Wheatland Conservation Area Inc.
Swift Current, SK.

Seeding Rates to Reduce Tillering and Flowering Duration for Fusarium Head Blight ADOPT (20200515)

Final Report

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Abstract

In 2021 a trial was established in Swift Current, Saskatchewan titled “Seeding Rates to Reduce Tillering and Flowering Duration for Fusarium Head Blight” 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. The premise is that higher seeding rates will reduce tillering, flowering time, and the overall window during which head infection can occur and with a well-timed fungicide application can both improve yield and quality. Part of the rationale for using higher seeding rates in production agriculture is that denser plant populations can reduce crop staging variability and make foliar fungicide applications easier to time. Regardless of whether increased seeding rates combined with foliar fungicide applications are an effective strategy to reduce FHB infection, producers need this information to produce the highest quality grain while avoiding unnecessary input costs. Although CWRS may be the dominant class of wheat grown in many of the regions where this project is proposed, durum is an excellent test crop due its susceptibility to FHB infection. The variables evaluated were seeding rates, spring emergence, head density, heads per plant, lodging, fusarium index, seed yield, test weight and percent fusarium damaged kernels (FDK) and deoxynivalenol (DON) determination.

Project Objectives

The objectives of the proposed project are to:

1) Demonstrate the potential for higher seeding rates to reduce tillering, duration of flowering, fusarium head blight (FHB) infection, and subsequent quality loss in durum wheat under field conditions
2) Demonstrate the ability of foliar fungicide applications to increase grain yield and reduce fusarium head blight infection along with subsequent quality loss in durum wheat under field conditions
3) Demonstrate the combined ability of higher seeding rates and foliar fungicide to optimize both yield and quality of durum wheat

Project Rationale

While fusarium head blight (FHB) levels in Saskatchewan have been somewhat lower over the past few seasons due to drier conditions leading up to and during anthesis, this disease is still a major concern for wheat growers. 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 timely fungicide application. Consequently, integrated approaches to managing this disease are important for minimizing its potential impact and reducing our reliance on foliar fungicides along with the potential development of resistance. While choosing varieties with genetic resistance to FHB is an excellent starting point, such resistance is limited (i.e. especially with durum) and producers need additional options for managing this disease more consistently. In addition to fungicides, one approach has been to utilize higher seeding rates to reduce tillering and the overall duration of flowering. In addition to shortening the window for infection, this also has potential to reduce field-scale variability in crop stage and make it easier for producers to time fungicide applications appropriately. While this practice has merit, research results have been variable and documented interactions between seeding rates and fungicide application are rare. We postulate that the combination of high plant populations and fungicide applications will result in the best yields and quality; however, it is important that producers also understand the limitations of these management practices. Both higher seeding rates and fungicide applications increase production costs. Higher seeding rates also typically result in a denser crop canopy that can retain humidity or be more susceptible to lodging, conceivably even increasing the potential for disease development.

The proposed project will 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. Regardless of whether increased seeding rates combined with foliar fungicide applications are an effective strategy to reduce FHB infection, producers need this information to produce the highest quality grain while avoiding unnecessary input costs. Although CWRS may be the dominant class of wheat grown in many of the regions where this project is proposed, durum is an excellent test crop due its susceptibility to FHB infection.

Methods

A field demonstration with durum wheat was established on barley stubble at Swift Current with eight treatments *(Table 1)* arranged in a four replicate RCBD consisting of a factorial combination of four seeding rates (125, 250, 375, and 500 seeds/m2) and two fungicide treatments (unsprayed versus sprayed). Seeding rates were adjusted for germination, but not expected mortality. Timing of Prosaro XTR fungicide application was at 50% anthesis (Zadok 65) and applied with a small plot sprayer.

