Emergence of great brome grass and barley grass

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Summary Barley grass and great brome grass seed were harvested from crop and adjoining roadside populations during December 2015 in three high rainfall and three low rainfall locations in the Western Australian wheatbelt (12 populations per species). Fifty seeds of each population were planted in trays and seedlings were counted and removed for a year. Most barley and great brome grass populations reached 50% emergence on 2 or 3 May 2016. However, two barley grass populations from cropping fields reached 50% emergence two weeks or four weeks later than the roadside populations (50% emergence of the crop populations on 19 May 2016 and 31 May 2016 compared to 2 May 2016 for the roadside populations). Only one great brome grass crop population had significantly delayed emergence compared to the roadside population, and emergence was delayed by less than a week (50% emergence of the roadside and crop population on 2 May and 8 May 2016). Rainfall in the seed collection zone had no impact on seed emergence time. Management programs for these weeds will need to be altered where delayed emergence allows seedlings to avoid the non-selective herbicides prior to seeding.

Keywords *Bromus diandrus*, *Hordeum leporinum*, dormancy, germination.

INTRODUCTION

Brome grass (*Bromus* sp.) is the most notable new weed in Australia, ranking nationally as the fourth worst weed in terms of area covered (1,414,297 ha), yield loss (91,392 t) and revenue loss ($22.5m) per year (Llewellyn *et al.* 2016). Barley grass (*Hordeum* sp.) is a less severe issue, but nationally ranks as the ninth worst weed in terms of area covered (244,558 ha) and fourteenth in terms of revenue loss ($1.7m) per year (Llewellyn *et al.* 2016). These weeds are difficult to control due to limited selective herbicide options, especially in cereal crops (Storrie 2014). Therefore, the development of an effective integrated weed management program relies on accurate knowledge of the biology and ecology of these species.

Research in South Australia (SA) has indicated that the dormancy characteristics of both species have changed. Gill and Fleet (2012) noted delayed emergence of smooth barley grass (*H. murinum* L. ssp. *glaucum* (Steud.) Tzvelev) collected from cropping pastures compared to populations collected from roadside or pasture. Likewise, Kleemann and Gill (2013) noted delayed emergence of great brome grass (*B. diandrus* Roth.) collected from cropped fields compared to roadsides. This research aims to test the hypothesis that great brome grass and barley grass (*H. leporinum* Link) in Western Australia (WA) will have developed delayed emergence in cropping fields compared to roadside populations.

MATERIALS AND METHODS

Seeds of barley grass and great brome grass populations were collected during December 2015. Seed was taken from three populations in cropped fields and matching populations on the adjacent roadside, in both high and low rainfall zones of the WA wheatbelt (12 populations per species, Table 1). Seeds were taken from at least 20 plants at each site, and the GPS coordinates and land use were recorded. Seed was kept in a storage room without air-conditioning, at the Department of Primary Industries and Regional Development, Northam, to keep the seed safe while partially mimicking the temperature fluctuations seed would experience outdoors. Trays measuring 30 × 30 × 10 cm were filled with sand to within 2 cm of the top. Within 2–3 weeks of collection, samples of 50 seeds of each population were placed in trays, replicated four times. Trays were placed in the field on 18/12/2015 and covered with netting to prevent seeds being introduced and to protect trays from animals. Seedlings were counted and removed each week for a year.

Analysis Seedling emergence was calculated as a percent of total emergence. The two great brome grass populations with emergence under 10% were removed from the analysis. Simple linear fit was used to estimate the time taken for each population to reach 50% emergence in year one. Standard errors were calculated from the mean of four replications (VSN International 2017).

Table 1. The species, nearest town to the collection site, rainfall zone and latitude/longitude of the roadside and crop collection site for each seed sample.

Species	Town	Rainfall	Roadside	Crop
Barley grass	Beacon	Low	−30.664652, 117.895068	−30.663937, 117.897033
	Wongan Hills	Low	−30.828428, 116.726661	−30.833077, 116.725389
	Merredin	Low	−31.483294, 118.221582	−31.483791, 118.221792
	Grass Valley	High	−31.629109, 116.814790	−31.629414, 116.814880
	Frankland	High	−34.353914, 117.107018	−34.353118, 117.109640
	York	High	−31.911945, 116.808146	−31.912359, 116.809094
Great brome grass	Meckering	Low	−31.623780, 117.052531	−31.623476, 117.052399
	Kellerberrin	Low	−31.634072, 117.744590	−31.634194, 117.743625
	Doodlakine	Low	−31.636054, 117.924943	−31.634575, 117.925650
	York	High	−31.911945, 116.808146	−31.912359, 116.809094
	Grass Valley	High	−31.591162, 116.829930	−31.592261, 116.830340
	Toodyay	High	−31.522843, 116.573438	−31.523573, 116.574209

RESULTS

Total barley grass emergence ranged from 13–72%. Great brome grass emergence ranged from 0.5–81%.

