Project Identification

1. **Project Title:** On-Farm Applied Granular Herbicide products for the control of wild oats and kochia after oats
2. **Producer Group Sponsoring the Project:** Saskatchewan Oat Development Commission
3. **Project Location:** RM of Birch Hills (no. 460)
4. **Project start and end dates:** September 2024 to December 2025
5. **Project Contact Person & Contact Details:**

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6. Objectives and Rationale:

Project Objectives: The first objective of this demonstration was to evaluate the efficacy of Edge® and Fortress® Microactiv herbicides on wild oat and kochia populations when applied to oat crop residue. The second objective was to demonstrate whether a light (45° tine angle) or heavy (70 to 90° tine angle) harrow would affect herbicide efficacy.

Project Rationale:

Herbicide resistance of tough to control weeds, such as kochia and wild oats is an ongoing problem on the Canadian Prairies. Herbicide resistance surveys conducted over the last two decades on the Prairies continue to demonstrate the increasing prevalence of herbicide-resistant weeds (Beckie et al. 2006, 2017; Geddes et al. 2020; Sharpe et al. 2023). In a 2003 survey of Saskatchewan fields, 10% of fields with wild oats had group 1 resistance and 4% had group 2 resistance (Beckie at al. 2006). Several weed-resistant surveys have been conducted since then; however, in a more recent survey completed in 2019 and 2020, 77% of fields with wild oats demonstrated group 1 herbicide resistance, while 30% of fields demonstrated group 2 herbicide resistance in Saskatchewan (Geddes et al. 2020). This survey marked a significant increase in group 1 and 2 wild oat resistance since the early 2000's. As for Kochia, it is known to have resistance to multiple groups of herbicides, including widespread group 2 and glyphosate resistance. A randomized survey conducted in 2019 by Agriculture and Agri-Foods Canada in southern and central Saskatchewan found glyphosate resistance in 87% of Kochia samples, while back in 2013, only 5% of randomly selected fields demonstrated glyphosate resistance (Beckie et al. 2015; Sharpe et al. 2023). With increasing incidence of herbicide resistance, utilization of different herbicide groups for control of resistant types is essential to ensure farmers don't lose crop yield to weed pressure. Herbicide resistant weeds cost farmers a significant loss in income every year, at an estimated $340 million in Saskatchewan alone (Geddes et al. 2020).

Herbicide layering techniques along with alternating herbicide modes of action can be used to slow down the development of herbicide resistant weeds (Top Crop Manager 2022). Pre-emergent soil-applied herbicides, such as Fortress®Microactiv and Edge®Microactiv allow different herbicide modes of action to be utilized to minimize the risk of developing herbicide resistant weeds. Fortress®Microactiv is a group 3 and 15 granular herbicide that contains 10% triallate and 4% trifluralin. Edge®Microactiv is a group 3 granular herbicide that contains 10% ethalfluralin. Both herbicides are taken up through the soil, and provide residual control of emerging weeds, such as wild oats and kochia. Incorporation after application is ideal, however, in no-till continuous cropping areas, such as Saskatchewan, managing crop residue before application is an important consideration.

For soil applied herbicides to be effective, they must be present within the soil profile where weed seeds are germinating (Iowa State University). Mechanical incorporation has typically been used; however, with the adoption of conservation tillage, rainfall is often relied upon by producers to move soil-applied herbicides into the soil profile. Another consideration for producers is the surface crop residue following harvest. Crops such as oats can leave behind a considerable amount of crop residue on the soil surface, which has the potential to interfere with the efficacy of soil applied herbicides. A study conducted at The University of Western Australia found that high levels of crop residue intercepted the leaching of soil-applied herbicides from rainfall significantly as compared to no or low levels of crop residue (Khalil et al. 2018). In this study, cereal crop residues (wheat and barley) also intercepted greater amounts of soil-applied herbicide than canola or pulse residue due to it's greater ground cover in comparison. This study further supports that residue management is an important consideration for herbicide efficacy when utilizing soil-applied herbicides.

