2025 Final Report

for the

Saskatchewan Wheat Development Commission

Project Title: Improving Standability in Wheat without PGR's

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Project Identification

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- East Central Research Foundation, Yorkton, RM #244;
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Objectives and Rationale

Project Objectives:

This project was intended to demonstrate the impact of various management strategies for improving standability in wheat, independently assess multiple factors affecting standability of wheat including; PGR, seed rate, variety, nitrogen fertility and potassium and to assess all management strategies applied together for a "high risk" and "low risk" management package.

Project Rationale:

Lodging is the process by which shoots are displaced from their vertical stance, and can be a common issue for producers in wheat (Berry et al., 2004). Lodging can reduce yields from 7 to 35% and cause several issues such as reduced grain quality, greater drying costs, and difficulty at harvest (Alberta Agriculture, 2018; Berry et al., 2004). Lodging is a major constraint in high yield environments and is generally worsened by moderate to high precipitation and high fertility. Although, research suggests that many different management strategies can be used to mitigate the risk of lodging.

Firstly, plant densities can greatly influence the standability of wheat, with lower densities resulting in plants with greater anchorage systems. Webster & Jackson (1993) assessed two wheat varieties for their lodging resistance and found that both varieties experienced significantly reduced lodging when seeded to target 200 plants/m2, compared to 300 and 400 plants/m2. Berry et al. (2000) found similar results in winter wheat where seeding to target 200 plants/m2 reduced the lodging risk compared to 400 plants/m2. The reduced lodging risk was attributed to an increase in the strength of the anchorage system by more than 50%, and an increase in the strength of the stem base by 15%. Lower plant densities in wheat generally results in greater number of tillers per plant, each of which develop crown roots which increases the strength of the anchorage system (Berry et al., 2004).

Plant growth regulators (PGRs) are synthetic compounds that modify plant growth and development and can be used to produce shorter stems, which in turn reduces lodging risk and maintains grain yields (Alberta Agriculture, n.d.). PGRs have been used for decades and in many areas of the world to reduce the risk of lodging in wheat crops. Webster & Jackson (1993) studied the use of ethephon [(2-chloroethyl) phosphonic acid], trade name Cerone, on two wheat cultivars. Both cultivars experienced significantly less lodging with the application of PGR, in particular the cultivar most susceptible to lodging. Berry et al. (2000) evaluated PGR application in winter wheat in the UK and found that PGRs increased failure wind speeds (wind speed needed to cause lodging) by 2-3 m/s for winter wheat grown with all combinations of management strategy (delayed sowing, reduced seeding rate, reduced N). Research in Saskatchewan has found similar results when PGRs are applied to wheat. A study in Yorkton in 2016 confirmed that application of Manipulator resulted in significantly decreased lodging and increased yields by 10 bu/ac compared to no PGR (ADOPT #20140424). Ultimately, PGRs are effective tools in reducing lodging in wheat.

It is well documented and understood that nitrogen fertility and management can have a significant influence on the growth and yield of wheat. Generally, high amounts of N, either applied or in the soil, can increase yields but also increase lodging potential. N management strategies have been used to reduce the risk of lodging in wheat with success by altering either the rate, form, or placement of N. Studies have found the greatest risk of lodging occurs with early applications of N fertilizer (Mulder, 1954; Berry et al., 1998), while no effect is observed when N is applied after anthesis (Webster & Jackson, 1993). Thus, suggesting a benefit to split applications or enhance efficiency nitrogen fertilizer (EENF). Split application of nitrogen is a practice where a portion of the total applied N is applied at seeding, and the remainder is applied in-season. Mangin et al. (2022) studied the effect of split applications of N on lodging and yield of wheat in Manitoba. Despite the hot and dry conditions during the study, the stalk measurements suggested that split applications of N may reduce lodging in environments more favorable to lodging (Mangin et al., 2022). Additionally, EENF shows promise in mitigating lodging risk. EENF are fertilizer products designed to control the release of applied nitrogen into the soil, resulting is available nitrogen throughout the season. Zhang et al. (2023) found that a mixture of controlled-release urea and untreated urea showed lower lodging ratings than untreated urea, even under high rates of applied product. Finally, the rate of N is proven to largely influence lodging in cereals. Higher rates of N are often used to maximize wheat yields; however, these rates of N also increase the risk of lodging. Berry et al. (2000) found that increasing the N supply to winter wheat, either from residual soil N or fertilizer applications in spring, reduced the stem strength by up to 50%. Therefore, management of N is very important to maintain yields while reducing the risk of lodging.

Potassium is responsible for improving stem strength in cereal crops (Sask Ag, n.d.), which can reduce the risk of lodging. However, the research on the effect of potassium fertility on lodging suggests that benefits are inconsistent and may only be observed on soils with a potassium deficiency. Research on high K soils have found that additional K fertilizer has no effect on the lodging of cereal crops. Gasper et al. (1994) studied KCl fertilizer additions effect on yield and lodging of oats on high soil test K soils (>391 kg/ha). However, the effect of KCl on lodging was not significant. Similarly, a study at Indian Head evaluated the response of wheat and barley to K fertilization and found no effect of K on lodging (ADOPT #20150391). However, the soil K at this site was extremely high (771 ppm). Alternately, Mulder (1954) studied lodging of wheat, oats, and rye on potassium deficient soils and found that K fertilization sometimes reduced lodging but also had no effect. In Saskatchewan, it is estimated that one million acres are K deficient. Majority of these acres are in north and north-east areas of the province, but some localized areas have potential for K deficiency as well (Sask Ag, n.d.). Therefore, depending on soil K levels, the application of K fertilizer may improve the standability of wheat.

Lastly, lodging can vary dramatically between wheat varieties and the management of susceptible varieties. Wheat breeders have countered the lodging risk caused by high yielding crops by breeding shorter plants (Berry et al., 2000). There are a number of commercially available wheat varieties with “very good” tolerance to lodging (Sask Seed Guide, 2024). However, producers do not always choose the most lodging resistant cultivar for reasons of disease resistance, yield potential, grain quality and seed availability. The combination of management and varieties has proven successful in reducing lodging, especially with susceptible wheat varieties. Webster & Jackson (1993) found that low seeding rates and PGR application was effective in reducing lodging in two wheat varieties, but the degree to which lodging was reduced was much greater in the susceptible variety. This was similar to results from a study in Yorkton, where wheat varieties with differing susceptibility to lodging [Unity (F); Goodeve (VG)] responded differently to PGR and N fertility (ADOPT #20140425). At 100 lbs/ac N, Unity wheat was lodging but this lodging was significantly reduced with Manipulator application. Alternately, N fertility did not increase lodging in Goodeve, and Manipulator improved its standability although not significant. Ultimately, choosing lodging resistant varieties is a recommended practice, and when these varieties are not available using management strategies can reduce the risk of lodging.

Altogether, there are many different management strategies proven to reduce lodging in wheat. A comprehensive study to assess each strategy individually and altogether would be beneficial to demonstrate to producers the impact of these strategies on lodging in wheat.

