

2025 Project Report
for the
Saskatchewan Wheat Development Commission (SWDC)

Managing Lodging and Optimizing Yield and Quality in Wheat with Plant Growth
Regulators and Intensive Nitrogen Management
(Project SWDC #371-250401)



Principal Investigator: Chris Holzapfel¹

¹Indian Head Agricultural Research Foundation, Indian Head, SK, S0G 2K0

Collaborators: Brianne McInnes² and Jessica Enns³

²Northeast Agriculture Research Foundation, Melfort, SK, S0E 1A0

³Western Applied Research Corporation, Scott, SK, S0K 4A0

Correspondence: cholzapfel@iharf.ca or (306) 695-7761

Project Identification

1. **Project Title:** Managing lodging and optimizing yield and quality in wheat with plant growth regulators and intensive nitrogen management
2. **Project Number:** SWDC 371-250401
3. **Producer Group Sponsoring the Project:** Saskatchewan Wheat Development Commission (SWDC)
4. **Project Locations:** Indian Head (R.M. 156), Melfort (R.M. 428), and Scott (R.M. 380)
5. **Project Start & End Dates:** April 2025 – March 2026
6. **Project Contract Person and Contact Details:**
Chris Holzapfel, Research Manager
Indian Head Agricultural Research Foundation
Box 156, Indian Head, SK, S0G 2K0
Email: cholzapfel@iharf.ca
Phone: 306-695-7761

Objectives and Rationale**7. Project Objectives:**

The overall project objective was to demonstrate the ability of plant growth regulators (PGR) combined with more intensive nitrogen (N) management strategies to achieve the highest possible CWRS yield potential, without compromising grain quality. Additional objectives were to better understand potential PGR effects on grain protein in wheat, particularly in cases where the PGR results in higher yields and further explore the capacity for split N applications versus enhanced efficiency fertilizer (EEF) products to optimize yield and protein while also potentially reducing lodging. We aimed to assess how these responses might differ across environments and look for synergies between PGR and intensive N management strategies with respect to lodging, yield, and grain protein concentrations.

8. Project Rationale:

Lodging and low protein are two frequently recurring challenges reported by wheat growers in Saskatchewan. Cereal crop lodging is normally most severe in environments where moisture is relatively non-limiting and vegetative growth/yield potential are high. Since becoming readily available to farmers more than a decade ago, PGRs such as Manipulator (chlormequat chloride) and Moddus® (trinexapac-ethyl) have proven to be quite effective for reducing both height and lodging and, in doing so, have potential to result in higher yields. Unfortunately, these yield increases may be coupled with lower protein if N management is not adjusted accordingly. This project aims to benefit Saskatchewan farmers by demonstrating the ability of PGRs combined with more intensive N management to simultaneously reduce lodging risk while optimizing grain yield and protein. Although previous work looking at the combined effects of plant growth regulators (PGR) and split nitrogen (N) applications or enhanced efficiency fertilizer (EEF) N products is limited, all these practices have been well researched and/or demonstrated individually.

Focusing on PGR, the project utilizes Manipulator 620 (620 g chlormequat chloride/L), a product which we have worked with in regional industry trials and publicly funded demonstrations going back to 2012. While the benefits associated with this product have varied with environment and management, chlormequat chloride has proven to be highly effective for reducing plant height and lodging in wheat. These responses have the potential to increase grain yields which can have the undesired effect of reducing grain protein due to the long-recognized relationship between these parameters (Simmonds

1995). In 2019 and 2020 at Indian Head, PGR substantially reduced height and, to a lesser extent, increased yields, but did not affect grain protein (Holzapfel 2020). Notably, however, foliar fungicide, which resulted in a larger yield increase than PGR, reduced protein from 14.4% to 14.1% when averaged over the two years and the magnitude of the protein reductions were consistent with that of the yield response to fungicide for individual years. In a single year demonstration, which combined a wide range of N rates with PGR, Holzapfel (2015), observed height reductions and yield increases at all N rates, but a greater yield response to PGR when combined with high rates of N. While the effect of PGR on grain protein concentration across N rates was only marginally significant ($P = 0.063$), the reduction for individual N rates was as high as 0.5 percentage points and much more prominent when N was more limited. In a multi-site Agri-ARM trial conducted in 2023, conditions were extremely dry and, although heights were reduced with reasonable consistency, lodging was mostly negligible and PGR effects on yield were small at best and negative at worst (McInnes et al., 2024). However, at Indian Head, there was a trend for higher yields with Manipulator over the control (5434 kg/ha versus 5271 kg/ha) and, with this, a significant reduction in protein from 12.9% to 12.6%. This work was repeated in 2024 when lodging was more severe at Indian Head and effectively reduced with PGR; however, with high variability and late season heat/drought stress, PGR did not significantly affect either yield or protein.

Looking at N management, split applications and, more specifically, top-dressing N, have long been touted as means of either reducing risk or increasing grain yields and/or quality. The risk reduction can be realized through either managing uncertain yield potential in dry springs (i.e., applying less N at seeding and reserving the option to top-dress if conditions improve) or through lowering the risk of environmental N loss where the potential is high (i.e., poorly drained fields, hot and wet environments). Split applications also prolong N release until later in the season, when crop uptake is highest, helping to ensure that N availability is sufficient to support grain filling and protein development. In an extreme example, Holzapfel et al (2007) delayed the entire N requirements of wheat by up to 30 days post-seeding and only reduced wheat yields with this practice under exceptionally dry conditions (at 1/5 sites) – grain protein was never affected. They also compared surface-dribble banding to in-soil coulter applications and found that any advantages to the coulter applications were small and, again, only occurred under drought conditions. In a follow-up project, Lafond et al. (2008) explored different proportions of starter N and based the timing of the in-crop applications on crop stage. This work found that, for wheat, applying 50% of the crops N requirements at seeding and top-dressing the remainder by the 6-leaf stage effectively mitigated any risks of yield losses. They did not explore later application dates in this study; however, Hall et al. (2022) compared 3-5 leaf stage applications to early flag-leaf timing. Here, yields and protein at Indian Head, one of the more uniform and responsive sites, were maintained provided that the in-crop N was top-dressed at the earlier growth stages. At Swift Current, under drought and yield limited conditions, the wheat did not respond to post-emergent N and the lowest rates were sufficient to optimize yield and protein. Earlier Agri-ARM work (Hall et al. 2018) delayed post-emergent N until after anthesis in wheat and compared foliar versus dribble-band applications; however, they observed significant leaf burn with foliar applications and the greatest grain protein increases with post-anthesis N were coupled with lower yields. Certain EEF products release N in a more controlled manner and over a longer period, deferring N availability until later in the season and often lowering the risk of environmental losses. As such, EEF N formulations could have potential to provide some of the benefits of in-crop N applications without some of the added risk (i.e., poor uptake due to lack of rain after application) and labour requirements. Results in field trials, however, have been mixed. Averaged over a three-year period, Holzapfel (2022) only saw a significant protein (and yield) advantage to SUPERU[®] over untreated urea with fall, surface broadcast applications. The effects of N fertilizer formulation on wheat protein under more optimal timing/placement options (i.e. in-soil banding) were mixed and never significant. Similarly, with 25 sites throughout Alberta and

Saskatchewan, Fast et al. (2024), did not observe any significant N source effects on grain protein, regardless of soil type, despite seeing a significant yield advantage to the dual inhibitor in the Dark Brown soil zone. All N forms performed similarly with respect to both yield and protein responses in the Black and Grey soil zones.

