Brome grass management
Part I: selecting the right rotation and herbicide

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Key findings

- The ecology of brome grass has changed, making it more problematic to control in crops. Higher levels of seed dormancy are allowing brome to escape pre-sowing control tactics, resulting in greater in-crop emergence.
- Increased seed dormancy associated with a requirement for cold or chilling. Under field conditions this increased chilling requirement would not be met until late Autumn or early Winter.
- Knockdown herbicides are less effective in the management of highly dormant populations of brome. Therefore, brome grass management has become heavily reliant on Group A and B herbicides, especially the Clearfield™ technology, which is expected to increase the risk of herbicide resistance development.
- High levels of seedbank persistence from one year to the next (approximately 25%) means multiyear control of brome grass is required to exhaust seedbanks to manageable levels. **Plan a three-year rotation.**

Why do the trial?

The spread of brome grass in South Australia

Brome grass has been infesting crops in SA for many years; however its status as a troublesome weed in cereal crops has become more prevalent in recent years (Llewellyn *et al.* 2015). Increased occurrence of brome appears to be associated with the adoption of no-till farming and the intensification of cereal-based cropping systems (ie. wheat on wheat), where few effective herbicides are available for its control.

Some of the increase in abundance in SA could also be explained by the adoption of earlier sowing or dry sowing. In paddocks where brome has become established, it can reduce wheat yields by as much as 30-50%. In addition the seeds of brome are often found as contaminants in grain samples, resulting in down grading upon delivery to grain handling facilities.

The two main species of brome grass commonly found infesting crops are *Bromus diandrus* and *Bromus rigidus* with accepted common names of great and rigid brome. Both species have similar appearance in early vegetative stage of growth (i.e. hairy leaves and pronounced striping at the base of the stem), but they are clearly distinguished in the reproductive stage with *B. diandrus* possessing a looser or nodding panicle in contrast with the erect or rigid panicle of *B. rigidus*. *B. diandrus* is more prevalent in crops across the Mid-North where it can be found on acid or alkaline sandy or loamy sands, whereas *B. rigidus* is more common on calcareous sands in the coastal regions.

A change in brome grass behaviour

Selection for increased seed dormancy could be responsible for the increased dominance of this weed species over the last ten years. Research has clearly shown higher levels of seed dormancy in brome grass populations collected from cropping fields than those from non-crop situations such as fence-lines or roadsides (Figure 1).

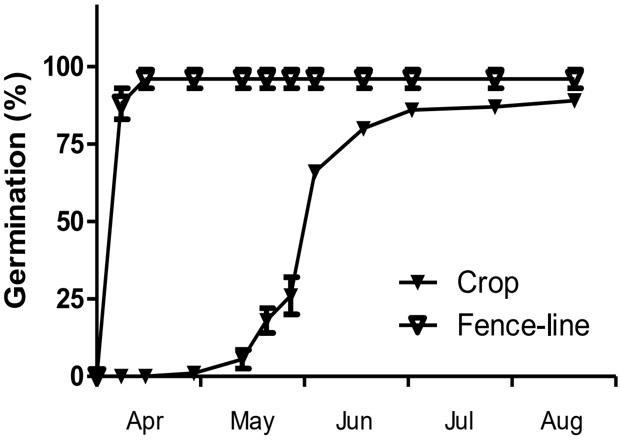

Figure 1. Differences in germination and seedling emergence between in-crop and fence-line populations of great brome collected from the same farm at Warnertown, SA. Bars show ± standard error.

These results clearly indicate that management practices used by farmers to control brome in cropping paddocks can cause a shift in weed population behaviour. This increase in seed dormancy appears to have been caused by the selection of individuals in these populations that possess greater seed dormancy to escape pre-sowing weed control tactics such as tillage or knockdown herbicides. The process of selection for increased seed dormancy would be similar but slower than selection for herbicide resistance. Over time weed management in cropping paddocks would select for biotypes that possess higher dormancy and select against or kill plants with low dormancy.

Germination of dormant seeds of brome grass was overcome by the addition of gibberellic acid (GA) rather than by seed coat removal indicating that dormancy is under hormonal control in the embryo. Seed of these dormant populations of brome grass were also responsive to chilling (i.e. exposure to 5°C), a process which has been shown to increase GA production within the seed. In the field this means that the dormant brome grass requires not only moisture, but also a period of cold temperatures to germinate. Therefore, significant germination of highly dormant brome populations would not be expected until cooler-moist conditions in late Autumn-early Winter, allowing it to evade early control tactics and emerge within crops. Another biological mechanism that appears to be contributing to delayed emergence is the strong inhibitory effect of light on seed germination. Strong photo-inhibition is likely to aid brome survival in the field by preventing germination in seeds present on the soil surface until after the sowing of the crop, thus preventing seedlings from being killed by seed-bed preparation. This feature of brome grass ecology would enable this species to proliferate under no-till, where seeds remain on the soil surface until burial by the sowing pass that would overcome the inhibitory effect of light.

