BROME GRASS FACT SHEET

NATIONAL

DECEMBER 2021

Brome grass, rigid brome and great brome

A diverse management strategy over two or three years, with late season control of survivors, is the key to depletion of the brome grass seedbank.

KEY POINTS

- Brome grass is common to southern Australian cropping systems in low, medium and high-rainfall regions. It is favoured by reduced tillage and increased intensity of cropping
- The common species, great brome (*Bromus diandrus*) and rigid brome (*B. rigidus*), are very similar and cannot be distinguished in the field. There is considerable variation between populations of each species in terms of seed dormancy and emergence times
- Staggered and delayed emergence during the season make it impossible to control this species with pre or post-emergent herbicide use alone. A diverse range of weed control tactics, including seed-set control, is usually required to drive the seedbank to low levels
- Optimal control is achieved in break crops or by growing herbicide-tolerant cereals, as these rotations allow use of more effective in-crop herbicide options
- Herbicide resistance is still rare over most of Australia, although there are regions with increasing resistance issues. Self-pollination ensures there is little opportunity for resistance spread by pollen flow. In the areas where resistance remains uncommon, make sure resistant seeds are not introduced to the farm or spread from one paddock to another on the same farm
- Depending on the density of the initial brome grass population, aim for three to four years of effective control to deplete the seedbank

Photo: Catherine Borger, DPIRD

A sparse infestation of brome grass may still reduce yield.

Brome grass in Australian cropping systems is referred to as *Bromus diandrus* (great brome or ripgut brome) and *B. rigidus* (rigid brome).

It is not possible to distinguish between *B. diandrus* and *B. rigidus* in the field, and taxonomists think the two may actually be subspecies of a single species.

This fact sheet refers to *B. diandrus* and *B. rigidus* collectively as brome grass. Other *Bromus* species, including *B. hordeaceus* (soft brome) and *B. rubens* (red brome), are common in localised areas and may also be referred to as brome grass.

Brome grass is a winter annual grass weed widely distributed across southern Australia (Figure 2). Brome grass seedlings often have a reddish colour at the base or red-purple veins (Figure 3).

Adult plants can be up to one metre tall with wide (10 millimetre), hairy leaves. Leaves may turn red as

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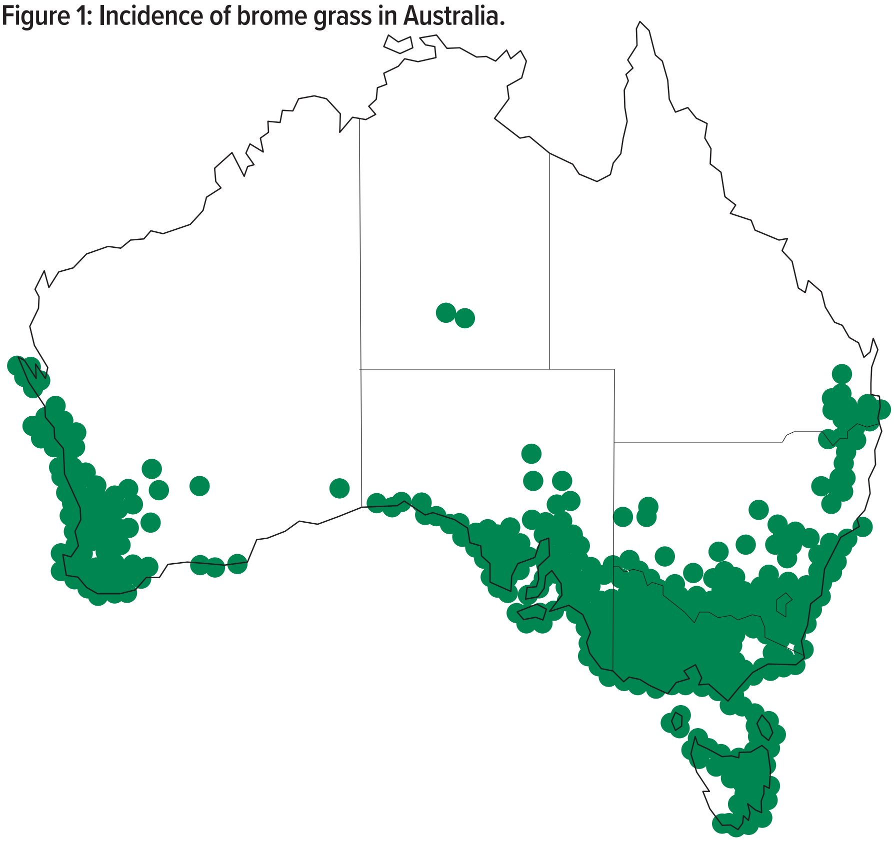
they mature. The ligule (thin outgrowth at the junction of the leaf and leafstalk) is prominent, membranous, white and with a fringe of hairs.

