

Barley grass (*Hordeum leporinum*) and brome grass (*Bromus diandrus*) control in barley (*Hordeum vulgare*).

Dr Harmohinder Dhammu, Dr Catherine Borger and Dave Nicholson, Department of Primary Industries and Regional Development (DPIRD), Northam WA.

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Key messages

1. CoAXium® barley system using quizalofop 37g/ha (e.g., Aggressor® AX at 200mL/ha) on Titan AX[®] barley at the 3–4 leaf stage provided 100% barley grass and 94% brome grass control.
2. Clearfield® barley system using Imazamox 24.75g + imazapyr 11.25g/ha (e.g., Intervix® or Intercept® at 750 mL/ha) on Maximus CL[®] barley at the 5-leaf stage achieved 92% control of barley grass and 65% control of brome grass. Although control was not as high as with quizalofop, the surviving weeds were severely stunted with root pruning.
3. In paddocks with mixed populations of brome grass and ryegrass, effective ryegrass herbicides are essential to control ryegrass populations, particularly those resistant to Group 1 and 2 herbicides such as quizalofop and imazamox + imazapyr.

Aims

To evaluate the CoAXium® and Clearfield® barley systems, utilising two levels of herbicide application to control in-crop barley grass in 2023 and brome grass infestations in 2024 in comparison to a standard wheat system.

Introduction

Brome grass and barley grass are ranked as the fourth and ninth most problematic weeds nationally, with an annual revenue loss of \$22.5 and \$1.7 million respectively (Llewellyn et al, 2016). Their staggered emergence patterns pose a challenge for pre-emergent herbicides in cereal crops. New barley herbicide tolerance technologies, such as CoAXium® and Clearfield®, either used alone or in integration with other herbicides, could offer more effective control of these species. The CoAXium® technology allows the use of post-emergent quizalofop, Group 1 herbicide (e.g., Aggressor®) on Titan AX[®] and PegasusAX[®] barley varieties for grass weed control (AGT, 2022). Similarly, Clearfield® technology permits the use of Group 2 herbicides, including pre-emergent imazapic + imazapyr (e.g., Sentry®) and post-emergent imazamox + imazapyr (e.g., Intercept® or Intervix®), on Maximus CL[®] and other IMI-tolerant varieties for control of certain grass and broadleaf weeds (Nufarm, 2021).

Method

In this study, we compared the efficacy of five treatments (T1-T5), against barley grass in 2023 and brome grass in 2024. Treatments 2 to 5 comprised of post-emergent application of quizalofop in Titan AX[®] and imazamox + imazapyr in Maximus CL[®] barley, both alone and in combination with pre-emergent trifluralin + metribuzin. For comparison with the barley treatments, the standard treatment (T1) was pre-emergent trifluralin followed by post-emergent pyroxsulam in Scepter[®] wheat. (with trial details in Table 1, and crop varieties and herbicides in Table 2 and 3).

Table 1: Trial details

Year and weed species	2023 and barley grass	2024 and brome grass
Trial location	East Pingelly, 32.52S, 117.43E	Near Highbury, 33.01S, 117.29E
Paddock rotations	2022: Serradella brown manured, 2021: TT canola, 2020: Barley	2023: Oat (grain), 2022: Canola, 2021: Barley, 2020: Oat
Soil type (0–10 cm)	Sandy with soil pH (CaCl ₂) ranging from 5.1 to 6.3, organic carbon (%) 1.33 to 1.59, and water repellency score of 2.	
Net plot size	48 m ²	20 m ²
Trial design	Completely randomised block design with 4 replications.	
Sowing date	22 May 2023	27 May 2024
Soil moisture at seeding (volumetric method)	0–10 cm: 14.3% 10–20 cm: 13.8%	0–10 cm: 16.8% 10–20 cm: 17.4%
Seeding system	Cone seeder fitted with knife points and press wheels, seeded at 3–4 cm depth, with 22 cm row spacing.	
Target crop density	150 plants/m ² for both wheat and barley.	
Herbicide treatments*	Table 2	Table 3
Herbicide application equipment	Spray rig fitted with air-induction nozzles and spray-shields on the boom using 100 L/ha spray volume.	
Herbicide application dates:		
Pre-seeding	22 May	27 May
3-4 crop leaves	28 June	25 June
5-6 crop leaves	10 July	11 July
Harvest date	16 November 2023	26 November 2024

*Note that crop topping treatments were planned (glyphosate products registered in feed barley varieties like Titan AX[®]) but were not applied due to a mismatch between the recommended growth stages of barley crop and the weeds.