Working with barley, Thompson et al. (2018) used a combination of fungicide applications, PGR, and in-crop UAN to significantly increase grain yields by 9% while, simultaneously, slightly increasing grain protein; however, the authors did not look at the effects of these inputs independently. The current project was initiated to explore potential synergies to combining PGR applications and more intensive N management as a means of optimizing both yield and grain quality in CWRS wheat while also minimizing the risk and severity of lodging.

Methodology and Results

9. Methodology:

Field trials with Canada Western Red Spring (CWRS) wheat were initiated at three Saskatchewan locations in the spring of 2025. The locations were Indian Head (thin-Black), Melfort (moist Black), and Scott (Dark Brown), focusing on the regions where the risk of lodging and yield potential were highest and farmers are more likely to use plant growth regulators (PGR). The treatments were a factorial combination of two PGR treatments and seven nitrogen (N) management treatments. The PGR treatments were an untreated control (UTC) versus 1118 g chlormequat chloride/ha as Manipulator 620 (TRT), applied when the crop was between Zadoks 31-37 (one above-ground node detectable to the beginning of flag-leaf emergence) in a minimum solution volume of 93 l/ha. The N treatments included side-banded urea at three rates (70%, 100%, and 130%), split N applications at two rates (100% and 130%), and two treatments utilizing side-banded enhanced efficiency fertilizer (EEF) products at the 100% N rate. The EEF products were either SUPERU® (dual urease/nitrification inhibitor) or ESN where 75% of the N was a polymer coated, controlled release product. Top-dressed N was urea ammonium nitrate (UAN; 28-0-0) applied in a surface dribble-band, ideally between Zadoks 13-15 (3-5 leaf stage). We did not combine the top-dressed UAN with any N stabilizer products as we wanted to ensure it would be available for crop uptake as soon as possible after application. The 100% N rate was based on a target of 150 kg total N/ha (residual soil NO₃-N plus fertilizer N) with all other proportions relative to the applied fertilizer rate as opposed to the total N target. For example, if residual soil NO₃-N was 50 kg N/ha, the 30, 70, 100, and 130% fertilizer rates would be 30, 70, 100, and 130 kg N/ha. The N treatments are described in greater detail in Table 1. Each treatment was replicated four times and, to facilitate PGR treatment applications with a field sprayer, we utilized a split-plot design with PGR as the main plot and N management as the sub-plots.

Table 1. Intensive nitrogen (N) management treatment descriptions.

#	Side-banded Nitrogen	Top-dressed Nitrogen ^Y	Abbreviation
1	70% as urea	Nil	70% Ur
2	100% as urea	Nil	100% Ur
3	130% as urea	Nil	130% Ur
4	70% as urea	30% surface dribble banded UAN	100% Split
5	100% as urea	30% surface dribble banded UAN	130% Split
6	100% as SUPERU®	Nil	100% DUAL
7	100% as ESN® (75% ESN/25% urea)	Nil	100% ESN

^Z The 100% N rate is based on target of 150 kg total N/ha (soil plus fertilizer) while all other proportions are based on the applied fertilizer rate as opposed to the total amount of N

^Y Top-dressed N is applied between Zadoks 13-32 with 13-15 being optimal

Pertinent agronomic information and dates of operations/data collection activities are presented in Table 13 of the Appendices. All locations used a target seeding rate of 375 seeds/m² and the same variety, CDC Adamant VB, selected for its relatively poor lodging resistance to increase the potential for responses to PGR. Except for N fertility and the PGR applications, the plots were managed using current recommended practices with all controllable factors other than those being evaluated intended to be non-limiting. All plots were directed seeded into canola stubble; however, plot size varied to accommodate the seeding and spraying equipment at each site. Phosphorus, potassium, and sulfur fertility were intended to be non-limiting and held constant across treatments. Weeds were controlled using registered pre-emergent and in-crop herbicides with a preventative fungicide applied at heading, regardless of disease pressure, to reduce the likelihood of weeds or disease being yield or quality limiting factors. Preharvest herbicides were used at the discretion of individual site managers, and the plots were straight combined after they were matured and sufficiently dried. Where possible, the outside rows of each plot were excluded from the harvest area to reduce potential edge effects on yield and quality.

Various data were collected during the growing season and from the harvested grain samples. While fall, whole site composite soil samples were permitted for calculating N rates, the specific trial areas were re-sampled in the spring and submitted to AGVISE Laboratories (Northwood, ND, USA) for analyses. Plant densities were estimated by recording the number of plants in 2 x 1m sections of crop row per plot after emergence was complete and converting the averaged values to plants/m². After the plants had finished elongating, the average total plant height for each plot was determined by recording length from the soil surface to the tip of the main stem spike (excluding awns) for eight plants per plot. After physiological maturity, lodging was rated on a scale of 1-9 for each plot, where a score of 1 indicated no lodging and a score of 9 indicated that the entire plot was essentially flat. Grain yields were determined by weighing the harvested grain samples, correcting for dockage and to a uniform moisture content of 14.5%, and converting the weights to kg/ha. Test weights are expressed as g/0.5 L and were determined using cleaned grain sub-samples, standard CGC equipment and methods, and two measurements per plot. Grain protein using NIR analyzers and a minimum of two measurements per plot; however, the specific instrument used to complete this measurement varied by site.

Response data were analysed using the generalized linear mixed model (GLIMMIX) procedure of SAS® Studio with, unless otherwise indicated, the effects of site (S), PGR, N treatment (NIT), and all possible interactions considered fixed. Replicate (REP) effects and PGR x REP (nested within site) were considered random. The exceptions were plant density where PGR effects were excluded from the model and lodging score which was only statistically analyzed for Indian Head. Heterogeneity amongst variance component estimates (by site) was tested for and permitted when significant, and doing so improved model convergence. Where justified by the overall tests of fixed effects, Fisher's protected LSD test was used to separate treatment means. All comparisons were contained within sites and the slicediff statement was used to help identify differences in responses when interactions with site were detected. All treatment effects and differences between means were considered significant at $P \leq 0.05$; however, meaningful trends or p-values ≤ 0.10 may also be acknowledged.