The seed heads (panicles) are nine to 20 centimetres long and can be loose and nodding like that of an oat plant or more compact and erect (Figure 4). The spikelet (cluster of seeds) is 24 to 44mm long with four to eight seeds. The awn (bristle extending from the top of the seed) is three to eight centimetres long, allowing the seeds to easily lodge in wool or skin of livestock. Flowers are generally self-pollinated; outcrossing is possible but rare.

Why is it a weed?

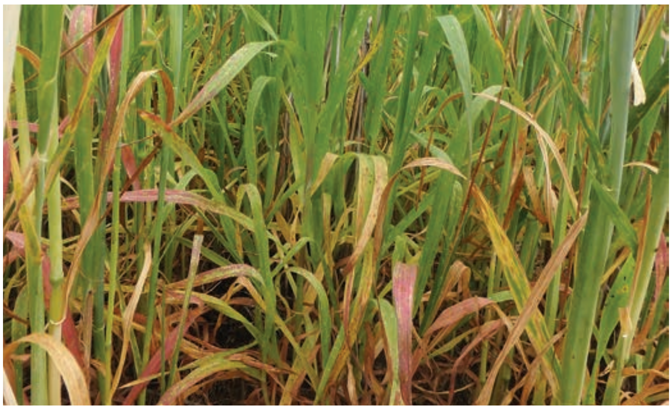
Brome grass is a serious weed of many Australian cropping regions but is particularly prevalent in the low-rainfall zones of Western Australia, South Australia, Victoria and southern New South Wales. It is estimated to cause $22.5 million in lost revenue annually across all regions, which is fourth on the list of all grain cropping weeds.

Figure 1: Incidence of brome grass in Australia.



Source: Courtesy of Australia's Virtual Herbarium, 2021

Top left: Brome grass seeds. Top right: Seedlings with a reddish base. Bottom left: The white ligule at the junction of the leaf and leaf stalk. Bottom right: Tillering plants in the inter-row of a wheat crop, with older leaves turning a reddish colour.



Photos: Catherine Borger, DPIRD

An example of a loose panicle (seed head), similar to that of an oat crop, or a compact panicle. Both species of brome grass (*Bromus diandrus* or *B. rigidus*) can have either the loose or compact panicle.

Photos: courtesy Dr Sam Kleemann, Plant Science Consulting, Australia

Brome grass has increased in prevalence due to increased intensity of cereal cropping as there are limited in-crop weed control options, including selective herbicides.

Brome grass has increased in prevalence due to increased intensity of cereal cropping as there are limited in-crop weed control options, including selective herbicides. This weed is also favoured by dry seeding and reduced tillage systems. As seedling emergence is stimulated by burial (i.e. dark conditions), the seedlings are unlikely to emerge until crop seeding buries a portion of the seeds.