Table 1. Treatment List

#	A) Fungicide	B) Seed Rate
1	1) No	1) 125 seeds/m^2
2	1) No	2) 250 seeds/m^2
3	1) No	3) 375 seeds/m^2
4	1) No	4) 500 seeds/m^2
5	2) Fungicide	1) 125 seeds/m^2
6	2) Fungicide	2) 250 seeds/m^2
7	2) Fungicide	3) 375 seeds/m^2
8	2) Fungicide	4) 500 seeds/m^2

The following measurements were taken:

- Soil sample to determine stored soil nitrogen
- Crop establishment- plants/m^2

- Days to heading
- Head density- heads/m^2
- Heads per plant
- Lodging
- Fusarium Index
- Seed Yield corrected to 14.5%
- Test Weight
- Fusarium damaged kernels (FDK) and deoxynivalenol (DON) determination

2021 List of Operations

03-May- Pre-seed burn-off Roundup @1L/ac + Aim @.49L/ac

12-May- Seeded Trial 1 1/2" seed depth.

02-June- Emergence counts

07-June- In crop spray application of Liquid Achieve @ 200 ml/ac + Buctril M @ 400 ml/ac

13-July- Prosaro XTR sprayed at 325 ml/ac on treatments 5 through 8. Calm day 23 Celsius

19-July- Head densities taken

30-July- Fusarium disease ratings

29-Aug- Lodging Ratings

30-Aug- Harvested (7 rows)

2021 General Site Conditions

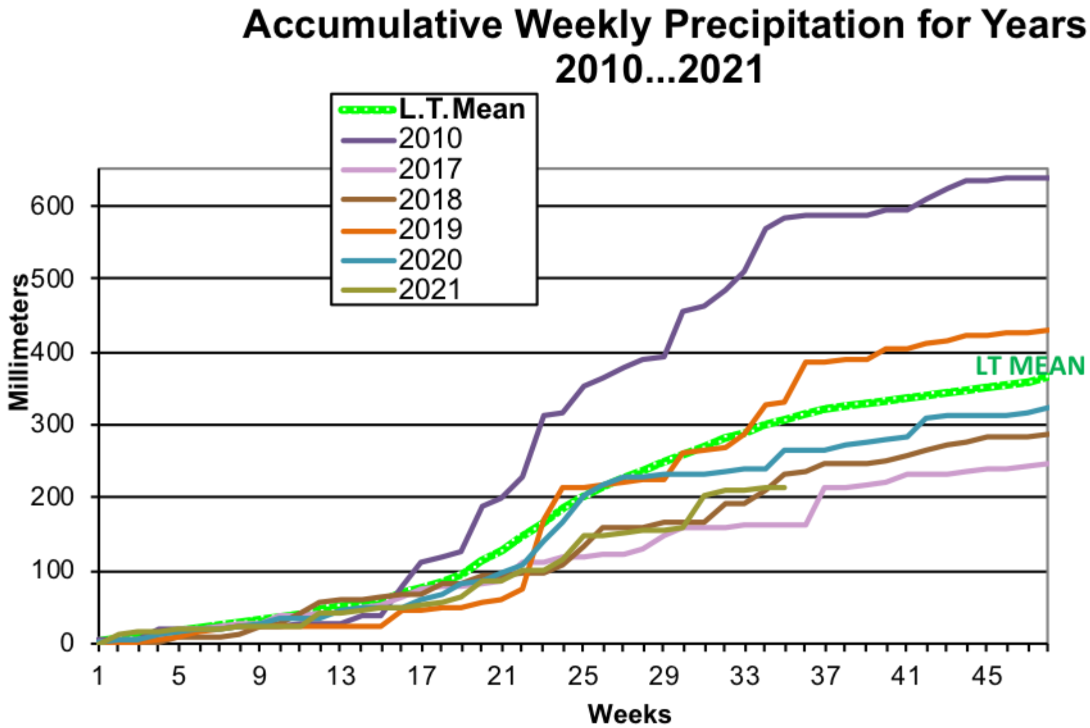

Figure 1. Accumulative weekly precipitation for years 2010 (record high), and 2017-2021

(Agriculture and Agri-Food Canada)

In 2021 according to the Saskatchewan Crop Report, Swift Current went into spring seeding with below adequate moisture levels.[1] Swift Current received very little rain throughout seeding followed by cool and dry conditions, emergence was delayed and soil moisture diminished very quickly. By the middle of June soil conditions at Swift Current were deteriorating rapidly with the onset of higher than normal temperatures. Dry and windy weather caused the crops to advance faster than usual, resulting in estimated yields to be well below average. From June 20th to July 20th as wheat heads were emerging and going into anthesis, Swift Current received total precipitation of 51.4 mm with 60% or 31 mm falling on July 7th.