Measurements and observations:

Crop emergence and heads (1m x 0.44m quadrats) and weed emergence and panicle (31.5cm x 31.5cm quadrats) counts were taken at four locations per plot. Weed control was also assessed visually (comparing plots to the buffers), where 0% represented no control and 100% indicated complete weed control. Further, a brief visual examination of individual surviving weeds was used to assess root growth.

Results

Barley grass control (2023)

Barley and wheat density (average of 226 plants/m²) was 1.5 times the target density (150 plants/m²). Treatments did not impact crop density, and post-emergent herbicides produced no visual symptoms on crop plants (data not shown).

Four weeks after seeding, the pre-emergent application of trifluralin or trifluralin + metribuzin had no significant negative effect on barley grass density (average of 769 plants/m²) compared to untreated controls (T2 and T3) (data not shown).

Application of post-emergent quizalofop in Titan AX[®] barley at the 4-leaf stage resulted in 100% control of 2-3 leaf stage barley grass. Post-emergent imazamox + imazapyr in Maximus CL[®] barley at 5-leaf stage resulted in 92% control of 3-4 leaf stage barley grass, significantly lower control than the

Titan AX[®] barley system. Visual assessment indicated that barley grass treated with imazamox + imazapyr recovered from initial damage, though older leaves remained necrotic. Most of these plants were present in clumps, with stunted growth and root pruning, with an average of 2 panicles/m².

The standard treatment of pre-emergent trifluralin followed by pyroxsulam at the 4-leaf stage of Scepter[®] wheat resulted in significantly lower barley grass control (58%) and crop yield (4.1t/ha), and higher barley grass panicles (138/m²) than both the Titan AX[®] and Maximus CL[®] barley variety systems.

Table 2: Effect of treatments on barley grass, and barley and wheat grain yield during 2023. Figures followed by the same letter are not significantly different.

Treatment, system, crop and variety	Herbicide rate/ha	Timing (crop)	Visual weed control (%) 4 Sept	Barley grass panicles/m ² * 23 Oct	Grain yield (kg/ha)
T1. Standard Wheat, Scepter [®]	Trifluralin 960g <i>fb</i> Pyroxsulam 15g (Crusader [®] GoDRI [®] 70g)	Pre-seeding <i>fb</i> Z13-31	58 a	138 (12) b	4095 a
T2. CoAXium [®] Barley, Titan AX [®]	Quizalofop 37g (Aggressor [®] AX 200mL)	Z12-Z25	100 c	0 (0) a	4967 b
T3. Clearfield [®] Barley, Maximus CL [®]	Imazamox 24.75g + imazapyr 11.25g (Intervix [®] or Intercept [®] 750mL)	Z15-Z31	91 b	2 (1.4) a	5572 b
T4. CoAXium [®] Barley, Titan AX [®]	Trifluralin 960g + metribuzin 101g <i>fb</i> quizalofop 37g <i>fb</i> glyphosate 940.5g (Roundup Ultra [®] Max 1.65L)	Pre-seeding <i>fb</i> Z12-Z25 <i>fb</i> Z87	100 c	0 (0) a	5421 b
T5. Clearfield [®] Barley, Maximus CL [®]	Trifluralin 960g + metribuzin 101g <i>fb</i> Imazamox 24.75g + imazapyr 11.25g <i>fb</i> glyphosate 940.5g	Pre-seeding <i>fb</i> Z15-Z31 <i>fb</i> Z87	92 b	2 (1.45) a	5646 b
F-value			p <.001	p = 0.004	p = 0.003
Lsd (0.05)			6	5.5	765

Pyroxsulam applied with BS1000[®] at 0.25%, quizalofop with Hasten[™] at 1% and imazamox + imazapyr with Hasten[™] at 0.5% volume by volume. *Fb* = followed by, and Z87=late dough stage of barley.

*Values in parenthesis are square root transformed values. The LSD should be applied to the values in parenthesis.

Brome grass control (2024)

Brome grass seed distribution in the soil across the site was uneven (data not shown), with T6 plots containing nearly double the seed density (4,821 seeds/m²) compared to T2 plots (2,418 seeds/m²).

