Competitiveness of emerging weed species in a wheat crop

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Key messages

- Great brome (*Bromus diandrus*) can reduce wheat yield by up to 69%. Barley grass (*Hordeum leporinum*) can reduce wheat yield by 37%.
- Doublegee (*Rumex hypogaes)*, sowthistle (*Sonchus oleraceus*) and wireweed (*Polygonum aviculare*) can each reduce wheat yield by up to 21%.
- Early intervention to control these weed species is important to prevent seed set as their seedbank can persist for three years or longer.

Aims

Weeds compete with crops for resources including nutrients, water and light (Neito et al. 2009). Competition from weeds is the most important of all biological factors that reduce agricultural crop yield (Gallandt 2015**)**. In Western Australia (WA), some of the minor weeds are now emerging as major weeds with greater infestation and frequency (Hashem et al. 2017). Crop–weed competition studies can provide valuable information to farmers and land managers on whether weed control is warranted (Swanton et al 2015).The extent of crop loss from five newly emerging weed species (great brome, barley grass, doublegee, sowthistle and wireweed) has not been investigated in intensive no-tillage cropping systems in WA. The aim of this study was to determine the loss in wheat yield due to competition from five winter weed species.

Method

Competitiveness of five emerging weed species (great brome, barley grass, doublegee, sowthistle and wireweed) were tested against a wheat crop growing on a sandy soil at the DPIRD Wongan Hills Research Station in 2018. The site was selected with few weeds, and no prior seed bank of the five target species.

During summer in 2018, weeds were controlled using a tank mixture of 1.8L/ha of Roundup ULTRA® MAX, 0.5L/ha of 2,4-D Ester®, 100mL/ha of Garlon® and 0.5% LI700® on 8 February 2018. Seed of each weed species was broadcast at different densities (Table 1) over a 5m x 1.1m area of each unit plot on 29 May 2018, prior to sowing wheat. Seed of barley grass and sowthistle were lightly incorporated with a rake to prevent seed movement by wind.

Wheat CV Mace⦸ was sown at 50kg/ha at 22cm row spacing, with fertiliser Macopro Plus® applied at 80kg/ha, using a unit plot of 5m x 2m into a lupin stubble. On 18 July 2018, 50L/ha of Flexi N and insecticide Dimethoate® was applied at 500mL/ha across all plots. No residual or post-emergent herbicides were applied.

Volunteer lupin and ryegrass plants that emerged with the wheat crop were hand-weeded at two weeks and 14 weeks after crop emergence (WAE). Four rows per plot were machine -harvested on 29 November 2018.

Measurements

Initial density of crop and weed species was recorded at 3 WAE. Final density of plants (plant numbers for broadleaf weeds and tiller numbers for grass weeds and wheat) was recorded at 17 WAE (8 October 2018). Fresh biomass was harvested from each plot using a quadrat of 44cm x 50cm on 8 October and then converted to fresh biomass per square metre. Percent reduction in fresh biomass and head numbers of wheat was calculated based on the maximum fresh biomass and head numbers. Clean grain yield (t/ha) was recorded for each plot at harvest. Loss in grain yield (%) was calculated based on the yield of the weed-free plots for each species and replication.

Design and analysis

The trial was conducted in a randomised complete block design with four replications. Data were subjected to ANOVA (GENSTAT Inc. 2018).

Results

Weed emergence

Density of barley grass at 3 WAE increased with the density at which the species was sown (Table 1). However, there was no significant difference in the initial great brome or doublegee density at D2 to D3, or significant difference in any density for sowthistle or wireweed. Although the initial emergence of weed species was quite low compared to the sown density (initial emergence was 14% great brome, 46% barley grass, 18% doublegee, 25% sowthistle and 0.2% wireweed of the sown density), additional cohorts of all the weed species emerged later in the season (Table 1). Final observed density of sowthistle was 40%-60% less than the initial observed density probably due to self- thinning (Table 1). Self-thinning was not observed in doublegee or wireweed.

