2023 Final Report

for the

Saskatchewan Wheat Development Commission

Project Title: Demonstrating Wheat Varieties and Blends Against Wheat Stem Sawfly Damage

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Project Identification

1. **Project Title:** Demonstrating Wheat Varieties and Blends Against Wheat Stem Sawfly Damage
2. **Project Number:** SWDC Ref #281-221123
3. **Producer Group Sponsoring the Project:** Saskatchewan Wheat Development Commission
   Contact: Brianna Zoerb (brianna.zoerb@saskwheat.ca)
4. **Project Location:** Scott Saskatchewan, R.M. #380 Legal land description: NE-17-39-20-W3
5. **Project start and end dates (month & year):** April 2023 to April 2024
6. **Project contract person & contact details:**

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Objectives and Rationale

Objectives

This project intends to evaluate the effectiveness of different wheat varieties and blends of those varieties on wheat stem sawfly damage.

Rationale

This project is relevant to local producers because spring wheat is a common crop grown in the area and cereal crops such as spring and durum wheat, rye, triticale, barley and even winter wheat are the preferred hosts of wheat stem sawfly. Wheat stem sawfly has not been a concern for multiple years due to adequate moisture. However, in 2021 and 2022 where drought conditions have persisted, stem sawfly damage has been ranked as a top concern for producers in the upcoming growing season. This is a particular concern for 2023 as wheat stem sawfly over-winter in the stubble and re-emerge in June and July. Therefore, fields that were infected last year are at a high risk of infection in the following growing season. Varietal resistance is also the most effective management practice producers have to reduce wheat stem sawfly damage. Due to the lack of damage, producers have not had to focus on variety resistance which is provided by the stem solid-ness rating of wheat varieties provided by the Saskatchewan Seed Guide annually. Varieties may be rated as hollow, semi – solid or solid. Solid stemmed varieties, especially in the lower stem, are filled with pith, which slows development and movement of the wheat stem sawfly, resulting in less damage. Therefore, the intended benefit of this project for producers is to demonstrate the effectiveness of different stem solid-ness spring wheat varieties and blends of those varieties.

Methodology

The trial was arranged as a randomized complete block design (RCBD) with four replicates of six treatments at Scott, SK. 2023 (Table 1). The treatments consisted of four different wheat varieties of varying stem solidness and two wheat variety blends. The utilization of varietal blends aims to assess whether a specific host crop within a population of wheat has an impact on both yield and the occurrence of sawfly damage.

Prior to seeding, an application of Glyphosate 540 at 1 L/ac and Aim at 35 mL/ac was applied on May 11th, 2023. On May 12th, 2023, the wheat varieties specified in the treatment list (Table 1) were sown into canola stubble. Plots were seeded with a Fabro knife opener drill with a 10-inch row spacing at a target seed rate of 300 seeds/m^2. A fertilizer blend of 73-17-7-3 was applied in the side-band at 150 lbs/ac based on spring soil tests. On June 2nd, there was an in-crop herbicide application of Axial Ipak (Axial at 0.5 L/ac and Infinity at 0.33 L/ac) and a second in-crop application of Buctril M at 0.4 L/ac was applied on June 13th. A foliar fungicide, Caramba, was applied at a rate of 400 mL/ac on July 13th. Wheat stem sawfly incidence was recorded on July 28th, 2023 by splitting 10 stems per plot lengthwise to determine the presence of larvae. The wheat was desiccated at physiological maturity with an application of Glyphosate 540 at 1 L/ac, Heat LQ at 59 mL/ac and Merge at 200 mL/ac on August 15th. After desiccation, lodging attributed to wheat stem sawfly damage was quantified using a visual scale rating damage from 1-10. The wheat was harvested on August 28th, 2023.

Table 1. Treatment list for "Demonstrating Wheat Varieties and Blends Against Wheat Stem Sawfly Damage*"* in Scott SK, 2023.