The reduced tillage system, in which a high proportion of seeds are left on the soil surface, leads to delayed, staggered emergence of multiple cohorts. However, dense crop residue may produce enough shade to create dark conditions at the soil surface and stimulate emergence. Staggered emergence is also common on non-wetting sands. Delayed emergence makes it very difficult to get complete control with pre-emergent or early post-emergent herbicides.

Brome grass is more competitive with crops than are other common grass weeds such as barley grass (*Hordeum* spp.) or annual ryegrass (*Lolium rigidum*). A dense infestation can reduce wheat yield by 95 per cent (Figure 5) and lupin yield by 60 per cent, but a sparse infestation will still cause yield loss. The seeds contaminate grain, leading to a financial penalty if the level of contamination exceeds the prescribed limit.

Seeding with contaminated grain may introduce the weed to a new area or spread herbicide-resistant populations.

The sharp awns on the seeds allow them to penetrate the skin, mouth, eyes and intestines of livestock, causing animal welfare issues and reduced revenue from contaminated wool or carcass.

Biology and ecology

Brome grass is well adapted to high, medium and low-rainfall environments. Seed production can be more than 30,000 seeds/m^2 in a crop. Seeds produced at the end of the cropping season are initially dormant, requiring an after-ripening period over summer. Germination is stimulated by cold and dark conditions, so most seeds do not emerge until autumn/winter, around crop seeding.

Moisture is the biggest determinant of brome grass germination, which can be very low if autumn is dry or for non-wetting soils. Seeds can remain viable for at least four years in the soil. It is possible for more than 20 per cent of the seedbank to carry over from one season to the next. However, given adequate rain and seed burial, seven sites across Western Australia and South Australia had 90 to 99 per cent of seeds emerge in the first year after seed production.

In South Australia, research has indicated that some brome grass populations have developed a greater degree of dormancy early in the season to further delay emergence and avoid pre-emergent and post-emergent herbicides. This increased dormancy has not been observed in Western Australia.

Seed retention at crop maturity is variable, dependent on population and season. In Western Australia it can range from 0 to 77 per cent. Even where seed retention is high, shedding occurs rapidly following crop maturity (Figure 6).

Management

Brome grass is a major weed of cropping and pasture systems throughout southern Australia but can be effectively managed through an integrated weed management (IWM) plan over three to four years. The efficacy of many control techniques can be highly variable, depending on seasonal conditions and soil moisture (Table 1). Further, many herbicides offer suppression rather than control and give very poor control when brome grass density is high.

An effective IWM plan needs to target this species with a range of control techniques in a single season, including chemical and non-chemical techniques, with the aim of:

- depleting the seedbank;
- killing existing weeds;
- preventing seed-set;
- avoiding seeds entering the seedbank; and
- preventing introduction of seeds from external sources.

Herbicide options

Knockdown herbicides

Knockdown herbicides are only effective in those seasons where there is a flush of emergence before crop planting. Optimal emergence requires dark conditions, and high crop residue biomass in a zero-tillage system can cause enough shade to create dark conditions. However, emergence also relies heavily on cold temperatures and adequate soil moisture. If combined with an autumn tickle using light harrows (and sufficient rainfall), knockdown herbicides are highly effective.

Pre-emergent herbicides

There are an increasing number of pre-emergent herbicides available for control of brome grass. However, performance of individual herbicide products is variable and is often poor in dry conditions. Dry conditions also result in low or staggered germination of brome seeds, further reducing control by pre-emergent herbicides.

Multiple products provide suppression rather than control of brome grass, i.e. cinmethylin (Luximax®, Group 30 (T)), bixlozone (Overwatch®, Group 13 (Q)) and simazine (Group 5 (C)). Control is often poor in dense populations of brome grass.

While mixtures such as pyroxasulfone plus triallate reliably provided good control (90 per cent or more), research in South Australia and Victoria indicated that control by a range of pre-emergent herbicides was normally less than 90 per cent in this crop.

