Brome grass behaviour & management

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Key messages

- Brome grass has increased in prevalence across the South Australian and Victorian Mallee since adoption of no-till farming and with intensification of cropping.
- The ecology of brome grass has changed, making it more problematic to control in crops. Higher levels of seed dormancy are allowing brome to thwart early control tactics, resulting in greater emergence in-crop.
- Increased dormancy was associated with a requirement for cold stratification 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.
- Because of high levels of seedbank persistence from one year to the next (~25%) multiyear control of brome grass is required to exhaust seedbanks to more manageable levels. Plan a three-year rotation.

Background

Brome grass has been infesting crops for many years; however, its status as a troublesome weed in cereal crops across southern Australia has been on the rise in recent years (Llewellyn et al 2015). This well adapted weed has increased in prevalence with growing adoption of no-till farming and with intensification of cereal-based cropping systems (i.e. wheat on wheat), where few effective herbicides are available for control. Some of the increase in abundance in low rainfall areas of South Australia could also be explained by adoption of earlier sowing or even dry sowing. Where brome has become an issue, it can significantly reduce productivity, and has been shown to 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 dockage 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 (ie hairy leaves and pronounced stripping at base of the stem), but they are clearly distinguished at 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 South Australian and Victorian Mallee where it can be found on acid or alkaline sandy or loamy sands, whereas *B. rigidus* is more common to calcareous sands along coastal regions.

Brome grass behaviour

Increased seed dormancy has also been responsible for the dominance of this weed species. Our 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).

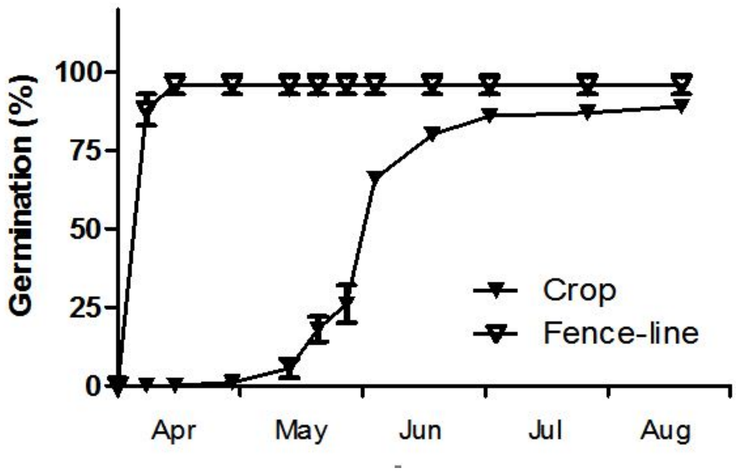


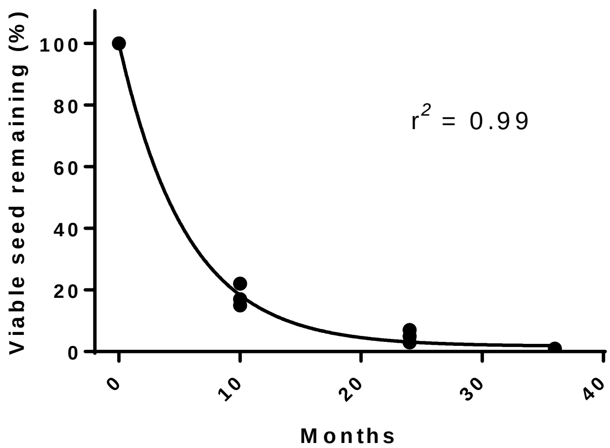
Figure 1. *Differences in germination and seedling emergence between in-crop and fence-line populations of great brome collected from the same farm at Warnertown, SA. Bars show ±SE.*

These results clearly indicate that management practices used by farmers to control brome in cropping paddocks have caused a shift in weed population behaviour. This increase in seed dormancy has been caused by selection for 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 remove those with low dormancy.

