Investigation of combinations of cropping sequence and herbicides for the management of brome grass at Cowell

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Location
Cowell
Rainfall
2024 Total: 108 mm
2024 GSR: 77 mm
Paddock history
2023: Scepter wheat
2024: Wheat (Calibre, Tomahawk CL), Barley (Titan AX), and Canola (Battalion)
Soil type
Sandy textured soil
Plot size
15 m x 3 m (two seeder plot) x 4 reps
Trial deisgn
Randomised Complete Block Design (RCBD)

Key messages

- **The use of Clethodim and Crucial (glyphosate) in herbicide tolerant canola resulted in the lowest brome grass plant density (1.8 plants/m^2) of all treatments tested. Other management systems based on wheat and barley had similar weed density.**
- **Brome grass plants that survived Sakura + Trifluralin treatment in system 1 recovered producing panicles (200 panicles/m^2) and seed set (>11,000 seeds/m^2).**
- **Brome grass is highly competitive for resources with crops and reduced grain yield of Calibre wheat in System 1 by 35% as compared to Tomahawk CL in which the imidazolinone (IMI) herbicide Intervix provided effective control of brome grass.**
- **Titan AX barley was an effective alternative to the Clearfield system based on IMI herbicides. In Titan AX barley, brome grass plant density, panicle density and seed set were statistically similar to Tomahawk CL wheat, but it produced higher grain yield and without any soil residual concerns.**
- **Grain yield performance of Battalion canola in an extremely dry growing season in 2024 was better than expected (>0.5 t/ha). Canola could be a valuable part of cropping sequences, even in low rainfall environments.**

Why do the trial?

Brome grass is currently ranked as the fourth main weed in terms of the area infested, and for yield and revenue losses in grain crops across Australia (Llewellyn et al., 2016). Brome grass tends to be difficult to control effectively with the pre-emergent herbicides that are registered for use in cereal crops. Development of herbicide tolerant cereal varieties has opened options for growers to manage brome grass effectively in the cereal phase of crop rotations. Integration of herbicide tolerant cereals with break crops, such as pulses and canola, offer opportunities to effectively deplete the brome grass seedbank and minimise the risk of buildup in its populations. It is important to evaluate the effectiveness of carefully considered cropping sequences for the management of brome grass in different agroecological environments. To achieve this objective, a 3-year GRDC funded field trial was initiated near Cowell on the Eyre Peninsula during the 2024 growing season.

How was it done?

A field trial was established in a randomised complete block design on a commercial farm near Cowell on the Eyre Peninsula. This farm has a sandy textured soil which is favoured by brome grass. The farmer collaborator has reported serious impacts of brome grass on crop productivity in the paddock.

Prior to crop seeding, soil cores were taken to determine the seedbank of brome grass at the trial site. Twenty cores of 9 cm diameter were collected from each replicate block and bulked. Soil samples were placed in seedling trays at Roseworthy in February and watered as required from April to maintain ideal conditions for seed germination and seedling establishment. Established brome grass seedlings were counted and removed each week until seedling emergence ceased. This information was used to determine brome grass seedbank and its seedling establishment pattern, which is an indicator of seed dormancy.

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 were two seeder runs per plot and the plots were 15 m long. There was one buffer plot of Clearfield barley 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 dispersal. Data was analysed using GenStat 23rd Edition. Information on herbicide active ingredients used in this trial is presented in Table 2. Information on crop sequences and herbicides is presented in Table 4.

Summer and autumn in 2024 were extremely dry with very low rainfall with February, March and April having 0 mm of rain recorded (Table 3). The start of winter (June) was also dry with about half the rainfall compared to the long-term average for the site. July was the only month of the growing season when rainfall above the long-term rainfall. Total annual rainfall at the trial site for 2024 was 108 mm as compared to the long-term average of 279 mm. A similar pattern was observed for the growing season rainfall (GSR), which was less than half (77 mm) as compared to 188 mm the long-term average GSR.

Table 1. Details of the experimental site location and crop seeding.

Operation	Details
Location	Cowell, SA
Seedbank soil cores	February, 2024
Plot size	3 m x 15 m (two runs of the seeder)
Seeding date	5 June 2024
Seeder information	No-till 6-row experimental seeder (2 seeder runs per treatment)
Crop density assessment	2 July
Weed assessments	Brome plant density - 2 July and 7 August Brome panicle density - 1 October
Crop grain yield harvest	Canola - 11 November Cereals - 5 December

Table 2. Herbicides used for brome grass control at Cowell in 2024.