Lodging is a common issue for wheat production, with greater risk in high-yielding environments. As producers strive for higher yields, their risk of lodging generally increases. Lodging can significantly reduce grain yields (up to 35%) and may cause reduced grain quality, greater drying costs and difficulty at harvest. (Berry et al., 2000; Alberta Agriculture, 2018). Lodging is caused by many different management and environmental factors, which makes it a complex issue to remedy. Therefore, numerous strategies are often implemented to reduce risks of lodging. Research has shown that low plant densities, PGRs, N fertility (rate, form, and timing), K fertility, and varieties with lodging tolerance can reduce the risk of lodging (Mulder, 1954; Webster & Jackson, 1993; Berry et al., 2000; Mangin et al., 2022). Furthermore, the combination of these factors has also proven to reduce the risk of lodging (Berry et al., 2000). Therefore, it is important to show producers the effect of these many different management strategies alone and in combination for better informed management decisions on the farm. This study is designed to independently assess each management strategy and its effect on standability of wheat. In doing so, we hope to demonstrate the degree to which each management strategy improves wheat standability so that producers can make informed decisions on their farm.

Methodology and Results

Methodology:

The study was set-up as a randomized complete block design (RCBD) with 4 replicates and 9 treatments. The treatment list was designed to independently show the effect of each management strategy on lodging in wheat, as well as to evaluate them comprehensively in “low risk” and “high risk” management packages (Table 1). The trial area at all sites received a pre-emergent herbicide application for weed control. Plots were seeded into canola stubble with seeding dates between May 8 to May 22, 2025, and plot sizes varied by site. Wheat varieties were selected based on lodging ratings in the Seed Guide (2024), and were CDC Adamant VB (P) in “Poor” standability treatments (1, 2, 4, 5, 6, 7 & 8) and AAC Wheatland VB (VG) in “Good” standability treatments (3&9). The seed rates were 37 seeds/ft2 in “High” seeding rate treatments and 23 seeds/ft2 in “Reduced” treatments. Nitrogen fertility accounted for soil NO3-N from spring soil tests and the treatment rates. The two nitrogen fertilizer rates used were “High” at 148 lbs N/ac and “Reduced” at 99 lbs N/ac (soil NO3-N plus fertilizer). The nitrogen form was described as the “Standard” practice of untreated urea, or as an enhanced efficiency fertilizer (“EEF”) with 85% ESN and 15% untreated urea. Nitrogen timing consisted of all N applied at seeding as side or midrow band or a split N application with 60% of N applied at seeding (side or midrow band) and 40% surface broadcast urea at the 4-6 leaf stage depending on the treatment. Potash (0-0-60) was either not applied or applied at seeding at a rate of 44 lbs product/ac depending on the treatment (Table 1). Phosphorus and sulphur fertility were kept consistent across all plots and based on site specific spring composite soil tests to be non-limiting. Necessary in-crop herbicide applications were applied, to provide control of grassy and broad-leaf weeds, equally to all plots (Table A1). A PGR application of Manipulator was applied at 0.73 L/ac targeting the 1-2 node stage to beginning of flag leaf emergence for treatments #2 and 9. Treatments #1, 3, 4, 5, 6, 7 and 8 did not receive a PGR application. A foliar fungicide was applied at FHB timing and no insecticides were needed. Pre-harvest herbicides were used at most sites for the desiccation of the trial and plot harvest occurred by small-plot combine at each site for yield and grain quality between August 29th and September 28th, 2025.

The treatment structure in this study was designed to evaluate both individual management factors and whole-system strategies that producers commonly consider. Treatments 2 through 8 primarily adjusted one factor at a time — including seeding rate, nitrogen rate, nitrogen form (standard vs. enhanced efficiency fertilizer), nitrogen timing (at seeding vs. split application), PGR use, potash application, and variety — while holding other practices constant. This approach allows us to isolate which individual decisions influence plant establishment. Treatment 1 served as the high-risk management check with high lodging risk, representing a stable, high-input baseline: high seeding rate, high nitrogen rate applied at seeding in standard form, no PGR, no potash, and a poor-standing variety. It reflects a conventional, but high risk-managed system that tends to result in lodging. In contrast, Treatment 9 functioned as a low-risk lodging management approach with reduced-input system, combining a reduced seeding rate and reduced nitrogen rate with multiple lodging management tools (EEF, split nitrogen timing, PGR, potash, and a good-standing variety). This treatment represents a low-risk strategy where producers trim foundational inputs while relying on efficiency tools and improved genetics to maintain performance. Comparing these two treatments helps define the boundaries of management flexibility.

Table 1. Treatment list for "Improving Standability in Wheat without PGR's" at Scott, Indian Head, Yorkton, Melfort and Redvers SK in 2025.

#	Treatment Effect	PGR	Lodging Rating	Seeding Rate	N Rate	N Form	N Timing	Potash	Explanation
1	High Risk	No	Poor	High	High	Standard	At Seeding	No	Highest risk of lodging
2	PGR	Yes	Poor	High	High	Standard	At Seeding	No	Apply a PGR to reduce risk of lodging
3	Variety	No	Good	High	High	Standard	At Seeding	No	Switch to VG variety to reduce lodging risk
4	Seeding Rate	No	Poor	Reduced	High	Standard	At Seeding	No	Use lower seeding rate to reduce risk of lodging
5	N Rate	No	Poor	High	Reduced	Standard	At Seeding	No	Use lower N rate to reduce risk of lodging
6	N Form	No	Poor	High	High	EEF	At Seeding	No	Switch to a slow-release N form to reduce risk of lodging
7	N Timing	No	Poor	High	High	Urea	60/40 Split	No	Split the N application to reduce risk of lodging (untreated urea as N source for both application times)
8	Potash	None	Poor	High	High	Urea	At Seeding	Yes	Apply 0-0-60 to reduce risk of lodging
9	Low Risk	Yes	Good	Reduced	Reduced	EEF	60/40 Split	Yes	Multiple approaches to reduce lodging (N at seeding will be 85% ESN while in-crop N will be untreated urea)

[1]PGR: None is no PGR; Yes is 0.73 L/ac Manipulator targeting 1-2 node stage to very beginning of flag leaf emergence (do not apply earlier than 1-2 node)

[2]Variety: Proposed poor variety is CDC Adamant VB (P), proposed good variety is AAC Wheatland VB (VG)

[3]Seeding Rate: High is 400 seeds/m^2, reduced is 250 seeds/m^2

[4]N Rate: high is 168 kg N/ha (soil NO_3-N plus fertilizer), reduced is 112 kg N/ha (soil NO_3-N plus fertilizer)

[5]N Form: Standard is untreated urea, EEF is 85% ESN/15% untreated urea

[6]N Timing: At seeding is side- or midrow banded, Split is 60% side- or midrow banded and 40% surface broadcast at 4-6 leaf stage

[7]Potash: No is no potash applied, yes is 50 kg product/ha of 0-0-60 (provides 30 kg K_2O/ha and 23 kg Cl/ha)

Data Collection:

Soil samples were collected as composite samples of each site's trial area prior to seeding at two depth increments, 0-6 inches and 6-24 inches. Data collection for plant density, was conducted between May 28th and June 5th following full emergence. Plant heights were recorded between July 30th and August 15th by measuring from the bottom of the furrow to the tip of the primary head (excluding awns) and then calculating the average per pot. Lodging ratings at Scott, Indian Head and Yorkton were done twice, once at physiological maturity and once before harvest. Meanwhile, one set of lodging ratings weas done before harvest in Melfort and Redvers. Lodging ratings were scored on a scale of 0-9; 0 meaning no lodging, and 9 indicating the whole plot was lying flat. Photos were taken for each plot to support lodging ratings at all dates. Yields were determined from cleaned harvested grain samples and corrected to a moisture content of 14.5%. Each site completed their own test weight and protein analysis, both of which were determined following CGC recommended procedures. Daily weather was collected at each location by an on-site weather station. Long-term weather data was collected from Environment Canada (1985-2014).

