and cannot be guaranteed, past field trials and demonstrations at Indian Head have shown that yield increases of 10-20% are commonly achieved for CWRW, CWRS and CWAD classes of wheat. Even when FHB pressure is low, the products used to control it are also effective against many leaf diseases and much of the observed yield responses can often be attributed to reductions in leaf disease. In order to increase the likelihood of response to the fungicide treatments in the current, no fungicide was applied at the flag-leaf stage.

Methodology and Results

9. Methodology:

A field trial was initiated in the spring of 2018 near Indian Head, Saskatchewan (50.544 N, 103.567 W) to evaluate the contributions of various inputs to CWRS wheat yield and quality components. Indian Head is situated in the thin-Black soil zone of southeast Saskatchewan and the soil is classified as an

Indian Head clay with typical organic matter concentrations of 4.5-5.5%. The design was a four-replicate RCBD with seven treatments including contrasting low and high input systems and five treatments where specific inputs were added to the low input system individually. Details for each treatment are provided in Table 1.

Table 1. Treatments evaluated in the wheat input demo at Indian Head, Saskatchewan (2018).

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

Selected agronomic information along with dates of certain measurements are provided in Table 2. AAC Prevail wheat was direct-seeded approximately 2.5 cm (1") deep into canola stubble on May 5. Seed-applied fungicide was utilized as per protocol with 325 ml/100 kg seed of Raxil Pro (3 g tebuconazole/l + 15.4 g/l prothioconazole/l + 6.2 g/l metalaxyl) applied where applicable. The fertilizer was side-banded urea (46-0-0), monoammonium phosphate (11-52-0), potash (0-0-60), and ammonium sulphate (21-0-0-24) with rates varied as per protocol. Weeds were controlled using registered pre-emergent and in-crop herbicides. Manipulator PGR and Prosaro foliar fungicide applications were completed using a CO_2 sprayer with a 2.5 m hand boom on June 16 (early stem elongation) and July 5 (anthesis), respectively. No insecticides were required. Pre-harvest glyphosate was applied on August 9 (past physiological maturity) and the centre five rows of each plot were straight-combined using a Wintersteiger plot harvester on August 14.

Various data were collected over the growing season and from the harvested grain samples. Plant and head densities were measured by counting the number of individual plants (June 12) and spikes (July 2) in the same, marked, 2 x 1 m sections of crop row and converting the mean values to plant/heads per square meter. Lodging was rated just prior to harvest on a scale of 0-9 where 0 indicated no lodging and 9 indicated severe lodging across the entire plot area. Grain yields were determined by weighing the harvested grain samples and are corrected for dockage and to a uniform moisture content of 14.5%. Test weight was measured using standard CGC methods with values expressed as g/0.5 l. Thousand kernel weight was calculated for each plot from a subsample of 500-1000 seeds. Grain protein concentrations and percent fusarium damaged kernels (by mass) were determined by an accredited third party facility (Seed Solutions Laboratories) using an NIR instrument and visual assessments.

All response data were analysed using the Mixed procedure of SAS with treatment effects considered fixed and replicate effects treated as random. Least significant difference (L.S.D.) values were calculated and are presented regardless of the F-test results; however, in cases where the overall F-test was not significant these values should be used cautiously. All treatment effects and differences between means were considered significant at $P \leq 0.05$.

Table 2. Selected agronomic information for the wheat input demo at Indian Head, Saskatchewan (2018).

Factor / Field Operation	Indian Head 2018
Previous Crop	Canola
Pre-emergent herbicide	894 g glyphosate/ha May 11, 2018
Seeding Date	May 5, 2018
Emergence Counts	June 12, 2018
In-crop Herbicide	280 g bromoxynil/ha + 280 g MCPA/ha + 15 g proxsulam/ha June 7, 2018
Plant Growth Regulator	1088 g chlormequat chloride/ha June 16, 2018 (as per protocol)
Head Density	July 2, 2018
Foliar Fungicide	100 g prothioconazole/ha + 100 g tebuconazole/ha July 5, 2018 (as per protocol)
Dry Matter	August 7, 2018
Lodging Ratings	August 12, 2018
Pre-harvest Herbicide	894 g glyphosate/ha August 9, 2018
Harvest date	August 14, 2018

10. Results:

Growing season weather and residual soil nutrients

Weather data for the 2018 growing season at Indian Head is provided alongside the long-term (1981-2010) averages in Table 3. Although there was less initial sub-soil moisture than previous seasons, the wheat was seeded into adequate soil moisture for germination and, generally speaking, timely late-May/early-June rains got spring seeded crops in the area off to a strong start. For May and June combined, precipitation was 88% of the long-term (1981-2010) average; however, July and August were much drier with only 34 mm of total precipitation, or 30% of the long-term average. The mean temperatures were well-above average in May and, to a lesser extent, June but below average in July and approximately average in August. Over the four-month growing period, the overall mean temperature was 16.4 °C compared to the long-term average of 15.6 °C.

