2015 Annual Report
for the

Agricultural Demonstration of Practices and Technologies (ADOPT) Program

Project Title: Managing Fusarium Head Blight in Durum with Higher Seeding Rates and Fungicides

(Project #20140428)

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Project Identification

1. **Project Title:** Managing fusarium head blight in durum with higher seeding rates and fungicides
2. **Project Number:** 20140428
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 2015 to January 2016
6. **Project contact person & contact details:**

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Objectives and Rationale

7. **Project objectives:**

The objective of this project is to demonstrate the effects of using combinations of higher seeding rates and foliar fungicide applications to reduce the impacts of fusarium head blight on the yield and quality of durum wheat.

8. **Project Rationale:**

Fusarium head blight (FHB) has been a major factor limiting durum (CWAD) wheat yields and grain quality in recent years and has become a deterrent for some in growing this crop. While FHB is also a concern for CWRS wheat growers, durum is particularly susceptible to this disease and, therefore, is a good test crop to evaluate the effects of various practices to manage this disease. While FHB levels in 2013 were generally lower than the previous season, the incidence and severity of leaf disease and fusarium head blight (FHB) has risen in many parts of Saskatchewan and was a major cause of yield and grade reductions throughout the province in 2014. While high disease pressure over recent years has resulted in increased overall fungicide use, significant wheat acres were still unsprayed and FHB damage was a cause of downgrading for many CWRS and CWAD acres that were sprayed with a fungicide.

The optimum timing of fungicide application targeting FHB is at early flowering, however depending on the duration of heading / flowering and the specific weather conditions encountered, significant disease and costly grade reductions can still occur even with a well-timed fungicide application. Many growers in 2014 had this experience and, while the economics don't typically favour doing so, are again questioning the merits of two fungicide applications to control this disease. While early flowering is optimal, producer testimonials vary with respect to whether spraying earlier or later during the fungicide application window was most effective. One reason for this is likely that actual crop stages are often so variable that it is impossible to hit all of the heads at an optimal time. Additionally, the specific environmental conditions encountered during heading are of utmost importance in determining the extent to which FHB develops and whether the early or later developing heads are most affected.

Using higher seeding rates in cereal crops is known to result in fewer tillers and therefore earlier maturity, less within plant variability and a shorter window of infection for FHB and orange blossom wheat midge. Focussing on the disease aspect, this can theoretically have the dual benefit of reducing the length of time where the crop is susceptible to infection while also making it easier to time fungicide applications. That being said, higher seeding rates also can result in a denser crop canopy that can retain humidity or potentially lodge, which could increase potential for disease to develop and cause yield or grade reduction.

This project was implemented to demonstrate the feasibility and potential merits of combining higher seeding rates and foliar fungicide applications to manage FHB with durum wheat as a test crop. This information will benefit producers by providing information which can be used to help guide them towards producing the highest quality grain while avoiding unnecessary input costs.

Methodology and Results

9. Methodology:

A field trial with CWAD (durum) wheat was established on a heavy clay soil east of Indian Head, Saskatchewan (R.M. #156; -103.573 W 50.556 N). Twelve treatments were arranged in a Randomized Complete Block Design and replicated four times. The treatments were a factorial combination of 2 seeding rates (200, 300 and 400 seeds m-2) and four fungicide treatments (none, T1, T2 and T1 + T2). The product used for both treatment applications was Prosaro 250 EC (0.86 l ha^{-1}) and applications were targeted for Zadoks GS57-59 (75% of heads emerged to head emergence complete) and GS60-65 (beginning of anthesis to anthesis 50% complete). Fungicide was applied using a flat fan nozzle in 224 l ha^{-1} (20 imp. gal ac^{-1}) solution. The actual application dates were July 11 and July 14.