10. Results:

Soil test results for each location are presented in Table 2. The basic characteristics for each site were considered representative of each location. Indian Head had the highest pH (7.7), intermediate organic matter (5.3%), and, due to the high clay content, the highest CEC (47 meq). Melfort had a lower pH (6.1) and the highest organic matter (7.9%) but with a slightly lower CEC (42 meq) compared to Indian Head, potentially indicating a coarser soil texture. Scott had the lowest pH (5.3), organic matter (3.5%) and CEC (17 meq) of the three sites. All sites were reasonably low in residual soil N (20-48 kg NO₃-N/ha) which

was desirable for the purposes of this project; however, at Melfort the spring, trial specific amount of NO₃-N was 24 kg N/ha higher than what was estimated from the fall composite. This was within the range of variability that might be reasonably expected and was unlikely to have any negative impact on the project outcomes. At Indian Head, the spring, trial specific samples were within 5 kg NO₃-N/ha of what was estimated from the fall composites while, at Scott, the N rates were based on a spring composite.

Table 2. Selected soil test results for the field trial areas at Indian Head (IH), Melfort (ME), and Scott (YK) in 2025. Unless otherwise indicated, all measurements are representative of the 0-15 cm soil profile.

Parameter	IH-25	ME-25	SC-25
pH	7.7	6.1	5.3
Organic Matter (%)	5.3	7.9	3.5
CEC (meq)	46.9	42.3	16.8
NO ₃ -N (kg/ha) ²	20	48	32
Olsen-P (ppm)	11	10	17
K (ppm)	724	401	218
kg S/ha (kg/ha) ²	36	78	177

² Values for residual NO₃-N and S are for the 0-60 cm soil profile

For each location, mean monthly temperatures and precipitation totals for the 2025 growing season (May-August) are presented relative to the long-term (1981-2010) averages in Tables 3 and 4. Temperature trends varied by location but, in general, May was warmer than average, June-July were cooler than average, and August was warmer than average. Over the four-month growing season, temperatures were approximately average at Indian Head (+0.1 °C) but warmer than average at Melfort and Scott (+0.4-0.8 °C); however, in absolute terms, Scott was the coolest location (15.2 °C versus 15.7-16.0 °C). Indian Head was the driest location with only 136 mm (56% of average) of May-August precipitation while Melfort and Scott received 209-236 mm, or 92-105% of average. The patterns differed with Indian Head receiving the most rain in May but less in June, July, and August. Melfort and Scott were dry in May and July, but wet in June and August. In general, the weather conditions were conducive to good crop establishment and reasonably high yield potential for all locations.

Table 3. Mean monthly temperatures along with long-term (LT; 1981-2010) averages for the 2025 growing season at Indian Head (IH), Melfort (ME), and Scott (SC), Saskatchewan.

Year	May	June	July	August	May-Aug
----- Mean Temperature (°C) -----					
IH-25	12.7	15.3	17.0	17.8	15.7 (+0.1)
IH-LT	10.8	15.8	18.2	17.4	15.6
ME-25	13.8	15.0	17.0	18.0	16.0 (+0.8)
ME-LT	10.7	15.9	17.5	16.8	15.2
SC-25	12.9	14.6	15.8	17.4	15.2 (+0.4)
SC-LT	10.8	14.8	17.3	16.3	14.8

Table 4. Total monthly precipitation amounts along with long-term (LT; 1981-2010) averages for the 2025 growing season at Indian Head (IH), Melfort (ME), and Scott (SC), Saskatchewan.

Year	May	June	July	August	May-Aug
----- Total Precipitation (mm) -----					
IH-25	42.6	39.4	27.1	26.9	136 (56%)
IH-LT	51.7	77.4	63.8	51.2	244
ME-25	4.8	93.2	25.9	113.5	237 (105%)
ME-LT	42.9	54.3	76.7	52.4	226
SC-25	11.8	103.7	28.7	64.5	209 (92%)
SC-LT	38.9	69.7	69.4	48.7	227

Results from the overall tests of fixed effects are presented in Table 5 which will be referred to throughout the discussion of results. The site (S) effect was significant for all response variables and these means, with corresponding statistics, are presented in Table 6. Due to unusual spatial variation in establishment that did not appear to be treatment related, data from one complete replicate at Indian Head was excluded from the statistical analyses for all response variables.

Table 5. Overall tests of fixed effects for selected CWRS wheat response variables in trials conducted in 2025 at Indian Head, Melfort, and Scott. Data were analyzed using the generalized linear mixed model (GLIMMIX) procedure of SAS® Studio with, in most cases, the effects of site (S), plant growth regulator (PGR), nitrogen (N) management (NIT), and all possible interactions considered fixed. Replicate effects (within site) were considered random. Heterogeneity of variance components was tested for and permitted when significant at $P \leq 0.05$.

Source	Plant Density	Plant Height	Lodging Score ^z	Seed Yield	Test Weight	Grain Protein
----- Pr > F (p-values) -----						
S	<0.001	<0.001	–	<0.001	<0.001	<0.001
PGR	–	<0.001	0.038	0.596	0.007	0.030
S x PGR	–	0.002	–	0.577	0.722	0.217
NIT	<0.001	0.759	0.021	<0.001	<0.001	<0.001
S x NIT	0.276	0.198	–	<0.001	<0.001	<0.001
PGR x NIT	–	0.589	0.400	0.229	0.530	0.836
S x PGR x NIT	–	0.436	–	0.274	0.429	0.398
Common Var.	0.002	0.087		<0.001	0.376	0.030

^z With no variation in lodging at Melfort or Scott, data from this variable was only statistically analyzed at Indian Head

Table 6. Overall site means for selected CWRS wheat response variables. Means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$) and values in parentheses are the standard error of the treatment mean (S.E.M.).

Site ^z	Plant Density	Plant Height	Seed Yield	Test Weight	Grain Protein
	--- plants/m ² ---	----- cm -----	---- kg/ha ----	---- g/0.5 L ----	----- % -----
IH-25	225 A (2.9)	74.2 A (0.68)	5531 A (70.0)	421.2 A (0.35)	13.38 B (0.069)
ME-25	161 C (12.2)	71.1 B (0.58)	5081 B (170.2)	408.1 B (0.30)	13.69 B (0.161)
SC-25	204 B (2.5)	65.2 C (0.58)	3841 C (26.7)	397.8 C (0.42)	15.68 A (0.048)

^z IH – Indian Head; ME – Melfort; SC - Scott

Wheat plant densities, or emergence, were affected by S ($P < 0.001$) and N treatment (NIT; $P < 0.001$), but there was no S x NIT interaction ($P = 0.276$; Table 5). While initial mortality was greater than

expected at all sites (40-57%), the S effect showed plant densities were highest at Indian Head (225 plants/m²), followed by Scott (204 plants/m²), and then Melfort (161 plants/m²; Table 6). The NIT effect showed that, on average, plant densities were highest when the N source was ESN (214 plants/m²) and lowest with the 130% rate of untreated urea (175 plants/m²; Table 7). Plant densities for the remaining treatments were more intermediate, and inspection of individual treatment means, along with the lack of an S x NIT interaction, confirms that this response was quite consistent across locations. The seed safety benefits of polymer coated ESN relative to untreated urea and/or SUPERU[®] are fairly well established (i.e., Malhi et al. 2003; Malhi and Lemke 2013); These results suggest that, even with side-banding, ammonium toxicity can have a slight but significant negative impact on crop emergence, even with relatively insensitive crops such as CWRS wheat. The PGR effects, and their corresponding interactions, were not included in the model because these measurements were completed before PGR was applied and there was reason to expect this treatment to affect crop establishment.