TRT	Wheat Variety	Stem Solidness*	Semi-dwarf
1	AAC Viewfield	Hollow	Yes
2	CDC SKRush	Hollow	No
3	CDC Landmark VB	Semi – solid	No
4	CDC Adamant VB	Solid	No
5	CDC Landmark VB & CDC Adamant VB & CDC SKRush	Blend 1:1:1	
6	CDC Landmark VB & CDC Adamant VB & AAC Viewfield	Blend 1:1:1	

*Stem solidness as classified in the 2022 Saskatchewan Seed Guide

Data Collection

Soil samples were collected and analysed by Agvise in the spring of 2023 at two depths of 0-6, 6-12 inches to determine residual soil nutrient levels and characteristics. Two wheat stem sawfly ratings were taken throughout the growing season. On July 28th, ten stems from each plot were cut lengthwise and

assessed for the presence of wheat stem sawfly larvae. The presence of larvae or larval damage inside the stem resulted in a positive "yes" rating. This was then reported as a percentage of presence per plot. After desiccation and prior to harvest, visual wheat stem sawfly incidence was recorded using a 1-10 rating scale to indicate percentage of stems lodged (Table 2). Photos were taken periodically throughout the growing season to capture plant development and visual treatment differences. Yields were determined from cleaned harvested grain samples and corrected to 14.5% moisture content. Protein levels and test weights were collected using an Inframatic 9500 NIR Grain Analyzer on each sample as an additional seed quality parameter. Daily and long-term weather data was collected by an Environment Canada on-site weather station.

Table 2. Visual wheat stem sawfly incidence rating scale.

Rating	Percentage of Stem Breakage/Lodging
1	10%
2	20%
3	30%
4	40%
5	50%
6	60%
7	70%
8	80%
9	90%
10	100%

Growing Conditions

The beginning of the 2023 growing season had little residual soil moisture as drought conditions persisted throughout 2021 and 2022. As a result, conditions were very dry and cool for the first month of the growing season. The average temperature in April was lower than the long-term average, but increased in May. Total precipitation was considerably lower than the long-term average in April and May. June experienced above average temperatures and precipitation. Majority of the precipitation in June occurred in two days, June 6th and 18th, with 33.6 and 20.7 mm of rainfall, respectively. June temperatures were unusually high, with the highest temperature of 32.0 ^{o}C on June 5th. July had average temperatures but below average precipitation, resulting in poor growing conditions. August had below average temperatures and precipitation. From April to August there was 87 mm less precipitation than the long-term average. Due to the warm conditions in May, June and July there was 210 more growing degree days (based on 5^{o}C) compared to the long-term average. The higher temperature, decreased precipitation, and low residual soil moisture in the spring, resulted in poor growing conditions throughout the growing season (Table 3).

Table 3. Mean monthly temperature, precipitation, and growing degree days accumulated from April to August 2023 at Scott, SK.

Year	April	May	June	July	August	Total/Average
----------*Temperature (°C)* ----------						
2023	0.4	14.9	17.2	17.1	17.4	13.4
Long-term[z]	3.8	10.8	14.8	17.3	16.3	12.6
----------*Precipitation (mm)*----------						
2023	5.4	16.6	81.1	29.7	31.7	164.5
Long-term[z]	24.4	38.9	69.7	69.4	48.7	251.1
----------*Growing Degree Days 5˚C*----------						
2023	20	297	367	376	389	1450
Long-term[z]	44	171	295	381	350	1240

[z]Long-term average (1985-2014)

Data Analysis

The data was statistically analyzed using JMP software (JMP, 2024) to determine the effects of wheat varieties and blends on wheat stem sawfly incidence, yield, and seed quality at Scott, Saskatchewan. A linear mixed effects model was used with wheat variety/blend as a fixed effect and replication as a random effect. When analysis of variance (ANOVA) indicated significant differences ($p<0.05$), means were separated using either Fishers LSD or Tukeys HSD post hoc tests. Pearson's correlation coefficient was used to determine the impact of wheat stem sawfly incidence on response variables.

Results

Soil Test Results

Lab results from Agvise for spring soil samples revealed soil nutrient concentrations and characteristics at 0-6-inch and 6-12-inch depths (Table 4). Residual nitrogen levels were low, ranging from 4-6 lbs/ac. Phosphorus and potassium levels were considered "high" by the Agvise report. Additionally, sulfur levels were 26 and 30 lbs/ac and considered "medium". The site had "medium" organic matter levels at 4%. The pH levels were slightly acidic at the 0-6-inch depth (6.4), and higher at the 6-12-inch depth (7.6). The cation exchange capacity was 18.0 meq.

Table 4. Soil nutrient concentrations and characteristics for Scott, SK., 2023.