References

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7. Methodology and Results:

Methodology:

The trial was field-scale, and treatments were blocked within the field and not randomized (Figure 1). There were four treatments consisting of a combination of two herbicides and two harrowing methods. The two herbicides used were Edge® Microactiv and Fortress® Microactiv. Both herbicides were granular and were broadcast on the soil surface in the fall after harvest of the oat crop. Herbicides were to be applied at rates based on label recommendations for the particular soil type (black, brown, etc.), crop type being seeded the following spring, and/or organic matter (OM) content of the field. Herbicides were applied at 14kg/ha on October 18, 2024. The two harrowing methods used in the demonstration were a light harrow (45° tine angle) or a heavy harrow (70-90° tine angle). Harrowing was to be completed after application of the herbicides, and was completed on October 18, 2024. The field was approximately 160 acres in total area, with each treatment encompassing approximately 40 acres. The field was located at NE 8-47-23 W2 (53.041700, -105.324319) in the Rural Municipality of Birch Hills (no. 460). Field-scale equipment was used for all operations, including but not limited to broadcast application of herbicides, harrowing, seeding, spraying and harvesting. Outside of treatment indications, the field was managed for best management practices. The field was seeded to canola in the spring of 2025 and was sprayed for weeds after weed identification was completed in the summer of 2025. The producer applied fertility, in-crop herbicides, insecticides, fungicides and desiccants at their own discretion.

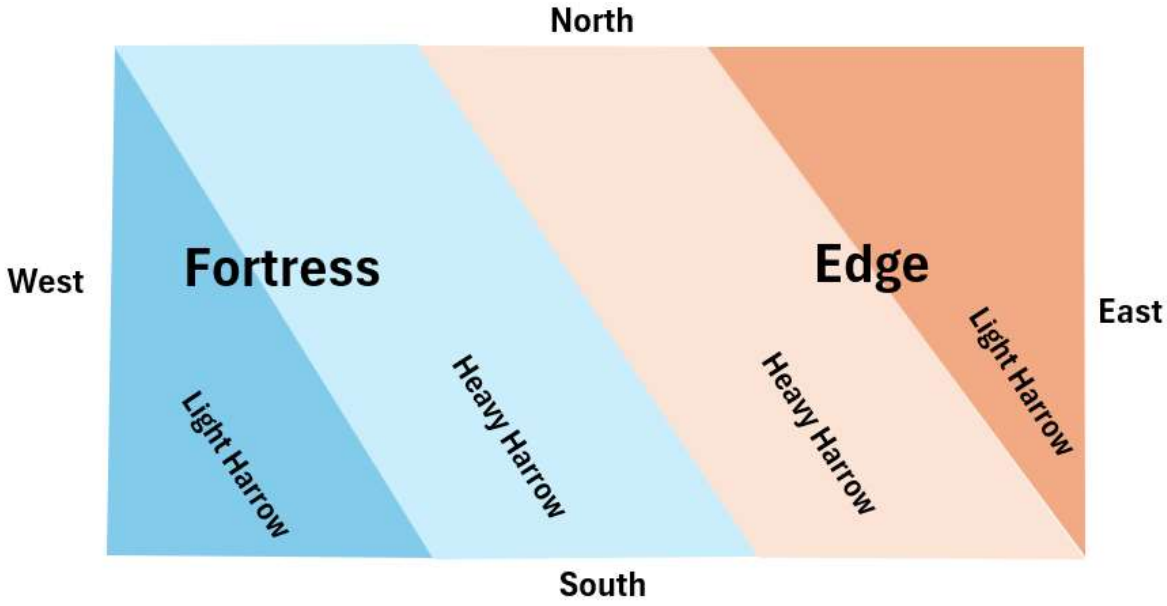

Figure 1. Field design for treatments in On-Farm Applied Granular Herbicide products for the control of wild oats and kochia after oats in 2025.