Product name	Active ingredient	Label rate
Sakura	Pyroxasulfone (850 g/kg)	118 g/ha
Treflan	Trifluralin (480 g/L)	1.5-2.0 L/ha when used as incorporated by sowing
Intervix	33 g/L imazamox and 15 g/L imazapyr	375-750 mL/ha for brome grass
Propyzamide	Propyzamide 500 g/L	1 L/ha
Clethodim	Clethodim 240 g/L	175-250 mL/ha
Crucial	Glyphosate 600 g/L	1-1.5 L/ha (in Truflex canola)
Aggressor AX	Quizalofop 185 g/L	200 mL/ha

Table 3. Rainfall during 2024 and long-term rainfall (1885 to present) for the trial site. Rainfall data was obtained from climate data online from the Bureau of Meteorology for Cowell. http://www.bom.gov.au/climate/data/

Month	Rainfall in 2024 (mm)	Long-term rainfall (mm)
Jan	11	15.2
Feb	0	18.2
Mar	0	18
Apr	0	24.9
May	2.6	28.9
Jun	15.4	29
Jul	28.2	25.2
Aug	9.6	25.8
Sep	5	27.6
Oct	16.4	27.1
Nov	20.2	20.7
Dec	0	18.5
Annual total	108.4	279.1
Growing season rainfall	77.2	188.5

Table 4. Management systems (crop sequences x herbicide treatments) under investigation at Cowell. (fb = followed by)

Management system	2024	2025	2026
1 (no break)	Calibre wheat Sakura 118g + Treflan 2 L IBS	Calibre wheat Arcade 2 L + Treflan 2 L IBS	Compass barley Treflan 2 L IBS
2 (1 year break)	Wheat Tomahawk CL Plus Treflan 2 L IBS fb Intervix 600mL POST	Calibre wheat Arcade 2 L + Treflan 2 L IBS	Compass barley Treflan 2 L IBS
3 (1 year break)	Canola XC Battalion Propyzamide 1 L IBS fb Crucial + Clethodim POST + Crucial POST	Calibre wheat Arcade 2 L + Treflan 2 L IBS	Compass barley Treflan 2 L IBS
4 (2 year break)	Titan AX Barley AX Treflan 2 L IBS fb Aggressor 200mL	Wheat Tomahawk CL Plus Treflan 2 L IBS fb Intervix 600mL POST	Compass barley Treflan 2 L IBS
5 (2 year break)	Canola XC Battalion Propyzamide 1 L IBS fb Crucial + Clethodim POST + Crucial POST	Wheat Tomahawk CL Plus Treflan 2 L IBS fb Intervix 600mL POST	Compass barley Treflan 2 L IBS
6 (3 year break)	Titan AX Barley AX Treflan 2 L IBS fb Aggressor 200mL	Lupins - farmer practice Simazine IBS Fb Verdict 520 @ 50 ml/ha + Uptake spray oil at GS14 of brome	Wheat Tomahawk CL Plus Treflan 2L IBS fb Intervix 600mL POST

What happened?

Brome grass plant density

The analysis of data from soil cores collected from the trial site in February showed presence of high brome grass (4908 ± 662 seeds/m^2). The host grower had reported difficulty in achieving good brome grass control in 2023, which was reflected in a high seedbank. Data from seedling establishment pattern was used to determine time taken to 50% emergence (t_{50}), which is an indicator of seed dormancy level of a weed population. Seedling emergence data fitted well to a logistic function and showed t_{50} of Cowell population to be 16 days, which indicates a moderate level of dormancy (Figure 1).

Brome grass plant density in all management systems was similar in assessments undertaken on 2 July. Even though the seedbank of brome was 4900 seeds/m^2, the highest brome grass density was less than100 plants/m^2. This lower-than-expected weed density in 2024 is likely to be associated with the dry conditions for most of the growing season. Herbicide treatment effects manifested themselves clearly after the first weed density assessment. At the second weed density assessment on 7 August, use of Clethodim and Crucial (glyphosate) in herbicide tolerant canola resulted in the lowest brome grass plant density (1.8 plants/m^2) compared to all treatments (Table 5). Other management systems based on wheat and barley had statistically similar weed density.