Germination of dormant seeds of brome grass was overcome by addition of gibberellic acid (GA) rather than by seed coat removal indicating that dormancy is under strong hormonal control in the seed embryo. Seed of the same 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 a period of colder temperatures to germinate. Therefore, larger germinations of brome would not be expected until cooler-moist conditions in late autumn-early winter, allowing it to evade early control tactics and emerge in 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 enabling seeds to remain ungerminated on the soil surface until sowing of the crop, thus preventing seedlings from being killed by seed-bed preparation. This feature of brome grass ecology also goes some way to explaining why it has proliferated under no-till, where seeds remain on the soil surface until being buried by the sowing pass, removing the inhibitory effect of light.

Greater dormancy in brome grass has also likely contributed to development of more persistent seedbank. A field study undertaken at Lock showed that seedbank carryover of brome from one season to the next to be as high as 20%, with seeds remaining viable on the surface for up to 3 years (Figure 2). Similar levels of persistence were also shown at 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 under cereal monoculture where few effective herbicide options have been available in the past.

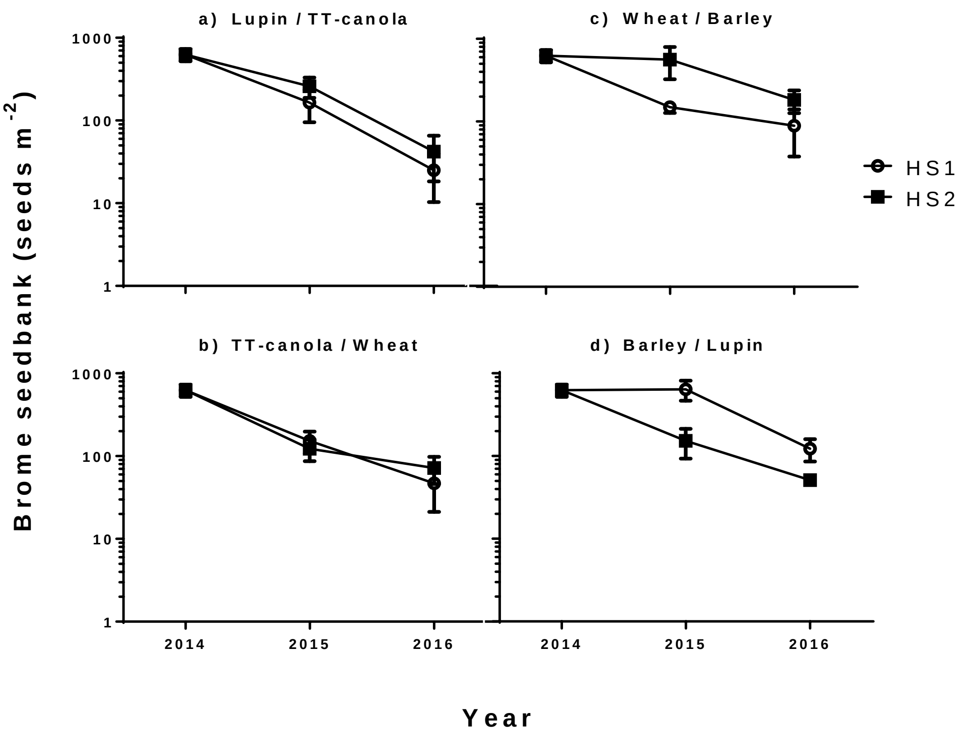
Figure 2. *Longevity of brome grass seed in the field at Lock from 2003 to 2006.*



Brome grass management

If long-term control of brome is to be achieved given the persistence of seed in the soil, then effective multiyear management is required in order to deplete the weed seedbank. Fortunately, the introduction of imidazolinone-tolerant wheat (Clearfield™) has widened grower's options for the management of brome in the wheat cropping-phase. Alternatively break crops, either legume or canola, can provide a range of options for brome control and can be included in a rotation to prevent seed set. In a field study undertaken at Balaklava (SA), crop rotations that utilised break crops of lupin with TT-canola, a high level of effective control and reduction in the brome seedbank was achieved (93-96%; Figure 3 (a)). Similar levels of seedbank depletion (93%) resulted 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 manageable levels within 2 years (from ~600 seeds to <30 seeds/m^2).