On May 5, AC Brigade was seeded into field pea stubble using a ConservaPak plot drill with 14 openers on 30 cm spacing. Seeding rates were varied as per protocol and all granular urea, monoammonium phosphate and potassium sulphate were side-banded to supply 125-35-35-12 kg N-P_2O_5-K_2O-S ha^{-1}. Weeds were controlled using a pre-emergent application of 890 g glyphosate ha^{-1} (May 2) plus an in-crop application of Prestige (0.32 l Prestige A ha^{-1} and 2 l Prestige B ha^{-1}) tank-mixed with 0.5 l Simplicity ha^{-1} on June 8. The crop was terminated with 890 g glyphosate ha^{-1} on August 26 and the centre five rows of each plot were straight-combined with a Wintersteiger plot combine on September 3.

Various data were collected over the course of the growing season and from the harvested grain samples. Actual spring plant densities were measured by counting seedlings in two separate 1 m sections of crop row on June 4 and calculating plants m^{-2}. The counted areas were flagged and returned to on July 30 to measure head density in the same manner. Heads per plant was estimated by dividing the average heads m^{-2} by the average plants m^{-2} for each plot. Fusarium head blight was assessed visually on August 10 (Zadoks 77) by rating the severity of infection on 50 heads per plot on a scale of 0-100 (percent head area affected). From these values, FHB incidence (percentage of heads affected) and FHB index (FHB incidence x average FHB severity) were calculated. Yields were determined from the harvested grain samples and are corrected for dockage and to 14% seed moisture content. Test weights were determined using Canadian Grain Commission methodology and are expressed in g 0.5 l^{-1}. Seed weight was determined by mechanically counting and weighing a minimum of 1000 seeds and converting the values to g 1000 $seeds^{-1}$. Cleaned sub-samples were submitted to Intertek (Winnipeg, MB) for determination of percent fusarium damaged kernels (FDK).

Response data were analysed using the GLM procedure of SAS 9.3 with a factorial analyses where the effects of seeding rate (SR), fungicide rate (F) and SR × F were considered fixed and the effect of replicate was considered random. Treatment means were separated using Fisher's protected LSD test. All treatment effects and differences between means were considered significant at $P \leq 0.05$.

10. Results:

Growing Season Weather

Mean monthly temperatures and precipitation amounts for the 2015 growing season at Indian Head are presented relative to the long-term averages in Table 1. While seed and fertilizer were placed into adequate, but not excessive moisture, the spring as whole was extremely dry with no significant precipitation events until late in the third week of June when the durum was approaching the flag-leaf stage. From this point onwards, moisture conditions improved dramatically and the weather throughout heading was warm, humid and conducive to FHB development.

Table 1. Mean monthly temperatures and precipitation amounts along with long-term (1981-2010) averages for the 2015 growing season at Indian Head, SK.

Year	May	June	July	August	Avg. / Total
	---------- Mean Temperature (°C) ----------				
2015	10.3	16.2	18.1	17.0	15.4
Long-term	10.8	15.8	18.2	17.4	15.6
	---------- Precipitation (mm) ----------				
2015	15.6	38.3	94.6	58.8	207
Long-term	51.8	77.4	63.8	51.2	244

Seeding Rate Effects on Establishment and Tillering

While plant density, head density and heads plant^{-1} were analyzed using the same statistical model as the remaining crop response data, these variables were not affected by fungicide treatment there only the seeding rate effects are presented (Table 2). As expected, plant density increased with increasing seeding rates from 162 plants m^{-2} at the 200 seeds m^{-2} rate to 290 plants m^{-2} at 400 seeds m^{-2}. Head density also increased with seeding rate, but not the extent of plant density indicating that, as expected, the individual plants responded to higher seeding rates with reduced tillering. Based on the actual plant and head densities, a total of 2.8 heads per plant were calculated at the 200 seeds m^{-2} rate while only 1.74 heads plant were observed at the 400 seeds m^{-2} rate. While data on this were not specifically collected, it was observed that the duration of heading and flower was also extended with low seeding rates.