Statistical Analysis:

Individual site data were analyzed using one-way analysis of variance (ANOVA) in JMP® Pro 18 (SAS Institute Inc., Cary, NC). Treatments were considered fixed effects, and replication was treated as a random effect. When treatment effects were significant, means were separated using Tukey's Honestly Significant Difference (HSD) test at a significance level of $\alpha = 0.05$.

A combined analysis across sites was conducted using a mixed-model ANOVA in JMP Pro 18 to account for environmental variability among locations. In the combined model, site was treated as a random effect, replication was treated as a random effect nested within site, and the site × treatment interaction was included as a random effect, while treatment was considered a fixed effect. Treatment effects were evaluated for plant density, lodging, plant height, yield, test weight, and protein concentration. When significant treatment effects were detected, means were separated using Tukey's HSD at $P \leq 0.05$.

Environmental Conditions:

Growing season temperatures across Scott, Melfort, Indian Head, Redvers and Yorkton were generally warmer than long-term averages, particularly early in the season. All sites experienced elevated May temperatures compared to historical norms, suggesting a warm start to crop establishment. At Melfort, this warm start coincided with an extremely dry spring, with virtually no rainfall in May, potentially compounding early-season stress despite favorable temperatures. Early-season temperatures in Redvers were notably above normal, with May averaging 13.2 °C, about 2.1 °C warmer than the long-term mean (11.1 °C), which likely supported rapid early crop development and establishment. June through August temperatures were largely near to slightly above long-term means, with August notably warmer at Scott, Melfort, and Yorkton. June–August temperatures in Indian Head were slightly cooler than the long-term mean, particularly in July, suggesting less mid-season heat stress but also slightly slower thermal accumulation. September temperatures, where available, were also substantially above normal, particularly at Scott and Indian Head. At Scott, mean April–September temperatures averaged 13.6 °C (110% of the long-term mean), with warmer-than-normal May, August, and September offset by a cooler-than-average July, resulting in near-normal seasonal Growing Degree Day accumulation (97% of long-term). Yorkton showed a consistently warm growing season, with May through August temperatures at or slightly above long-term averages. Overall, the season was characterized by a warmer-than-average temperature profile, which likely accelerated crop development and shortened key growth stages at several locations.

Table 2. Mean monthly temperatures (°C) amounts along with long-term (1985-2014) normals for the 2025 growing season in Scott, Indian Head, Redvers, Melfort and Yorkton, Saskatchewan.

Location	Year	May	June	July	August	September	Avg.
		----------------------------*Mean Temperature (°C)* -------------------					
Scott		12.9	14.6	15.8	17.4	17.5	13.6
	Long-term	***10.8***	***14.8***	***17.3***	***16.3***	***11.2***	***12.4***
Indian Head		12.7	15.3	17	17.8	15.3	15.7
	Long-term	***10.8***	***15.8***	***18.2***	***17.4***	***11.5***	***15.6***
Redvers		13.2	16.2	17.5	17.9	14.9	15.9
	Long-term	***11.1***	***16.2***	***18.7***	***18***	***12.5***	***15.3***
Melfort	2025	13.8	15	17	18	15	15.76
	Long-term	***10.1***	***15.2***	***17.8***	***16.7***	***11.7***	***14.3***
Yorkton	2025	12.40	15.70	17.50	18.30	-	15.98
	Long-term	***10.40***	***15.50***	***17.90***	***17.10***	***-***	***15.20***

Precipitation during the 2025 growing season was highly variable across Scott, Indian Head, Melfort, Redvers and Yorkton, with several sites experiencing significant early-season moisture deficits and uneven rainfall distribution. At Scott, total growing season precipitation (279.5 mm) was near the long-term average; however, April and May were markedly dry, including only 11.8 mm in May compared to a long-term average of 38.9 mm, followed by substantially above-average rainfall in June and September. Melfort experienced an extremely dry spring, receiving only 4.8 mm of precipitation in May, but this deficit was partially offset by above-average rainfall in June and exceptionally high precipitation in August (113.5 mm), resulting in near-average total seasonal precipitation. In contrast, Indian Head received consistently below-average precipitation throughout the growing season, totaling only 136 mm (56% of the long-term mean), with all months from June through August substantially drier than normal. Rainfall distribution in Redvers was uneven, with June particularly dry (27 mm vs. 95.2 mm long-term), which likely increased early-season moisture stress during vegetative growth. Yorkton also recorded reduced seasonal precipitation (195 mm vs. 272 mm long-term), with below-average rainfall from May through July and above-average moisture in August, indicating partial late-season moisture recovery. Overall, differences in precipitation timing rather than total seasonal rainfall were a major contributor to site-specific growing conditions in 2025.

Table 3. Precipitation (mm) amounts along with long-term (1985-2014) normals for the 2025 growing season in Scott, Indian Head, Redvers, Melfort and Yorkton, Saskatchewan.

Location	**Year**	**May**	**June**	**July**	**August**	**September**	**Total**
		------------------------------ *Precipitation (mm)* --------------------					
Scott		11.8	103.7	28.7	64.5	64.5	279.5
	Long-term	38.9	69.7	69.4	48.7	26.5	277.6
Indian Head		***42.6***	***39.4***	***27.1***	***26.9***	***43.1***	***136***
	Long-term	***51.7***	***77.4***	***63.8***	***51.2***	***35.3***	***244.1***
Redvers		65	27	80	40	48	260
	Long-term	***60***	***95.2***	***65.5***	***46.6***	***32.7***	***300***
Melfort	2025	4.8	93.2	25.9	113.5	20.3	257.7
	Long-term	***33.4***	***79.5***	***69.6***	***45.9***	***36***	***264.4***
Yorkton	2025	23.60	63.40	36.80	71.20	-	195.00
	Long-term	***51.00***	***80.00***	***78.00***	***62.00***	-	***272.00***

Soil Test:

Pre-seeding soil test results indicated substantial variability in soil fertility and chemical properties across sites. The Scott site, situated in the Dark Brown soil zone, exhibited lower organic matter (3.5%) and cation exchange capacity (16.8 meq/100g) compared to the Black soil zone sites. It also showed moderate residual nitrate-N and adequate phosphorus and potassium levels, although surface soil pH was acidic (pH 5.3). In contrast, the Indian Head, Yorkton, and Melfort sites, all located within the Black soil zone, exhibited higher organic matter and cation exchange capacity, reflecting greater nutrient-holding capacity. Residual nitrate-N in the 6–24-inch depth was highest at Yorkton, indicating substantial subsoil nitrogen availability, while Indian Head and Melfort had comparatively lower residual nitrogen at depth. Phosphorus levels were lowest at Yorkton and Redvers, suggesting potential P limitations, whereas potassium and sulphur levels were generally adequate to high across sites, particularly at Yorkton and Melfort. Soil pH varied by depth, with surface acidity at Scott and Melfort and neutral to alkaline conditions at depth across all locations, with Redvers being the most alkaline.

Table 4. Soil nutrient concentration and characteristics at Scott, Indian Head, Yorkton, Redvers and Melfort SK sampled in the spring of 2025.