Four weeks after seeding, both wheat and barley establishment (averaged 196 plants/m²) exceeded the target density of 150 plants/m². The pre-emergent application of trifluralin + metribuzin to Titan AX[®] barley (T5) reduced crop establishment to 170 plants/m² compared to the treatment with no pre-emergent herbicide (T2), but density was still above the target threshold (data not shown).

The dominant weed species at the trial site was brome grass, but a low to medium density of ryegrass was also present. Four weeks after seeding, the pre-emergent application of trifluralin or trifluralin + metribuzin did not significantly reduce brome grass density compared to the plots using no pre-

emergent herbicides (T2 and T3). However, these pre-emergent herbicides effectively reduced early establishment and panicle numbers of ryegrass (81–93%). Moreover, the ryegrass population might be resistant to Group 1 and 2 herbicides (Table 3).

Application of quizalofop at 3-leaf stage of barley to 1.5 to 2-leaf stage brome grass reduced panicle numbers by 90–98%. Similarly, imazamox + imzapyr application at 5-leaf stage of barley to 3-leaf brome grass reduced its panicle numbers by 55–74%, compared to the standard wheat treatment (Table 3).

By early August, wheat and barley crops showed yellowing and stunting, with uneven growth patches in every plot. Soil sampling confirmed *Rhizoctonia solani* fungus (195–491 pgDNA/g), likely reducing crop competition and grain yield, especially in wheat.

Brome grass control was more effective in both barley herbicide tolerance systems compared to wheat, resulting in lower brome grass panicles, leading to 76–90% higher barley yields than wheat. Further, combining pre-emergent herbicides with post-emergent quizalofop or imazamox + imzapyr doubled barley yield, due to reduced brome and ryegrass panicles and increased crop tillers (Table 3).

Table 3: Effect of treatments on panicle number of brome grass and ryegrass, and tillers and grain yield of barley and wheat during 2024. Figures followed by the same letter are not significantly different.

Treatment, system, crop and variety	Herbicide rate/ha	Timing (crop)	Brome grass panicles/m ² 23 Oct	Rye grass panicles/m ² 23 Oct	Crop tillers /plant 22 Oct	Grain yield (kg/ha)
T1. Standard Wheat Scepter [®]	Trifluralin 960g <i>fb</i> Pyroxsulam 15g (Crusader [®] GoDRI [®] 70g)	Pre-seeding <i>fb</i> Z13-31	1814 c	48 a	1 a	155 a
T2. CoAXium [®] Barley Titan AX [®]	Quizalofop 37g (Aggressor [®] AX 200mL/ha)	Z12-Z25	39 a	760 b	2 b	650 b
T3. Clearfield [®] Barley Maximus CL [®]	Imazamox 24.75g + imazapyr 11.25g (Intervix [®] or Intercept [®] 750mL)	Z15-Z31	831 b	565 b	2 b	769 b
T4. CoAXium [®] Barley Titan AX [®]	Trifluralin 960g + metribuzin 101g <i>fb</i> quizalofop 37g <i>fb</i> glyphosate 940.5g (Roundup Ultra [®] Max 1.65L)	Pre-seeding <i>fb</i> Z12-Z25 <i>fb</i> Z87	178 a	113 a	3 c	1302 c
T5. Clearfield [®] Barley Maximus CL [®]	Trifluralin 960g + metribuzin 101g <i>fb</i> Imazamox 24.75g + imazapyr 11.25 g <i>fb</i> glyphosate 940.5g	Pre-seeding <i>fb</i> Z15-Z31 <i>fb</i> Z87	421 a	126 a	3 c	1577 d
F-value			p <0.001	p <0.001	p <0.001	p <0.001
LSD (0.05)			412	337	0.6	228

Herbicide application as for Table 2, *fb* = followed by and Z87 = late dough stage of barley.

Conclusion

CoAXium[®] and Clearfield[®] barley systems were more effective in managing barley and brome grass than a standard non-Clearfield[®] herbicide combination used in wheat.

Implementing harvest weed seed control can further reduce brome grass seed return to the soil. Visual assessment indicated that seeds remained on the panicles at crop harvest, unlike barley grass where seed shed prior to harvest.

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Contact details

Dr Harmohinder Dhammu
Department of Primary Industries and Regional Development
75 York Road (PO BOX 483), Northam WA 6401
Ph: 0403 156 942
Email: harmohinder.dhammu@dpiird.wa.gov.au

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