Selection for greater seed dormancy in brome grass is likely to have contributed to the development of more persistent seedbank. A field study undertaken at Lock showed that seedbank carryover of brome from one season to the next was 20%, with seeds remaining viable on the soil surface for up to three years (Figure 2). Similar levels of persistence were also shown in the long-term study at Balaklava where more than 25% of seedbank persisted from one season to the next. Seedbank carryover of this magnitude could be an important factor in the proliferation of brome grass where crop rotations have provided only a single year's intervention (ie pasture-wheat rotation) or a single break crop in rotation with cereals or under cereal monoculture where few effective herbicide options have been available in the past.

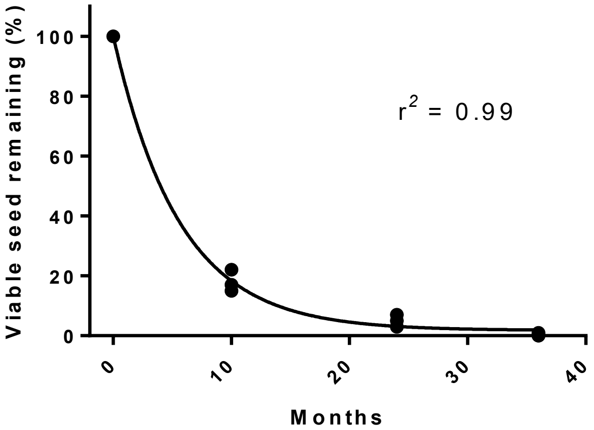

Figure 2. Longevity of brome grass seed in the field at Lock from 2003 to 2006.

How was the trial done?

Trial location:	Balaklava	**Plot size:**	5.8 m x 15 m
Rotation	**Cropping phase**	**Herbicide strategy (HS)**	
Lupin/TT canola/wheat/barley	Lupin	HS1: Simazine pre haloxyfop post HS2: Simazine pre haloxyfop post paraquat crop-top	
	TT canola	HS1: Atrazine pre atrazine plus haloxyfop post HS2: Propyzamide pre atrazine plus haloxyfop post glyphosate crop-top	
	Wheat (CLF)	HS1: Trifluralin pre Intervix post HS2: Sakura plus avadex pre Glyphosate crop-top	
	Barley (CLF)	HS1: Trifluralin plus metribuzin pre HS2: Trifluralin pre Intervix post	

The trial design is a split-plot; with four crop phases assigned to main-plots and two herbicide strategies to sub-plots with three replicates. Pre-sowing herbicides were incorporated by sowing within a few hours of application, while post-emergent herbicides were applied following label recommendations. Brome seedbank (seeds/m^2) was monitored in March and September of each year from 2014 to 2016 to determine combined effectiveness of cropping phase and herbicide strategy against brome (% of the initial population).

Results and discussion

Lupins followed by TT-canola provided two consecutive years of effective control and reduced brome seedbank by 93-96% (Figure 3a). Similar levels of seedbank depletion (93%) was achieved when CLF-wheat followed TT-canola. The effectiveness of combinations of pre- and post-sowing herbicides, plus seed-set control tactics, used in these rotations were able to deplete the seedbank to low levels within two years (from ~600 seeds to <30 seeds/m^2).

