Harvest Weed Seed Destruction – Does it Work for Great Brome and Barley Grass?

Catherine Borger, Abul Hashem, Department of Primary Industries and Regional Development, Western Australia

Key messages

Shedding of great brome and barley grass varies between seasons and ecotypes. Plant height also varies between ecotypes.

Harvest weed seed destruction will be effective for some populations, in some years, but growers need to be familiar with the ecological characteristics of their own populations to plan effective weed management strategies.

Aims

Brome grass and barley grass are ranked as the fourth and ninth most detrimental weeds nationally, with an annual revenue loss of $22.5 and $1.7 million respectively (Llewellyn et al, 2016). A potential control technique for these species is harvest weed seed destruction (Walsh et al, 2013). However, both species shed seed at maturity, and harvest weed seed destruction is most effective for those species that retain the majority of their seed, like annual ryegrass (Walsh et al, 2013). Initial work indicated that great brome retained 77% of seed at crop maturity, although seed retention dropped to 40% over the following 28 days of the harvest period (Walsh & Powles, 2014). However, this research occurred in a single year and did not capture the seasonal variability in great brome shedding. There is no research on the variability of barley grass seed retention. This research investigated seed shedding variation between populations of great brome and barley grass.

Method

Field trial

A field trial was conducted at Department of Primary Industries and Regional Development (DPIRD) Wongan Hills Research Station in 2016, 2017, and 2018 on yellow sand. In 2016, a site with few weeds was selected and prior to the trial, existing weeds were killed using non-selective herbicide (Roundup® PowerMAX 2L/ha + Hammer® 25mL/ha) and cultivation to 5cm. Prior to seeding in 2016, the plots (of 3m by 5m) were sown with one of 11 different weed species. However, the current paper only includes the results from great brome, barley grass and annual ryegrass. Annual ryegrass was included for comparison, as the efficiency of harvest weed seed destruction for control of this species is well documented. The trial was established in a randomised block design with two dimensional balance (Coombes, 2008). In each year, non-selective herbicide was applied (Roundup® PowerMAX 2L/ha + Hammer® 25mL/ha or Spray.Seed® 2.5L/ha) and 80kg/ha Mace® wheat was sown (with knife points and press wheels) at 22cm row spacing, 3-4cm deep, with 80kg/ha MacroPro Plus® fertiliser banded 3cm below the seed, on 25 May 2016, 25 May 2017 and 29 May 2018. In July of each year, 50L/ha FlexiN was applied, but no pre-emergent or in-crop herbicides were applied during each growing season. Any additional weeds (i.e. species not deliberately sown as part of the treatment structure) in the trial were removed by hand, and other pests were controlled as required to ensure healthy crop growth. The crop was harvested at a height of 15cm.

Each year, ten weeds per plot were marked with pegs to monitor growth and seed production of individual plants in the initial weed cohort. For all weed species, later cohorts emerged during the season, but the ten marked plants were the earliest weeds to appear in each plot, as these initial weeds are the first to mature and shed seed. The seed heads of the marked weeds were covered with mesh bags and checked every two weeks to monitor total seed production and time of shedding. Bags were removed directly prior to harvest and final seed number remaining on the plant was assessed. Plants were then marked at ground level to determine the fate of plants during harvest. Height of each seed head was also assessed.

Screen house trial

Ten populations each of great brome and barley grass were sown in a screen house (where the soil is 30cm of brown-yellow sand over clay loam) on 14 June 2018, at the DPIRD Northam office, in plots of 50cm by 50cm, in a randomised block design with three replications. Forty seeds per plot were sown in four rows (10 seeds per row) of 30cm long, with 10cm between rows, at 1cm depth. Seedlings germinated in the week following seeding and plots were irrigated and fertilised to ensure healthy growth. Barley grass plants remained upright but great brome plants were tied to stakes to prevent lodging. Plant density and seed head production was assessed, as well as average height of the seed heads. Once seeds senesced, shed seeds were collected by hand once a week until shedding was complete.

Results

Field trial

In 2016, 2017 and 2018, the earliest possible harvest date occurred in mid-November (Table 1). In all years, annual ryegrass retained most seed until crop harvest, with only 24%, 13% and 5% of seed lost prior to harvest in 2016 to 2018. All annual ryegrass seed heads were above harvest height, at the same height as or just below the crop heads.