Results

Plant establishment across all seeding rates ranged from 68 plants/m^2 (seeded at 125 seeds/m^2) to 217 plants/m^2 (seeded at 500 seeds/m^2). Each increase in seeding rate saw a linear incremental rise in plant density. Due to the dry, drought conditions in 2021 seed germination and plant mortality was quite high ranging from a 45.4% decline in plant establishment seeding at 125 seeds/m^2 to 58.7% when seeding at 500 seeds/m^2. *(Figure 2).* According to the Saskatchewan Ministry of Agriculture the optimal plant density for wheat is 215-275 plants/m^2 with the lower range usually recommended for dryer areas of the province.[2] As such, only seeding at 500 seeds/m^2 attained 215 plants/m^2.

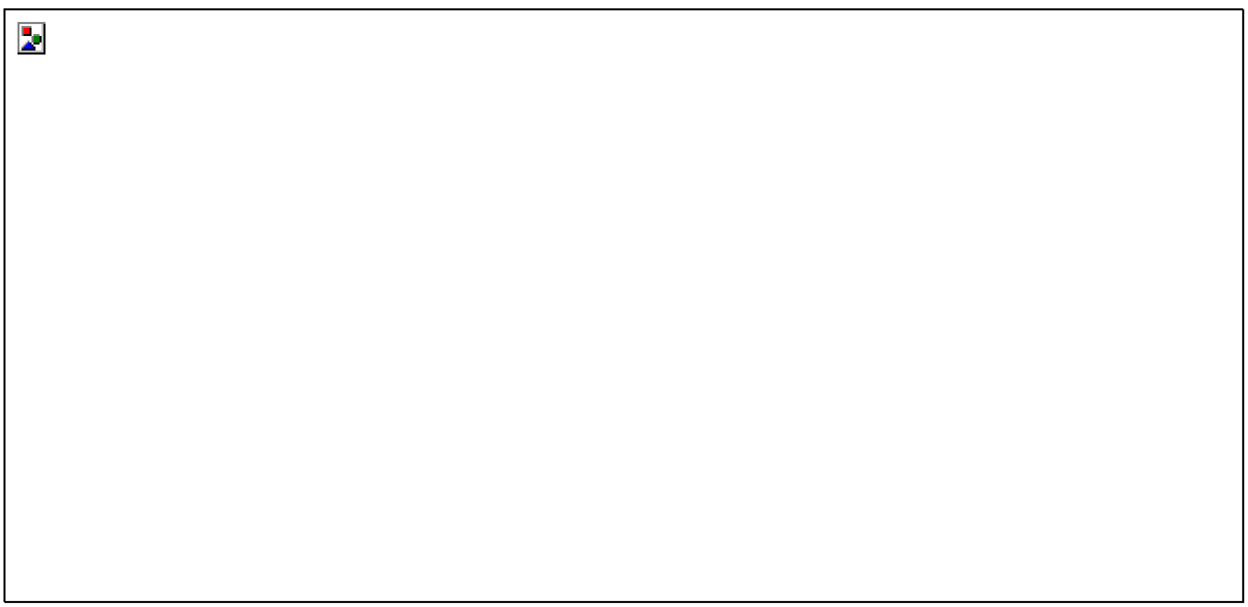

Figure 2. Higher Seeding Rates Effect on Plant Establishment

Seeding at 125 seeds/m^2 produced the highest number of tillers and averaged 2 heads per plant. Each increase in seed rate saw a decline in tillers resulting in 1.475 heads at 250 seeds/m^2, 1.335 heads at 375 seeds/m^2, and 1.1875 heads when seeding at 500 seeds/m^2. The average number of heads per plant was estimated by dividing the values for heads/m^2 by plants/m^2 for each plot. Overall, the greatest reduction in tillers occurred when the seeding rate increased from 125 seeds/m^2 to 250 seeds/m^2. The thought being we

[1] https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/market-and-trade-statistics/crops-statistics/crop-report/previous-crop-reports

[2] https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/crops-and-irrigation/field-crops/cereals-barley-wheat-oats-triticale/wheat-canada-prairie-spring-wheat

would see reduced tillering as we increased seeding rates, possibly narrowing the window for FHB infection, reduce disease levels, and make fungicide applications easier to time *(Figure 3)*.