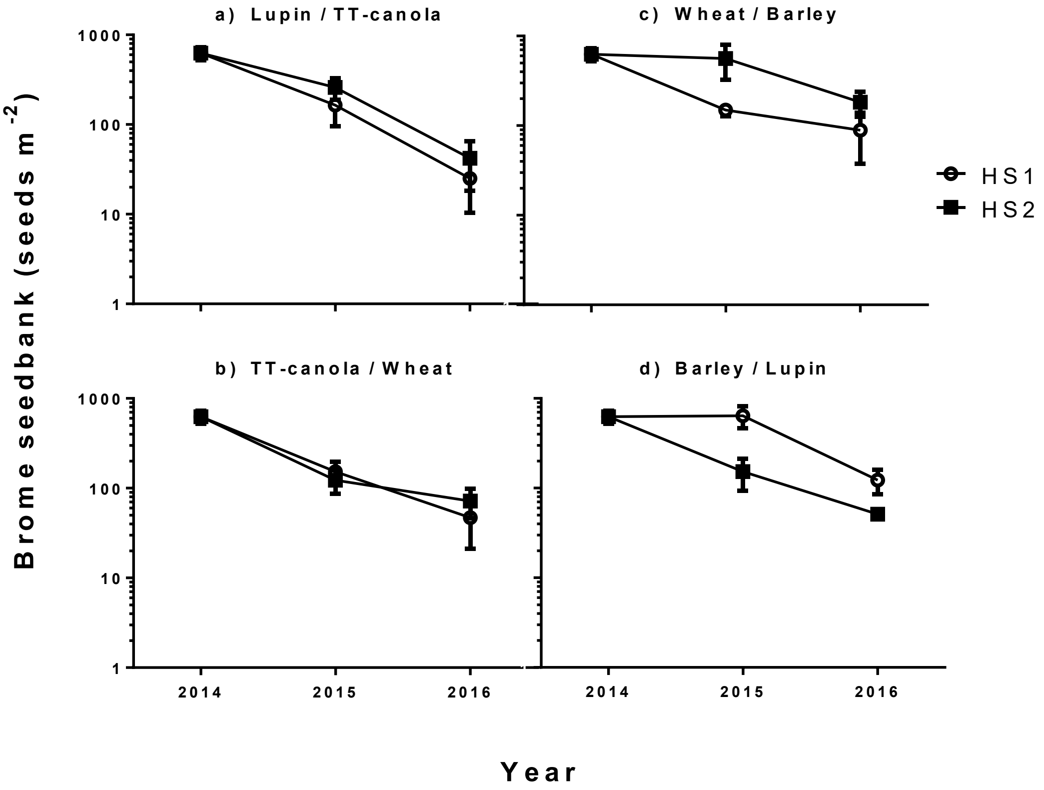

Figure 3. Change in brome seedbank in response to herbicide strategy (HS1-2) in (a) lupin/TT-canola, (b) TT-canola/wheat, (c) wheat/barley, and (d) barley/lupin rotational phases at Balaklava. Vertical bars represent standard error. The initial brome seedbank was 626 seeds/m^2.

Brome control in lupins was particularly effective because crop-topping with paraquat ensured late escapes were unable to set viable seed. Recent registration of Weedmaster® DST® (glyphosate) at windrowing or desiccation also provides an opportunity for seed-set control in canola. Even though brome seedbank declined under crop phases of wheat-barley and barley-lupin (Figure 3c & d), brome seedbank remained higher, which could be the legacy effect of less effective control by pre-sowing herbicides and absence of seed set control in cereals. Because brome is a prolific seed producer it would expected to rebound quickly under these phases of the rotation to cause high levels of crop yield loss and harvest contamination.

Herbicide efficacy

Recent introduction of several imidazolinone-tolerant crops as part of the Clearfield™ system provides excellent opportunity to control brome and avoid herbicide residue issues. However, overreliance on this herbicide group (ALS-inhibitor, Group B) has unfortunately led to resistance to these herbicides, with the first SA case recently reported (pers. comm. P Boutsalis). Many populations from the Victorian Mallee already show confirmed resistance to Group A herbicides Targa and Verdict. Alternate herbicide and cultural tactics for controlling brome should be implemented as part of an effective IWM plan to help delay herbicide resistance development.

Recognising the need to find more effective alternatives to the heavily used Group A and B herbicides, several herbicide efficacy trials funded by GRDC have been undertaken over the past four years in SA and Victoria. The trials have compared several new and experimental pre-emergent options against common farmer practice of IBS (incorporated by sowing) trifluralin plus logran in wheat (see Figure 4).

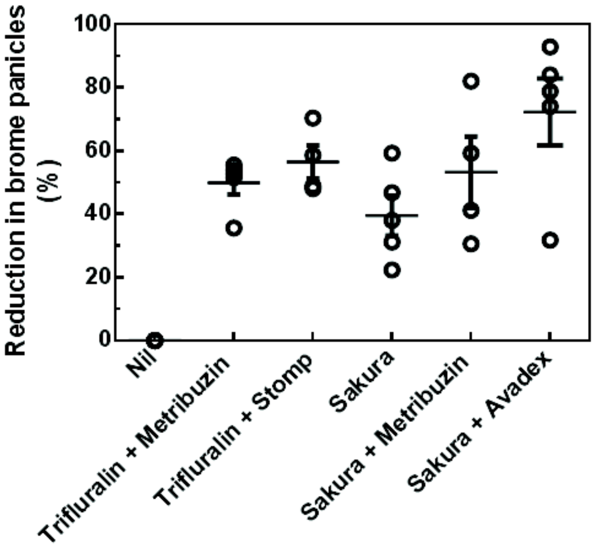

Figure 4. Performance of different pre-emergent herbicides on brome grass from several field trials undertaken across SA and Vic. Horizontal and vertical bars represent the average and standard error.

Of the herbicides examined, Sakura plus Avadex provided the best brome control (averaging >75%) at most of the field trials (Figure 4). However, in seasons with below-average rainfall, the mixture was less effective (<35% weed control). While Sakura plus Avadex has been the most consistent option, it is unfortunately cost prohibitive ($70/ha) for many growers in low rainfall environments where herbicide budgets are constrained by low crop yields. At low brome infestations, tank mixes of trifluralin with either Stomp or metribuzin, whilst providing lower control (50-60%) have been far more cost effective.

Participants of a brome grass workshop inspecting the herbicide efficacy trial which include current and new chemistry. Balaklava, September 2016.