Combinations of crop rotations and herbicides for effective management of brome grass (Snowtown, SA)

Ben Fleet[1], Kaidy Morgan[2], Sam Trengove[3], Stuart Sherriff[3], Gurjeet Gill[1] and Rebekah Allen[2]

[1]School of Agriculture, Food and Wine, Adelaide University, [2]Hart Field-Site Group, [3]Trengove Consulting

Key findings

- In this trial report, the term 'break' refers to the year in which the selected crop × herbicide combinations are expected to effectively prevent brome grass seed production.
- Brome grass plant density in the no-break system (S1) in 2025 was close to 300 plants/m^2, which reduced wheat yield by more than 1000 kg/ha compared to the single year break systems, which were also sown to wheat in 2025.
- A single year break in brome grass seed set tends to be inadequate for long-term brome grass population management. This was also seen in the trial at Snowtown, where brome grass panicle density in the one-year break systems (S2 and S3) increased by 40 to 50-fold from 2024 to 2025.
- Management systems with a 2-year or 3-year break in brome grass seed set maintained low brome grass panicle density (0 to 3.4 panicles/m^2) in 2025.
- Even though brome grass panicle density in the three systems with lentils in 2025 (S4, S5, S7) was very similar (0 to 2 panicles/m^2), Metro lentil grain yield was 500 kg/ha lower than GIA Thunder lentils. Such a high level of fitness penalty in metribuzin tolerant Metro lentils is consistent with the results from previous research and will reduce its on-farm adoption.
- In System 6 (3-year break), brome grass was effectively controlled in 2024 in lentils and in canola in 2025. In this system brome grass produced only 3 panicles/m^2 in 2025 and canola performed well to produce grain yield of 1500 kg/ha. Therefore, inclusion of canola in the rotation would be a profitable option for brome grass management.

Introduction

Brome grass is currently ranked the second worst weed in grain crops in Australia, causing annual revenue loss of $42 million (Ouzman et al. 2025). Brome grass is difficult to effectively control with pre-emergent herbicides currently registered for use in cereal crops. Development of herbicide tolerant cereal varieties has increased herbicide options available for growers to effectively manage brome grass in the cereal phase of rotations. Integration of herbicide tolerant cereals with break crops such as pulses and canola offers opportunities to effectively deplete brome seedbank and manage its populations. It is important to demonstrate to growers the effectiveness of carefully considered combinations of cropping sequences and herbicide options for the management of brome grass in different agroecological environments.

This study aims to identify rotations and herbicide programs that effectively suppress brome grass populations and minimise seedbank replenishment while maintaining crop productivity.

Methodology

A three-year field trial was established in a randomised complete block design on a commercial farm near Snowtown in the Mid North of SA. This farm has a sandy loam soil which is favoured by brome grass and the participating grower reported difficulty in managing this brome grass population even though it has not yet evolved resistance to any herbicide group.

The trial was sown with an experimental no-till cone seeder with 25 cm row spacing and seeding width of 1.5 m (Table 1). There was a single seeder run per plot, and the plots were 12 m long. There was one buffer plot of Tomahawk CL wheat between all experimental plots to minimise the risk of herbicide spray drift and the dispersal of weed seeds to neighbouring plots during crop harvest or by wind. All pre-emergent herbicides were sprayed just prior to crop sowing and incorporated by the no-till seeding tines (IBS). Broadleaf weeds, insect pests and diseases were managed effectively in all crops. Information on herbicide products, active ingredients and label rates can be found in Table 2. All data was analysed by using the statistical software GenStat 23rd Edition.

Table 1. Trial management details for 2025.

Project duration	2024–2026 (3-years)
Trial location	Snowtown, SA
Plot size	12 m x 1.5 m
Replications	4
Soil type	Sandy loam
Sowing date	May 5, 2025
Target crop density (m^2)	Wheat 180, lentils 120 and canola 50
Fertiliser	80 kg/ha MAP with Zn at sowing; canola and wheat also had 80 kg/ha urea at sowing
Herbicides	See Table 2
Crop-topping	Paraquat 800 ml/ha or glyphosate 4L/ha DST 470 (System 6) on October 27
Harvest date	Lentils - November 5; wheat and canola - November 19

Table 2. Information about the herbicides used for brome grass control in the trial at Snowtown in 2025.