Brome grass panicle density and seed production

Brome grass plants that survived Sakura + Treflan treatment in System 1 recovered and produced more than 200 panicles/m^2 (Table 6). This recovery to produce large number of panicles may be related to degradation of these herbicides to sub-lethal rates in treated soil. A similar trend was observed for brome grass seed production, with >11,000 seeds/m^2 in Calibre wheat in System 1. All other systems had statistically similar brome seed set (Table 6), with a range from 11 to 97 seeds/m^2, which is 99% lower than the system1 Calibre wheat (Sakura + Treflan). Seed set per panicle ranged from close to 4 seeds/panicle in Battalion canola to 37 seeds/panicle in Calibre wheat where Sakura + Avadex mixture was used for weed control. As expected, there was a strong relationship between brome panicle density and seed production (Figure 2).

Grain yield

Brome grass is highly competitive for resources with crops, and this was reflected in low grain yield in Calibre wheat where Sakura + Treflan mixture was unable to provide effective weed control (Table 7). Grain yield in Calibre wheat was 35% lower than Tomahawk CL, in which imidazolinone (IMI) herbicide Intervix provided effective control of brome grass. The results of this trial clearly show that Titan AX barley provides an effective alternative to the Clearfield system based on IMI herbicides. In Titan AX barley, brome grass plant density, panicle density and seed set (>99% control compared to Calibre wheat) were statistically similar to Tomahawk CL wheat, but Titan AX had higher grain yield than Tomahawk CL in this dry season. The Clearfield system is based on the use of herbicides that can persist in the soil for many months especially under low rainfall conditions. In contrast, Titan AX and other AX systems are based on the use of quizalofop herbicide, which has no soil persistence issues.

Grain yield performance of Battalion canola in an extremely dry growing season was better than expected (>0.5 t/ha) (Table 7). Herbicide tolerant canola adds diversity to the range of effective herbicide options for brome grass control.

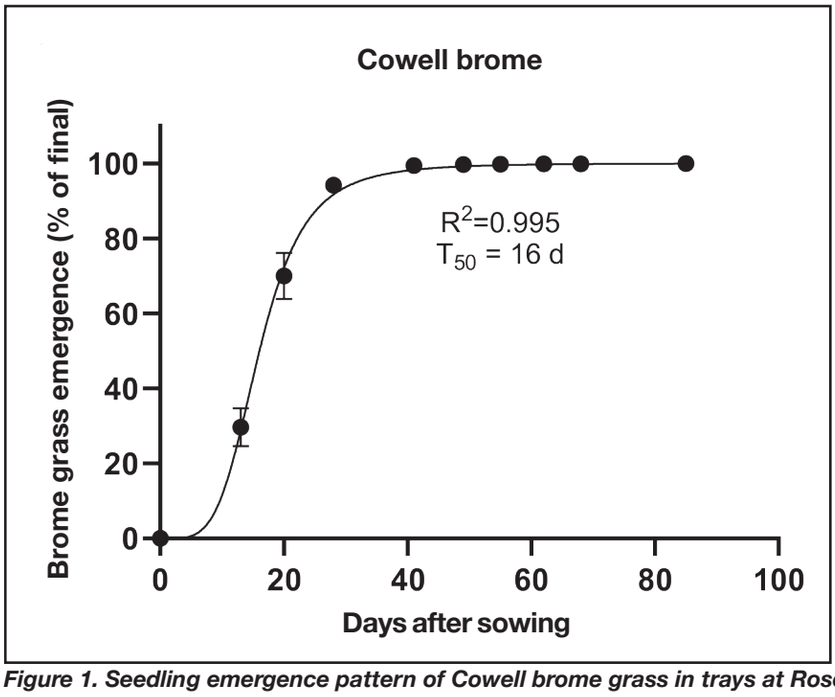

Figure 1. Seedling emergence pattern of Cowell brome grass in trays at Roseworthy in 2024.