Table 7. Nitrogen (N) management treatment (NIT) effects on CWRS wheat emergence for individual sites (S) and across sites in 2025. With no significant S x NIT effects, these means are presented solely for interest and transparency. Means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	Indian Head	Melfort	Scott	Average
----- Plant Density (plants/m ²) -----				
NIT				
70% Ur	238	161	207	202 B
100% Ur	230	146	202	193 B
130% Ur	209	134	181	175 C
100% Split	220	178	213	204 AB
130% Split	214	164	206	195 B
100% DUAL	220	160	197	193 B
100% ESN	244	181	218	214 A
S.E.M.	7.6	13.7	6.6	5.7
----- Pr > F (p-value) -----				
Effect Slice ^z	–	–	–	–

^z Effect slices are only presented when doing so is justified by a corresponding interaction with site

Spring wheat plant height was affected by S ($P < 0.001$) and PGR ($P < 0.001$), with a significant S x PGR interaction ($P = 0.002$), but not NIT nor any of the interactions associated with it ($P = 0.198-0.759$; Table 5). The site effects showed that, on average, the wheat was tallest at Indian Head (74 cm), intermediate at Melfort (71 cm), and shortest at Scott (65 cm; Table 6). The taller plants at Indian Head were attributed to this site being wetter earlier in the season and generally good growing conditions, despite being the driest site overall. The PGR effects were such that plant height was reduced by 10 mm (14%) when averaged across sites (Table 8). Individually, the reductions were 7-8 cm (10-11%) at Indian Head and Scott versus 16 mm (20%) at Melfort. The S x PGR interaction was due to the more prominent height reduction at Melfort where values were similar at Indian Head and Melfort in the absence of PGR (78-79 cm), but shorter at Melfort versus Indian Head when the PGR was applied (63 cm versus 70 cm). The reason for this difference was unclear but may have been due to Melfort being wetter during and after the PGR treatments compared to Indian Head. Even though plant heights often increase with N fertilizer, they usually level off at relatively low N rates. This project did not include an absolute control treatment where no N was applied; therefore, the lack of any NIT effects was not unexpected. Again, heights were similar across N treatments when averaged across sites (70-71 cm) and any discrepancies amongst individual sites were not consistent or large enough to be statistically significant ($P = 0.198$); however, we do see a trend for heights to increase with the rate of side-banded urea at Melfort and this

effect was, in fact, significant when data from Melfort was analyzed alone ($P = 0.027$; not shown). With neither the PGR x NIT nor S x PGR x NIT effects being significant ($P = 0.436-0.589$), these results will not be discussed in detail; however, individual treatment means for height are in the Appendices (Table 14).

Table 8. Plant growth regulator (PGR) and nitrogen (N) management treatment (NIT) effects on CWRS wheat plant height for individual sites (S) and across sites in 2025. With no significant NIT nor S x NIT effects, these means are presented solely for interest and transparency. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	Indian Head	Melfort	Scott	Average
<u>PGR</u> ----- Plant Height (cm) -----				
UTC	78.1 a	78.9 a	68.9 a	75.3 A
TRT	70.3 b	63.4 b	61.5 b	65.1 B
S.E.M	0.96	0.83	0.83	0.50
----- Pr > F (p-value) -----				
Effect Slice ^z	<0.001	<0.001	<0.001	–
<u>NIT</u> ----- Plant Height (cm) -----				
70% Ur	74.5	69.4	66.4	70.1
100% Ur	74.0	71.8	64.7	70.2
130% Ur	74.0	73.5	65.4	71.0
100% Split	74.4	71.0	65.6	70.3
130% Split	73.3	71.6	65.0	69.9
100% DUAL	75.1	70.4	64.7	70.0
100% ESN	74.2	70.3	64.9	69.8
S.E.M.	1.12	0.97	0.97	0.59
----- Pr > F (p-value) -----				
Effect Slice ^z	–	–	–	–

^z Effect slices are only presented when doing so is justified by a corresponding interaction with site

While specific efforts were always made to complete lodging ratings, the pressure was low at all sites and both Melfort and Scott reported no variation and the minimum score (1.0) for all plots. As such data from these locations was not statistically analyzed. At Indian Head, values were also low, averaging less than 1.5; however, statistically significant effects of both PGR ($P = 0.038$) and NIT ($P = 0.021$) were detected with no interaction between these factors ($P = 0.400$; Table 5). The main effect means (Table 9) showed lodging score reductions from 1.4 to 1.1 (out of 9) with PGR and the highest values (1.5/9) when the 130% N rate was side-banded urea. Numerically, the score was slightly less when the 130% N was provided in a split application (1.3/9) but the difference was not significant and, in practical terms, lodging was too low to be of any concern for all treatments. Individual treatment means are provided in Table 15 and, even with the highest N rate as side-banded urea and no PGR, the average lodging score was only 1.7/9.

Table 9. Plant growth regulator (PGR) and nitrogen (N) management treatment (NIT) effects on CWRS lodging for individual sites in 2025. With no variation in lodging reported at Melfort and Scott, data from these locations were not statistically analysed. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	Indian Head	Melfort	Scott
----- Lodging Score (1-9) -----			
<u>PGR</u>			
UTC	1.43 a	1.0	1.0
TRT	1.14 b	1.0	1.0
S.E.M	0.077	–	–
----- Lodging Score (1-9) -----			
<u>NIT</u>			
70% Ur	1.17 c	1.0	1.0
100% Ur	1.17 c	1.0	1.0
130% Ur	1.50 a	1.0	1.0
100% Split	1.25 bc	1.0	1.0
130% Split	1.33 abc	1.0	1.0
100% DUAL	1.42 ab	1.0	1.0
100% ESN	1.17 c	1.0	1.0
S.E.M.	0.100	–	–

^z Effect slices are only presented when doing so is justified by a corresponding interaction with site