Table 3. Mean monthly temperatures and precipitation amounts along with long-term (LT; 1981-2010) averages for the 2018 growing season (May through August) at Indian Head, SK.

Year	May	June	July	August	Avg. / Total
	------------------------------------ Mean Temperature (°C) ------------------------------------				
IH-2018	13.9	16.5	17.5	17.6	16.4
IH-LT	10.8	15.8	18.2	17.4	15.6
	--------------------------------------- Precipitation (mm) ---------------------------------------				
IH-2018	23.7	90.0	30.4	3.9	148
IH-LT	51.8	77.4	63.8	51.2	244

A composite soil sample was collected on May 4 (0-15 cm, 15-60 cm) and analyzed for basic chemical properties and residual nutrient levels (Table 4). The site had a pH of 7.8 and soil organic matter content of 4.8% in the upper profile. Residual N and P levels were considered low and likely to be limiting while K and S levels were considerably higher and response to these latter two nutrients was unlikely.

Table 4. Selected soil test results for the wheat input demo at Indian Head, Saskatchewan (2018).

Attribute / Nutrient	0-15 cm	15-60 cm	0-60 cm
pH	7.8	8.0	–
C.E.C. (meq/100g)	45.0	–	–
S.O.M. (%)	4.8	–	–
NO_3-N (kg/ha)^Z	9	15	24
Olsen-P (ppm)	5	–	–
K (ppm)	659	–	–
S (kg/ha)	37	42	79

Field Trial Results

As mentioned earlier, conditions were excellent for emergence; however, percent mortality did tend to be higher at the higher seeding rates. For the treatments that received the lower seeding rate, plant populations were similar except for the higher fertility treatment (#4) where plant populations were slightly but significantly higher. The reasons for this effect are uncertain – it is possible that the higher fertility resulted in stronger seedlings which were better equipped to survive early season stresses. As expected and despite the tendency for higher mortality, plant populations were significantly greater at the higher seeding rate (323-336 versus 222-256 plants/m^2).

As expected, treatment differences in final head densities were fewer and smaller than for plant density indicating that the plants compensated with increased tillering. While the overall F-test was only marginally significant (P = 0.054), there was a tendency for higher head densities in the high input treatment. Tillering was assessed by calculating heads/plant from the plant and head counts. As expected, the least tillering was observed with the higher seeding rate (Trt. 3 and 7) where an average of 1.5-1.6 heads/plant were measured compared to 2.0-2.2 heads/plant in the remaining treatments where the lower seeding rate was utilized. No other individual inputs appeared to affect tillering.

The number of kernels per head (head size) was calculated from the observed number of heads and mass of grain in the 2 x 1 m plot areas that were sub-sampled along with the actual thousand kernel weights determined from the harvest sample. The overall F-test was not significant for this variable ($P = 0.089$) and no specific trends were identified.

Table 5. Treatment means, overall F-tests, and measures of variability for wheat emergence, head density, tillering and head size. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test, $P \leq 0.05$). No letter groupings are provided for variables where the overall F-test was not significant.

Treatment	Emergence	Head Density	Tillering	Head Size
	---- plants/m^2 ----	---- heads/m^2 ----	-- heads/plant --	-- kernels/head --
1) Low Input	224 c	481	2.2 ab	20.7
2) Seed Treatment	222 c	446	2.0 b	22.0
3) Seed Rate	323 a	492	1.5 c	19.9
4) Higher Fertility	256 b	513	2.0 b	21.9
5) PGR Application	226 c	468	2.1 ab	22.8
6) Foliar Fungicide	226 c	495	2.2 a	22.3
7) High Input	336 a	532	1.6 c	21.8
$LSD_{0.05}$	27.5	52.4	0.22	2.01
S.E.M.	9.4	17.8	0.07	0.75
Pr > F (p-value)	<0.001	0.054 [Z]	<0.001	0.089 [Z]

[Z] The overall F-test was not significant at the desired probability level for this variable therefore L.S.D. values should only be used for specific, pre-determined comparisons between pairs of treatments

The overall F-test for plant height was highly significant ($P < 0.001$); with wheat heights affected by the PGR application but no other inputs (Table 7). The two treatments where Manipulator was applied (Trt. #5 and 7) had similar heights (80-82 cm) and were, on average, 15 cm (16%) shorter than the treatments where no PGR was applied (96-97 cm). These results were not necessarily unexpected. While N fertilization generally increases height to some extent, the response is usually curvilinear levelling off of rates well below those included in the current project. With all other factors (i.e. yield and quality) being equal, shorter plants are generally considered desirable for improved harvestability (i.e. less material to put through combine) and resistance to lodging.