Product name	Active ingredient	Label rate
Sakura®	Pyroxasulfone 850 g/kg	118 g/ha
Overwatch®	Bixlozone 400 g/L	1.25 L/ha
Avadex®	Triallate 500 g/L	3.2 L/ha when used as incorporated by sowing in no-till
Crusader GoDri	Pyroxsulam 215 g/kg	70 g/ha
Intercept®	Imazamox 33 g/L + Imazapyr 15 g/L	375-750 mL/ha for brome grass
Propyzamide	Propyzamide 500 g/L	1 L/ha
Ultro	Carbetamide 900 g/kg	1.1-1.7 kg/ha
Clethodim 360	Clethodim 360 g/L	116-333 mL/ha
Verdict®	Haloxyfop 520 g/L	75 mL/ha
Metribuzin 750 WG	Metribuzin 750 g/kg	370 mL/ha
Crucial®	Glyphosate 600 g/L	1-1.5 L/ha (in Truflex canola) x 2

Paraquat 250	Paraquat 250 g/L	400-800 mL/ha

The summer of 2025 was extremely dry with only 16.4 mm rainfall from January to the end of May. Therefore, the seedbed was extremely dry when the trial was sown on May 5. Rainfall in June was close to the long-term average for the site, but July was extremely wet with more than double the long-term average rainfall (Table 3). However, August and September were slightly below the average. Over the whole growing season (April to October), rainfall received at the site was close to the long-term average.

Table 3. Rainfall during 2025 and long-term rainfall for the trial site. Rainfall data for 2025 and long-term was obtained from climate data online from Bureau of Meteorology for Snowtown (Rayville Park).

Month	**Rainfall in 2025 (mm)**	**Long-term rainfall (mm)**
Jan	1.0	17.4
Feb	0.0	17.0
Mar	4.8	15.5
Apr	3.0	23.0
May	7.6	33.8
Jun	39.8	49.9
Jul	107.6	40.4
Aug	38.4	42.9
Sep	23.8	36.5
Oct	26.0	26.7
Nov	30.0	28.7
Dec	4.6	28.7
Annual total	286.6	360.5
Growing season	246.2	253.2

In this trial report, the 'break' refers to the year where crop × herbicide combinations are expected to effectively prevent brome grass seed production.

No-break system (S1): Pre-emergent Overwatch + Avadex was followed by Crusader (pyroxsulam) post-emergent (Table 4) to prevent excessive build-up in brome grass infestation. This system is expected to allow some brome grass seed production each year.

1-year break systems (S2 and S3): Canola (S2) or lentils (S3) in 2024 were followed by wheat sprayed with pre-emergent herbicides in 2025. These management systems are expected to lead to a rebound in brome grass populations due to weed establishment from the residual seedbank.

2-year break systems (S4 and S5): Brome grass was controlled in 2024 in CL barley (Maximus CL), which was followed in 2025 by Thunder lentils with either carbetamide (S4) or propyzamide (S5) as the pre-sowing treatment followed by group 1 post-emergent herbicides and crop-topping to prevent any seed set.

3-year break systems (S6 and S7): Thunder lentils in 2024 were followed by canola in 2025 (S6) to provide an effective second break from brome grass. This canola variety allowed use of Group 1 herbicides early post-emergent followed by glyphosate late to eliminate brome grass (Table 4). In the other 3-year break system (S7), AX barley grown in 2024 was followed by metribuzin tolerant Metro lentils. The Hart Research Committee group was interested in exploring the suitability of Metro lentil variety in this trial. Metro lentils are tolerant to metribuzin, which can control brome grass and several broadleaf weed species when used post-emergent in lentils. However, this variety also suffers from a significant fitness penalty associated with the metribuzin tolerance gene. This trial will provide local data to objectively assess the pros and cons of using Metro lentils in this medium rainfall environment.

Table 4. Crops, varieties and herbicide input programs at Snowtown in 2024 and 2025.