Table 1. Introduced and observed densities (i.e. D0 to D3) of different weed species in 2018 at the Wongan Hills Research Station. Figures outside parenthesis are initial observed plant numbers assessed 3 weeks after emergence and figures within parenthesis are final observed density at 17 weeks after emergence (head numbers for barley grass and great brome, and plant numbers for doublegee, sowthistle and wireweed).

Weed Species	No weed: D0		Low weed density (plant/m^2): D1		Medium weed density (plant/m^2): D2		High weed density (plant/m^2): D3	
	Sown	Observed	Sown	Observed	Sown	Observed	Sown	Observed
Barley grass	0	0	125	17 (72)	250	64 (338)	500	143 (326)
Great brome	0	0	125	57 (289)	250	152 (438)	500	186 (445)
Doublegee	0	0	250	9 (31)	500	14 (23)	1000	30 (65)
Sowthistle	0	0	50	64 (26)	100	183 (93)	200	164 (99)
Wireweed	0	0	500	1 (14)	1000	5 (23)	2000	8 (59)

P-value for initial and final observed density <0.001 (species *density); LSD(5%) for initial observed density was 41.0 and final observed density was 139

Effect of weed species on biomass and head numbers of wheat

All weed species reduced fresh biomass and head numbers of the wheat crop, regardless of level of densities (Figure 1, left). Great brome reduced wheat fresh biomass by 69% and wheat head numbers by 57%. Other weed species reduced wheat fresh biomass by 42-49% and wheat head numbers by 31-39% (Figure 1, left). Grain yield of wheat was the lowest with great brome followed by barley grass, sowthistle, doublegee and wireweed (Figure 1, right). The trend in grain yield due to weed species was similar to the trend in the reduction of biomass and head numbers of wheat (Figure 1).

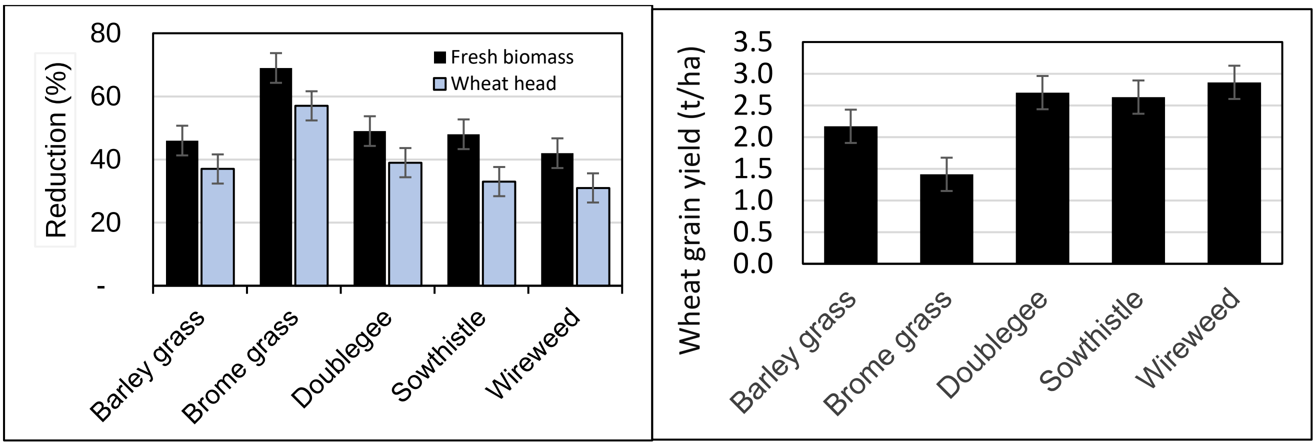

Figure 1. Effect of different emerging weed species on the fresh biomass and head numbers of wheat at anthesis (left) and on the average grain yield of wheat (right) at Wongan Hills in 2018. Vertical short bars on bar are standard errors of means over four reps and four densities. P-value for weed species effect on wheat fresh biomass is <.001 and Lsd (5%) is 8.66; P-value for weed species effect on wheat head numbers is <.001 and Lsd (5%) is 8.19; P-value for grain yield is <.001 and Lsd (5%) is 0.229

Interaction of weed species and weed density on wheat yield

Weed species and weed densities interacted to reduce the wheat yield (Figure 2). Great brome densities of 57 to 186 plants/m^2 reduced wheat yield 30% to 69%. Barley grass was the next most competitive weed species, with 17 to 143 plants/m^2 reducing yield by 14% to 71%. Other weed species (doublegee, sowthistle and wireweed) were far less competitive than great brome, reducing yield by 3%-21% (Figure 2).