		Scott	**Indian Head**	**Yorkton**	**Redvers**	**Melfort**
Soil Zone		Dark Brown	Black	Black	Black	Black
Nitrate (NO3)- 0-6" depth	lbs/ac	14	8	19	12	18
Nitrate (NO3)- 6-24" depth		15	15	41	15	9
Phosphorus (Olsen)	ppm	17	11	9	8	13
Potassium	ppm	218	725	260	153	468
Sulphur- 0-6" depth	lbs/ac	80	12	58	120+	12
Sulphur- 6-24" depth		78	24	120 +	360+	24
Organic Matter	%	3.5	5.2	5.8	2.7	8.8
pH- 0-6”		5.3	7.7	7.8	8.0	5.9
pH- 6-24”		7.7	8.1	7.9	8.4	7.4
Cation Exchange Capacity	Meq/100g	16.8	49.2	30.3	34.7	41.1

Results:

Plant Emergence & Establishment:

Across sites, seeding rate was the primary and most consistent driver of plant density. Treatments with reduced seeding rates produced the lowest plant populations, most notably at Indian Head ($p = 0.0106$), Yorkton ($p = 0.0146$), Scott ($p < 0.0001$), and Redvers ($p = 0.0015$) (Table 5). At Melfort, treatment differences approached significance ($p = 0.058$) and were less distinct than at the other locations, however, lower plant densities were achieved with the targeted lower seeding rates in Treatment 4 & 9.

Nitrogen form (standard vs. EEF), nitrogen timing (seeding vs. split application), and the use of potash generally had minimal impact on final plant density. At Melfort, the use of enhanced efficiency fertilizer (EEF) significantly increased plant density in Treatment 6 (14 plants/ft^2), suggesting that improved nitrogen availability at this site may have supported early establishment under those growing conditions. At Scott and Redvers, the highest plant densities were observed with the split nitrogen application in Treatment 7, indicating that nitrogen timing may have contributed to stronger early growth in those environments. However, these benefits were not observed in Treatment 9, where EEF and split nitrogen were also used. This is likely because the reduced seeding rate in that treatment had a larger influence on final plant population than any positive effects from fertilizer strategy. Similarly, the use of the “Good” variety slightly increased plant density in the combined analysis and at Indian Head and Yorkton, suggesting some genetic influence on establishment. Overall, however, these effects were smaller than those associated with changes in seeding rate, which remained the dominant factor influencing final stand.

In the combined analysis, treatments differed strongly in plant density ($p < 0.0001$), showing that results were consistent across all environments. Overall, plant populations were primarily driven by seeding rate. Treatments with standard or high seeding rates produced the highest plant densities and were statistically similar to the standard check (Treatment 1), based on Dunnett’s comparisons (Table 6). This indicates that changes in nitrogen source or timing, PGR use, or added potash did not meaningfully affect final plant stands when seeding rate was maintained. In contrast, the two treatments that reduced seeding rate (Treatments 4 and 9) were the only ones with significantly lower plant density than the check. Treatment 4 had 67 fewer plants/ft^2 ($p < 0.0001$), and Treatment 9 had 44 fewer plants/ft^2 ($p = 0.0016$). Treatment 9 was not different from Treatment 4, confirming that reduced seeding rate was the main reason for stand loss, and that additional inputs did not recover plant populations.

Table 5. Treatment means for plant density (plants/ft²) at Indian Head, Yorkton, Melfort, Scott, Redvers, and Combined (all sites) for "Improving Standability in Wheat without PGR's" in 2025.

		Indian Head		Yorkton		Melfort	Scott		Redvers		Combined	
		p-value										
		0.0106		**0.0146**		0.058	**<0.0001**		**0.0015**		**<0.0001**	
Trt #	**Treatment Effect**	Treatment Means										
1	High Risk	**23**	**A**	21	AB	11	22	AB	**18**	**A**	**19**	**A**
2	PGR	19	AB	21	AB	11	20	AB	15	AB	17	AB
3	Variety	**22**	**A**	**25**	**A**	11	23	AB	14	AB	**19**	**A**
4	Seeding Rate	**16**	**B**	**15**	**B**	8	**13**	**C**	**11**	**B**	**13**	**C**
5	N Rate	21	AB	23	AB	10	23	AB	16	AB	**18**	**A**
6	N Form	21	AB	21	AB	14	23	AB	17	AB	**19**	**A**
7	N Timing	20	AB	21	AB	11	**24**	**A**	**19**	**A**	**19**	**A**
8	Potash	22	AB	**23**	**A**	9	20	AB	14	AB	18	AB
9	Low Risk	18	AB	20	AB	7	**19**	**B**	**12**	**B**	15	BC

Table 6. Dunnett's Comparison of combined site plant densities (plants/ft^2) across treatments using Standard (Treatment 1) and stacked lodging, reduced-input systems (Treatment 9) as references for "Improving Standability in Wheat without PGR's" in 2025.

TRT	Difference vs Trt 1	p-value	Significant	Difference vs. Trt 9	p-value	Significant
1	-	-	-	**4.1**	**0.0016**	**Yes**
2	-1.6	0.4523	No	**2.5**	**0.098**	**Yes**
3	0.1	1	No	**4.2**	**0.0012**	**Yes**
4	**-6.3**	**<0.0001**	**Yes**	-2.2	0.169	No
5	-0.6	0.9892	No	**3.5**	**0.0088**	**Yes**
6	0.2	1	No	**4.2**	**0.001**	**Yes**
7	-0.1	1	No	**4.0**	**0.0019**	**Yes**
8	-1.4	0.6091	No	**2.7**	**0.0597**	**Yes**
9	**-4.1**	**0.0016**	**Yes**	-	-	-

Plant Height:

Plant height responded significantly to the various management strategies at all locations, with strong treatment effects at Indian Head, Melfort, Redvers and in the combined analysis ($p < 0.0001$), and smaller but still significant responses at Yorkton ($p=0.0025$) and Scott ($p=0.0121$). Across sites, most treatments that maintained high seeding and nitrogen rates produced similar plant heights. The most consistent reductions in height occurred where PGR was used (Treatment 2) and in the low-risk, reduced-input system (Treatment 9). Treatment 2, PGR applied under otherwise standard management, consistently shortened plants across sites, particularly at Indian Head, Yorkton, Melfort, and Scott, confirming that the PGR effectively reduced plant height. Treatment 9, which combined reduced seeding rate and reduced nitrogen rate with PGR, EEF, split N timing, and potash, also produced shorter plants at most locations, with the greatest separation observed at Redvers (5.3 in).

Table 7. Treatment means for height (inches) at Indian Head, Yorkton, Melfort, Scott, Redvers, and Combined (all sites) for "Improving Standability in Wheat without PGR's" in 2025.