Data collection consisted of soil sampling for OM, weed density, and seed yield. Soil sampling of the field was to be taken in the fall of 2024 as both Edge and Fortress herbicides were to be applied at rates dependent on the OM content of the soil. Unfortunately, the field in this demonstration was never soil-sampled; however, an adjacent field was. The adjacent field had an OM content of 5.9%, and this was used for determining herbicide application rates. Weed density was assessed by identifying and counting the weeds in a 0.5 m^2 quadrat at eight different locations per treatment. Weed density was evaluated in the fall of 2024 on October 23 and again before post-emergent herbicide applications in the summer of 2025 on June 25. Seed yield was determined at harvest by recording the weight of grain from four representative areas within each treatment. Seed yield was reported in bu/ac based on the weights provided by the producer using calibrated harvesting equipment. Lastly, the data collected for weed density and seed yield were statistically analyzed using split-plot in Statistix 10.

Results:

Baseline (Fall) Weed Density

Weed density in the fall of 2024 was collected as a baseline measure to evaluate control the following spring after the herbicide treatments had time to become active. Although treatment differences were not anticipated at this collection, there were significant differences for wild oat between harrow treatments ($p=0.0481$) and for volunteer oat for a combination of herbicides and harrowing ($p=0.0231$) (Table 1). For wild oat, densities were higher by 2 plants/m^2 when heavy harrowing as compared to light harrowing, while for volunteer oat, densities were significantly higher for light harrowing with Edge as compared to heavy harrowing with Edge by an average of 10 plants/m^2. At the time of fall weed identification, treatment differences would have likely been due to random variability in the field and not as a result of herbicide efficacy, as weeds were identified

only 5 days after treatment applications. At the time of collection, the weed species present included wild oats, volunteer oats, Canada thistle, foxtail barley, barnyard grass, volunteer canola and plantain (Figure 2). Volunteer oat (13.5 plants/m²) and wild oat (3.2 plants/m²) were of the highest density across the field, while other weeds, such as Canada thistle, foxtail barley, barnyard grass, volunteer canola, and plantain were sparsely populated throughout the field (<1plant/m²). Kochia was not identified in the field.

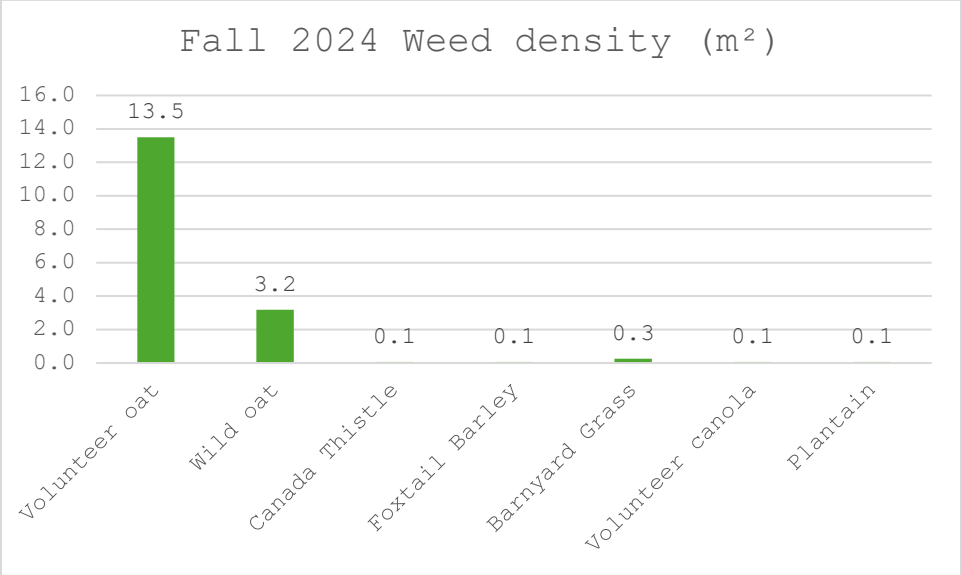

Figure 2. Fall 2024 weed density (m²) averaged across treatments for On-Farm Applied Granular Herbicide products for the control of wild oats and kochia after oats in 2025.