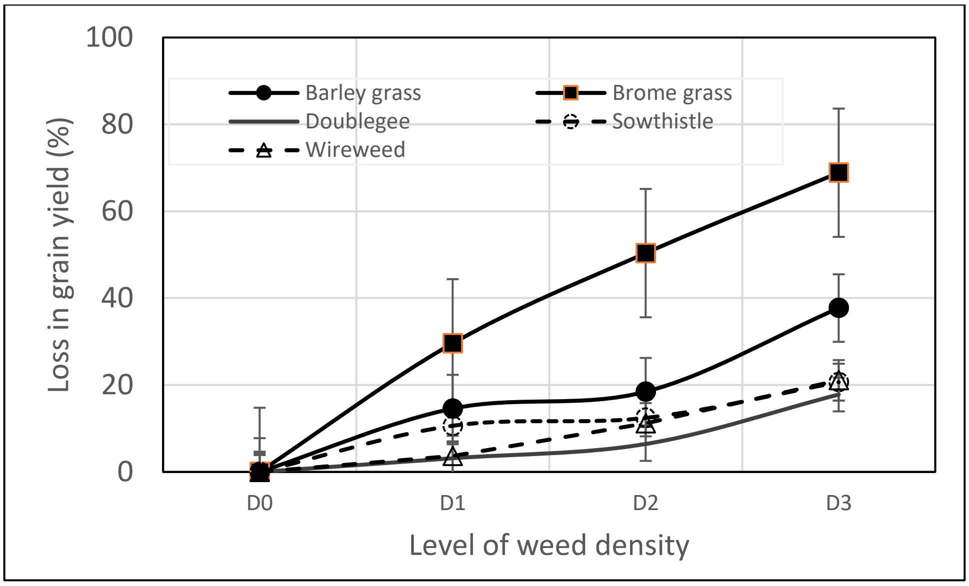

Figure 2 Extent in the loss of grain yield of wheat due to competition from different weed species during 2018 growing season at Wongan Hills Research Station. P-value for interaction of weed species and weed density was <.001 and Lsd (5%) was 11.518. The vertical lines are standard errors of the means. For the level of densities (sown and observed) of each species, refer to Table 1.

Conclusion

Results of this trial clearly show that these weeds can cause substantial reduction in the crop if no intervention is in place to control the weeds. Great brome reduced wheat yield by 69% and barley grass by 37% at the highest density. Other weed species reduced wheat yield by 18-21%. Control of these weeds early in the season is necessary to minimise yield loss in the current crop and to stop replenishment of the soil seed bank. While some seed heads of great brome and sowthistle are likely to be destroyed by harvest weed seed control (HWSC) methods, seed heads of barley grass, doublegee and wireweed are often too low to be caught at harvest. Sowthistle seed can be dispersed by wind and birds for long distances (Sánchez et al 2006). Doublegee seed can persist in the soil seedbank for longer than three years (Cheam and Lee 2009), while brome and barely grass seed persist in soil for up to three years (Gill 2007). It is therefore highly important to stop seed set of these weed species within the WA grain-belt. While the detrimental impact of these weeds is clear in the current study, further research is required on their competitive impact in other crops or regions. Sowthistle tends to be more common in the southern grain-belt and may be more competitive in this region than in Wongan Hills (Borger et al., 2018). Doublegee can be more competitive and difficult to control in short pulse crops, and can grow up into the canopy to contaminate yield in some locations (Peltzer & Douglas, 2017). Further, there may be considerable variation in competitive ability of different ecotypes of these species. Gill (2007) has demonstrated that some great brome and barley grass populations are evolving later germination strategies to avoid pre-emergent herbicides, but this may affect competitive impact.

Key words

Crop-weed competition, wheat, emerging weeds, biomass, grain yield loss,

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