Most barley grass populations reached 50% emergence in the first week of May (on 2 or 3 May 2016) (Figure 2). There was high rainfall in March and April 2016, but average maximum and minimum temperature in these months was high (Figure 1). Barley grass seed collected from Beacon WA reached 50% emergence significantly later than other populations, on 6 May 2016 for the crop population and 8 May 2016 for the roadside population. Seed from Merredin WA had the crop seed reach 50% emergence a month after

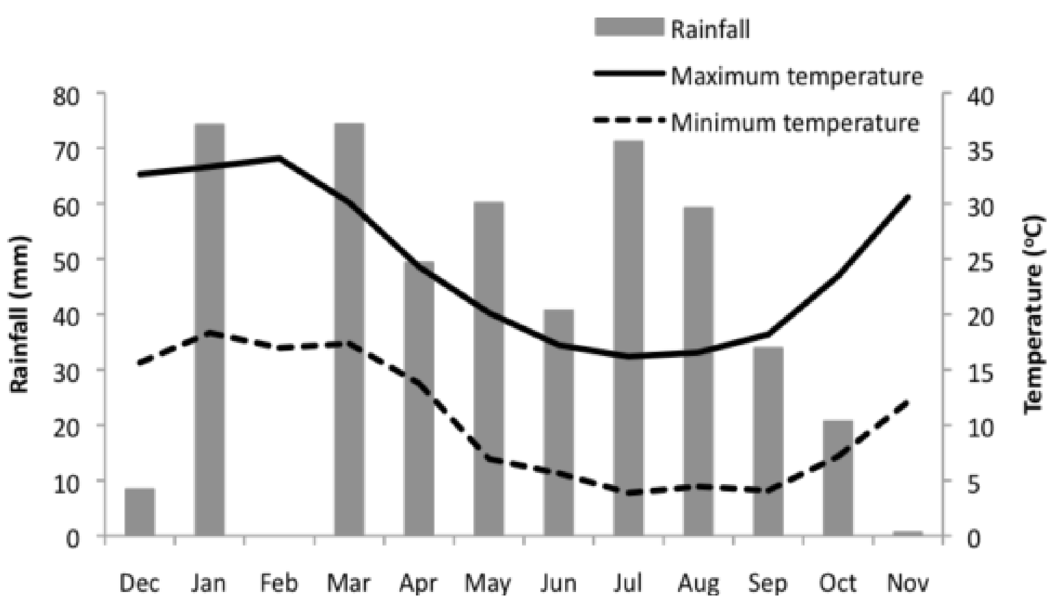

Figure 1. The total monthly rainfall and average maximum and minimum temperature from December 2015 to November 2016, from the Northam weather station 10111 (Department of Science Information Technology and Innovation 2018).

the seed from the roadside population (2 and 31 May 2016). Likewise, the population from York WA had the crop seed reach 50% emergence significantly later than the roadside seed (2 and 19 May 2016). There was no significant difference in emergence of seed harvested from high or low rainfall zones.

Great brome grass also reached 50% emergence on 2 or 3 May 2016 (Figure 3). There was only one population (Grass Valley WA) where the seed harvested from the crop had a significant delay in reaching 50% emergence (on 8 May 2016) compared to the seed from the roadside (2 May 2018).

Great brome grass populations reached 90–100% emergence 1–2 weeks after seedlings first emerged in May (Figure 3). By comparison, many barley grass populations took four months to reach 100% emergence (Figure 2).