Table 2. Seeding rate effects on CWAD wheat plant density, head density and tillering in the FHB Management Demonstration at Indian Head in 2015.

Seed Rate	Plant Density -------- plants m^{-2} --------	Head Density -------- heads m^{-2} --------	Tillers ------ heads plant^{-1} ------
200 seeds m^{-2}	162 c	458 b	2.81 a
300 seeds m^{-2}	234 b	479 ab	2.08 b
400 seeds m^{-2}	290 a	502 a	1.74 c
S.E.M.	6.2	8.8	0.05
C.V. (%)	10.7	7.4	9.5
Pr. > F [Z]	< 0.001	0.005	< 0.001

[Z] P-values ≤ 0.05 indicate that an effect was significant and not due to random variability

Seeding rate and fungicide effects on FHB incidence and severity are presented in Table 3. Disease pressure was relatively high with approximately 30% of the heads (averaged across treatments) showing some level of infection at this time. These data were variable and affected by fungicide treatment but not seeding rate (Table 5); however, there was a tendency for visible FHB to decline with increasing seeding rate. Focussing on fungicide effects, FHB incidence and index followed identical patterns whereby the worse infection was observed in the control followed by the T1 application time and levels were statistically similar for both the T2 and dual application times.

Grain yield was also affected by fungicide treatment but not seeding rate (Tables 3 and 5). In general, yields were somewhat low (compared to CWRS wheat on the site) with disease and orange blossom wheat midge being the most probable limiting factors. For fungicide effects, yields were highest with the dual application followed by the T2 timing, then the T1 timing and finally the untreated control. The relative yield increases with fungicide ranged from 7% at the T1 timing to 13% at the T2 stage and to 20% with a dual application.

Table 3. Main effect means for seeding rate and fungicide effects on CWAD wheat fusarium head blight (FHB) incidence, FHB index and grain yield head.

	FHB Incidence	FHB Index	Grain Yield
	------------- % --------------	------------- % -------------	----------- kg ha^{-1} ----------
Seeding Rate			
200 seeds m^{-2}	33.1 a	3.65 a	3188 a
300 seeds m^{-2}	28.6 a	3.55 a	3232 a
400 seeds m^{-2}	26.1 a	3.01 a	3226 a
S.E.M.	1.33	0.24	29.1
Fungicide Treatment			
Untreated	44.8 a	5.81 a	2922 d
T1 (GS 57-59)	33.8 b	4.19 b	3127 c
T2 (GS 60-65)	20.8 c	2.04 c	3308 b
Dual (T1 + T2)	17.7 c	1.58 c	3503 a
S.E.M.	1.53	0.28	33.6

^{Z} P-values ≤ 0.05 indicate that an effect was significant and not due to random variability

Neither test weight nor seed weight were affected by seeding rate; however both were affected by fungicide treatment (Table 4). Of these two variables, test weight was most responsive with effects that mirrored those observed for grain yield. The relative increases in test weight over the control were 1.3% with the T1 timing, 2.0% for the T2 timing and 2.9% with the dual application. For thousand seed weight, on the dual fungicide application resulted in a significant increase over the control.

Interestingly, the percentage of fusarium damaged kernels (FDK) was affected by seeding rate but not fungicide. Focussing on seeding rate, FDK were similar for seeding rates of 200-300 seeds m-2 but were reduced from 1.7% to 1.3% when averaged across fungicide rates. While the fungicide effect was not significant at the desired 95% probability level it was significant at the 90% level (Table 5, P = 0.066) and tended to be lower with the T2 timing and the dual application (Table 4).

Table 4. Main effect means for seeding rate and fungicide effects on CWAD wheat fusarium head blight (FHB) incidence, FHB index and grain yield head.