The site effects for grain yield were such that values were highest at Indian Head (5531 kg/ha), slightly less at Melfort (5081 kg/ha), and lowest at Scott (3841 kg/ha; Table 6). Beyond this, we saw significant NIT ($P < 0.001$) and S x NIT ($P < 0.001$) effects, but no response to PGR ($P = 0.596$) nor any of the interactions that included it ($P = 0.229-0.577$). The S x NIT response justifies looking at each location individually (Table 10). At Indian Head, we saw the lowest yields when only the 70% N was applied but statistically similar yields (5524-5673 kg/ha) when 100-130% N rates were provided as side-banded urea. With dry conditions later in the season, yields at Indian Head trended lower with the split applications versus side-banded urea, but were never significantly less at the corresponding N rates. Both SuperU[®] (DUAL) and 75% ESN trended better but never significantly increased yields over side-banded urea at an equivalent rate; however, both EEF products produced a significant yield advantage over the equivalent split application. The overall yield response to N rate was strong at Melfort, with means incrementally increasing right to the 130% rate. With a dry start but wetter late season weather, the split applications at Melfort performed equally well, but not better than either side-banded urea or the EEF products at equivalent rates. At Scott, the NIT effects were only marginally significant ($P = 0.087$) but showed a trend for the highest yields with ESN and the lowest yields when the 130% N rate was entirely side-banded urea. At the 100% N rate, yields were mostly similar except for, somewhat unexpectedly, ESN producing higher yields than the dual inhibitor. Despite these environmental effects, when averaged across sites we see a strong overall N response and that side-banded urea at the 100% N rate (4832 kg/ha) produced statistically similar yields to all other treatments where the equivalent rate was applied (4750-4949 kg/ha). Of these treatments, the highest yields occurred with polymer coated ESN (4949 kg/ha) and the lowest were with the split application. Focusing on PGR, the lack of any significant effects was not necessarily unexpected given the lack of lodging at all sites and, at least periodically, dry conditions. Individual treatment means for individual sites and across sites appear in the Appendices (Table 16) but, with no PGR x NIT or S x PGR x NIT effects ($P = 0.229-0.274$), will not be discussed further.

Table 10. Plant growth regulator (PGR) and nitrogen (N) management treatment (NIT) effects on CWRS wheat grain yield for individual sites (S) and across sites in 2025. With no significant PGR nor S x PGR effects, these means are presented solely for interest and transparency. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	Indian Head	Melfort	Scott	Average
<u>PGR</u> ----- Grain Yield (kg/ha) -----				
UTC	5500	5030	3852	4794
TRT	5563	5131	3831	4842
S.E.M	76.6	209.7	37.8	75.5
----- Pr > F (p-value) -----				
Effect Slice ^z	–	–	–	–
<u>NIT</u> ----- Grain Yield (kg/ha) -----				
70% Ur	5190 d	4643 d	3920 ab	4584 C
100% Ur	5524 abc	5108 bc	3866 abc	4832 AB
130% Ur	5673 ab	5322 a	3704 c	4900 A
100% Split	5424 c	4986 c	3840 abc	4750 B
130% Split	5499 bc	5302 ab	3769 bc	4856 AB
100% DUAL	5738 a	5027 c	3794 bc	4853 AB
100% ESN	5673 ab	5177 abc	3997 a	4949 A
S.E.M.	103.1	182.4	70.8	73.7
----- Pr > F (p-value) -----				
Effect Slice ^z	<0.001	<0.001	0.087	–

^z Effect slices are only presented when doing so is justified by a corresponding interaction with site

^y Effect slice not quite significant at $P \leq 0.05$, interpret individual treatment differences at this site cautiously

The site effects for test weight (Table 6) exhibited the same trends as for yield with the highest values at Indian Head (421 g/0.5 L), intermediate at Melfort (408 g/0.5 L), and lowest at Scott (398 g/0.5 L). Additionally, we found significant PGR ($P = 0.007$) and NIT ($P < 0.001$) effects with an S x NIT interaction ($P < 0.001$) also detected (Table 5). Application of a PGR slightly but significantly reduced test weights from 409.6 g/0.5 L to 408.5 g/0.5 L (Table 11) and the lack of an S x PGR interaction showed this response to be consistent across locations. As indicated by the S x NIT interaction, NIT effects on test weight varied. At Indian Head, the response was only marginally significant, showing a tendency for test weight to decline with increasing rates of side-banded urea but the highest values with the EEF products. A similar, but more pronounced negative response to increasing side-banded urea rate occurred at Scott, where test weight fell from 400.3 g/0.5 L at the 70% N rate to 394.8 g/0.5 L at 130%. Splitting the N application lessened the impact slightly, particularly at the 130% rate. Like what was observed for yield at Scott, the highest test weights at the 100% N rate occurred with ESN. At Melfort, the response differed with the lowest test weights observed at the 70% N rate (406.8 g/1000 seeds), intermediate values with the 100% split application (407.8 g/0.5 L), and all other treatments resulting in similarly high values (408.0-408.8 g/1000 seeds). Individual treatment means for test weight are provided in Table 17 (Appendices), but with no significant PGR x NIT nor S x PGR x NIT interactions, will not be discussed in detail.

Table 11. Plant growth regulator (PGR) and nitrogen (N) management treatment (NIT) effects on CWRS wheat test weight for individual sites (S) and across sites in 2025. With no significant S x PGR effects, these means are presented solely for interest and transparency. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	Indian Head	Melfort	Scott	Average
<u>PGR</u> ----- Test Weight (g/0.5 L) -----				
UTC	421.7	408.8	398.2	409.6 A
TRT	420.7	407.4	397.3	408.5 B
S.E.M	0.45	0.39	0.39	0.24
----- Pr > F (p-value) -----				
Effect Slice ^z	–	–	–	–
<u>NIT</u> ----- Test Weight (g/0.5 L) -----				
70% Ur	421.6 ab	406.8 b	400.3 a	409.6 B
100% Ur	420.9 ab	408.0 a	397.8 bc	408.9 CD
130% Ur	420.6 b	408.2 a	394.8 e	407.9 E
100% Split	420.8 ab	407.8 ab	398.1 b	408.9 CBD
130% Split	420.4 b	408.7 a	396.2 d	408.4 DE
100% DUAL	421.9 a	408.5 a	397.0 cd	409.1 BC
100% ESN	422.0 a	408.8 a	400.2 a	410.3 A
S.E.M.	0.55	0.47	0.47	0.29
----- Pr > F (p-value) -----				
Effect Slice ^z	0.066 ^y	0.008	<0.001	–

^z Effect slices are only presented when doing so is justified by a corresponding interaction with site

^y Effect slice not quite significant at $P \leq 0.05$, interpret individual treatment differences at this site cautiously