Spring Weed Density

Weed density collected in the spring of 2025 was used to determine the ability of Edge and Fortress to control or suppress the weeds identified in the fall, most notably for wild oat. Of the weeds identified in the fall, only wild oat, Canada thistle, and foxtail barley were identified in the spring (Figure 3). Therefore, volunteer oat, barnyard grass, and plantain were either subject to winter kill, controlled by the herbicides applied, or were not documented in the spring due to random variability or sparse populations. Volunteer canola was identified in the fall, but not the spring, as canola was the seeded crop, so volunteers would have been hard to identify. Of the weeds identified in the fall and spring, Canada thistle and foxtail barley were both very low in density. Canada thistle increased in population from fall to spring by 0.1 to 1.3 plants/m², while foxtail barley also increased in population from fall to spring by 0.1 to 0.4 plants/m². These weeds were not on label for Edge or Fortress, so their increase in population is not concerning. Wild oat populations increased from 3.2 plants/m² in the fall to 21.7 plants/m² in the spring, when averaged across treatments (Figure 3,4). Although there was an increase in wild oat densities, the variability (CV=151) across treatments was so high that the differences between treatments was never significant.

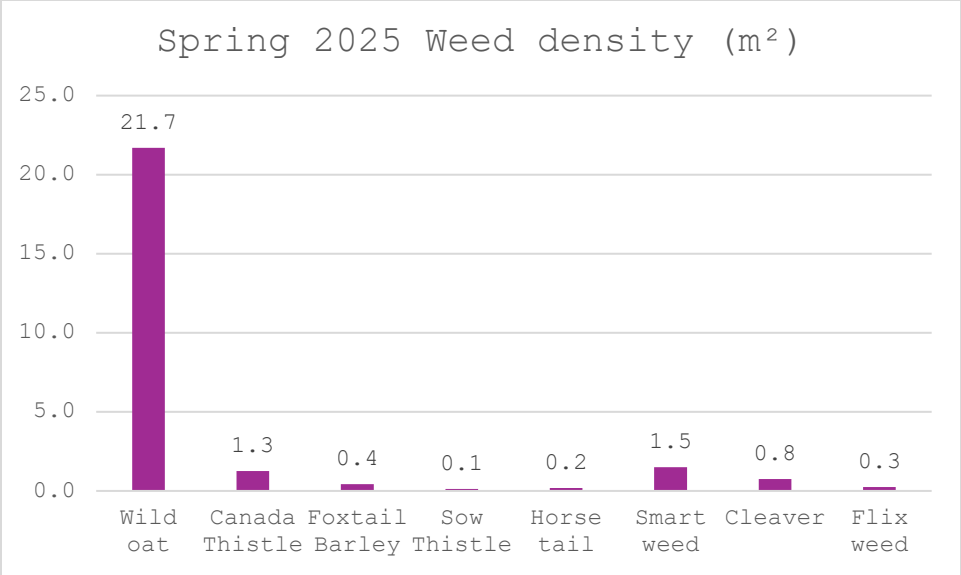

Figure 3. Spring 2025 weed density averaged across treatments for On-Farm Applied Granular Herbicide products for the control of wild oats and kochia after oats in 2025.

As for the effect of each treatment on control of wild oat, Fortress with a heavy harrow was the only treatment to demonstrate an average decrease in wild oat populations from the fall to the spring (Figure 4). The results of this could not be statistically analyzed, as the occurrence of wild oat in the fall of 2024 in the Edge light treatment was too infrequent to replicate the control. Overall, Fortress had lower wild oat densities (10 plants/m²) as compared to Edge (33 plants/m²), although the result was not significantly different, likely due to the high variability of wild oat populations.