System (S)	Weed management 2024	Weed management 2025
S1 (no break)	**Scepter wheat** PRE: Sakura @ 118 g + Avadex @ 2 L	**Tomahawk CL wheat** PRE: Overwatch @ 1.25 L/ha + Avadex @ 2.4 L/ha POST: Crusader GoDri @ 70 g/ha
S2 (1-year break)	**HyTTec Trophy TT Canola** PRE: Propyzamide @ 1 L/ha + Simazine @ 1 kg/ha POST: Clethodim 240 @ 500 ml/ha + Atrazine @ 1 kg/ha	**Tomahawk CL wheat** PRE: Sakura @ 118 g/ha + Avadex @ 2.4 L/ha
S3 (1-year break)	**GIA Thunder XT** PRE: Propyzamide @ 2 L/ha POST: Factor @ 180 g/ha + Clethodim 240 @ 500 mL/ha + Intercept @ 375 mL/ha Fb Crop topping	**Tomahawk CL wheat** PRE: Overwatch @ 1.25 L/ha
S4 (2-year break)	**Maximus barley CL** PRE: BoxerGold @ 2.5 L/ha + Trifluralin @ 2 L/ha POST: Intercept @ 750 mL/ha	**GIA Thunder XT** PRE: Ultro @ 1.4 kg/ha POST: Clethodim 360 @ 330 mL/ha + Verdict @ 75mL Crop-topping: Paraquat @ 800 mL/ha
S5 (2-year break)	**Maximus barley CL** PRE: BoxerGold @ 2.5 L/ha + Trifluralin @ 2 L/ha + Sentry @ 40 g/ha	**GIA Thunder XT** PRE: Propyzamide 900 @ 560 mL/ha POST: Clethodim 360 @ 330 mL/ha + Verdict @ 75 mL Crop-topping: Paraquat @ 800 mL/ha
S6 (3-year break)	**GIA Thunder XT** PRE: Propyzamide @ 2 L/ha POST: Factor @ 180 g/ha + Clethodim 240 @ 500 mL/ha + Intercept @ 375 mL/ha Fb Crop Topping	**Hyola Regiment XC** PRE: Overwatch @ 1.25 L/ha POST: Crucial @ 1.5 L/ha + Clethodim 360 @ 330 mL POST 2: Crucial @ 1.5 L/ha Crop-topping: Glyphosate DST 470 @ 4 L/ha
S7 (3-year break)	**Titan AX barley** PRE: Trifluralin @ 2 L/ha + Avadex @ 2 L/ha + Metribuzin @ 280 g/ha POST: Aggressor @ 200 mL/ha	**Metro lentils** PRE: Ultro @ 1.4 kg/ha POST: Metribuzin 750 @ 370 mL Clethodim 360 @ 330 mL/ha + Verdict @ 75 mL Crop-topping: Paraquat @ 800 mL/ha

Results and discussion

Crop establishment

Wheat plant establishment in this trial was close to the target of 180 plants/m^2 (Table 5). This is an impressive result considering the dry seedbed at sowing and that significant rainfall post-seeding did not arrive until June. Plant establishment in both lentil cultivars was slightly greater than the target of 120 plants/m^2. A similar trend was also seen in canola, where plant establishment was also greater than the target of 50 plants/m^2. Importantly, good establishment of all crop species would have allowed them to effectively compete with brome grass plants that survived the herbicide treatments.

Table 5. Density of crop plants established in the Snowtown trial in 2025. Crop names in bold indicate the phase in 2025.

System (S)	Rotation sequence	Crop density (plants/m^2) ± SEM
S1 (no break)	Wheat – **Wheat** – Barley (PRE herbicides – weak system)	134 ± 1.4
S2 (1-year break)	TT Canola – **Wheat** - Barley	162 ± 8.0
S3 (1-year break)	Lentil XT – **Wheat** - Barley	185 ± 11.0
S4 (2-year break)	Barley CL – **Lentil XT** - Wheat	132 ± 11.3
S5 (2-year break)	Barley CL – **Lentil XT** - Wheat	139 ± 3.5
S6 (3-year break)	Lentil XT – **Canola XC** – Wheat CL	63 ± 4.4
S7 (3-year break)	Barley AX – **Metro lentil** – Canola TF	145 ± 12.4