	Indian Head		**Yorkton**		**Melfort**		**Scott**		**Redvers**		**Combined**	
P-value	**<0.0001**		**0.0026**		**<0.0001**		**0.0121**		**<0.0001**		**<0.0001**	
TRT #	Treatment Means											
1	**30.5**	**A**	29.9	AB	**29.7**	**A**	28.5	AB	**36.0**	**A**	**31.2**	**A**
2	**27.2**	**B**	**26.3**	**B**	**24.8**	**B**	**26.5**	**B**	33.1	BC	**27.8**	**B**
3	29.4	AB	27.9	AB	**30.1**	**A**	28.4	AB	34.3	AB	**30.3**	**A**
4	**30.3**	**A**	**32.1**	**A**	**29.5**	**A**	**29.8**	**A**	**36.7**	**A**	**31.9**	**A**
5	**30.3**	**A**	31.0	AB	**29.8**	**A**	27.8	AB	35.5	AB	**31.1**	**A**
6	**30.5**	**A**	30.1	AB	**29.3**	**A**	28.6	AB	**36.2**	**A**	**31.2**	**A**
7	29.3	AB	**31.9**	**A**	**29.5**	**A**	28.6	AB	**37.0**	**A**	**31.6**	**A**
8	**29.6**	**A**	30.5	AB	**28.0**	**A**	27.6	AB	34.6	AB	**30.3**	**A**
9	**27.4**	**B**	**26.7**	**B**	**25.4**	**B**	27.7	AB	**30.7**	**C**	**27.8**	**B**

In the combined analysis, treatment effects were highly significant ($p < 0.0001$), providing strong evidence that these trends were consistent across environments. The high-risk check (Treatment 1) averaged 31.2 inches and was among the tallest group. Dunnett's comparisons against Treatment 1 showed that only Treatments 2 and 9 were significantly shorter, both by approximately 3.3 inches ($p < 0.0001$) (Table 8). All other treatments, including reduced seeding rate alone (Treatment 4), reduced nitrogen rate (Treatment 5), EEF (Treatment 6), split nitrogen timing (Treatment 7), and potash (Treatment 8), were not significantly different from the high-risk check. Notably, across sites and in the combined analysis, the reduced seeding rate in Treatment 4 produced some of the tallest plants, placing it within the tallest grouping of treatments. This suggests that reduced plant competition can allow individual plants to grow taller due to increased access to light, moisture, and nutrients. However, seeding rate alone was not the primary driver of plant height. In Treatment 9, where seeding rate was also reduced but a PGR was applied, plant height was significantly shorter. This demonstrates that the PGR exerted a stronger influence on final plant height than plant population. This relationship is further supported in Table 8, where plant height in Treatments 9 and 2 did not differ significantly. Because both treatments included a PGR, this confirms that growth regulator application was the dominant driver of reduced height in Treatment 9, rather than changes in seeding rate or nitrogen rate. Overall, while reduced competition can contribute to increased height, PGR application was the dominant factor affecting crop stature in this study.

Table 8. Dunnett's Comparison of combined site heights (inches) across treatments using high-risk (Treatment 1) and low- risk input systems (Treatment 9) as references for "Improving Standability in Wheat without PGR's" in 2025.

TRT	**Difference vs Trt 1**	**p-value**	**Significant**	**Difference vs. Trt 9**	**p-value**	**Significant**
1	-	-	-	**8.5125**	**<0.0001**	**Yes**
2	**-3.3**	**<.0001**	**Yes**	0.05312	1	No
3	-0.9	0.5237	No	**6.21979**	**0.0015**	**Yes**
4	0.7	0.7171	No	**10.39792**	**<0.0001**	**Yes**
5	0.0	1	No	**8.38646**	**<0.0001**	**Yes**
6	0.0	1	No	**8.61667**	**<0.0001**	**Yes**
7	0.4	0.9865	No	**9.4875**	**<0.0001**	**Yes**
8	-0.8	0.6113	No	**6.40521**	**0.0011**	**Yes**
9	**-3.4**	**<.0001**	**Yes**	-	**-**	**-**

Lodging:

Lodging levels were generally low across all sites, with most ratings near 1 (minimal lodging), indicating that the crop stood well under the conditions of this study. Significant treatment effects were detected at Indian Head for both physiological maturity (L1) and harvest timing (L2) and at Melfort prior to harvest, while Scott, Yorkton, and Redvers showed no significant treatment differences. At Indian Head, some separation among treatments occurred, with the high-risk check (Treatment 1) tending to have slightly higher lodging scores compared to several other treatments, including those with PGR or reduced inputs. At Melfort, lodging differences were observed prior to harvest, but the overall magnitude of lodging remained relatively small. Across the remaining sites, lodging pressure was minimal and treatments performed similarly.

Table 9. Treatment means for lodging (0-9) at physiological maturing (L1) and prior to harvest (L2) at Indian Head, Yorkton, Melfort, Scott, Redvers, and Combined for "Improving Standability in Wheat without PGR's" in 2025.

	Indian Head				**Melfort**			**Scott**	**Yorkton**	**Redvers**	**Combined**			
	L1		**L2**		**L1**	**L2**					**L1**		**L2**	
P-value	**0.0001**		**<0.0001**		NS	**0.043**		NS	NS	NS	0.4551		0.1051	
TRT #	Treatment Means													
1	1.75	A	**1.5**	**A**	1	2.25	AB	1	1	1	1.1	A	1.3	A
2	1.125	BC	**1**	**B**	1	1.75	AB	1	1	1	1.0	A	1.1	A
3	**1**	**C**	**1**	**B**	1	2	AB	1	1	1	1.0	A	1.2	A
4	1.375	ABC	**1.5**	**A**	1	**3**	**A**	1	1	1	1.1	A	1.5	A
5	1.25	BC	1.25	AB	1	2.25	AB	1	1	1	1.0	A	1.3	A
6	1.5	AB	**1.375**	**A**	1	2.5	AB	1	1	1	1.1	A	1.3	A
7	1.375	ABC	**1.375**	**A**	1	2.5	AB	1	1	1	1.1	A	1.3	A
8	1.5	AB	**1.5**	**A**	1	2	AB	1	1	1	1.1	A	1.3	A
9	**1**	**C**	**1**	**B**	1	**1.5**	**B**	1	1	1	1.0	A	1.1	A

In the combined analysis, there were no significant treatment effects for either L1 ($p = 0.4551$) or L2 ($p = 0.1051$). Dunnett's comparisons against the high-risk check (Treatment 1) confirmed that no treatment differed significantly from the check in overall lodging response (Table 10). Differences among treatments were small (generally less than 0.25 points on the 0–9 scale) and were not statistically meaningful.

Table 10. Dunnett's Comparison of combined site lodging ratings (0-9) at L1 (physiological maturity) and L2 (prior to harvest) across treatments using high-risk input (Treatment 1) and low- risk input systems (Treatment 9) as references for "Improving Standability in Wheat without PGR's" in 2025.