		Soil Depth	
		0-6"	6-12"
Nitrate	lb/ac	6	4
Phosphorus	ppm	19	--
Potassium	ppm	314	--
Sulfur	lb/ac	30	26
Organic Matter	%	4.0	
pH		6.4	7.6

Cation Exchange Capacity	meq	18.0	

Wheat Stem Sawfly Incidence

Wheat stem sawfly prevalence was assessed using two methods to determine; 1) the percentage of wheat stem sawfly incidence, and 2) percentage of wheat stem sawfly damage as indicated by the amount of stem lodging. The were significant differences between treatments for the wheat stem sawfly incidence ($p=0.056$) and the wheat stem sawfly damage ($p=0.007$). The wheat stem sawfly incidence was greatest for the CDC SKRush variety with a mean of 70% incidence (Figure 1). The treatment of AAC Viewfield observed the lowest wheat stem sawfly presence with a mean of 35% incidence. Altogether, wheat stem sawfly incidence followed the order of CDC SKRush > CDC Adamant VB $\geq$ CDC Landmark VB & CDC Adamant VB & CDC SKRush > CDC Landmark VB > CDC Landmark VB & CDC Adamant VB & AAC Viewfield > AAC Viewfield. Furthermore, when evaluating the percentage of stems lodged, the treatments of CDC SKRush and CDC Landmark VB & CDC Adamant VB & CDC SKRush resulted in the greatest amount of damage at 24% and 23%, respectively (Figure 2). For all other treatments the percentage of stems lodged averaged below 20%. The lowest amount of damage was recorded for AAC Viewfield at 11%. Overall, wheat stem sawfly incidence was influenced by the varieties and blends in this study. It appeared that CDC SKRush, seeded alone and in a blend, resulted in the highest wheat stem sawfly incidence and damage compared to other treatments, suggesting that this is a susceptible variety to wheat stem sawfly. Alternately, the least amount of damage was consistently found with AAC Viewfield seeded alone and in a blend, suggesting that this may be a variety with tolerance to wheat stem sawfly. The wheat stem sawfly incidence did not appear to be influenced by single varieties versus blends; however, particular varieties included in blends (ie: CDC SKRush and AAC Viewfield) may have had an influence on the amount of damage in blends.

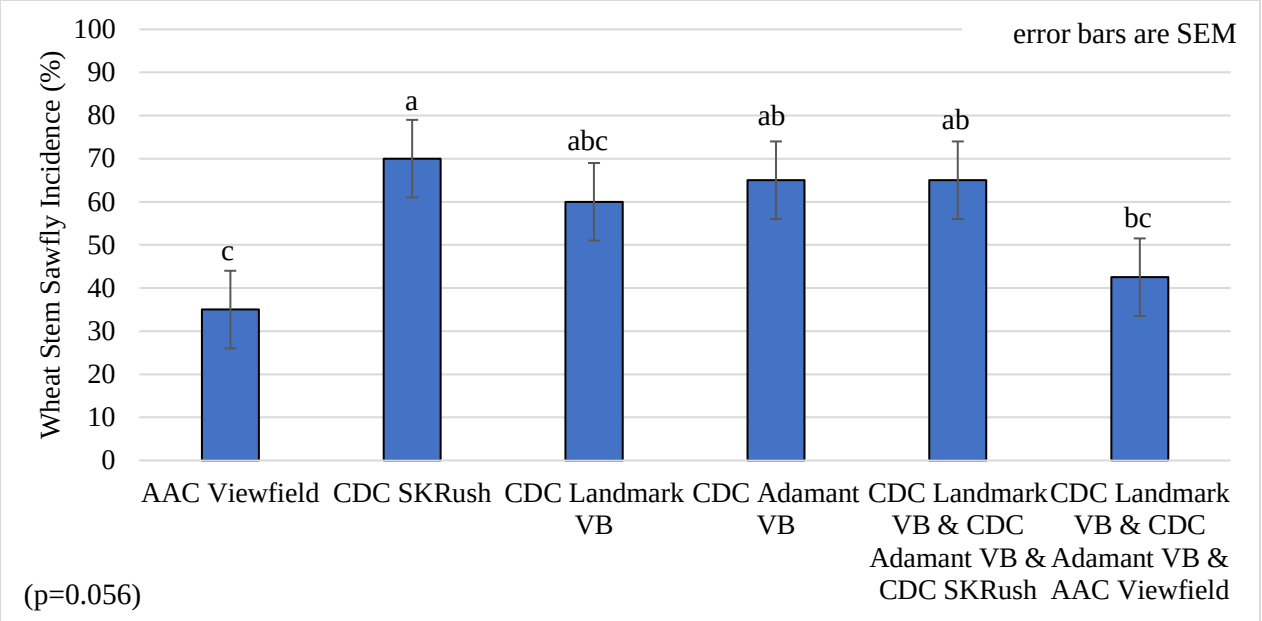

Figure 1. Mean wheat stem sawfly incidence (%) of wheat varieties and blends at Scott, 2023. Significance at $p<0.05$ using Fishers LSD. Error bars are standard error of the mean.