Because each site used a different instrument for determining protein, differences amongst them should be interpreted cautiously; however, the S effect showed that protein was inversely related to yield with Indian Head and Melfort having the lowest values (13.4-13.7%) but considerably higher protein at Scott (15.7%; Table 6). Protein was also affected by PGR ($P = 0.030$) and NIT ($P < 0.001$) with a significant S x NIT interaction ($P < 0.001$). The PGR effect revealed a slight protein reduction with PGR (14.1%) relative to the UTC (14.4%), which was consistent with the (non-significant) trends observed for yield. Consistent with the yield trends, we see the largest response at Melfort (from 14.1% in UTC to 13.3% with PGR); however, with similar trends for all sites, the S x PGR interaction was not significant ($P = 0.217$). Looking at N treatment effects, the responses at Indian Head and Melfort were identical and purely driven by N rate as opposed to application time/placement or N form. At these locations, we see the lowest values when the total N rate was 70% (11.6-12.2%), intermediate values for all treatments that received a total N rate of 100% (13.2-13.7%), and the highest values at the 130% N rate (14.4-14.7%). At Scott, overall values were higher, but we did not see further increases going from 100% to 130% N rates and, with the 100% rate, protein values were comparable to where the 70% was provided as side-banded urea but no further N was top-dressed. When averaged across locations, protein ranged from 13.0-15.0% with identical patterns to what was discussed for Indian Head and Melfort, whereby differences in grain protein were driven purely by rate and there was no advantage to either the split applications or EEF N formulations.

Table 12. Plant growth regulator (PGR) and nitrogen (N) management treatment (NIT) effects on CWRS wheat grain protein for individual sites (S) and across sites in 2025. With no significant S x PGR effects, these means are presented solely for interest and transparency. Main effect means within a column followed by the same letter do not significantly differ (Fisher's Protected LSD test; $P \leq 0.05$); however, letter groupings are only provided when justified by the overall tests of fixed effects.

Main Effect	Indian Head	Melfort	Scott	Average
----- Grain Protein (%) -----				
PGR				
UTC	13.41	14.05	15.76	14.41 A
TRT	13.35	13.34	15.60	14.10 B
S.E.M	0.089	0.228	0.068	0.085
----- Pr > F (p-value) -----				
Effect Slice ^z	–	–	–	–
----- Grain Protein (%) -----				
NIT				
70% Ur	11.59 c	12.15 c	15.21 b	12.98 C
100% Ur	13.32 b	13.65 b	15.71 a	14.23 B
130% Ur	14.46 a	14.65 a	16.00 a	15.04 A
100% Split	13.30 b	13.64 b	15.34 b	14.09 B
130% Split	14.43 a	14.44 a	15.79 a	14.88 A
100% DUAL	13.38 b	13.64 b	15.91 a	14.31 B
100% ESN	13.22 b	13.68 b	15.81 a	14.23 B
S.E.M.	0.153	0.199	0.127	0.094
----- Pr > F (p-value) -----				
Effect Slice ^z	<0.001	<0.001	<0.001	–

^z Effect slices are only presented when doing so is justified by a corresponding interaction with site

Extension Activities

This project was a scheduled stop during the Indian Head Crop Management Field Day, held on July 15, 2025 (157 attendees) where Chris Holzapfel explained the project and objectives in addition to discussing results highlights from past relevant projects. On July 16, 2025, the project was shown to a group of global BASF scientists and agronomists (26 attendees). On August 5, 2025, a small group of agronomists, farmer directors, and staff from SaskWheat (9 attendees) visited the site to discuss project objectives and details along with more general research needs and small plot site management. At Melfort, the project was signed and acknowledged during the NARF & AAFC Joint Annual Field Day on July 24th, 2025 (126 attendees). Chris Holzapfel presented highlights from the project at the AGVISE Soil Fertility Seminars at Portage la Prairie (March 3, approximately 150 attendees) and Saskatoon (March 5, approximately 75 attendees). This technical report will be freely available online and we will continue to share the results through oral presentations and extension materials, as opportunities arise.

Recommendations, Acknowledgements, and Appendices:

11. Conclusions and Recommendations

Overall, this project has demonstrated consistent height reductions with plant growth regulator (PGR) applications but, with essentially no lodging, impacts on yield were negligible. Despite the yield response to PGR not being statistically significant, we saw a significant, albeit small, protein reduction with this practice. Under the conditions encountered, the effect of the different N management strategies on crop lodging was negligible; however N management did affect grain yield and quality. For the most part, N rate was more important than the formulation or application method; however, split applications tended to perform poorer at Indian Head where it went from wet to dry and we saw a trend

for lower yields with split applications but no protein advantage. At Melfort, where late-season moisture was coupled with high yield potential, split applications performed well but were not advantageous over side-banding the entire N requirements as urea for either yield or protein. At Scott, yields were less responsive to N, but protein tended to be higher with side-banded urea versus split applications. Polymer coated ESN appeared to perform particularly well at Scott producing amongst the highest yields while maintaining protein. It may be that using this N formulation reduced any potential ammonium toxicity or other negative effects of high N rates under the extremely dry conditions early on while ensuring adequate N supply later, when moisture conditions improved. There were no specific interactions detected to suggest that optimum N management differed depending on whether a PGR was applied, despite the small observed protein reduction with PGR. Evaluating these treatments under wetter conditions with more lodging and stronger responses to PGR may provide additional insights; however, because protein was largely driven by N rate and the responses were independent of PGR, our best advise is to ensure that N rates are sufficient to support the higher yield potential that may be achieved with PGR while maintaining protein concentrations and meeting the requirements for high quality CWRS wheat. Utilizing EEF N forms may help to achieve this but are less likely to provide agronomic benefits over untreated urea with side-band placement as opposed to fall or surface applications that leave the applied N more vulnerable to environmental losses. This project will be repeated at four locations in 2026, after which time our results and conclusions will be updated accordingly.

12. Acknowledgements:

Financial support for this work was provided by the Saskatchewan Wheat Development Commission (SaskWheat). Many of the inputs and crop protection products utilized in the field trials, including some of those which were evaluated, were provided as in-kind industry donations. We would also like to recognize the Board of Directors from each of the participating organizations in addition to the many technical and professional staff, without whom this project could not have been completed. IHARF, NARF, and WARC have strong working relationships and memorandums of understanding with Agriculture and Agri-Food Canada which should be acknowledged. Additionally, these organizations have received substantial funding for infrastructure and basic operating expenses from the Saskatchewan Ministry of Agriculture and several other producer/commodity groups, all of which has helped to make work like this possible.

13. Appendices:*Literature Cited*

Fast, A., Strydhorst, S., Wang, Z., Hernandez-Ramirez, G., Hao, X., Semach, G., Thompson, L, Holzapfel, C., Enns, J., Spaner, D., and Beres, B. 2024. Integrating enhanced efficiency fertilizers and nitrogen rates to improve Canada Western Red Spring Wheat. *Can. J. Plant Sci.* **104**: 144-160.