	Test Weight	Seed Weight	Fusarium Damaged Kernels (FDK)
	-------- g 1000 l^{-1} ---------	------- g 1000 seeds -------	------------- % --------------
Seeding Rate			
200 seeds m^{-2}	377.0 a	38.4 a	1.69 a
300 seeds m^{-2}	377.3 a	37.4 a	1.70 a
400 seeds m^{-2}	377.1 a	37.6 a	1.28 b
S.E.M.	0.63	0.36	0.095
Fungicide Treatment			
Untreated	371.4 d	36.6 b	1.72 a
T1 (GS 57-59)	376.2 c	37.1 b	1.70 a
T2 (GS 60-65)	378.7 b	37.7 b	1.41 a
Dual (T1 + T2)	382.2 a	39.8 a	1.38 a
S.E.M.	0.73	0.41	0.110

Extension and Acknowledgement

While this demonstration could not be shown at the 2015 IHARF Crop Management Field held on July 21 due to logistic constraints, the site was visited by agronomists, farmers and industry representatives on several occasions throughout the growing season. Results from this project will be made available in the 2015 IHARF Annual Report (available online) and also through a variety of other media (i.e. oral presentations, popular agriculture press, fact sheets, etc.) as opportunities arise.

11. Conclusions and Recommendations

The project has demonstrated the potential for using seeding rates combined with properly timed fungicide applications for managing FHB in susceptible crops such as CWRS and especially CWAD wheat. While the overall head density increased with increasing seeding rate, this also had the effect of substantially reducing the number of tillers per plant theoretically reducing the length of the period where wheat is susceptible to FHB infection. The visual FHB ratings suggested that disease levels were relatively high with approximately 30% of the heads affected when averaged across fungicide treatments. While higher seeding rates tended to have less infection, fungicide had a greater effect, particularly with the T2 and dual applications. Seeding rate did not affect yield, but fungicides had a strong effect with up to a 20% yield increase with a dual application. Timing of the fungicide application was also critical as the T1 application only increased yields by 7% compared to 13% when the application was delayed by three days. Actual fusarium damaged kernels were measured by a third party and FDK were significantly lower at the highest of the three seeding rates. Seeding rate actually had a greater, or more consistent, impact on FDK than fungicide applications; however, both the T2 timing and dual applications tended to have lower FDK than the control or T1 applications. While there were no significant interactions between seeding rate and fungicide treatment, both practices proved beneficial for helping to manage FHB in durum wheat. For seeding rate, actual populations of approximately 300 plants m-2 were required to have benefits reducing the impacts of FHB while, for fungicide, timing was critical and dual applications may be necessary depending on disease pressure and the duration of heading.

Supporting Information

12. Acknowledgements:

This project was financially supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement. Acknowledgement of the Saskatchewan Ministry of Agriculture's support for this demonstration will be included as part of all written reports and oral presentations that arise from this work. Fertilizer formulations were provided in-kind by Koch Agronomic Services and Agrium while several of the crop protection products were provided by BASF, Bayer CropScience and Dow Agrosciences. The support and contributions of Christiane Catellier, Dan Walker, Carly Miller and Danny Petty are greatly appreciated.

13. Appendices

Table 5. Analyses of variance for effects of seeding rate (SR), fungicide treatment (F) and SR × F interactions.

Effect	FHB Inc. (%)	FHB Index (%)	Yield (kg ha^{-1})	Test Weight (g 0.5 l^{-1})	Seed Mass (g $_{1000}$ seeds^{-1})	FDK (%)
			p-value			
Fungicide (F)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.066
Seed Rate (SR)	0.003	0.115	0.523	0.932	0.134	0.004
F × SR	0.601	0.455	0.252	0.294	0.372	0.349
C.V. (%)	18.1	28.1	3.6	0.7	3.8	24.5

[Z] P-values ≤ 0.05 indicate that an effect was significant and not due to random variability

Table 6. Individual treatment means for seeding rate (SR) and fungicide (F) effects on fusarium head blight (FHB) incidence, FHB index and grain yield. Data were analyzed using the GLM procedure of SAS and means within a column followed by the same letter do not significantly differ.