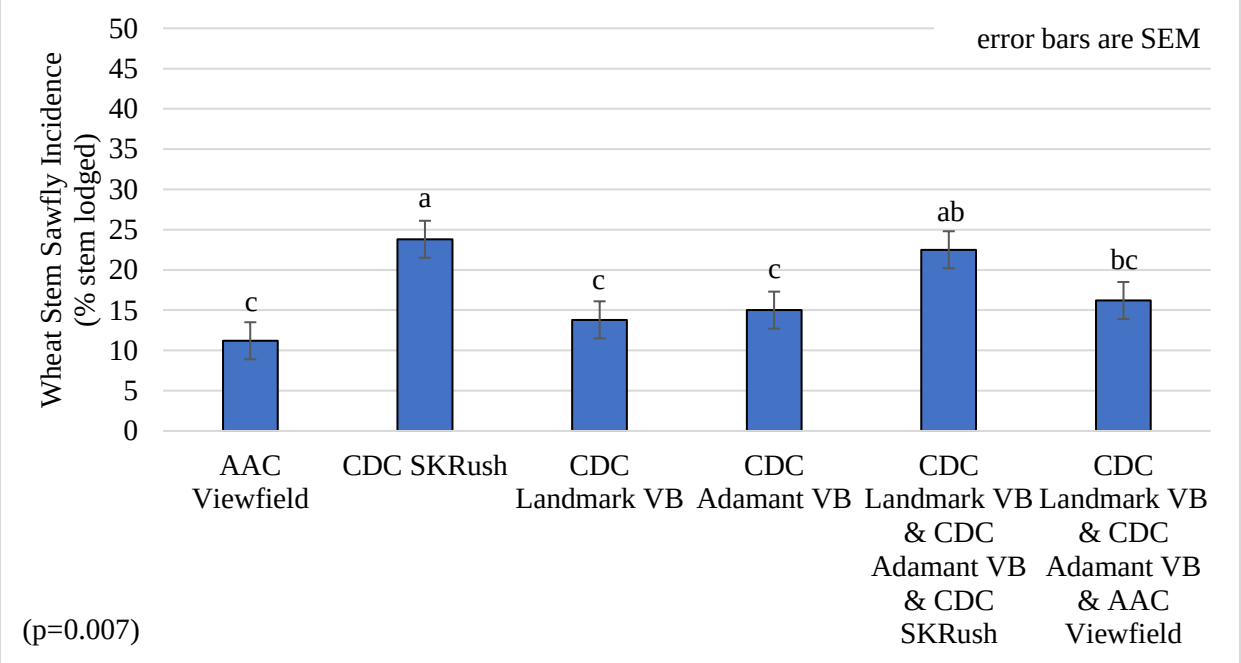

Figure 2. Mean wheat stem sawfly incidence (% stem lodged) of wheat varieties and blends at Scott, 2023. Significance at $p<0.05$ using Fishers LSD. Error bars are standard error of the mean.

Yield

Despite differences in wheat stem sawfly incidence, the mean yield of wheat varieties and blends did not significantly differ (p=0.086). The greatest yields were achieved with AAC Viewfield (59 bu/ac), followed by CDC SKRush (57 bu/ac), the blend of CDC Landmark VB & CDC Adamant VB & AAC