L1 (Physiological Maturity)						
TRT	**Difference vs Trt 1**	**p-value**	**Significant**	**Difference vs. Trt 9**	**p-value**	**Significant**
1	-	-	-	0.15	0.21	No
2	-0.125	0.3815	No	0.025	0.9998	No
3	-0.15	0.21	No	1.11E-16	1	No
4	-0.075	0.8511	No	0.075	0.8511	No
5	-0.1	0.6159	No	0.05	0.9794	No
6	-0.05	0.9794	No	0.1	0.6159	No
7	-0.075	0.8511	No	0.075	0.8511	No
8	-0.05	0.9794	No	0.1	0.6159	No
9	-0.15	0.21	No	-	-	-
L2 (Prior to Harvest)						
1	-	-	-	0.25	0.2992	No
2	-0.2	0.5306	No	0.05	0.9996	No
3	-0.15	0.7967	No	0.1	0.9675	No
4	0.15	0.7967	No	**0.4**	**0.0275**	**Yes**
5	-0.05	0.9996	No	0.2	0.5306	No
6	0.025	1	No	0.275	0.2139	No
7	0.025	1	No	0.275	0.2139	No
8	-0.05	0.9996	No	0.2	0.5306	No
9	-0.25	0.2992	No	-	-	-

Yield:

Yield response varied by location, highlighting the importance of environment in determining which management practices are most beneficial. At all sites except Scott and Redvers, AAC Wheatland consistently produced higher yields than CDC Adamant, while reduced nitrogen rates (Treatments 5 and, in some cases, 9) decreased yield depending on the environment. At Scott, the response differed from other locations, with the highest significant yields observed in Treatment 2 (PGR), Treatment 7 (split nitrogen timing), and Treatment 9 (PGR + split N + reduced N). The lowest yield at Scott occurred with reduced nitrogen alone (Treatment 5), suggesting that nitrogen timing and canopy management provided benefit under those growing conditions. At Redvers, no significant yield differences were detected; however, the highest numerical yield was achieved under the high-risk input system (Treatment 1), while Treatment 9 was numerically the lowest. This indicates that at Redvers, maintaining high seeding and nitrogen rates under conventional management provided the most stable performance, and reductions in seed and nitrogen were not offset by additional practices. Similarly, at Melfort—and likely at Redvers—the combination of reduced seeding and reduced nitrogen in Treatment 9 could not be compensated for by adding PGR, split nitrogen timing, EEF, or potash. Overall, these results reinforce that variety selection and maintaining adequate nitrogen supply were the most consistent drivers of yield, while reducing foundational inputs such as seeding rate and nitrogen rate carried measurable risk that was not reliably mitigated by stacking additional management strategies.

Table 11. Treatment means for yield (bu/ac) at Indian Head, Yorkton, Melfort, Scott, Redvers, and Combined (all sites) for "Improving Standability in Wheat without PGR's" in 2025.

	Indian Head		**Yorkton**		**Melfort**		**Scott**		**Redvers**		**Combined**	
P-value	**0.0368**		0.2315		**0.0282**		**0.0052**		0.7845		**0.0342**	
TRT #	Treatment Means											
1	77.4	AB	62.8	A	69.0	AB	46.5	AB	63.2	A	64.8	AB
2	78.2	AB	62.9	A	70.7	AB	**50.7**	**A**	57.3	A	65.0	AB
3	**83.0**	**A**	76.0	A	**80.5**	**A**	47.7	AB	57.5	A	**70.0**	**A**
4	77.8	AB	69.8	A	**66.6**	**B**	49.1	AB	58.7	A	65.4	AB
5	**72.7**	**B**	61.2	A	**67.1**	**B**	**44.3**	**B**	59.5	A	**62.0**	**B**
6	79.7	AB	66.3	A	69.9	AB	49.3	AB	56.8	A	65.4	AB
7	74.2	AB	72.5	A	68.2	AB	**50.0**	**A**	61.8	A	66.4	AB
8	75.5	AB	66.9	A	68.4	AB	48.8	AB	59.7	A	64.9	AB
9	75.4	AB	65.1	A	**65.2**	**B**	**50.4**	**A**	52.2	A	**62.6**	**B**

Yield differences among treatments were modest when compared directly to the high-risk check (Treatment 1). Dunnett's comparisons showed that none of the treatments differed significantly from Treatment 1 at the 0.05 significance level (Table 12), indicating that observed yield differences were within the range of normal experimental variation. Although Treatment 3 (AAC Wheatland under high-risk input management) produced the largest numerical yield increase, averaging 5.2 bu/ac greater than the check, this difference was not statistically significant (P = 0.0954), suggesting a trend rather than a confirmed improvement.

When treatments were compared directly to the low-risk management system (Treatment 9), Treatment 3 yielded significantly higher. This result indicates that maintaining a full seeding rate and nitrogen rate with a strong genetic package (AAC Wheatland) was more effective for maximizing yield than adopting the stacked reduced-input strategy. In contrast, all other treatments—including reduced seeding rate (Treatment 4), reduced nitrogen rate (Treatment 5), enhanced efficiency fertilizer (Treatment

6), split nitrogen timing (Treatment 7), potash application (Treatment 8), and the full reduced-input package (Treatment 9)—produced yields statistically similar to the standard high-risk practice.

Table 12. Dunnett's Comparison of combined site yields (bu/ac) across treatments using high-risk input (Treatment 1) and low- risk input systems (Treatment 9) as references for "Improving Standability in Wheat without PGR's" in 2025.

TRT	Difference vs Trt 1	p-value	Significant	Difference vs. Trt 9	p-value	Significant
1	-	-	-	2.1762	0.8563	No
2	0.15545	1	No	2.33166	0.8124	No
3	5.21827	0.0954	No	**7.39447**	**0.0078**	**Yes**
4	0.61183	0.9999	No	2.78803	0.6637	No
5	-2.86044	0.6389	No	-0.68423	0.9999	No
6	0.62964	0.9999	No	2.80584	0.6576	No
7	1.5837	0.9681	No	3.75991	0.3536	No
8	0.08998	1	No	2.26618	0.8315	No
9	-2.1762	0.8563	No	-	-	-

Seed Quality

Protein:

Protein concentration responded significantly to treatment effects at Indian Head, Yorkton, Melfort, and in the combined analysis ($P < 0.0001$), with a smaller but still significant response at Scott ($P = 0.0111$), while Redvers showed no treatment effect. At Indian Head and Yorkton, the lowest protein levels were observed in Treatments 5 (reduced nitrogen rate) and 9 (reduced nitrogen and seeding rate), indicating that nitrogen supply was a key driver of grain protein at these sites. A similar trend occurred at Melfort, where Treatments 5 and 9 were again among the lowest protein groupings, while treatments maintaining full nitrogen rates generally produced higher protein. Scott showed less separation overall, but Treatment 9 still ranked among the lower protein treatments. At Scott, however, protein was influenced somewhat differently, where variety choice, reduced seeding rate, and split nitrogen timing were associated with slightly higher protein levels. In contrast, Redvers showed no statistical differences among treatments, suggesting that environmental conditions there limited the influence of management on protein expression. Overall, these results reinforce that maintaining adequate nitrogen supply is the most reliable strategy for preserving grain protein, while reductions in nitrogen rate consistently lowered protein across locations.

Table 13. Treatment means for protein (%) at Indian Head, Yorkton, Melfort, Scott, Redvers, and Combined for "Improving Standability in Wheat without PGR's" in 2025.