***Figure 3**. Change in brome seedbank in response to herbicide strategy (HS1-2) in lupin/TT-canola (a), TT-canola/wheat (b), wheat/barley (c), and barley/lupin rotational phases at Balaklava. Vertical bars represent SE. The initial brome seedbank ~626 seeds/m2.*

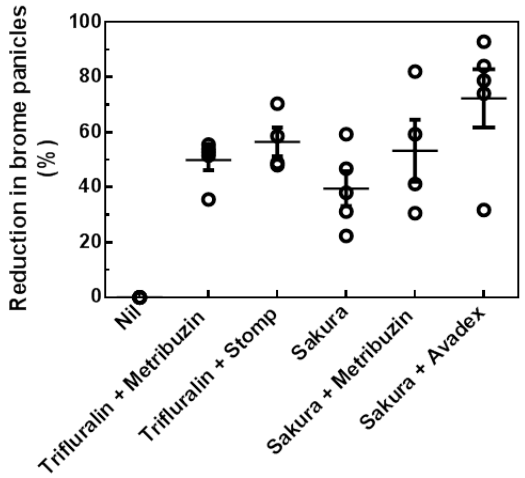


Control in lupins was particularly effective because crop-topping with paraquat ensured that late escapes were unable to set viable seed. Recent registration of Weedmaster® DST® (glyphosate) at windrowing or desiccation also provides an opportunity for seed set control in canola. Even though brome seedbank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

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

Of the herbicides examined, Sakura plus Avadex provided excellent brome control (averaging >75%) at most of the field trials (Figure 4). However, where moisture conditions were inadequate, the mixture struggled to provide adequate control (<35%). 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. Several experimental herbicides have also been evaluated alone or as tank mixtures with Avadex. Some treatments appear to be useful.

Figure 4. *Performance of different pre-emergent herbicides on brome grass from several field trials undertaken across South Australia and Victoria. Horizontal and vertical bars represent the mean and SE.*



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 South Australian 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. A few examples are shown in Table 1.

Table 1. Effectiveness of different management tactics and techniques for brome grass control (Source: Bowcher, Gill & Moore, 2005).

Tactic	Likely % control (range)	Comments on use
Burning residues	70 (60-80)	Sufficient crop residues are needed – not recommended on light soil types.
Autumn tickle	50 (20-60)	Depends on seasonal break. Seed burial through shallow cultivation enhances seed depletion through germination, especially in *B. diandrus* with its shorter dormancy and faster germination.
Delayed sowing	70 (30-90)	Depends on seasonal break and brome population - less effective for dormant brome.
Knockdown (non-selective herbicide)	80 (30-99)	If possible delay spraying until full emergence and youngest plants have 2 leaves.
Pre-emergent herbicide	80 (40-90)	Follow label recommendations, especially on incorporation requirements of some herbicides. Use triazines and trifluralin mainly in pulses.
Post-emergent (selective)	90 (75-99)	Apply when weeds have 2-6 leaves and are actively growing – consult label.
Pasture spray-topping	75 (50-90)	Timing is critical. Respray or graze survivors.
Silage & hay	60 (40-80)	Hay freezing works well. Silage is better than hay. Graze or spray regrowth.
Grazing	50 (20-80)	Graze infested areas heavily and continuously in winter and spring.
Residue collection at harvest	40 (10-75)	Works best on early harvested crops before weeds drop their seeds – less effective for *B. rigidus* because of its early maturity

Acknowledgements

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Useful link:

http://www.sagit.com.au/brome-grass-bulletin/