Figure 3. Higher Seeding Rates Effect on Heads per Plant

Head densities increased linearly with declining seeding rate. When averaging both fungicide and no fungicide treatments seeding at 125 seeds/m^2 produced on average 136 heads/m^2, increasing to 240 heads/m^2 when seeding at 500 seeds/m^2 *(Figure 4)*.

Figure 4. Higher Seeding Rates Effect on Head Density

Fusarium index ratings were done between late milk and soft dough growth stages where 10 heads from four random locations in each plot were visually assessed for fusarium and recorded as a percentage of infected kernels *(Figure 5)*.

Although visual disease was very low because of the extremely dry conditions, treatments without a fungicide application showed higher visual incidence of fusarium head blight compared to no fungicide treatments. The <u>No Fungicide</u> treatments of 500 seeds/m^2 resulted in the highest visual fusarium of 2.96% followed by 2.93% from 125 seeds/m^2 and 2.31% when seeding at 375 seeds/m^2 with 250 seeds/m^2 recording the lowest visual FHB at 1.82%. Higher disease prevalence seen in the lowest seeding rate of 125 seeds/m^2 may be the result of the extra tillers increasing flowering duration thus widening the window of infection. When applying a fungicide, we saw lower visual disease across all seeding rates. Seeding at 500 seeds/m^2 showed the lowest overall visual fusarium of 0.25% compared to 2.96% seeding at the same rate without a fungicide application.