Total dry matter yield (straw plus grain) was affected by the treatments (*P* = 0.040) with the lowest yields observed when higher seeding rates were implemented in an otherwise low input system (Trt. 3; 7834 kg/ha) and the highest values with increased fertility in the otherwise low input system (Trt. 4; 9307 kg/ha). Relatively high dry matter yields were also observed when the foliar fungicide was applied in the otherwise low input system (9149 kg/ha); however, biomass measurements tend to be quite variable and the most differences between treatment means were not significant. Dry matter yields in the high input system were intermediate (8607 kg/ha) and did not significantly differ from any of the other individual treatments.

Under the dry conditions, there was essentially no lodging observed in any treatments; however, the overall F-test was highly significant ($P < 0.001$). While the differences were too small to be of much practical significance, the results showed a tendency for more lodging with higher seeding rates (1.1) and, to a lesser extent, increased fertility (0.8) and the least lodging when PGR was applied in an otherwise low input system (0.0).

Harvest index is the ratio of the mass of grain to total biomass and, with annual grain crops, higher HI values are preferred provided that it does not come at the expense of overall productivity or grain quality. The highest harvest index values appeared to be associated with the PGR application (Trt. 5 and 7; 0.43) while values were intermediate when the seeding rate was increased in the low input system (Trt. 3; 0.42) and lowest in the remaining treatments (0.40-0.41). Despite these trends, the observed range in HI values was small and it is probable that genetics and environment have a bigger impact on this variable than inputs or management.

Table 6. Treatment means, overall F-tests, and measures of variability for wheat height, lodging, grain yield, and harvest index . Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test, $P \leq 0.05$).

Treatment	Plant Height	Dry Matter Yield	Lodging Rating	Harvest Index	Grain Yield
	------ cm -----	---- kg/ha ----	----- 0-9 -----	- grain/total -	---- kg/ha ----
1) Low Input	96.3 a	8182 c	0.5 c	0.408 b	3502 c
2) Seed Treatment	95.5 a	8263 bc	0.5 c	0.403 b	3510 c
3) Seed Rate	96.7 a	7834 c	1.1 a	0.421 ab	3494 c
4) Higher Fertility	97.0 a	9307 a	0.8 b	0.404 b	3680 b
5) PGR Application	81.9 b	8253 bc	0.0 d	0.430 a	3789 ab
6) Foliar Fungicide	96.3 a	9149 ab	0.5 c	0.403 b	3768 ab
7) High Input	80.2 b	8607 abc	0.5 c	0.431 a	3896 a
$LSD_{0.05}$	2.41	951.9	0.20	0.021	156.3
S.E.M.	0.89	329.3	0.07	0.0071	88.9
Pr > F (p-value)	<0.001	0.040	<0.001	0.022	<0.001

Grain yields ranged from 3494-3896 kg/ha with, as expected, the low input system (Trt. 1) having amongst the lowest yields and the greatest yields in the high input system (Trt. 7). When incorporated alone into a low input system, yields were not affected by either seed treatments or higher seeding rates (Trt. 2 and 3; 3494-3510 kg/ha) but were significantly increased with higher fertility (3680 kg/ha) and, somewhat unexpectedly especially under the dry conditions, to an even greater extent with the PGR and foliar fungicide applications (3768-3789 kg/ha).

While the overall F-test for test weight was significant, the only difference amongst the treatments was that test weights in the high input treatment (Trt. #7; 397 g/0.5 l) were significantly lower than those observed in any other individual treatments (400-401 g/0.5 l). With none of the individual inputs affecting test weight when applied to the low input treatment, it is unclear which may have specifically contributed to the lower values; however, in practical terms, the range of 397-401 g/0.5 l, or 65.2-65.6 lb/bu, was small and unlikely to have any impact on the value or marketability of the wheat.