Viewfield (56 bu/ac), the blend of CDC Landmark VB & CDC Adamant VB & CDC SKRush (55 bu/ac), CDC Landmark VB (53 bu/ac), CDC Adamant VB (52 bu/ac) (Figure 3). The varieties that resulted in the highest yields (AAC Viewfield and CDC SKRush) had notably different incidences of wheat stem sawfly. The level of incidence (70%) and damage (24%) observed by CDC SKRush was significantly higher than AAC Viewfield incidence (35%) and damage (11%). However, these varieties resulted in the highest yields in this study. Despite the level of wheat stem sawfly incidence being fairly high for some varieties (35-70%), the overall visual damage observed in this study was reasonably low (< 25%). While it was clear that CDC SKRush was a more susceptible variety, the damage that occurred was not substantial enough to cause significant yield losses. In years with higher lodging damage, the effect on yields could be significant enough to cause economic losses. Currently, there are no economic thresholds for wheat stem sawfly, but the results of this study would indicate that the level of visual damage from wheat stem sawfly (< 25%) was not significant enough to cause yield reductions. Further investigations into the level of lodging caused by wheat stem sawfly that results in significant yield reductions would be beneficial to determine economic thresholds.

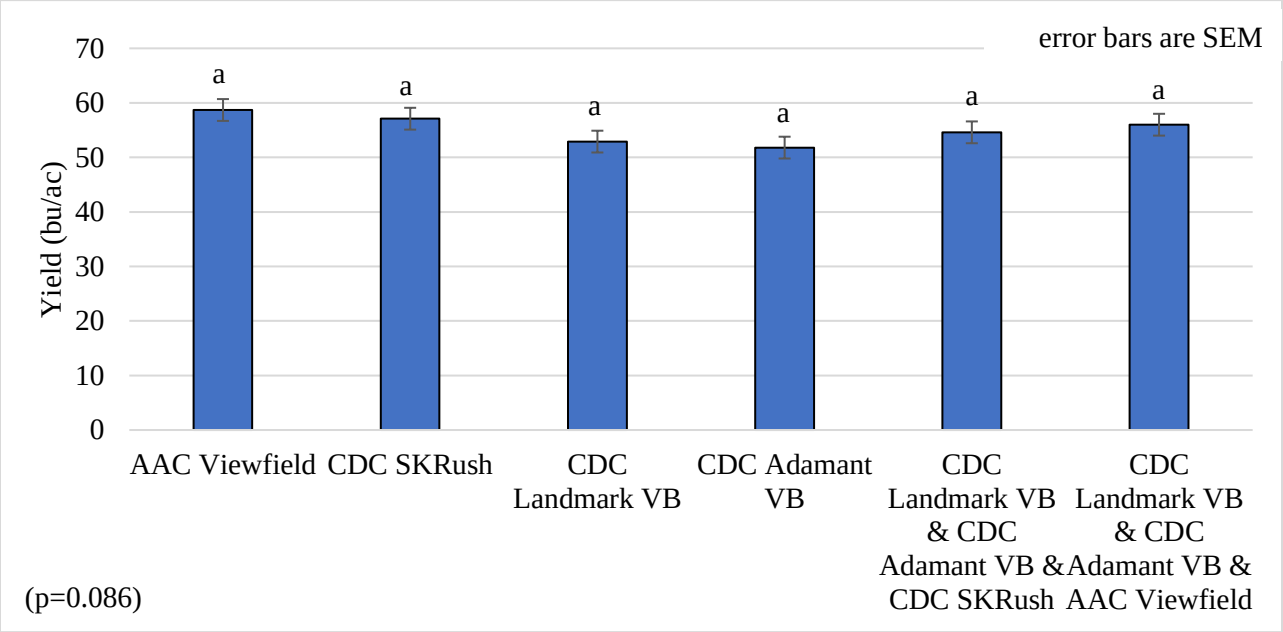

Figure 3. Mean yield (kg/ha) of wheat varieties and blends at Scott, 2023. Significance at p<0.05 using Tukeys HSD. Error bars are standard error of the mean.

Test Weight

Economic losses can occur as a reduction in seed weight or grade due to larval feeding within the stem stopping the flow of nutrients to kernels (Sask Ag., 2023). According to the Canadian Grain Commission (2023), the standard quality of No. 1 CWRS is a minimum test weight of 75 kg/hL. All treatments in this study resulted in test weight for No.1 grade CWRS. Significant differences were