Post-emergent herbicides

Control in wheat can be achieved by a range of Group 2 (B) herbicides, i.e. Intervix® (imazamox and imazapyr) for use in Clearfield® wheat varieties, Monza® (sulfosulfuron), Atlantis® (mesosulfuron-methyl) and Crusader® (pyroxsulam).

Some limitations include: plant-back restrictions (especially in low-rainfall seasons), herbicide cost and occasional damage when applied to stressed crops. In addition, Monza®, Atlantis® and Crusader® tend to provide suppression rather than a complete kill of brome grass, so control is again reduced in high-density weed populations. Plants may still produce seeds. In some areas such as the South Australian and Victorian Mallee, resistance in brome grass to sulfonylurea herbicides is significant.

Post-emergent control in barley includes Group 2 (B) in Clearfield® varieties or metribuzin (Group 5 (C), i.e. Sencor®). A Group 5 (C) herbicide offers a different mode of action to the Group 2 (B) products in wheat, but performance of metribuzin can be variable, particularly in dry conditions or non-wetting sands. It may also cause crop damage if excessive rainfall moves this product into the furrows.

In break crops (e.g. lupins, canola, field peas) a wider range of herbicide options is available for brome grass control. Herbicide-tolerant canola in particular (i.e. triazine tolerant, Roundup® Ready or Clearfield®) allows greater rotation of chemical groups. The triazines (Group 5 (C), i.e. simazine) and Group 1 (A) herbicides (i.e. Targa®)

Figure 2: Yield of wheat cv. Mace⦸ infested with brome grass or annual ryegrass (as a percentage of the weed-free control) over three years. Note that each weed species was sown at a rate of 100 seeds/m² prior to sowing the crop in year 1 and left to grow uncontrolled, except for non-selective herbicide application before seeding each year. Weed density was 60, 346 and 1168 brome grass plants/m² and 65, 198 and 405 annual ryegrass in years 1, 2 and 3.

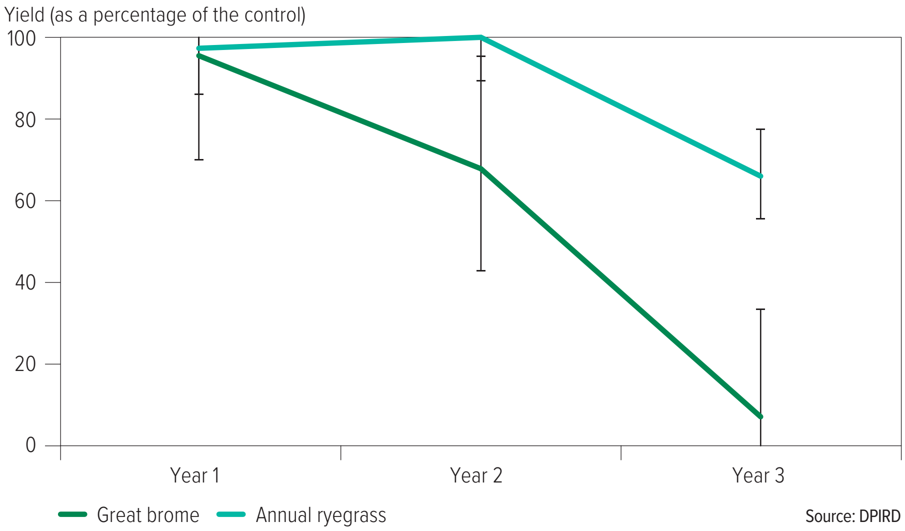


Figure 3: Percentage of seeds retained by a single population of brome grass in a wheat cv. Mace⦸ crop at Wongan Hills, Western Australia, over three years from early October to the time of crop harvest. Seed retention was high in early November in each year, but seeds shed rapidly later in November.