Hall, M., Holzapfel, C., Pratchler, J., Shaw, L., Hnatowich, G., Weber, J., and Nybo, B. 2018. Increasing wheat protein with a post-emergent application of urea ammonium nitrate. ADOPT Final Project Report. Online [Available]: <https://iharf.ca/document/increasing-wheat-protein-with-a-post-emergent-application-of-uan/> (February 24, 2026).

Hall, M., Sorestad, H., Holzapfel, C., Hnatowich, G., Singh, G., McInnes, B., Enns, J., Nybo, B., and Wall, A. 2022. Managing drought risk with split applications of nitrogen in spring wheat. ADOPT Final Project Report. Online [Available]: <https://iharf.ca/document/managing-drought-risk-with-split-applications-of-nitrogen-in-spring-wheat/> (February 24, 2026).

Holzapfel, 2015. Optimal nitrogen rates for wheat with and without plant growth regulators. ADOPT Report. Online [Available]: <https://iharf.ca/document/nitrogen-rates-for-wheat-with-and-without-plant-growth-regulators/> (February 24, 2026).

Holzapfel, C. B., Lafond, G. P., Brandt, S. A., May, W. E., and Johnston, A. M. 2007. In-soil versus post-seeding liquid nitrogen applications in no-till spring wheat and canola. *Can. J. Plant Sci.* **87**: 223-232.

Holzapfel, C. 2020. Input contributions to spring wheat yield, quality, and profits. ADOPT Report. Online [Available]: <https://iharf.ca/document/input-contributions-to-spring-wheat-yield-quality-and-profits/> (February 24, 2026).

Lafond, G. P., Brandt, S. A., Irvine, B., May, W. E., and Holzapfel, C. B. 2008. Reducing the risks of in-crop nitrogen fertilizer applications in spring wheat and canola. *Can. J. Plant Sci.* **88**: 907-919.

Malhi, S., Oliver, E., Mayerle, G., Kruger, G., and Gill, K. 2003. Improving effectiveness of seedrow-placed urea with urease inhibitors and polymer coating for durum wheat and canola. *Commun. Soil Plant Anal.* **34**: 1709-1727.

Malhi, S. S. and Lemke, R. L. 2013. Effectiveness of seedrow-placed N with polymer-coated and nbpt-treated urea for canola and wheat. *J. Plant Nutr.* **36**: 2205-2224.

McInnes, B., Holzapfel, C., Slind, K., Lokken, R., Singh, G., and Hall, M. 2024. Standing up with your own stalk: Do the plant growth regulators available for spring wheat improve the productivity of spring wheat improve the productivity of current CWRS varieties. ADOPT/SaskWheat Report. Online [Available]: <https://iharf.ca/document/do-the-plant-growth-regulators-available-for-spring-wheat-improve-the-productivity-of-current-cwrs-varieties/> (February 24, 2026).

Simmonds, N. W. 1995. The relationship between yield and protein in cereal grain. *J. Sci. Food Agric.* **67**: 309-315.

Thompson, L. A., Strydhorst, S. M., Hall, L. M., Yang, R. C., Pauly, D., Gill, K. S., and Bowness, R. 2018. Effect of cultivar and agronomic management on feed barley production in Alberta environments. *Can. J. Plant Sci.* **98**: 1304-1320.

Supplemental Tables

Table 13. Pertinent agronomic information for 2025 wheat plant growth regulator (PGR) by nitrogen (N) management demonstrations conducted at Indian Head, Melfort, and Scott, Saskatchewan in 2025.

Operation / Activity	Indian Head	Melfort	Scott
Previous Crop	Canola	Canola	Canola
100% Fertility ^z (kg N-P ₂ O ₅ -K ₂ O-S/ha)	135-40-10-10	126-56-22-6	117-19-10-5
Seeding Date	May-9-2025	May 16	May-9-2025
Plant Density	Jun-4-2025	Jun-3-2025	May-28-2025
In-Crop N Date	Jun-6-2025	Jun-12-2025	Jun-10-2025
PGR Application	Jun-20-2025	Jul-1-2025	Jun-20-2025
Height Measurements	Jul-31-2025	Aug-5-2025	Aug-7-2025
Fungicide Date	Jul-9-2025	Jul-11-2025	Jul-5-2025
Lodging Ratings	Aug-18-2025	Sep-22-2025	Aug-18-2025
Pre-harvest Herbicide	Aug-24-2025 (glyphosate)	Sep-8-2025 (glyphosate)	Sep-8-2205 (glyph. + saflufenacil)
Harvest Date	Aug-31-2025	Sep-22-2025	Sep-20-2025

^z Phosphorus, potassium, and sulfur fertility was not varied across treatments

Table 14. Plant growth regulator (PGR) by nitrogen (N) management treatment (NIT) effects on CWRS wheat grain yield for individual sites (S) and across sites in 2025. With no significant PGR x NIT or S x PGR x NIT effects, these means are presented solely for interest and transparency. Letter groupings are only provided when justified by the overall tests of fixed effects.

PGR	NIT	Indian Head	Melfort	Scott	Average
----- Plant Height (cm) -----					
UTC	70% Ur	78.5	77.9	70.3	75.6
	100% Ur	77.3	78.3	68.3	74.6
	130% Ur	78.1	80.3	69.2	75.9
	100% Split	80.2	79.4	68.5	76.0
	130% Split	75.7	79.4	68.7	74.6
	100% DUAL	79.2	77.4	69.0	75.2
	100% ESN	77.8	79.4	68.6	75.3
PGR	70% Ur	70.5	60.9	62.5	64.6
	100% Ur	70.6	65.4	61.2	65.7
	130% Ur	69.9	66.7	61.6	66.0
	100% Split	68.5	62.6	62.8	64.6
	130% Split	70.8	63.8	61.2	65.2
	100% DUAL	71.0	63.4	60.4	64.9
	100% ESN	70.5	61.3	61.2	64.3
S.E.M		1.58	1.37	1.37	0.83
----- Pr > F (p-value) -----					
Effect Slice ^z		—	—	—	—

^z Effect slices are only presented when doing so is justified by a corresponding interaction with site

Table 15. Plant growth regulator (PGR) by nitrogen (N) management treatment (NIT) effects on CWRS wheat lodging for individual sites (S) in 2025. With no variation in lodging reported at Melfort and Scott, data from these locations were not statistically analysed. With no significant PGR x NIT effects, these means are presented solely for interest and transparency. Letter groupings are only provided when justified by the overall tests of fixed effects.