The results observed for TKW, or seed size, were similar to those for test weight with the only difference amongst treatments being slightly smaller seeds in the high input system (32.0 g/01000 seeds) than in any other individual treatment (33.3-34.0 g/1000 seeds). While seed size is not a specific grading factor, it is a yield component and the observed results suggest that the higher yields associated with certain treatments were not a result of larger seeds.

Grain protein concentrations were affected by the treatments ($P < 0.001$) with values ranging from 12.8-14.3% and with several differences amongst specific treatments detected. Not unexpectedly, the highest grain protein was achieved when higher fertility was utilized in an otherwise low input system (Trt. 4). In contrast, the lowest values were achieved when PGR or foliar fungicides were applied in the low input system – this could be explained by the fact that these were the only two inputs besides increased fertility that increased grain yield relative to the low input treatment. For these treatments, the observed protein concentrations were significantly less than in the low input treatment (13.3%). Past experience has shown that any inputs besides N fertilizer that result in a yield increase tend to also lead to lower protein. At 13.9%, the observed protein concentrations were intermediate in the high input treatment, lower than when fertility was increased on its own but higher than any of the remaining treatments.

Despite the dry conditions and low disease pressure, percent fusarium damaged kernels (FDK) was significantly affected by the treatments ($P < 0.001$). Using higher seeding rates in the otherwise low input system led to significantly higher FDK levels over the low input system while the foliar fungicide application significantly reduced the damage. While there was a tendency for slight further reductions in FDK in the high input system (0.016%) relative to when fungicide was applied in the low input system (0.022%), the difference between these treatments was not significant. Despite the statistical significance and treatment effects noted, the observed values for percent FDK were all well below the maximum allowance of 0.25% for No. 1 CWRS wheat.

Table 7. Treatment means, overall F-tests, and measures of variability for wheat test weight, seed size, grain protein concentration and percent fusarium damaged kernels. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test, *P* ≤ 0.05).

Treatment	Test Weight	1000 Kernel Weight	Protein Concentration	Fus. Damaged Kernels
	------ g/0.5 l -----	-- g/1000 seeds --	-------- % --------	-------- % --------
1) Low Input	400.8 a	33.8 a	13.3 c	0.051 bc
2) Seed Treatment	400.2 a	34.0 a	13.4 c	0.039 cd
3) Seed Rate	401.1 a	33.6 a	13.1 cd	0.081 a
4) Higher Fertility	400.2 a	33.4 a	14.3 a	0.063 ab
5) PGR Application	400.3 a	33.3 a	12.9 de	0.042 bcd
6) Foliar Fungicide	399.7 a	33.3 a	12.8 e	0.022 de
7) High Input	397.2 b	32.0 b	13.9 b	0.016 e
$LSD_{0.05}$	1.49	0.89	0.32	0.0222
S.E.M.	0.50	0.42	0.23	0.0085
Pr > F (p-value)	<0.001	0.006	<0.001	<0.001

A simple economic analyses was provided to provide further insights for producers; however, the reported values do not take into account either potential differences in grain value related to quality or all of the expenses associated with wheat production. Consequently, the relative profit values presented in Table 8 are solely a reflection of the observed impacts on yield, the estimated grain value, and approximate input costs. Under the assumptions used, the only inputs to increase profits over the low input treatment were the PGR application and, to lesser extent, foliar fungicide. Notably, the high input system was the least profitable by a substantial margin which reinforces the notion that producers must choose their inputs carefully in order to maximize economic returns in wheat production. Again, these results should be interpreted with caution as actual input costs and grain revenues are likely to vary and certain quality parameters (i.e. grain protein in particular) were not taken into consideration. The results may have also differed under wetter, higher yielding conditions.

Table 8. Marginal profits and estimated revenues and partial input costs associated with the various treatments in the wheat input demo at Indian Head (2018).

Trt #	Seed Trt [Z]	Seed Rate[Y]	Fertility[X]	PGR[W]	Fungicide[W]	Revenue[V]	Profit[U]
	----------	----------	----------	$/ha	----------	----------	----------
Low Input	$0.00	$40.56	$126.04	$0.00	$0.00	$900.09	$733.49
Seed Treatment	$15.62	$40.56	$126.04	$0.00	$0.00	$902.06	$719.84
Higher Seed Rate	$0.00	$66.33	$126.04	$0.00	$0.00	$898.06	$705.69
Higher Fertility	$0.00	$40.56	$201.85	$0.00	$0.00	$945.68	$703.27
PGR	$0.00	$40.56	$126.04	$46.95	$0.00	$973.75	$760.20
Fungicide	$0.00	$40.56	$126.04	$0.00	$62.34	$968.50	$739.56
High Input	$15.62	$66.33	$201.85	$46.95	$62.34	$1,001.27	$608.18