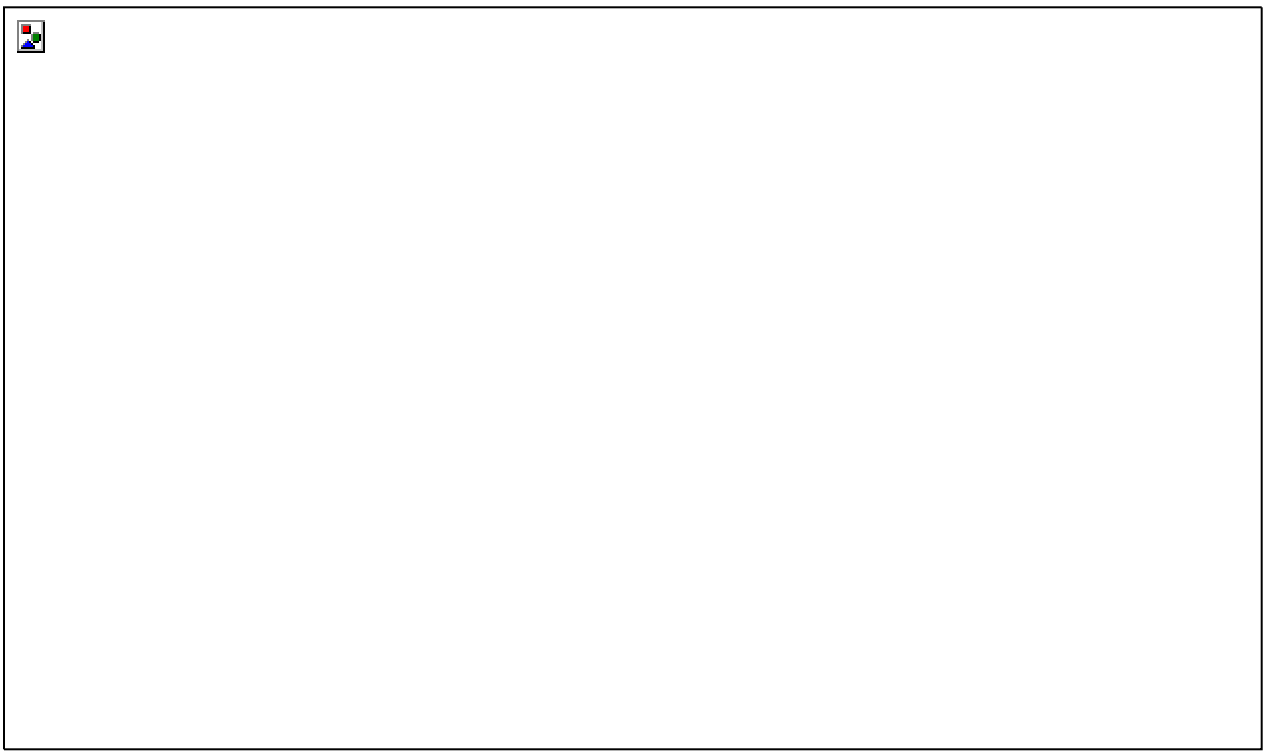

Figure 5. Visual Fusarium Index Rating in Durum

Results for FDK and DON levels in harvested grain were provided by Seed Solutions Seeds Lab. The Canadian Grain Commission states that, to achieve grades of No. 2 CWAD or better, FDK cannot exceed 0.5%. Fusarium damaged kernels must not exceed 2% for No. 3 or No. 4 CWAD.[3] Very dry conditions throughout the season made it favourable for low levels of fusarium head blight. Fusarium damaged kernel analysis was under 0.1% for all treatments except when seeding at 500 seeds/m^2 without a fungicide application which showed the highest FDK at 0.135% and the highest DON level at 0.31 ppm *(Figure 6).*

Although all harvested seed had low FDK and DON levels there were differences between treatments. Looking at the No Fungicide treatments the low seeding rate of 125 seeds/m^2 resulted in 0.0% FDK, trending higher as seeding rates increased with 250 seeds/m^2 at (0.025%), 375 seeds/m^2 (0.045%), and 500 seeds/m^2 (0.135% FDK). Showing a correlation between increasing plant density/m^2 and rising fusarium

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[3] https://www.grainscanada.gc.ca/en/grain-quality/official-grain-grading-guide/04-wheat/export-grade-determinants/cwad-en.html

levels. Similar to FDK, levels of DON were quite low 0.18 ppm (125 seeds/m^2), 0.21 ppm (250 seeds/m^2), 0.21 ppm (375 seeds/m^2), and 0.31 ppm (500 seeds/m^2).

When a fungicide application was added the incidence of FDK and DON levels were reduced across all seeding rates. The most notable reduction was at the 500 seeds/m^2 rate (FDK reduced from 0.135% to 0.025% and DON levels from 0.31 ppm to 0.12 ppm).