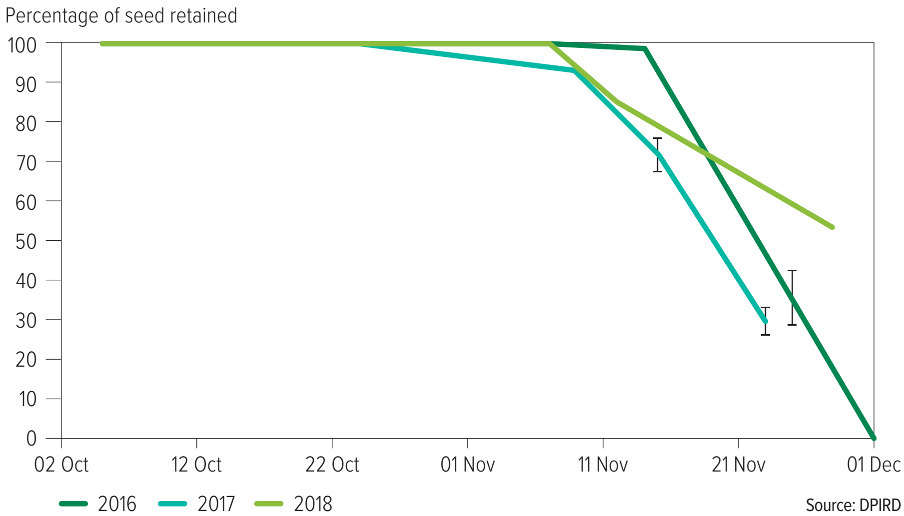


Table 1: Weed control tactics. The percentage weed control or range in control achieved by each tactic and comments on effective use.

Tactic	Likely control (range)	Comments on use
Burning residue	70% (65–96%)	Dependent on crop residue biomass.
Shallow cultivation in autumn	50% (20–60%)	Brome grass emergence is stimulated in dark conditions, but this tactic is dependent on seasonal break and adequate moisture.
Full soil inversion	98% (97–99%)	Initial burial by a mouldboard removes most seeds, but not all seeds are buried deep enough to prevent emergence.
Knockdown herbicides pre-sowing	80% (30–90%)	Highly dependent on autumn rainfall, time of sowing and the dormancy of the brome grass population. With populations that have low seed dormancy, this tactic can be highly effective. If possible, wait until plants are at two-leaf stage. Control by knockdowns <1% in dry-seeding systems as most seeds have not yet germinated.
Pre-emergence herbicide	80% (8–95%)	Highly variable performance due to product efficacy, seasonal conditions and population density.
Post-emergence herbicide	90% (75–99%)	Apply at two to six-leaf stage of actively growing weeds.
Spray topping	75% (50–90%)	Seasonal conditions affect time of maturity. Different cohorts may be at different growth stages. Respray or graze survivors.
Silage and hay	60% (40–80%)	Graze or spray regrowth.
Grazing	50% (20–80%)	Dependent on grazing pressure in winter and spring. Brome grass is avoided by livestock once flower heads emerge.
Harvest weed seed control	50% (36–77%)	Seasonal conditions affect degree of shedding at crop maturity, but removal of even a small proportion of seeds has long-term value.

Table 2: Model output to predict the number of brome grass seeds in the soil, in December each year in a six-year wheat/wheat/lentil rotation. In the model, harvest was set to normal harvest (1% of brome grass seeds removed as a contaminant of grain) or harvest weed seed control destroying 20%, 40%, 60%, 80% or 100% of the brome grass seeds. The initial soil seed bank (before the six-year rotation) had 100 seeds/m².

	Percentage seed capture at harvest					
Year	1%	20%	40%	60%	80%	100%
1	319	266	210	143	125	42
2	2709	1890	1179	309	247	13
3	1831	1197	692	209	168	5.2
4	5611	3279	1593	487	350	1.4
5	18,210	9997	4204	266	191	0.7
6	10,954	5925	2378	86	59	0.1

Pasture topping with paraquat or glyphosate can prevent seed-set, although this is not a reliable control method.

are very effective in broadleaf crops. While resistance is uncommon in brome grass, other grass weeds in Australia and overseas have readily developed resistance to Group 1 (A) herbicides.