[Z] Not adjusted for differences in seeding rate between Trt. 2 and 7
[Y] Assumes certified seed price of $0.478/kg
[X] Assumes $725/tonne for MAP and $525/tonne for urea – K and S costs excluded as these nutrients were unlikely to have been limiting
[W] Includes SRP of products plus $12.36/ha application cost
[V] Based on actual yields and a CWRS wheat price of $257/Mt ($7/bu) regardless of quality
[U] Values presented do not take into account all production costs and are only estimates – actual input costs and revenues may vary substantially

Extension Activities and Dissemination of Results

This project was discussed and the plots were toured by approximately 200 guests at the Indian Head Crop Management Field Day on July 17, 2018. This provided an excellent opportunity to discuss specific yield and quality components, building versus protecting yield potential and various management considerations for CWRS wheat. Additionally, this demonstrations and the discussion surrounding it complimented the ongoing Intensive Wheat Management project (ADF/SWDC/WGRF) which was also highlighted during this segment of the tour. The full project report will be made available online on the IHARF website (www.iharf.ca) and potentially elsewhere in the winter of 2018-19. Results may also be made available through a variety of other media (i.e. oral presentations, popular agriculture press, fact sheets, etc.) as opportunities arise and where appropriate. This project was conducted at multiple Agri-ARM locations and results will be compiled for future extension purposes.

Conclusions and Recommendations

Despite the dry weather and somewhat below average yield potential, this project demonstrated the contributions of various crop inputs on wheat establishment, growth, yield and grain quality and also provided a basic analyses of the potential economic returns associated with various management practices. One key comparison that can be made throughout is looking at the agronomic and economic performance of intensive management versus a much lower input, less intensive approach to growing wheat. Bear in mind that the low input wheat was still reasonably well managed (i.e. midge tolerant variety/certified seed, timely seeding and weed removal, modest but balanced fertility) and that the results are specific to the conditions encountered and actual experiences will vary. With regard to establishment, increasing seeding rates had the greatest effect, seed treatments had no impact, and higher fertility also resulted in slightly higher plant populations. As expected, the plants responded to higher populations with reduced tillering and there were few differences in the number of heads/m^2 amongst the treatments. Head size, or the number of kernels per head, was also largely unaffected by the treatments. Plant height was only affected by the PGR application which resulted in a 16% height reduction. Lodging was not an issue in any plots under the dry conditions despite some small statistically significant differences between treatments. The application of a PGR also appeared to have a positive impact on harvest index, or the ratio of grain mass to total biomass. Although there was some variation in the yields achieved and several significant differences amongst treatments, the intensively managed wheat only yielded 11% higher the than the low input treatment. The only inputs to significantly increase yields over the low input system individually were higher fertility, the PGR application and a foliar fungicide application. The yield response to higher fertility (5%) was modest, presumably due to the dry weather and subsequently reduced yield potential due to the drought. The 8% yield increases with PGR application and fungicide were somewhat unexpected as both lodging and disease pressure were low; however, some leaf disease and trace amounts FHB infection were observed. It is conceivable that the PGR could have helped reduce water use earlier in the season and subsequent drought stress; however, previous work has shown that yield responses to PGR applications are inconsistent under drought conditions. While none of the individual inputs affected test weight or TKW when incorporated into the low input system, both of these variables were slightly but significantly lower in the high input treatment than for any other treatments. Protein was increased from 13.3% to 14.3% when fertility was increased in the low input system but fell to 12.8-12.9% when either the PGR or fungicide were applied without adjusting fertility for the higher yield potential. Percent FDK was not high enough to result in downgrading from No. 1 CWRS wheat in any treatments; however, a few significant differences were detected. The lowest FDK values were associated with the foliar fungicide application, particularly in the high input treatment, while the highest values were observed when seeding rate was increased in the otherwise low input treatment. This suggests that higher plant populations (and reduced tillering) alone are unlikely to consistently reduce fusarium pressure but may be beneficial when combined with an optimally timed fungicide application. With regard to economic returns, the assumptions used were crude but clearly showed the intensively managed wheat to be the least profitable treatment and considerably less profitable than the low input system on the opposite end of the spectrum. The PGR and, to a lesser extent, foliar fungicide were the only inputs to increase profits over the low input treatment; however, this does not take into account any quality considerations (i.e. protein). Again, results may vary dramatically with the specific conditions encountered but this suggests that wheat producers must choose their inputs carefully in order to stay as profitable as possible. Due to the limited number of treatments it is uncertain what the optimal combination of inputs may have been in this particular case. As a general recommendation, soil testing to determine fertility rates and choosing crop protection products carefully (i.e. based on knowledge of past pest problems, thorough and frequent crop scouting) will provide the best opportunity to achieve near optimal yields and quality while managing costs and maximizing economic returns.