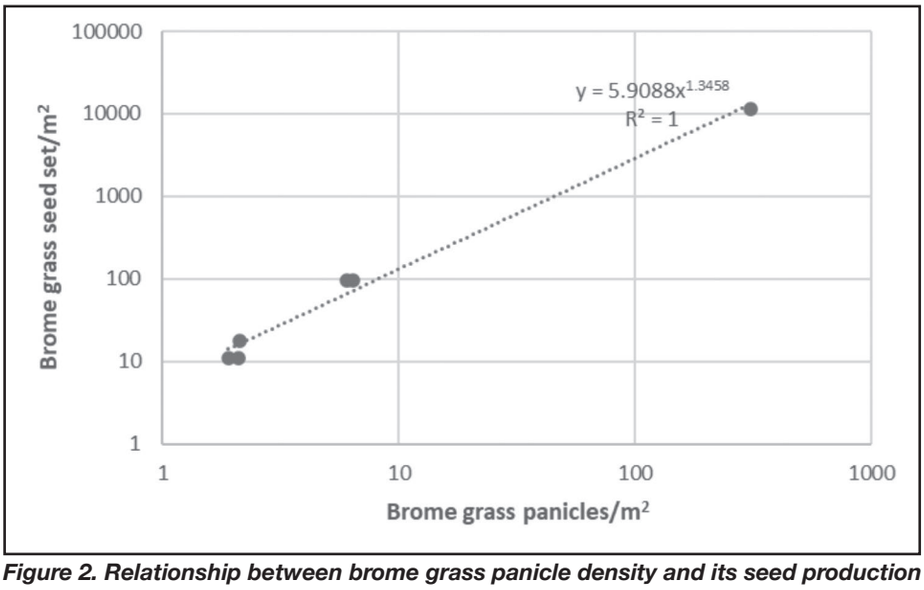

Figure 2. Relationship between brome grass panicle density and its seed production at Cowell, 2024.

Table 5. Effect of different management strategies on brome grass plant density. A different letter (a,b,c) after the mean indicates a significant differences at P=0.05. Square root transformation was used to normalise distribution of residuals for brome plant density.

System	Crop in 2024	Brome plants/m² 2-Jul	Brome plants/m² 7-Aug
1 (no break)	Calibre wheat	78.6	15 b
2 (1 yr break)	Tomahawk CL wheat	81.6	20 bc
3 (1 yr break)	Battalion canola	76.8	1.8 a
4 (2 yr break)	Titan AX barley	89.1	30.9 c
5 (2 yr break)	Battalion canola	62.8	1.1 a
6 (3 yr break)	Titan AX barley	81.6	34.9 c
Probability		*ns*	*P<0.001*

Table 6. Effect of different management strategies on brome grass panicle density and seed production. A different letter (a,b,c) after the mean within a column indicates a significant differences at P=0.05. Square root transformation was used to normalise distribution of residuals for brome plant density.

System	Crop in 2024	Brome panicles/m²	Brome seed set seeds/m²
1 (no break)	Calibre wheat	306.7 b	11308 b
2 (1 yr break)	Tomahawk CL wheat	1.9 a	11 a
3 (1 yr break)	Battalion canola	2.1 a	11 a
4 (2 yr break)	Titan AX barley	6.4 a	97 a
5 (2 yr break)	Battalion canola	2.12 a	18 a
6 (3 yr break)	Titan AX barley	6.0 a	95 a
Probability		*P<0.001*	*P<0.001*

Table 7. Effect of different management strategies on crop grain yield. Different letter after the mean within a column indicate significant differences at P=0.05.

System	Crop in 2024	Crop grain yield (t/ha)
1 (no break)	Calibre wheat	0.29 a
2 (1 yr break)	Tomahawk CL wheat	0.45 b
3 (1 yr break)	Battalion canola	0.52 b
4 (2 yr break)	Titan AX barley	0.74 d
5 (2 yr break)	Battalion canola	0.58 bc
6 (3 yr break)	Titan AX barley	0.70 cd
Probability		*P<0.001*

What does it mean?

Sakura plus Treflan did not effectively control brome grass in Calibre wheat and this can lead to a buildup in brome grass population.

Tomahawk CL wheat had higher yield than Calibre wheat because Intervix effectively controlled brome grass at the site. However, Tomahawk CL produced less yield compared to Titan AX barley with similar levels of brome grass control. Therefore, Titan AX barley in rotational sequences with application of Aggressor AX (Quizalofop) may be a useful option for brome grass control.

There is an opportunity to include canola in cropping sequences as a break crop in this region, as Batallion canola produced higher yield than expected (>0.5 t/ha) in an extremely dry season at Cowell in 2024. Clethodim and Crucial (Glyphosate) provided excellent brome grass control in canola.

Reference

Llewellyn RS, Ronning D, Ouzman J, Walker S, Mayfield A and Clarke M (2016) Impact of Weeds on Australian Grain Production: the cost of weeds to Australian grain growers and the adoption of weed management and tillage practices Report for GRDC. CSIRO, Australia.

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