	Indian Head		**Yorkton**		**Melfort**		**Scott**		**Redvers**		**Combined**	
P-value	**<0.0001**		**<0.0001**		**<0.0001**		**0.0111**		0.5371		**<0.0001**	
TRT #	Treatment Means											
1	14.2	A	**15.3**	**A**	16.1	AB	**16.2**	**A**	13.4	A	14.9	A
2	14.3	A	14.6	AB	16.1	AB	15.7	AB	13.0	A	14.6	A
3	13.8	A	13.6	BC	16.0	AB	**16.1**	**A**	13.2	A	14.4	A
4	14.4	A	15.0	AB	**16.8**	**A**	**16.0**	**A**	13.0	A	14.9	A
5	**12.6**	**B**	12.2	CD	**14.7**	**B**	15.0	AB	12.3	A	**13.2**	**B**
6	14.0	A	14.7	AB	**16.6**	**A**	15.8	AB	13.0	A	14.7	A
7	14.0	A	14.9	AB	**17.1**	**A**	**16.0**	**A**	13.3	A	14.9	A
8	14.6	A	15.0	AB	**16.7**	**A**	15.8	AB	12.8	A	14.8	A
9	**11.9**	**B**	**11.5**	**D**	**14.8**	**B**	**14.5**	**B**	13.0	A	**13.0**	**B**

In the combined analysis, treatment effects were highly significant ($P < 0.0001$), confirming that nitrogen management consistently influenced protein across environments. The high-risk check (Treatment 1) averaged 14.89% protein and ranked in the highest statistical grouping. Dunnett's comparisons showed that Treatment 5 (–1.64%) and Treatment 9 (–1.91%) were significantly lower than Treatment 1, while all other treatments were statistically similar to the check. When compared directly to Treatment 9, every treatment except Treatment 5 had significantly higher protein, reinforcing that reduced nitrogen was the primary factor lowering grain protein.

Table 14. Dunnett's Comparison of combined site proteins (%) across treatments using high-risk (Treatment 1) and low-risk input systems (Treatment 9) as references for "Improving Standability in Wheat without PGR's" in 2025.

TRT	**Difference vs Trt 1**	**p-value**	**Significant**	**Difference vs. Trt 9**	**p-value**	**Significant**
1	-	-	-	**1.90775**	**<.0001**	**Yes**
2	-0.28425	0.9342	No	**1.6235**	**0.0001**	Yes
3	-0.47875	0.5664	No	**1.429**	**0.0008**	**Yes**
4	0.00625	1	No	**1.914**	**<.0001**	**Yes**
5	**-1.64275**	**0.0001**	**Yes**	0.265	0.9536	No
6	-0.2205	0.983	No	**1.68725**	**<.0001**	**Yes**
7	0.0335	1	No	**1.94125**	**<.0001**	**Yes**
8	-0.05025	1	No	**1.8575**	**<.0001**	**Yes**
9	**-1.90775**	**<.0001**	**Yes**	-	**-**	**-**

Test Weight:

Test weight responded to treatment at most locations, with significant effects at Indian Head, Yorkton, Melfort, and Scott, while Redvers showed no treatment response. At Indian Head, differences were modest but significant, with Treatment 9 ranking among the highest. Yorkton showed clearer separation, where AAC Wheatland (Treatment 3) and the low-risk input system (Treatment 9) produced the greatest test weights. Melfort and Scott showed the strongest treatment responses overall ($p < 0.0001$), again with Treatments 3 and 9 performing at or near the top. In contrast, Redvers showed no statistical differences among treatments, indicating that environmental conditions there likely limited management-driven differences in kernel density. Across locations, these results suggest that variety selection played a larger role in influencing test weight than PGR application alone. The consistent performance of AAC Wheatland (Treatment 3), and its inclusion in Treatment 9, indicates that genetic potential for grain quality had a stronger and more reliable effect than individual management adjustments such as PGRs.

Table 15. Treatment means for test weight (lbs/bu) at Indian Head, Yorkton, Melfort, Scott, Redvers, and Combined for "Improving Standability in Wheat without PGR's" in 2025.

	Indian Head		**Yorkton**		**Melfort**		**Scott**		**Redvers**		**Combined**	
P-value	**0.0236**		**0.0007**		**<0.0001**		**0.0001**		0.9148		**0.0002**	
TRT #	Treatment Means											
1	65.1	AB	**57.1**	**B**	63.9	AB	62.1	B	57.3	A	61.1	BC
2	**64.9**	**B**	**57.2**	**B**	**63.3**	**C**	61.9	B	57.4	A	60.9	C
3	65.2	AB	**58.1**	**A**	**64.4**	**A**	62.2	B	57.5	A	61.4	AB
4	65.1	AB	57.4	AB	63.4	BC	61.8	B	57.5	A	61.0	BC
5	65.2	AB	57.3	AB	63.6	BC	62.0	B	57.1	A	61.0	BC
6	65.3	AB	**57.1**	**B**	63.6	BC	62.2	B	57.4	A	61.1	BC
7	65.0	AB	57.4	AB	63.6	BC	62.1	B	57.3	A	61.1	BC
8	65.0	AB	57.3	AB	63.4	BC	62.2	B	57.3	A	61.0	BC
9	**65.4**	**A**	**58.1**	**A**	**64.2**	**A**	**62.9**	**A**	57.4	A	61.6	**A**

In the combined analysis, treatment effects were highly significant (P = 0.0002), confirming that site-level trends were consistent enough to influence overall grain quality. The high-risk input check (Treatment 1) averaged 61.1 lbs/bu and fell within the intermediate grouping. Dunnett's comparisons against Treatment 1 showed that only Treatment 3 (+0.3 lbs/bu; P = 0.0456) and Treatment 9 (+0.6 lbs/bu; P = 0.0037) were significantly higher than the check (Table 12), while all other treatments were statistically similar to high-risk input management. Treatment 3 represents AAC Wheatland under full seeding and nitrogen rates, whereas Treatment 9 combined reduced seeding and nitrogen rates with PGR, EEF, split nitrogen timing, and potash. Importantly, Treatments 3 and 9 were not significantly different from each other for test weight, indicating that the improvement in bushel weight was primarily driven by the AAC Wheatland variety rather than differences in seeding rate or nitrogen management.

Table 16. Dunnett's Comparison of combined site test weights (lbs/bu) across treatments using high-risk input (Treatment 1) and low- risk input systems (Treatment 9) as references for "Improving Standability in Wheat without PGR's" in 2025.

TRT	Difference vs Trt 1	p-value	Significant	Difference vs. Trt 9	p-value	Significant
1	-	-	-	**-0.5**	**0.0037**	**Yes**
2	-0.2	0.8012	No	**-0.7**	**0.0002**	**Yes**
3	**0.4**	**0.0456**	**Yes**	-0.1	0.8807	No
4	-0.1	0.9995	No	**-0.6**	**0.0012**	**Yes**
5	0.0	0.9999	No	**-0.6**	**0.0015**	**Yes**
6	0.0	1	No	**-0.5**	**0.0068**	**Yes**
7	0.0	1	No	**-0.5**	**0.0037**	**Yes**
8	-0.1	0.9984	No	**-0.6**	**0.001**	**Yes**
9	**0.5**	**0.0037**	**Yes**	-	-	-

Conclusions and Recommendations

This multi-site demonstration confirmed that lodging risk in 2025 was low across environments, and under these conditions most lodging-focused management strategies provided limited benefit. Although PGR application (Treatments 2 and 9) consistently reduced plant height, this response did not translate into a consistent reduction in lodging when sites were combined. Reduced seeding rate alone (Treatment 4) also influenced crop structure, producing taller plants likely due to reduced inter-plant competition, but lodging levels remained low overall and treatment differences were small and inconsistent across locations. As a result, lodging did not emerge as a major management constraint in this study, and the opportunity for measurable lodging reduction was limited by the naturally low lodging pressure.