In mid-November (14 November 2016, 15 November 2017 and 12 November 2018), great brome had shed 64% of seed in 2016, 70% in 2017 and 46% in 2018. However, in 2017, the crop was ready for harvest on 9 November 2017, when great brome had only shed 28% of seed. Great brome shed rapidly over November, and in 2016, where harvest did not occur until December, 100% of seed was shed prior to harvest. All great brome seed heads formed above harvest height, with most heads at the same height or taller than the crop heads.

Barley grass started shedding seed in October, but retained 62% of seed at the earliest possible date of harvest in 2016, 96% in 2017 and 99% in 2018. In this trial the barley grass was poorly competitive due to late emergence and the plants did not grow taller than 10-12cm, i.e. below the harvest height of 15cm. In 2016 and 2017, harvest caused sufficient agitation that the remaining barley grass heads shed from the plant, but fell onto the ground rather than being captured at harvest. In 2018 the barley grass was late to senesce, and most heads were retained during and after harvest.

Table 1: The cumulative percent of seed loss* by each weed species from early October to the date of harvest in 2016, 2017 and 2018. Note that the crop reached maturity (earliest possible date that harvest could have been completed) on 14 November 2016, 9 November 2017 and 12 November 2018.

Species	Year	7/10/2016	24/10/2016	7/11/2016	14/11/2016	25/11/2016	1/12/2016
Annual ryegrass	2016	0	1	3	9	24	100
Great brome		0	0	1	64	100	
Barley grass		0	8	13	38	100	
Species		**9/10/2017**	**24/10/2017**	**9/11/2017**	**15/11/2017**	**23/11/2017**	
Annual ryegrass	2017	0	1	3	13	100	
Great brome		0	6	28	70	100	
Barley grass		0	4	4	8	100	
Species		**5/10/2018**	**19/10/2018**	**1/11/2018**	**12/11/2018**	**28/11/2018**	
Annual ryegrass	2018	0	1	3	5	100	
Great brome		0	0	14	46	100	
Barley grass		0	0	0	1	5	

*Seed loss is defined by natural seed shedding or harvest. In 2016 annual ryegrass reached 100% seed loss due to harvest removal of seed heads on 1/12/2016, and great brome and barley grass shed 100% of seed prior to harvest. In 2017, all species reached 100% seed loss due to harvest on 23/11/2017. In 2018, annual ryegrass and great brome heads were removed at harvest on 28/11/2018 but barley grass was too short to harvest.

Screen house

In the screen house, barley grass plants produced an average of 3 to 7 seed heads and 69 to 232 seeds. Average height of the seed heads ranged from 9 to 31cm. Great brome plants produced an average of 2 to 6 heads and 80 to 395 seeds. Height of the seed heads ranged from 14 to 84cm.

Barley grass populations had wide variation in shedding times. Most populations started shedding by 8 to 11 October 2018 and continued until 22 November 2018 (Figure 1). However, one population from York shed from 23 November to 6 December 2018 and another York population shed seed from 16 November to 6 December 2018.

Four of the ten great brome populations (from Kellerberrin, Meckering, Meckering and York) commenced shedding over 8 to 23 October, but total seed loss was less than 5% (Figure 2). By 9 November 2018, nine of the ten populations had started shedding, with seed loss ranging from 2% (York population) to 41% (Meckering population). A population from Merredin did not commence shedding until 22 November 2018, but lost 75% of seed in the first week of shedding. All populations finished shedding by 6 December 2018.