PGR	NIT	Indian Head	Melfort	Scott
----- Lodging Score (1-9) -----				
UTC	70% Ur	1.3	1.0	1.0
	100% Ur	1.2	1.0	1.0
	130% Ur	1.7	1.0	1.0
	100% Split	1.5	1.0	1.0
	130% Split	1.5	1.0	1.0
	100% DUAL	1.5	1.0	1.0
	100% ESN	1.3	1.0	1.0
PGR	70% Ur	1.0	1.0	1.0
	100% Ur	1.2	1.0	1.0
	130% Ur	1.3	1.0	1.0
	100% Split	1.0	1.0	1.0
	130% Split	1.2	1.0	1.0
	100% DUAL	1.3	1.0	1.0
	100% ESN	1.0	1.0	1.0
S.E.M		0.13	–	–

Table 16. Plant growth regulator (PGR) by nitrogen (N) management treatment (NIT) effects on CWRS wheat grain yield for individual sites (S) and across sites in 2025. With no significant PGR x NIT or S x PGR x NIT effects, these means are presented solely for interest and transparency. Letter groupings are only provided when justified by the overall tests of fixed effects.

PGR	NIT	Indian Head	Melfort	Scott	Average
----- Grain Yield (kg/ha) -----					
UTC	70% Ur	5111	4736	3927	4591
	100% Ur	5423	4886	3887	4732
	130% Ur	5673	5277	3675	4875
	100% Split	5552	5042	3848	4814
	130% Split	5522	5148	3786	4819
	100% DUAL	5612	5039	3837	4829
	100% ESN	5605	5086	4003	4898
PGR	70% Ur	5269	4549	3914	4577
	100% Ur	5624	5330	3844	4933
	130% Ur	5673	5366	3733	4924
	100% Split	5296	4931	3833	4687
	130% Split	5475	5456	3751	4894
	100% DUAL	5863	5016	3751	4876
	100% ESN	5742	5268	3990	5000
S.E.M		131.5	229.2	100.1	94.2
----- Pr > F (p-value) -----					
Effect Slice ^z		–	–	–	–

^z Effect slices are only presented when doing so is justified by a corresponding interaction with site

Table 17. Plant growth regulator (PGR) by nitrogen (N) management treatment (NIT) effects on CWRS wheat test weight for individual sites (S) and across sites in 2025. With no significant PGR x NIT or S x PGR x NIT effects, these means are presented solely for interest and transparency. Letter groupings are only provided when justified by the overall tests of fixed effects.

PGR	NIT	Indian Head	Melfort	Scott	Average
----- Test Weight (g/0.5 L) -----					
UTC	70% Ur	422.0	408.0	400.5	410.2
	100% Ur	421.3	408.2	397.6	409.0
	130% Ur	421.6	409.2	395.1	408.6
	100% Split	421.0	408.6	399.1	409.5
	130% Split	420.7	408.8	397.0	408.8
	100% DUAL	422.5	409.3	398.0	409.9
	100% ESN	422.5	409.7	400.2	410.8
PGR	70% Ur	421.3	405.6	400.1	409.0
	100% Ur	420.4	407.8	397.9	408.7
	130% Ur	419.6	407.1	394.6	407.1
	100% Split	420.6	407.0	397.2	408.3
	130% Split	420.1	408.7	395.3	408.0
	100% DUAL	421.3	407.7	396.0	408.3
	100% ESN	421.4	408.0	400.3	409.9
S.E.M		0.75	0.65	0.65	0.39
----- Pr > F (p-value) -----					
Effect Slice ^z		–	–	–	–

^z Effect slices are only presented when doing so is justified by a corresponding interaction with site

Table 18. Plant growth regulator (PGR) by nitrogen (N) management treatment (NIT) effects on CWRS wheat grain protein for individual sites (S) and across sites in 2025. With no significant PGR x NIT or S x PGR x NIT effects, these means are presented solely for interest and transparency. Letter groupings are only provided when justified by the overall tests of fixed effects.

PGR	NIT	Indian Head	Melfort	Scott	Average
----- Grain Protein (%) -----					
UTC	70% Ur	11.83	12.48	15.33	13.21
	100% Ur	13.27	13.83	15.83	14.31
	130% Ur	14.55	15.10	16.08	15.24
	100% Split	13.03	14.18	15.40	14.20
	130% Split	14.45	14.80	15.90	15.05
	100% DUAL	13.45	14.03	15.83	14.43
	100% ESN	13.31	13.93	16.00	14.41
PGR	70% Ur	11.35	11.83	15.10	12.76
	100% Ur	13.36	13.48	15.60	14.15
	130% Ur	14.38	14.20	15.93	14.83
	100% Split	13.57	13.10	15.28	13.98
	130% Split	14.40	14.08	15.68	14.72
	100% DUAL	13.30	13.25	16.00	14.18
	100% ESN	13.12	13.43	15.63	14.06
S.E.M		0.212	0.283	0.180	0.132
----- Pr > F (p-value) -----					
Effect Slice ^z		–	–	–	–

^z Effect slices are only presented when doing so is justified by a corresponding interaction with site

14. Abstract:

Field trials were conducted at three Saskatchewan locations in 2025 to explore how plant growth regulators (PGR) and intensive nitrogen (N) management may be combined to manage lodging while optimizing yield and grain protein in wheat. The locations were Indian Head, Melfort, and Scott, focusing on the Dark Brown and Black soil zones where the potential for lodging and overall yield potential is generally highest. The treatments were a factorial combination of two PGR treatments (untreated versus treated) and seven N management treatments. The N treatments were three rates of side-banded urea (70, 100, and 130% of a baseline rate of 150 kg total N/ha), split applications where 70% or 100% was side-banded urea and 30% was in-crop dribble-banded urea ammonium-nitrate (UAN), and two treatments where 100% rates of enhanced efficiency fertilizer (EEF) N products were side-banded. While PGR consistently reduced height, lodging was always negligible. Although yields were not significantly affected, PGR did slightly reduce test weight and protein. The yield responses to N treatment varied with both Indian Head and Melfort responding well to increasing rates but split applications of N performing slightly better at Melfort than Indian Head due to the former location being initially dry but turning wet while the opposite occurred at the latter. At Scott, which was initially dry but became wet, there was a negative response to high rates of side-banded urea, but polymer coated ESN performed well. Protein responses to N treatment were primarily related to N rate and no protein advantages to either split applications or EEF N products were detected. With the lower N rate at Scott, there was a negative protein response to split N versus side-banded urea at seeding. Yield and quality responses to N management were always independent of PGR treatment and protein differences were primarily driven by N rate. While results may differ under wetter conditions where PGR are more beneficial, our current recommendation is simply to ensure that N rates are sufficient to support the higher yields that may be achieved with PGR while achieving protein targets and recognizing that higher N rates may also increase the potential benefits to PGR under some conditions.

15. Finances:

Detailed expenditure statements are provided in a separate document and are available upon request.