Brome grass plant and panicle density

Brome grass plant density in System 1 (no break) appears to have stabilised around 300 plants/m^2 (Table 4). However, such high brome grass densities are likely to cause a significant loss in crop yield. The use of post-emergent Crusader (pyroxsulam) in S1 reduced brome grass panicle density by about 50% when compared to 2024. Crusader was applied prior to tiller production, which allowed for some weed kill and suppress growth and panicle production of the survivors. Consistent with the results from other brome management trials in this project, 1-year break from brome seed set is inadequate and leads to a rapid rise in panicle density and seed set in year two (Table 6). In this trial, brome grass panicle density in S2 and S3 increased by 40 to 50-fold from 2024 to 2025. The lower brome grass panicle density in S2 compared to S3 appears to be related to superior brome grass control by pre-emergent Sakura + Avadex than Overwatch (Figure 1). It should be noted that these two systems had very similar brome grass plant and panicle density in 2024. In contrast, the 2-year and 3-year break systems were highly effective in maintaining brome grass panicle density at a very low level in 2025 (0 to 3.4 panicles/m^2). Such low plant and panicle density levels are expected to lead to very low brome grass infestations in 2026.

Table 6. Densities of brome grass plants and panicles across crop rotation sequences and herbicide input programs at Snowtown in 2024 and 2025. Crop names in bold indicate the phase in 2025. Shaded values in each column indicate best performing treatments. Means followed by a different letter indicate statistical significance (P=0.05).

System (S)	Rotation sequence	Brome density[1] 2024 (plants/m²)	Brome density[1] 2025 (plants/m²)	Brome panicles 2024 (panicles/m²)	Brome panicles 2025 (panicles/m²)
S1 (no break)	Wheat – **Wheat** – Barley (PRE herbicides – weak system)	316[cd]	327[d]	526[d]	272.8[d]
S2 (1-year break)	TT Canola – **Wheat** - barley	0[a]	50[b]	1[a]	59.1[b]
S3 (1-year break)	Lentil XT – **Wheat** - Barley	4[a]	189[c]	4[a]	181.1[c]
S4 (2-year break)	Barley CL – **Lentil XT** - Wheat	89[b]	2[a]	35[ab]	0[a]
S5 (2-year break)	Barley CL – **Lentil XT** - Wheat	410[d]	5[a]	115[c]	1.1[a]
S6 (3-year break)	Lentil XT – **Canola XC** – Wheat CL	8[a]	29[b]	1[a]	3.4[a]
S7 (3-year break)	Barley AX – **Metro lentil** – Canola TF	298[c]	23[ab]	70[bc]	2.2[a]
P-value		**<0.001**	**<0.001**	**<0.001**	**<0.001**

[1]Plant density of brome in Oct (late spring); all data for weed density and panicle density were square root transformed before performing ANOVA.