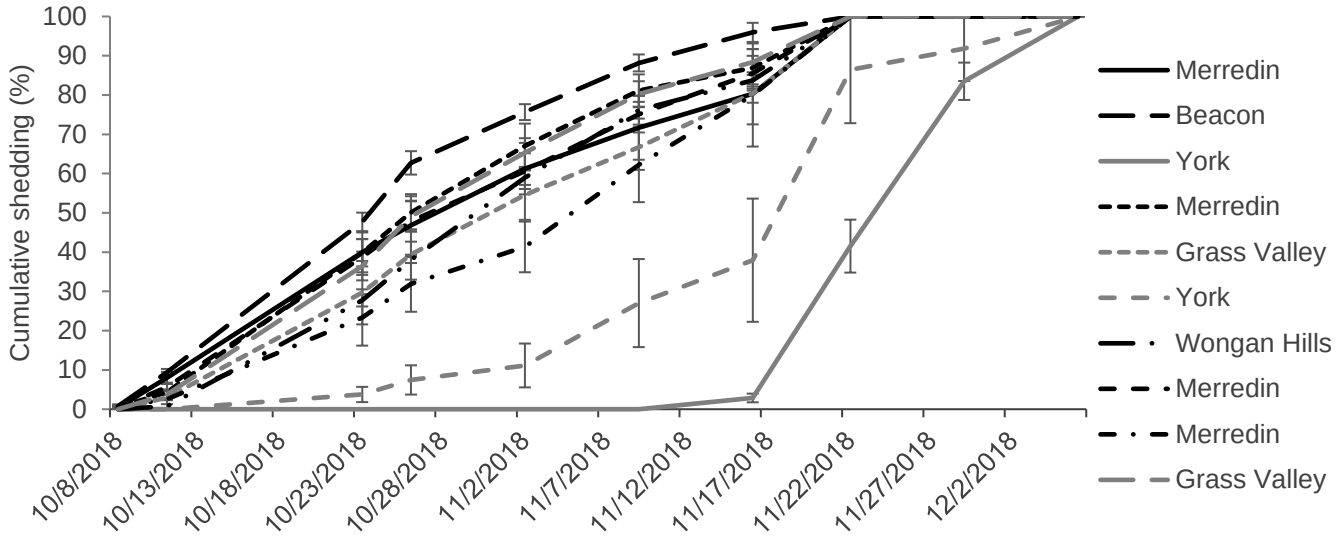

Figure 1: The cumulative percent seed shed from ten barley grass populations (note that populations are named after the shire in which seed was collected), where the vertical lines indicate the standard error of three replications.

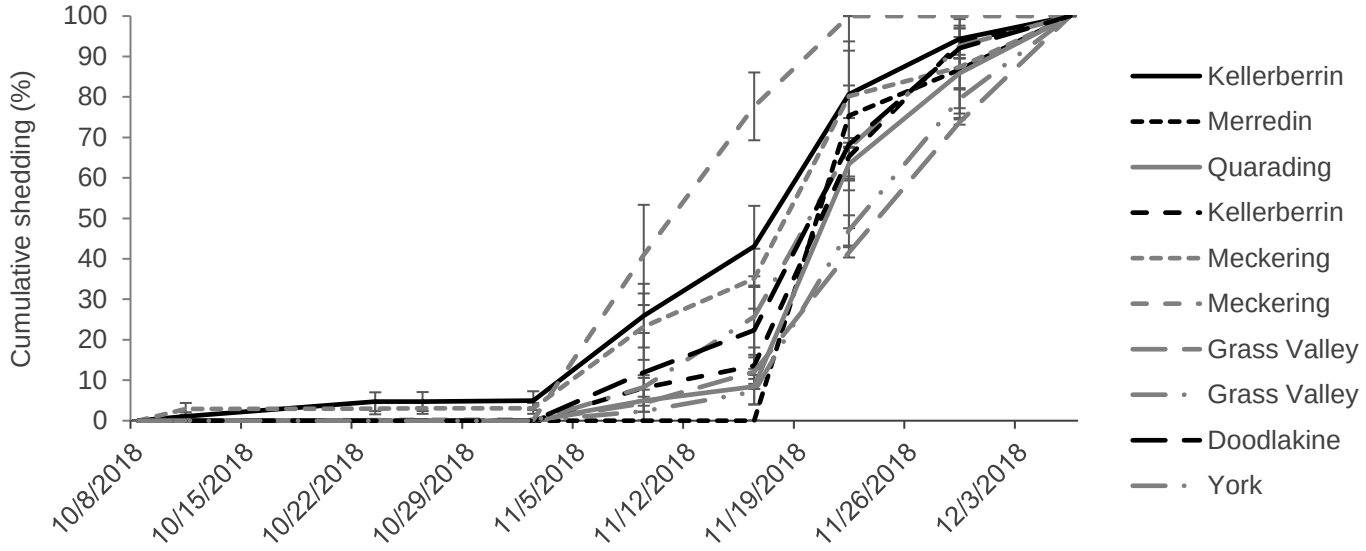

Figure 2: The cumulative percent seed shed from ten great brome populations (note that populations are named after the shire in which seed was collected), where vertical lines indicate the standard error of three replications.