Supporting Information

11. Acknowledgements:

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement. Crop protection products used for both plot maintenance and treatments were provided in-kind by Bayer CropScience, Corteva Agriscience, and Engage Agro. IHARF also has a strong working relationship and memorandum of understanding with Agriculture & Agri-Food Canada.

12. Appendices

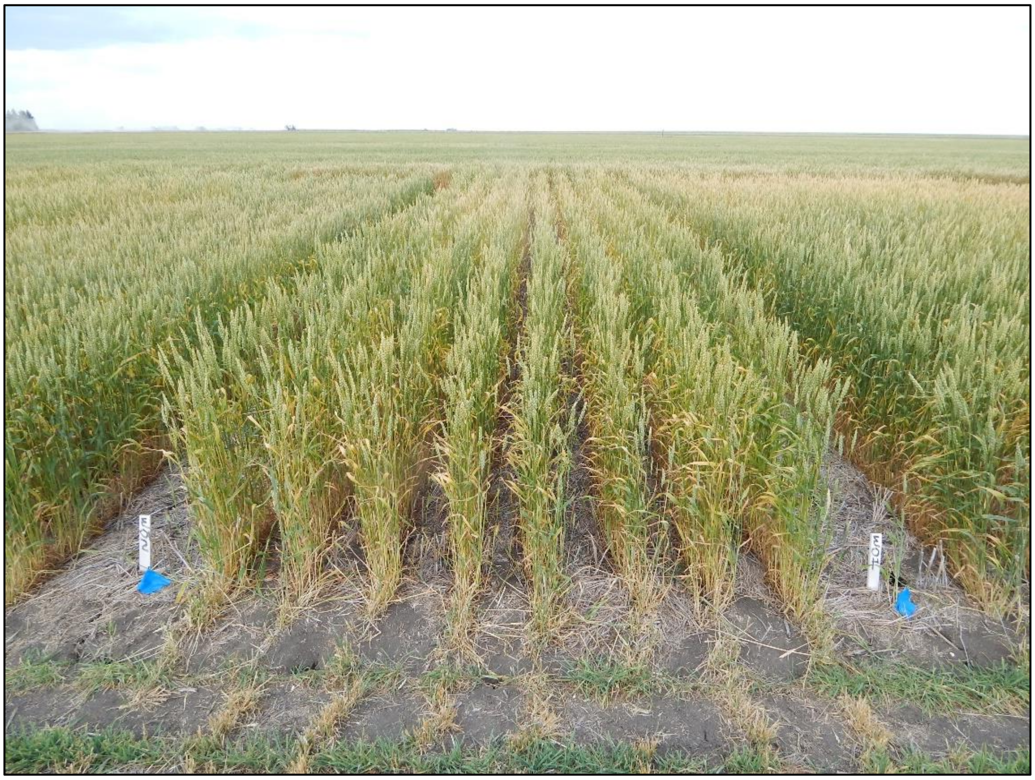

Figure 1. Low input wheat treatment at Indian Head in 2018 (July 26).

Figure 2. High input wheat treatment at Indian Head in 2018 (July 26).