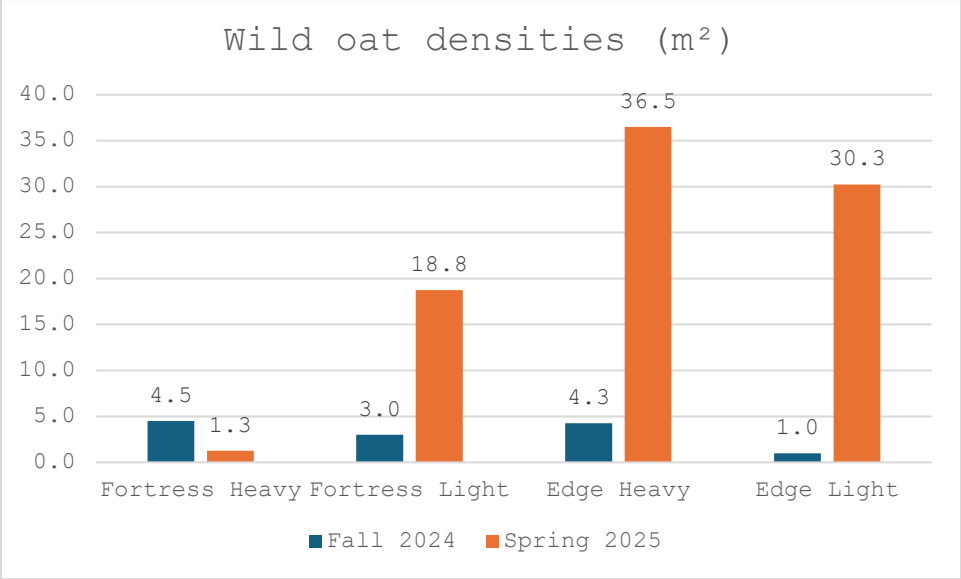

Figure 4. Wild oat densities (m²) per treatment from fall 2024 and spring 2025 for On-Farm Applied Granular Herbicide products for the control of wild oats and kochia after oats in 2025. Treatments do not significantly differ.

Grain Yield

Grain yield was not significantly different between treatments (Figure 5; Table 3). Average yields were higher for Fortress as compared to Edge by 4 bu/ac, however, the result was not significantly different.

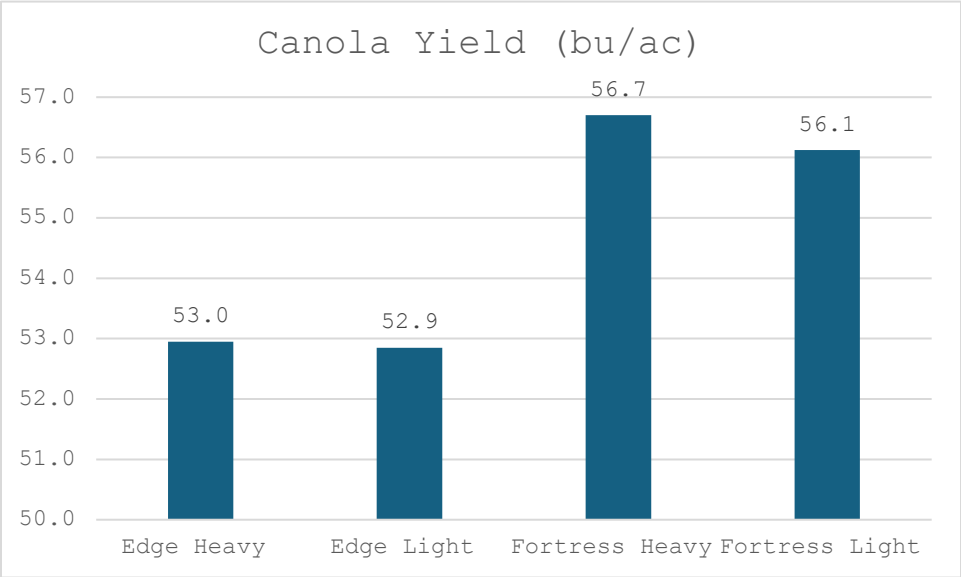

Figure 5. Average canola yield (bu/ac) per treatment for On-Farm Applied Granular Herbicide products for the control of wild oats and kochia after oats in 2025. Treatments do not significantly differ.