Conclusion

Harvest weed seed destruction may be an effective control measure for great brome. In both the field and screen house, great brome populations retained most seed until November. However, seed shed rapidly at maturity, so it is clear that a crop should be harvested as early as possible if great brome seed destruction is the goal. Timing of shedding varied between seasons for the single population at Wongan Hills, and between different ecotypes in the screen house. So the amount of seed captured will vary, and will depend on how early the crop reaches maturity. Walsh and Powles (2014) noted great brome seed retention of 77% at crop maturity, and Hashem et al (2017) found 74% of great brome seed could be captured if harvest height was 10cm. Compared to this field study, these values are similar to the 72% seed retention in 2017 but much higher than the 36% retention in 2016 or 54% retention in 2018. The screen house trial also highlighted that most great brome will lodge prior to shedding, where plants are not supported by crop. Lodging was not observed in the field, but the relatively high crop density (80kg/ha) and narrow row spacing (22cm) would have helped to support the weed seed heads. Walsh et al (2018) noted an increased proportion of annual ryegrass heads at a greater height in the crop canopy as crop competition increased. It is likely that lodging of great brome will be a greater issue in wide row, low density crops. Where harvest weed seed destruction is used to target great brome, crop competition should be maintained to support weeds and reduce lodging, and harvest should be completed as soon as possible.

The population of barley grass in the field trial shed later than great brome, but in the screen house barley grass populations generally shed earlier than great brome. The likely reason for this is that great brome in the field was at a similar height or taller than the crop at maturity, whereas barley grass in the field was about 10cm tall. These short plants were protected from wind and agitation against moving crop heads, which likely reduced shedding. By comparison, in the screen house both species were subject to similar levels of wind and there was no crop. Like great brome, barley grass populations in the screen house exhibited considerable variation in shedding time. Further, barley grass in the field and some populations in the screen house were below harvest height. However, screen house populations were not competing with a crop, and crop competition for light may encourage weed species to grow taller (Walsh et al, 2018).

There was considerable variation in shedding times of both species in this study, and it is clear that growers will need to be aware of the ecological characteristics of their own populations to determine a successful management strategy. The potential value of harvest weed seed destruction will depend on shedding time, plant height and lodging of the weed species; and timing of crop maturity. Research is required to determine the long term impact of harvest weed seed destruction for those species where seed capture at harvest is low or variable between years. Research is also required to improve seed capture at harvest, which may involve shorter harvest height and improved capture of short or lodged weed seed heads, swathing to retain weed seeds or use of early maturing crops for an earlier harvest date.

Key words

Bromus diandrus, *Hordeum leporinum*, *Lolium rigidum, ecotypic variation, seed shed*

Note that ® indicates Registered Trademark.

Varieties displaying this symbol beside them are protected under the Plant Breeders Rights Act 1994.

Acknowledgements

The research undertaken as part of this 'Emerging weed-seed bank biology' project (UA00156) is made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC; the authors would like to thank them for their continued support. The trial was conducted by DPIRD staff Shari Dougall and Bruce Thorpe at the Wongan Hills Research Station, Nerys Wilkins and Dave Nicholson. Thanks are due to Peter Newman (Planfarm/AHRI) for reviewing this work.

References

COOMBES N (2008) DiGGer (licensed freeware). INTERNET, available at: http://www/austatgen.org/files/software/downloads/ (last accessed 15 January 2017)

HASHEM A, AMJAD M & BORGER C (2017) Effect of harvest height and windrow burning on brome grass seed bank. In: *Grains Reserach Updates*. Grain Industry Association of Western Australia, Perth, Western Australia.

LLEWELLYN R, RONNING D, CLARKE M, MAYFIELD A, WALKER S & OUZMAN J (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. INTERNET, available at: https://grdc.com.au/Resources/Publications/2016/03/Impact-of-weeds-on-Australian-grain-production (last accessed 20 March 2018)

WALSH M, NEWMAN P & POWLES S (2013) Targeting weed seeds in-crop: a new weed control paradigm for global agriculture. *Weed Technology* **27**, 431-436.

WALSH MJ, BROSTER JC, AVES C & POWLES SB (2018) Influence of crop competition and harvest weed seed control on rigid ryegrass (*Lolium rigidum*) seed retention in wheat crop canopies. *Weed Science* **66**, 627-633.

WALSH MJ & POWLES SB (2014) High seed retention at maturity of annual weeds infesting crop fields highlights the potential for harvest weed seed control. *Weed Technology* **28**, 486-493.

GRDC Project Number: UA00156