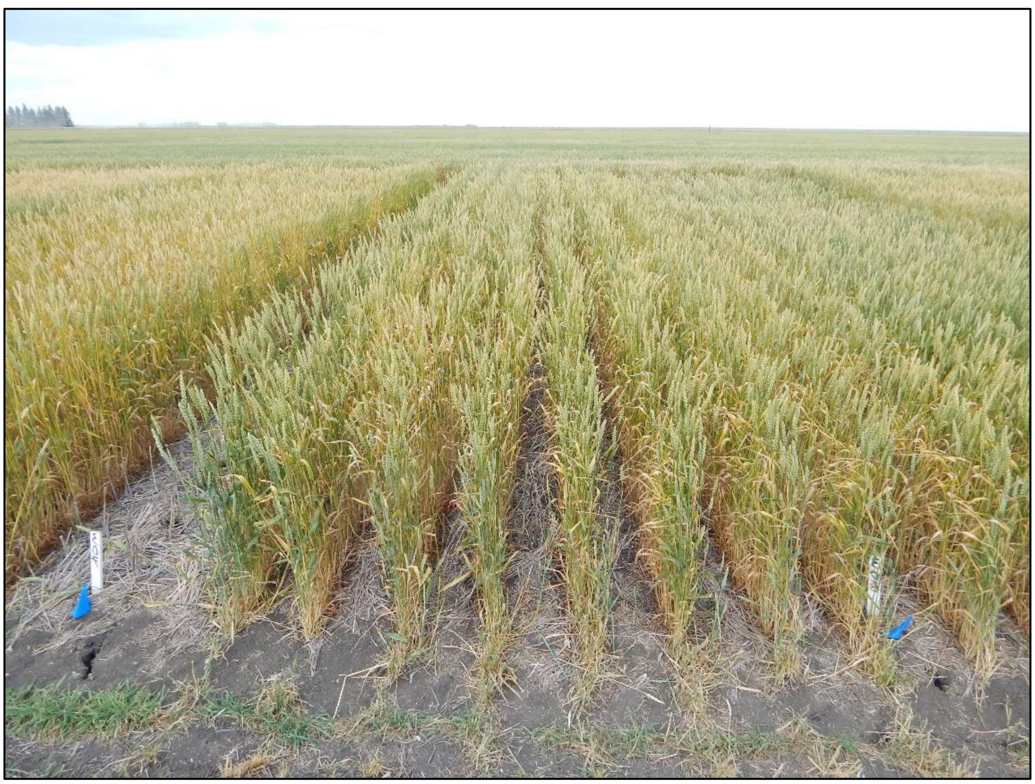

Figure 3. Low input plus seed-applied fungicide treatment at Indian Head in 2018 (July 26).

Figure 4. Low input plus higher seed-rate treatment at Indian Head in 2018 (July 26).

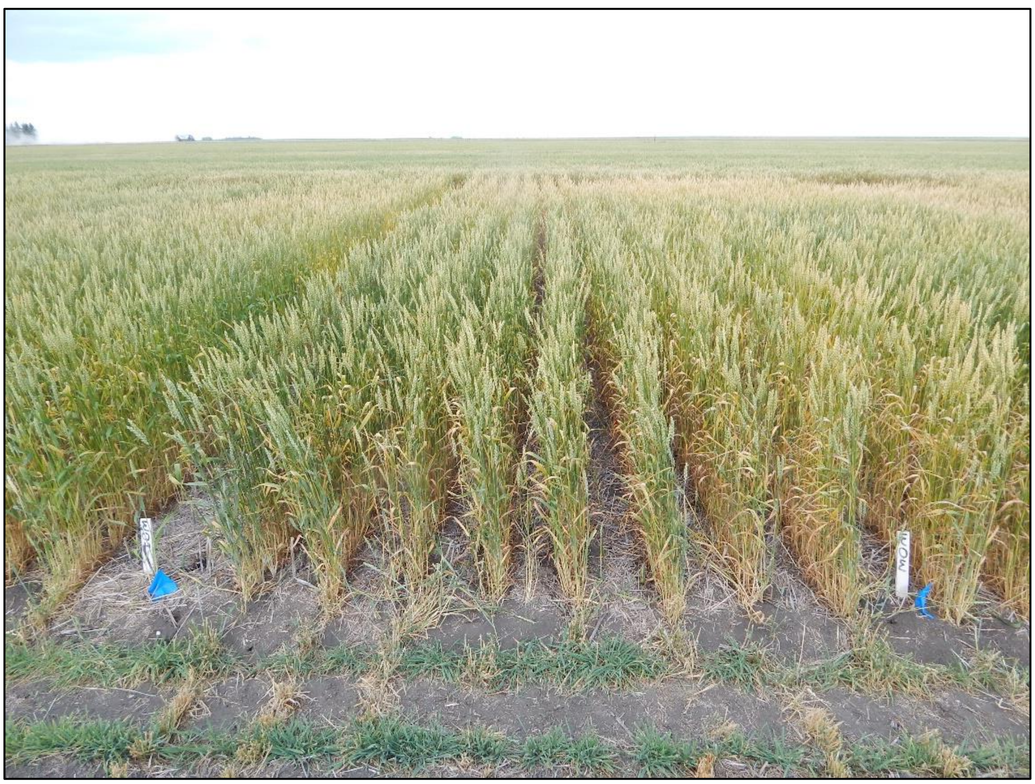

Figure 5. Low input plus higher fertility treatment at Indian Head in 2018 (July 26).