8. **Conclusions and Recommendations:**

Overall, Edge and Fortress did not demonstrate significant differences in their ability to control wild oat in one year of this demonstration**.** This is not surprising as both herbicides are registered for control of wild oat, so differences in their ability to control the weed would not be expected. However, wild oat populations were greater in the spring after application of the herbicides as compared to the fall, which suggests that the herbicides did not necessarily provide optimal control of wild oat. Moreover, wild oat is usually an annual weed, so more wild oats may have germinated in the spring as opposed to the fall, demonstrating an increase in populations that wasn't necessarily reflective of herbicide performance. To evaluate this better in the future, a no-herbicide control would be beneficial. Unfortunately, kochia was not identified in the field, and control could not be evaluated. As for the effect of harrowing, there were never any significant differences in wild oat populations or canola yield when comparing a light versus a heavy harrow. This suggests that light and heavy harrowing had the same effect. Lastly, there was never a significant interaction of herbicide and harrowing, suggesting that the performance of each herbicide was not improved with a heavy harrow as compared to a lighter harrow.

9. Acknowledgements:

The project was funded by the Saskatchewan Oat Development Commission and completed by the Northeast Agriculture Research Foundation. The Northeast Agriculture Research Foundation would like to thank the Saskatchewan Oat Development Commission for providing funding for the demonstration, and the staff at the Northeast Agriculture Research Foundation for completing the data collection and reporting writing for the project. The Northeast Agriculture Research Foundation and the Saskatchewan Oat Development Commission would also like to thank Brad Tomtene of Tomtene Seed Farm for providing land, applying the treatments, and collecting yield data for the demonstration.

10. Abstract:

A field-scale demonstration was conducted in the 2025 growing season near Birch Hills, SK to determine the efficacy of Edge® and Fortress® herbicides on wild oat and kochia when incorporated with a light versus heavy harrow on oat crop residue. Edge and Fortress were broadcast on oat stubble at 14kg/ha to soil with 5.9% organic matter in the fall of 2024. The field was approximately 160 acres, with each treatment blocked within the field and not randomized. A light harrow had harrow tines at a 45° angle, while a heavy harrow had harrow tines at a 70 to 90° angle. Harrowing was to be completed after herbicides were broadcast to determine whether a heavy harrow improved herbicide efficacy. Data collection consisted of weed density in the fall of 2024 and summer of 2025, and yield of the succeeding crop. Kochia was not present in the field; therefore, control could not be evaluated. Wild oat was present in both the fall and spring. Wild oat was only significantly greater for a heavy harrow in the fall by 2 plants/m^2 as compared to a light harrow. This could suggest that a heavy harrow increased wild oat germination in the fall; however, wild oats were counted only 5 days after harrowing, so it was unlikely that the difference was due to harrowing, but rather random variability. Wild oat density did increase from the fall (3 plants/m^2) to the spring (22 plants/m^2); however, the difference between treatments was never significant. Fortress with a heavy harrow demonstrated a lower average wild oat population (1 plant/m^2) as compared to the other treatments (19-37 plants/m^2). Due to the high variability of wild oat populations, the difference was not significant. Lastly, canola yields averaged at 55 bu/ac, and there were no significant differences between treatments, suggesting that both herbicide and harrowing angle had no significant effect on yield.

11. Appendices

Table 1. Weed populations in the fall of 2024 for On-Farm Applied Granular Herbicide products for the control of wild oats and kochia after oats near Birch Hills, SK in 2025. Letters signify treatments that are significantly different at p<0.05 using LSD.