observed between varieties and blends ($p<0.001$), indicating that the level of wheat stem sawfly damage impacted test weights. Test weight of all treatments ranged by 2.2 kg/hL (Figure 4). The greatest test weight was recorded for AAC Viewfield at 81.8 kg/hL, and the lowest was recorded for CDC SKRush at 79.6 kg/hL. This corresponds to the amount of wheat stem sawfly incidence and damage observed between treatments. AAC Viewfield resulted in the lowest amount of wheat stem sawfly incidence and the highest test weights, while CDC SKRush resulted in the highest incidence of wheat stem sawfly incidence and the lowest test weights. The Saskatchewan Seed Guide (2024) indicates that CDC SKRush has lower test weights (-1.0 of check) than AAC Viewfield (+0.7 of check). However, it is also known that damage from wheat stem sawfly can restrict seed development and result in reduced seed weight and quality. There was a significant negative correlation ($r=-0.47$; $p=0.020$) between wheat stem sawfly incidence and test weight, which indicates that increasing levels of wheat stem sawfly incidence results in decreasing test weights. Therefore, the results of this study suggest that the level of damage from wheat stem sawfly can have a negative impact on test weights. Overall, the test weights varied based on variety treatments and corresponded to the level of wheat stem sawfly damage observed.

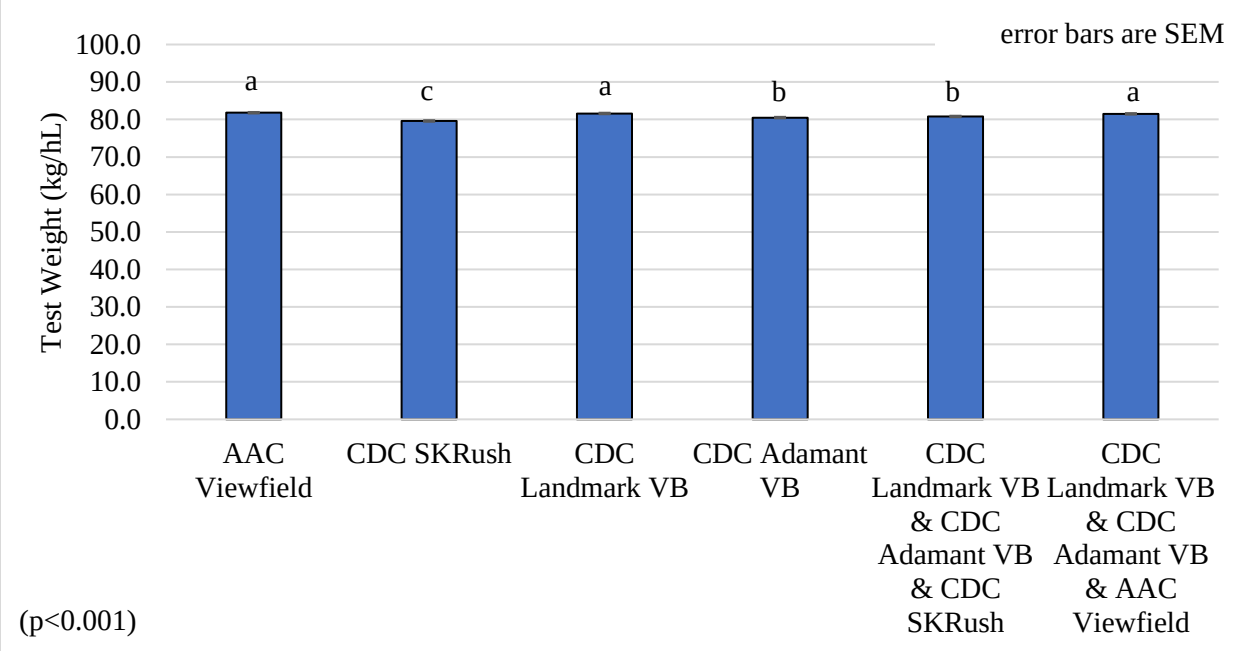

Figure 4. Mean test weight (kg/hL) of wheat varieties and blends at Scott, 2023. Significance at $p<0.05$ using Fishers LSD. Error bars are standard error of the mean.

Protein

Protein levels of harvested wheat samples were also evaluated to determine the effect of wheat stem sawfly damage on seed quality and grade. According to the Canadian Grain Commission (2023), the standard quality of No. 1 CWRS is a minimum protein of 10%. All treatments in this study resulted in

protein for No.1 grade CWRS. Minimal differences in protein were observed between varieties and blends (p=0.285), with protein levels ranging between 0.8% for all treatments. The highest protein was recorded for CDC Adamant VB at 14.8% and the lowest for AAC Viewfield at 14.0% (Figure 5). Overall, there were no apparent trends in protein levels between variety treatments suggesting that the effect of wheat stem sawfly incidence was negligible on seed protein.