Effect	FHB Inc. (%)	FHB Index (%)	Yield (kg ha^{-1})
Control – 200 seeds m^{-2}	49.5 a	5.38 ab	2890 e
Control – 300 seeds m^{-2}	44.0 ab	6.53 a	2947 e
Control – 400 seeds m^{-2}	41.0 bc	5.53 ab	2929 e
T1[Z] - 200 seeds m^{-2}	37.0 bcd	4.38 bc	3004 de
T1 - 300 seeds m^{-2}	31.0 ed	4.43 bc	3208 bc
T1 - 400 seeds m^{-2}	33.5 cd	3.78 cd	3169 cd
T2[Z] - 200 seeds m^{-2}	25.5 fe	2.60 de	3370 ab
T2[Z] - 300 seeds m^{-2}	22.5 fg	1.98 ef	3253bc
T2[Z] - 400 seeds m^{-2}	14.5 h	1.55 ef	3303bc
T1 + T2 – 200 seeds m^{-2}	20.5 fgh	2.25 ef	3488 a
T1 + T2 – 300 seeds m^{-2}	17.0 gh	1.28 ef	3520 a
T1 + T2 – 400 seeds m^{-2}	15.5 gh	1.20 f	3503 a
S.E.M.	2.66	0.479	58.3

[Z] P-values ≤ 0.05 indicate that an effect was significant and not due to random variability

Table 7. Individual treatment means for seeding rate (SR) and fungicide (F) effects on test weight, seed mass and fusarium damaged kernels (FDK). Data were analyzed using the GLM procedure of SAS and means within a column followed by the same letter do not significantly differ.

Effect	Test Weight (g 1000 seeds^{-1})	Seed Mass (g 1000 seeds^{-1})	Fusarium Damaged Kernels (%)
Control – 200 seeds m^{-2}	372.8 efg	37.1 cde	1.93 ab
Control – 300 seeds m^{-2}	372.3 fg	36.2 e	2.05 a
Control – 400 seeds m^{-2}	369.1 g	36.5 de	1.18 d
T1^{Z} - 200 seeds m^{-2}	374.8 edf	38.4 a-d	1.73 abc
T1 - 300 seeds m^{-2}	376.1 cde	36.9 cde	1.88 ab
T1 - 400 seeds m^{-2}	377.7 cd	36.0 e	1.50 bcd
T2^{Z} - 200 seeds m^{-2}	378.3 cd	38.6 abc	1.70 a-d
T2^{Z} - 300 seeds m^{-2}	378.8 cd	36.7 cde	1.30 cd
T2^{Z} - 400 seeds m^{-2}	379.1 abc	37.8 b-d	1.25 cd
T1 + T2 – 200 seeds m^{-2}	382.1 ab	39.4 ab	1.40 bcd
T1 + T2 – 300 seeds m^{-2}	382.1 ab	40.0 a	1.58 a-d
T1 + T2 – 400 seeds m^{-2}	382.5 a	40.0 a	1.18 d
S.E.M.	1.27	0.71	0.191

^{Z} P-values ≤ 0.05 indicate that an effect was significant and not due to random variability

Abstract

14. Abstract/Summary:

A trial was conducted at Indian Head to demonstrate seeding rate and fungicide effects on fusarium head blight (FHB) infection, grain yield and quality in CWAD wheat. The treatments were a combination of three seed rates (200, 300 or 400 seeds m^{-2}) and four fungicide treatments including a control, two application times and a dual application. With less tillering and a shorter heading period, higher seeding rates did not affect yield, test weight or seed size but tended to reduce visible FHB infection and significantly reduced fusarium damaged kernels (FDK). Fungicides had a large impact on yield and test weight, particularly with the later timing or a dual application; however, fungicides were less effective at reducing FDK than higher seeding rates. There was, however, a tendency for lower FDK with fungicide provided that the timing was optimal. There were no interactions between seeding rate and fungicide treatment for any variables; however, both practices proved beneficial for managing this challenging disease.