	Weeds fall 2024 (m^2)						
	Volunteer oat	**Wild oat**	**Canada Thistle**	**Foxtail Barley**	**Barnyard Grass**	**Volunteer canola**	**Plantain**
Herbicide (p-value)	0.1369	0.4503	0.3506	0.3506	0.1036	0.3506	0.3506
Harrow (p-value	0.3164	0.0481	0.3343	0.3343	0.0824	0.3343	0.3343
Herb*Harrow (p-value)	0.0231	0.4384	0.3343	0.3343	0.0824	0.3343	0.3343
Herbicide							
Edge	17.5	2.6	0.0	0.0	0.5	0.1	0.0
Fortress	9.5	3.8	0.1	0.1	0.0	0.0	0.1
Harrow							
Light	16.3	2.0b	0.0	0.1	0.5	0.1	0.1
Heavy	10.8	4.4a	0.1	0.0	0.0	0.0	0.0
*Herb*Harrow*							
Edge Heavy	8.0b	4.3	0.0	0.0	0.0	0.0	0.0
Edge Light	27.0a	1.0	0.0	0.0	1.0	0.3	0.0
Fortress Heavy	13.6ab	4.5	0.3	0.0	0.0	0.0	0.0
Fortress Light	5.6b	3.0	0.0	0.3	0.0	0.0	0.3
Grand mean	13.5	3.2	0.1	0.1	0.3	0.1	0.1
CV	110.9	97.3	565.7	565.7	302.4	565.7	565.7

Table 2. Weed populations in the summer of 2025 for On-Farm Applied Granular Herbicide products for the control of wild oats and kochia after oats near Birch Hills, SK in 2025.

	Weeds summer 2025 (m^2)							
	Wild oat	**Canada Thistle**	**Foxtail Barley**	**Sow Thistle**	**Horse tail**	**Smart weed**	**Cleaver**	**Flix weed**
Herbicide (p-value)	0.1734	0.3506	0.2771	0.1705	0.6845	0.5326	0.6059	0.2275
Harrow (p-value	0.6348	0.1792	0.2583	0.1489	0.2011	0.2896	0.5635	0.2071
Herb*Harrow (p-value)	0.3227	0.1792	0.2583	0.1489	0.6616	0.0879	0.0977	0.2071
Herbicide								
Edge	33.4	1.5	0.0	0.0	0.3	1.0	1.0	0.5
Fortress	10.0	1.0	0.9	0.3	0.1	2.0	0.5	0.0
Harrow								
Light	24.5	0.8	0.0	0.0	0.0	2.3	0.5	0.5
Heavy	18.9	1.8	0.9	0.3	0.4	0.8	1.0	0.0
*Herb*Harrow*								
Edge Heavy	36.5	1.5	0.0	0.0	0.5	1.5	2.0	0.0
Edge Light	30.3	1.5	0.0	0.0	0.0	0.5	0.0	1.0
Fortress Heavy	1.3	2.0	1.8	0.5	0.3	0.0	0.0	0.0
Fortress Light	18.8	0.0	0.0	0.0	0.0	4.0	1.0	0.0
Grand mean	21.7	1.3	0.4	0.1	0.2	1.5	0.8	0.3
CV	151.1	160.0	480.0	370.3	421.6	257.0	318.7	427.6

Table 3. Canola yield (bu/ac) for On-Farm Applied Granular Herbicide products for the control of wild oats and kochia after oats near Birch Hills, SK in 2025.

	Yield
	Bu/ac
Herbicide (p-value)	0.1851
Harrow (p-value	0.8419
Herb*Harrow (p-value)	0.8883
Herbicide	
Edge	52.9
Fortress	56.4
Harrow	
Light	54.5
Heavy	54.8
*Herb*Harrow*	
Edge Heavy	53.0
Edge Light	52.9
Fortress Heavy	56.7
Fortress Light	56.1
Grand Mean	54.7
CV	5.9