The clearest and most consistent treatment effects were observed for plant density, grain protein, and yield. Seeding rate was the dominant driver of establishment: reduced seeding rates significantly lowered plant populations across environments, and no combination of additional inputs—including variety, nitrogen form or timing, PGR, or potash—recovered the lost stand. Nitrogen rate was the most consistent driver of grain protein, with reduced nitrogen (Treatments 5 and 9) resulting in significantly lower protein across sites, highlighting a clear quality risk when foundational nitrogen fertility is reduced. Yield was generally stable across treatments when compared to the standard management check, indicating that the baseline program performed reliably under the conditions of this study. However, maintaining full seeding and nitrogen rates with strong genetics (Treatment 3; AAC Wheatland under high-input management) significantly outperformed the stacked reduced-input system (Treatment 9), reinforcing that genetics paired with adequate foundational inputs remains the most dependable pathway to maximizing yield potential. Test weight also responded to variety, further emphasizing that grain density is influenced more by genetics and overall crop balance than by individual fertility timing or product adjustments.

For producers, the key implication is that foundational management decisions—variety selection, seeding rate, and nitrogen rate—continue to drive the most reliable gains in yield and grain quality. In contrast, reducing seeding rate or nitrogen rate carried measurable risk, particularly for stand establishment and protein, and those losses were not consistently offset by stacking additional tools such as EEF, split nitrogen timing, potash, or PGR. Under the low-lodging conditions experienced in 2025, lodging-specific tools should be viewed as situational risk-management options rather than practices that can be expected to deliver consistent economic return every year.

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Project Extension

Knowledge Transfer Product or Activity	Event/Location Where Knowledge Transfer Was Conducted	Estimated Number of Producers Participated in Knowledge Transfer	Link (if available)
Marked and Signage	NARF & AAFC Field Days; July 23 & 24, 2025	126 on July 23, 2025; 36 on July 24, 2025	
Marked and Signage	ECRF Field Day July 24 2025	100 people	
C. Holzapfel (IHARF) plot tour/ presentation	Indian Head Crop Management Field Day (July 15, 2025)	157	https://iharf.ca/indian-head-crop-management-field-day/
C. Holzapfel (IHARF) plot tour/ presentation	BASF Global Herbicide Group/ IHARF Plot Tour (July 16, 2025)	26	
C. Holzapfel (IHARF) plot tour/ presentation	Sask Wheat / IHARF Plot Tour (Aug-5-2025)	9	
Presented by Dr. Alireza	Southeast Research Farm’s Annul Field Day on 10 July 2025	approx. 80 Attendees	

Appendices

Appendix I: Agronomic Management of Field Sites

Table A1. Agronomic operations for early seeded wheat at Scott, Indian Head, Yorkton, Redvers and Melfort, SK., 2025.

Operation	Scott	Indian Head	Yorkton	Redvers	Melfort
Row Spacing	10"	12”	12”	12”	12"
Stubble Type	Canola	Canola	Canola	Oats	Canola
Seed Depth	¾”	7/8”	7/8”	1’	1"
Seed Date	May 8, 2025	May 9, 2025	May 18, 2025	May 22, 2026	May 20, 2025
Plant Counts	May 28, 2025	June 5, 2025	June 2, 2025	June 5, 2025	June 3, 2025
Pre-Emergent Date	May 7, 2025	May 13, 2025	May 22, 2025	May 24, 2025	May 15, 2025
Pre-Emergent Herbicide	Glyphosate 540 @ 1 L/ac & Aim	Roundup Weathermax	Roundup Transorb @ 1L/ac	Roundup @ 0.67L/ac	Avadex @ 1.2 L/ac & StartUp @ 670 ml/ac
In-Crop Herbicide Date	June 16, 2025	June 11, 2025	June 12, 16 & 27, 2025	June 18, 2025	June 20, 2025
In-crop herbicide	Axial Xtreme@ 0.5 L/ac & Buctril M @ 0.4 L/ac	Octain XL @ 0.45L/ac & Simplicity GoDRI @ 28 g/ac	Prestige XL (900 ml/ac), Axial (500 mL/ac) & Axial (500mL/ac) + AMS	Puma Advance 413 mL/ac	Momentum @ 0.45 L/ac, MCPA @ 0.38 L/ac & Puma Advance @ 413 ml/ac
N Broadcast (trt 7&9)	June 20, 2025	June 9, 2025	June 13, 2025	June 16, 2025	July 1, 2025
PGR App (trt 2&9)	June 20, 2025	June 19, 2025	July 2, 2025	June 30, 2025	July 1, 2025
Fungicide Date	July 5, 2025	July 9, 2025	July 8, 2025	N/A	July 11, 2025
Fungicide	Caramba @ 400 ml/ac	Miravis Era A @ 253 ml/ac, Miravis Era B @ 202 ml/ac & Agral 90 @ 0.125%	Miravis Ace @ 404 ml/ac	N/A	Miravis Era A @ 253 mL/ac + Miravis Era B @ 202 mL/ac
Insecticide	none	none	none	none	none
Heights	July 31, 2025	July 30, 2025	August 8, 2025	August 8, 2025	August 15, 2025
Lodging	August 28, 2025 & September 19, 2025	August 15, 2025 & August 28, 2025	August 25, 2025 & Sept 8, 2025	August 10, 2025	September 22, 2025
Desiccation Date	September 8, 2025	August 24, 2025	N/A	N/A	September 8, 2025
Desiccation	Glyphosate 540 @ 0.67 L/ac, Heat LQ @ 59 mL/ac & Merge @ 200 mL/ac	Roundup Weathermax @ 0.67 L/ac	N/A	N/A	StartUp @ 0.67L/ac
Harvest Date	Sept 20, 2025	August 29, 2025	September 8, 2025	September 28, 2025	September 22, 2025

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Abstract

This project evaluated multiple management strategies to improve wheat standability without relying solely on plant growth regulators (PGRs). A nine-treatment randomized complete block design was conducted across five Saskatchewan locations in 2025 to independently assess the effects of seeding rate, nitrogen rate, nitrogen form and timing, potash fertility, variety selection, PGR application, and a stacked reduced-input system. Measurements included plant density, plant height, lodging ratings at physiological maturity and harvest, yield, grain protein, and test weight. Lodging pressure was generally low across environments, and most treatments did not significantly differ in lodging severity. While PGR application significantly reduced plant height, it did not consistently reduce lodging when data were combined across sites. Seeding rate was the primary driver of plant density, with reduced seeding rates significantly lowering stand establishment. Nitrogen rate strongly influenced grain protein concentration, with reduced nitrogen consistently decreasing protein levels. Yield differences were modest relative to the high-risk management check; however, maintaining full seeding and nitrogen rates with AAC Wheatland significantly outperformed the reduced-input stacked system. Variety selection also contributed to improved test weight. Overall, results demonstrated that strong genetics combined with adequate seeding rates and nitrogen fertility provided the most consistent agronomic performance across environments, reinforcing the importance of balanced management over input reduction alone.

Project findings were shared through several knowledge transfer activities in 2025. Marked signage highlighting the study was displayed at the NARF & AAFC Field Days on July 23 and 24, reaching approximately 126 producers on July 23 and 36 on July 24. Additional signage was presented at the ECRF Field Day on July 24, which was attended by approximately 100 producers. C. Holzapfel (IHARF) also led plot tours and presentations featuring this research at the Indian Head Crop Management Field Day (July 15, 2025; 157 participants), the BASF Global Herbicide Group/IHARF Plot Tour (July 16, 2025; 26 participants), and the Sask Wheat/IHARF Plot Tour (August 5, 2025; 9 participants). These events provided valuable opportunities for direct engagement with producers and industry representatives.