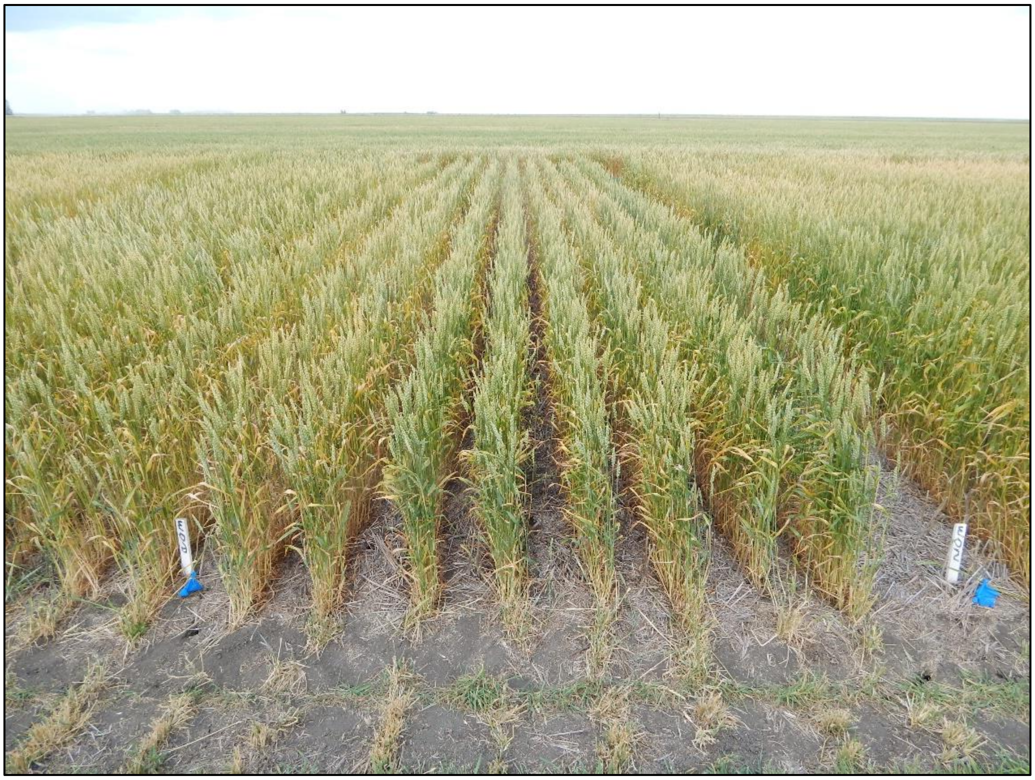

Figure 6. Low input plus PGR treatment at Indian Head in 2018 (July 26).

Figure 7. Low input plus foliar fungicide (at heading) treatment at Indian Head in 2018 (July 26).

Abstract

13. Abstract/Summary:

A field trial was established near Indian Head, Saskatchewan to demonstrate wheat response to low versus high input management. The inputs evaluated were seed-applied fungicides, higher seed rates, higher fertility, PGR and foliar fungicide. In addition to the low versus high-input treatments, each input was added to the low-input system individually. Both increasing seed rate and, to a lesser extent, fertility, increased plant density; however, there were few differences in the final observed head densities and head size was not affected. The PGR substantially reduced wheat height and tended to increase harvest index. There was an 11% yield difference between the low versus high input wheat and the individual inputs to increase grain yield were fertility (5%), PGR (8%), and foliar fungicide applications (8%). The yield increases were not additive in that the sum of individual increases was greater than the observed difference between the high and low input systems. Test weight and TKW were lower in the high input system than any other treatments; however, the differences were small and unlikely to impact marketability of the grain. Grain protein increased from 13.3% to 14.3% with higher fertility but fell to 12.8-12.9% when PGR or fungicides were applied in the low input system. Overall fusarium pressure was low and FDK was not high enough to be a grading factor in any treatments; however, FDK tended to be lowest with foliar fungicide and highest when only seed rate was increased in an otherwise low input system. Focussing on economic performance, the intensively managed wheat was the least profitable by a substantial margin and considerably less profitable than the low input treatment. The PGR application and, to a lesser extent, foliar fungicide were the only inputs to increase profits but this does not take into account any quality considerations (i.e. protein, FDK). Producer experiences will vary dramatically with the specific environmental conditions but this clearly demonstrates that wheat growers must choose their inputs carefully for maximum profit. Soil testing, knowledge of past pest problems, and thorough and frequent crop scouting will provide the best opportunity to optimize yields and quality while managing costs and maximizing economic returns.