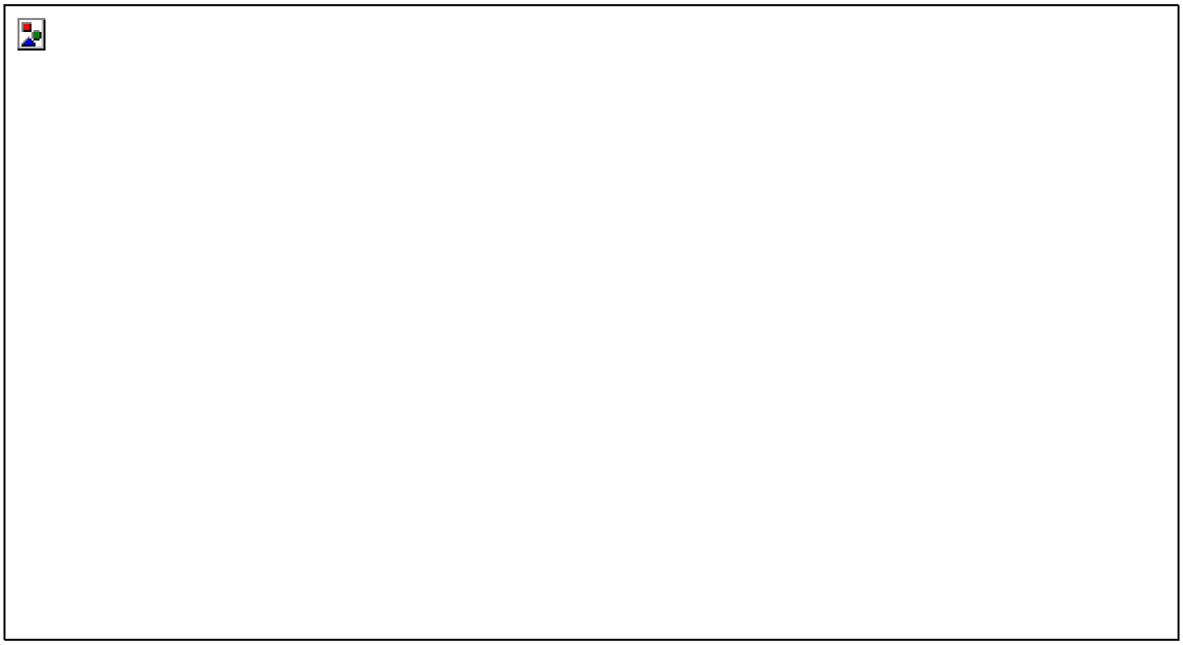

Figure 6. Higher Seeding Rates Effect on FDK and DON Levels

The highest overall yield resulted from seeding durum at 125 seeds/m^2 with a fungicide application (1289 kg/ha), significantly higher than seeding at the same rate with no fungicide (979.75 kg/ha, *Figure 7).* Yields steadily dropped as seeding rates increased, which was most likely due to the very dry conditions of 2021. Soil moisture steadily worsened throughout the season increasing competition between plants. Lower plant densities from seeding durum at the lower seeding rates enabled plants to access the limited moisture because of less competition.

Figure 7. Higher Seeding Rates Effect on Durum Yield

A similar pattern continued when looking at grain test weights *(Figure 8).* Higher test weights were achieved as seeding rates decreased. The 125 seeds/m^2 seeding rate with a fungicide had a test weight of 74.09 kg/hl and was highest overall, significantly higher than 73.71 kg/hl when seeding at the same 125 seeds/m^2 rate without a fungicide application. A fungicide application at higher seeding rates showed no statistical difference when compared to the untreated of the same seed rate.

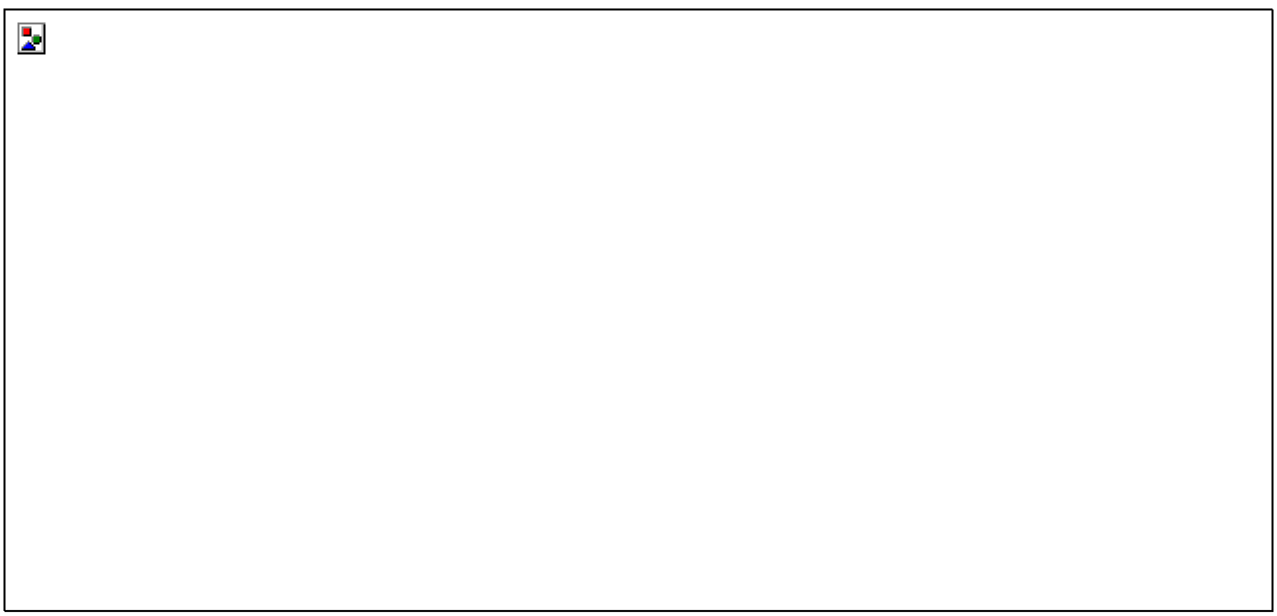

Figure 8. Higher Seeding Rates Effect on Test Weight

Conclusions and Recommendations

The project was designed to demonstrate the potential of combining higher seeding rates and a single foliar fungicide application to manage FHB in durum wheat. Regardless of whether increased seeding rates combined with foliar fungicide applications are an effective strategy to reduce FHB infection, producers need this information to produce the highest quality grain while avoiding unnecessary input costs.