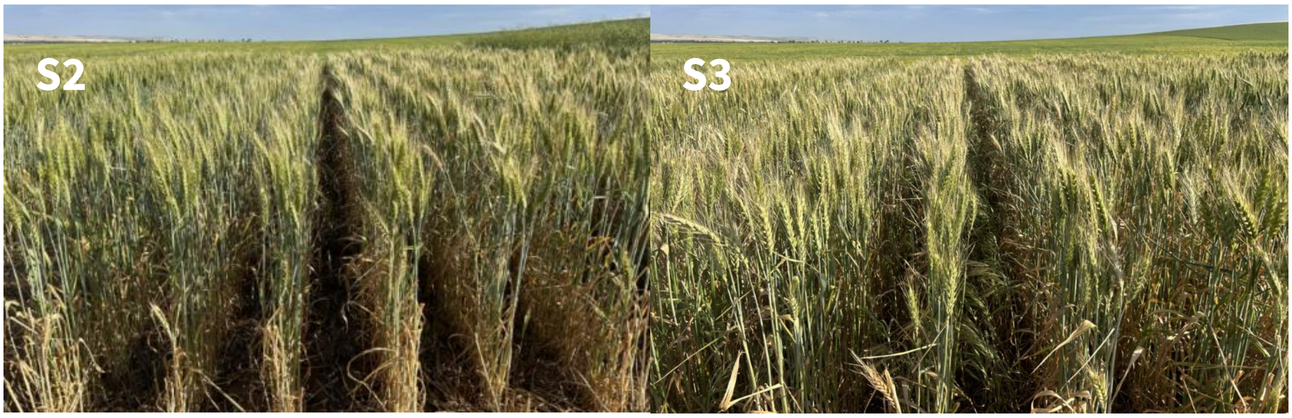

Figure 1. Late season brome grass pressure in Tomahawk CL wheat for System 2 (S2) and System 3 (S3). Improved brome grass control was noticed in S2 where Sakura + Avadex were applied when compared to Overwatch application in S3.

Crop grain yield

A comparison between S1 and S3, which were all in wheat in 2025, provides useful insights into the competitive ability of brome grass. Presence of more than 300 plants/m^2 of brome grass in wheat in S1 reduced wheat grain yield by more than 1000 kg/ha when compared to the single year break (S2 and S3; Table 7). S2, which had excellent weed control in canola in 2024 and was treated with Sakura + Avadex in 2025, had a much lower brome grass density (50 plants/m^2) and produced wheat yield of 3,076 kg/ha as compared to 1,741 kg/ha in S1. Brome grass is known to be a highly competitive weed with wheat where even 10 plants/m^2 can reduce yield by 5% (Gill and Davidson 2000). Therefore, it was not surprising to see around 50% yield loss in wheat in S1, which was infested by more than 300 plants/m^2 of brome grass.

The comparison of grain yield in the lentil-based systems provides an important insight into the fitness penalty associated with the metribuzin tolerance gene in Metro lentils. Even though brome grass panicle density in the three systems with lentils in 2025 was very similar (0 to 2.2 panicles/m^2), Metro lentil yield was 500 kg/ha lower than GIA Thunder (Table 7). A similar level of fitness penalty in metribuzin tolerant lentils has been reported previously. Even though Metro offers the opportunity to use metribuzin for post-emergent weed control, it would be associated with a considerable financial cost to the grower.

Table 7. Response of crop grain yield to brome grass management systems at Snowtown in 2025. Crop names in bold indicate the phase in 2025. Shaded values in each column indicate best performing treatments. Means followed by a different letter indicate statistical significance (P=0.05).

System (S)	Rotation sequence	Grain yield (kg/ha)
S1 (no break)	Wheat – **Wheat** – Barley (PRE herbicides – weak system)	1741^{ab}
S2 (1-year break)	TT Canola – **Wheat** – Barley	3076^{c}
S3 (1-year break)	Lentil XT – **Wheat** – Barley	2687^{c}
S4 (2-year break)	Barley CL – **Lentil XT** – Wheat	2058^{b}
S5 (2-year break)	Barley CL – **Lentil XT** – Wheat	2031^{ab}
S6 (3-year break)	Lentil XT – **Canola XC** – Wheat CL	1525^{ab}
S7 (3-year break)	Barley AX – **Metro lentil** – Canola TF	1514^{a}
P-value		**<0.001**

Canola XC (Hyola Regiment XC) is tolerant to glyphosate and Clearfield (imidazolinone) herbicides, which are both highly effective on brome grass (Table 5). In this system brome grass only produced 3 panicles/m^2 and canola grain yield of 1500 kg/ha. At canola grain price of >$600/t in 2025 and grain yield of >1.5 t/ha, inclusion of canola in the rotation for brome grass management would be a highly profitable option.

References

Gill, G. S. and Davidson, R. (2000). Weed interference. In Australian Weed Management Systems, ed. B. Sindel, pp. 61-80. RG and FG Richardson, Melbourne.

Ouzman J, Azeem M, Llewellyn R (2025) *Impact of weeds on Australian grain and cotton production*. Grains Research and Development Corporation. pp 66. Accessible at: https://grdc.com.au

Acknowledgements

This research was funded by GRDC through the 'Effective control of brome grass in the southern and western cropping zones' (UOA2303-006RTX). We also thank the grower collaborator and family for hosting this field trial.