Spray topping

Pasture topping with paraquat or glyphosate can prevent seed-set, although this is not a reliable control method. Timing is critical and it is possible that the brome grass cohorts will not all be at the same development stage. The issue of optimal developmental stage becomes even more difficult when targeting more than one weed species with spray topping.

Late-season control

Brome grass seeds can last in the seedbank for three to four years, but most will emerge in the year following seed production. Therefore, the population can be dramatically reduced by one to two years of intense control with zero seed-set. However, staggered emergence within a season makes it difficult to kill all plants with pre or post-emergent herbicides.

For late-season control, consider:

- glyphosate application in localised areas where brome grass infestation is the heaviest;
- green manuring to sections of the paddock with extremely dense or herbicide-resistant populations;
- early hay cut or heavy grazing; and
- seed collection and residue management at harvest.

Seed shedding is variable, but simulation modelling of harvest weed seed control in multiple field trials indicated that even modest seed destruction (20 per cent) is helpful in reducing the soil seedbank (Table 2). Seed destruction can be achieved through harvest weed seed control methods such as seed impact mills or narrow windrow burning.

Herbicide resistance

Total levels of herbicide resistance remain low, but resistance is common in localised regions such as the South Australian and Victorian Mallee. Populations have been identified with resistance to Group 1 (A) (FOPs), Group 2 (B) (imidazolinones, sulfonylureas) and Group 9 (M) (glyphosate) herbicides. Outcrossing is uncommon, so resistance is unlikely to spread via pollen flow between fields.

The most likely way resistant populations will spread is through grain contaminated with brome grass seeds. A study in Western Australia found brome grass seeds in 29 per cent of cleaned grain samples taken from storage bins on farm. Livestock may also carry seeds in wool. In those regions where resistance remains uncommon, good farm hygiene and prevention of resistant seed movement are important parts of brome grass management.

An IWM plan

- Use a robust crop rotation, ensuring at least two consecutive years of management to deplete the seedbank (three years for a very dense population of brome grass). For example, a break crop such as lupins or canola followed by Clearfield® wheat allows a rotation of herbicide groups and gives good control.
- Registered imidazolinone herbicides are very effective. However, their use should be considered with future rotation options in mind.
- Good crop agronomy is a key part of any IWM plan. A healthy, competitive crop is particularly important when using herbicides that suppress rather than kill brome grass.
- In low-rainfall environments, pasture might be a better choice of rotation, with the use of heavy grazing in winter followed by spray topping or brown manuring in spring.
- Aim for late-season control; harvest weed seed control tactics may only destroy a small portion of the seeds but this still has long-term benefits for reducing the soil seedbank.
- Herbicide resistance remains uncommon but resistant populations exist for some herbicide groups. Ensure potentially resistant seeds are not spread around the farm.

The Brome RIM Model is a hands-on, user-friendly decision-support software tool. It is well suited to testing brome grass strategies before taking the leap to make financial investments or practice changes on-farm. It enables users to look at long-term management scenarios, weed numbers over time and the profitability of different combinations of control strategies.

MORE INFORMATION

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USEFUL RESOURCES

Ecology of Major Emerging Weeds (August 2021): https://grdc.com.au/resources-and-publications/all-publications/publications/2021/ecology-of-major-emerging-weeds

Brome RIM Model: ahri.uwa.edu.au/our-research/wim-weed-integrated-management-tools/brome-rim

Common Weeds of Grain Cropping: the Ute Guide (April 2020): grdc.com.au/resources-and-publications/all-publications/common-weeds-of-grain-cropping-the-ute-guide

***GroundCover*™ May/June 2021 edition:** Brome grass control takes persistence – groundcover.grdc.com.au/weeds-pests-diseases/weeds/brome-grass-control-takes-persistence

Integrated Weed Management Manual: grdc.com.au/resources-and-publications/all-publications/publications/2019/iwmm

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