In this trial, overall head density increased with increasing seeding rate, this also had the effect of substantially reducing the number of tillers per plant from a high of 2 heads from the 125 seeds/m^2 seeding rate to a low of 1.1875 heads per plant from the 500 seeds/m^2. With higher number of tillers, comes higher variability in growth stage and plant development between the main stem and the last tiller, thus widening the window for FHB infection. Using a high seeding rate can result in even maturity, reducing the length of the period where durum is susceptible to FHB infection. Although only achieving a maximum of 2 heads per plant due to the extremely dry conditions, we saw some of the higher visual fusarium incidence when seeding at 125 seeds/m^2 indicating there was incidence variability in growing stages *(Figure 5).*

Overall visual FHB was very low because of the extremely dry conditions. However, seed rates without a fungicide application did show higher visual incidence of fusarium head blight compared to the no fungicide treatments. Visual FHB index ratings revealed there was an average of 2.5% infected kernels across all the no fungicide treatments compared to 0.68% when looking at the four seeding rates with a fungicide application. FDK and DON in the harvested seed from all treatments were within the Canadian Grain Commission guideline of 0.5% FDK to achieve grades of No. 2 CWAD or better. Analysis was under 0.1% for all treatments except when seeding at 500 seeds/m^2 without a fungicide application, which showed the highest FDK at 0.135% and the highest DON level at 0.31 ppm.

Although all harvested seed had low FDK and DON levels there were differences between treatments. Looking at the No Fungicide treatments the low seeding rate of 125 seeds/m^2 resulted in 0.0% FDK, trending higher as seeding rates increased with 250 seeds/m^2 at (0.025%), 375 seeds/m^2 (0.045%), and 500 seeds/m^2 (0.135% FDK). This shows a correlation between increasing plant density and rising fusarium levels. Similar to FDK, levels of DON were quite low 0.18 ppm (125 seeds/m^2), 0.21 ppm (250 seeds/m^2), 0.21 ppm (375 seeds/m^2), and 0.31 ppm (500 seeds/m^2). A fungicide was beneficial as incidence of FDK and DON levels were reduced across all seeding rates. The most notable reduction was FDK of 0.135% to 0.025% and DON levels of 0.31 ppm to 0.12 ppm when seeding at 500 seeds/m^2.

The highest overall yield came from seeding durum at 125 seeds/m^2 with a fungicide application yielding 1289 kg/ha, significantly higher than 979.75 kg/ha seeding at the same rate with no fungicide (*Figure 7).* Yields steadily dropped as seeding rates increased, which was most likely due to the very dry conditions of 2021. Soil moisture was steadily depleted throughout the season, increasing competition between plants. Lower densities from seeding durum at 125 seeds/m^2 enabled plants to access the limited moisture because of less competition.

Even though overall infection levels were low, all seeding rates with an application of a fungicide proved beneficial for helping to manage FHB in durum wheat. Yield, however, was impacted more by lower seeding rates that created less competition for soil moisture during a drought year. For this project in 2021, applying a fungicide when using low seeding rates (because of the wider window for possible disease incidence) proved the most beneficial to control FHB and increase yield.

Technology Transfer Activities

Extension activities were limited in 2021 due to Covid 19 restrictions and many of these activities will be postponed until restrictions are lifted. This trial was promoted on a segment of a CKSW radio program titled, "Walk the Plots" that was broadcasted on a weekly basis throughout the summer, as well on Facebook, Twitter and the Swift Current Online Podcast. Results will be also shared locally with the

Saskatchewan Ministry of Agriculture in Swift Current and a summary will be found on our website at www.wheatlandconservation.ca.

Acknowledgements

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