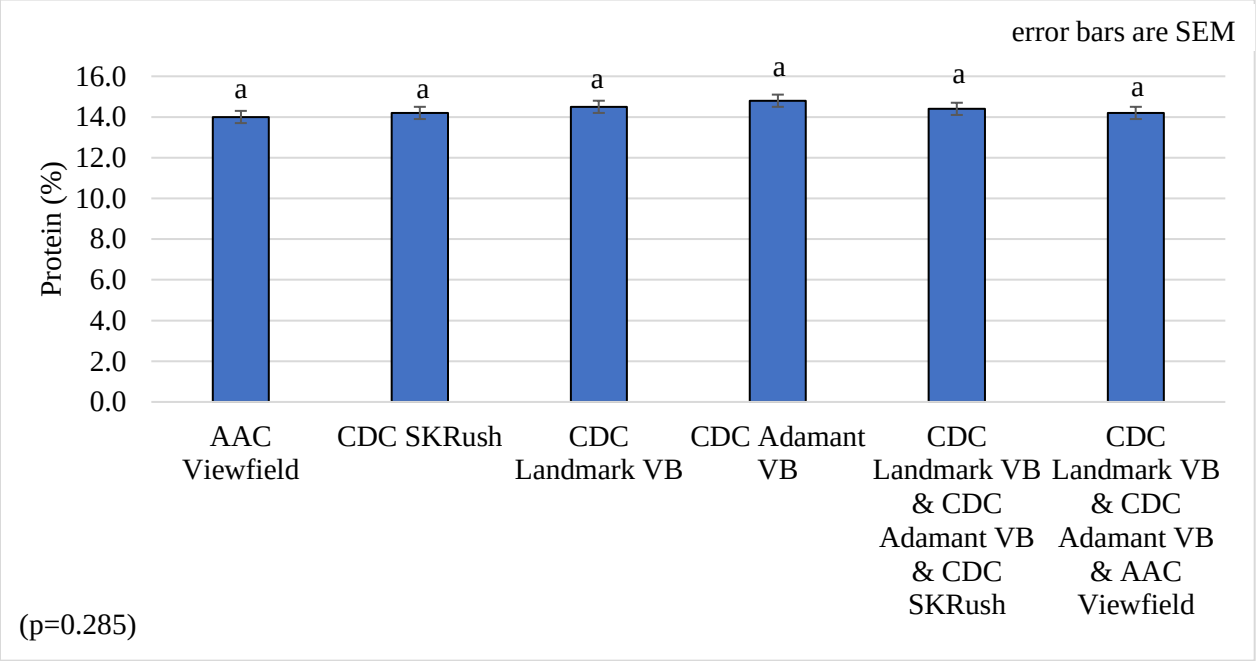

Figure 5. Mean seed protein (%) of wheat varieties and blends at Scott, 2023. Significance at $p<0.05$ using Fishers LSD. Error bars are standard error of the mean.

Conclusions and Recommendations

This study evaluated four different wheat varieties of varying stem solidness and two wheat variety blends to assess whether a specific host crop within a population of wheat has an impact on yield and wheat stem sawfly damage. There were significant responses of variety treatments to wheat stem sawfly incidence and damage. But differences in yields between varieties and blends were not significant. The highest wheat stem sawfly incidence and damage was observed by CDC SKRush seeded alone and in a blend; however, the yields for these treatments were not significantly different from other varieties or blends. The amount of lodging damage was fairly low in this study for all treatments (< 25%), and thus the impacts on yield were minimal. However, there was a significant response of variety treatments to test weight and a significant negative correlation between wheat stem sawfly incidence and test weights. This suggests that the level of incidence and damage in this study was not high enough to cause yield reductions but did cause reductions in test weights. Damage from wheat stem sawfly can restrict the flow of resources to the head, impeding seed development. Further damage from wheat stem sawfly can also cause stem lodging, which

was recorded in this study. It appears that the level of damage in this study was significant enough to reduce test weights by restricting the flow of nutrients to the head, but not significant enough to cause lodging effects that reduce yields. Additionally, the reduction of test weights was not significant enough to result in grade losses, as all varieties recorded test weights sufficient for No.1 CWRS. There are no economic thresholds currently developed for wheat stem sawfly; however, the results of this study suggest that the level of visual damage observed (< 25%) was not high enough to cause a reduction in yield or grade that would result in economic losses. Despite insignificant reductions in yield at < 25% damage, the Ministry of Agriculture (2023) recommends that management strategies be implemented when 10-15% of stems are lodged as damage at this level can produce enough adults to increase damage to 70% or greater in the following year. Considering this recommendation and the fact that incidence levels were high (35-70%), damage in the following year at our study location may be enough to cause significant reductions in yield. Surveys conducted by the Ministry of Agriculture in 2023 found that many areas of the province experienced moderate to high levels of wheat stem sawfly damage. If dry conditions persist for the 2024 growing season, wheat stem sawfly populations may continue to increase. Further investigations to determine the level of damage that would cause yield and grade reductions and understanding population cycles would generate data to accurately determine an economic threshold for producers.

Extension Activities

The final report and fact sheet will be distributed on the WARC and AgriARM websites as well as being highlighted in in local events to ensure the information will be transferred to producers.

Acknowledgements

Financial support was provided by the Saskatchewan Wheat Development Commission. The Scott site would like to acknowledge Kayla Slind, Koralie Mack, Alex Waldner, Stacy Hawkins, Herb Schell, Jessica Enns and our summer staff Paige Schulz, Devyn McLean and Hannah Kopp for their technical assistance with project development and implementation for the 2023 growing season.

Appendices

Table A1. Agronomic information for the study of "Demonstrating Wheat Varieties and Blends Against Wheat Stem Sawfly Damage" at Scott, SK., 2023.

Agronomic Information	Product	Rate	Date
Fertilizer	73-17-7-3	150 lbs/ac	May 12, 2023
Seed	See protocol	300 seeds/m^2	May 12, 2023
Herbicide:			

Pre-plant	Glyphosate 540 & AIM	1 L/ac & 0.35 L/ac	May 11, 2023
In-Crop	Axial & Infinity	0.5 L/ac & 0.33 L/ac	June 2, 2023
	Buctril M	0.4 L/ac	June 13, 2023
Fungicide	Caramba	400 ml/ac	July 5, 2023
Insecticide:	none	none	none
Desiccation	Glyphosate 540, Heat LQ, Merge	1 L/ac, 59 ml/ac & 200 ml/ac	August 15, 2023
Harvest	-	-	August 28, 2023

Abstract

Wheat stem sawfly is a growing concern for local producers and varietal characteristics such as stem solidness provide one of the only control methods against this pest. A field study was conducted at Scott, Saskatchewan in 2023 to assess whether a specific host crop within a population of wheat has an impact on wheat stem sawfly prevalence. Treatments were arranged in a randomized complete block design with four wheat varieties of varying stem solidness and two varietal blends. Data collection consisted of wheat stem sawfly assessments to measure presence of larvae in stems and amount of damage, yield, test weight, and protein. Significant differences were observed for wheat stem sawfly incidence (35-70%) and damage (11-24%). The level of wheat stem sawfly damage in this study was sufficient enough to cause reductions in test weight, but reductions in yield were minimal. Despite reductions in test weight, all treatments were considered No. 1 CWRS (> 75 kg/hL). Therefore, wheat stem sawfly damage less than 25% is not significant enough to cause yield or grade losses. However, the incidence levels observed in this study would cause concern for increased damage in the following year. Therefore, further investigations to determine the level of damage that would cause significant yield and grade reductions and understanding wheat stem sawfly population cycles would be beneficial for developing an economic threshold for producers.

Finances

Table. Expenditure statement for "Demonstrating Wheat Varieties and Blends Against Wheat Stem Sawfly Damage" at Scott, SK., 2023.

	Year 1	Total
Salaries and Benefits		
Students	$1,500	$1,500
Postdoctoral/Research Associates		
Technical/Professional Assistants	$3,000	$3,000
Contracted Services		
Rental Costs		
Materials and Supplies	$1,000	$1,000
Project Travel		
Field Work		
Collaborations/consultations		
Other		

Field Day		
Administration	$275	$275
Miscellaneous		
Total	$5,775	$5,775

References

Canadian Grain Commission (2023). Primary Grade Determinants Table for Canada Western Red Spring (CWRS) Wheat. https://www.grainscanada.gc.ca/en/grain-quality/official-grain-grading-guide/04-wheat/primary-grade-determinants/cwrs-en.html

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Saskatchewan Seed Growers' Association (2024). Saskatchewan Seed Guide (2024). https://saskseed.ca/seed-guides/