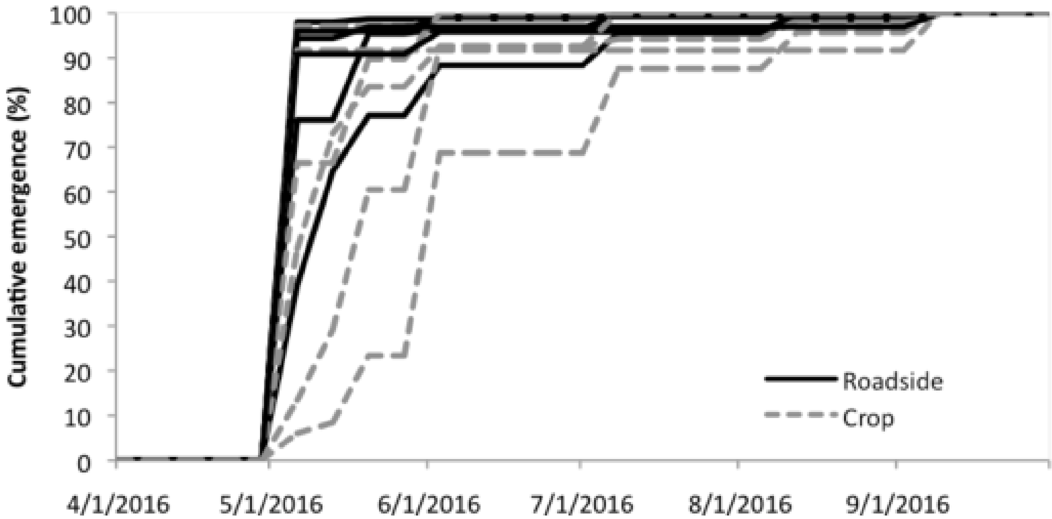

Figure 2. The cumulative emergence of seed from barley grass populations collected from six locations, with seed taken from the cropped field or adjoining roadside in each location.

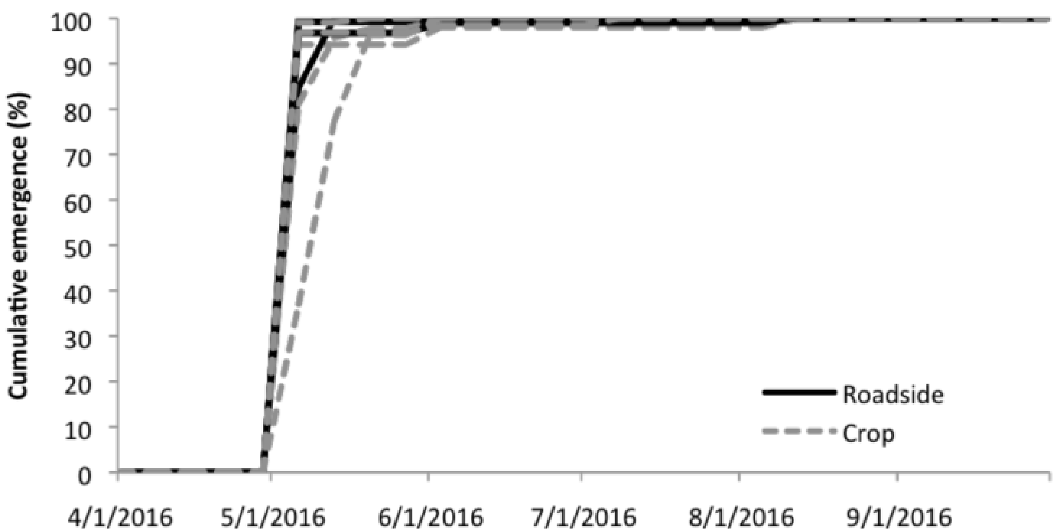

Figure 3. The cumulative emergence of seed from great brome grass populations collected from six locations, with seed taken from the cropped field or adjoining roadside in each location.

DISCUSSION

Barley grass populations in WA have the same capacity to develop delayed emergence as was observed in SA with smooth barley grass populations. This will affect the management of barley grass. Where emergence is delayed, non-selective herbicides will provide less effective control (Gill and Fleet 2012). However, the crop will be more competitive against the late emerging weeds, and early (dry) seeding will ensure the crop is as large as possible when the weeds emerge (Gill and Fleet 2012, Storrie 2014, Borger and Hashem 2018). However, there are few effective herbicides for selective control of barley grass in cereal crops, and growers will need to rotate crops to control barley grass (Storrie 2014). Development of delayed emergence was not consistent; only evident in two populations. Growers need to assess the emergence of barley grass on their own property, to determine an effective management strategy. However, most barley grass populations had staggered emergence, and so growers will need to plan for late weed control to prevent seed set.

Great brome grass did not develop delayed emergence, in contrast to the SA populations (Kleemann and Gill 2013). This is possibly because brome grass has not been managed as intensively in WA as in SA. The severity of brome grass as a weed has been increasing in Australia over the last 15 years (Llewellyn *et al.* 2016). Therefore, as great brome grass becomes a more problematic weed in WA, increased intensity of management may lead to evolution of delayed emergence to avoid weed control tactics early in the season. However, there is increasingly widespread use of harvest weed seed destruction in WA (Walsh *et al.* 2017). Both great brome grass and barley grass shed seed prior to and during crop harvest (Walsh and Powles 2014, Borger and Hashem 2018). If these species emerge late in the season and avoid a non-selective herbicide, then they are likely to retain a greater proportion of seed at harvest, to be destroyed by harvest weed seed destruction. The evolutionary pressure from harvest weed seed destruction may prevent these weeds evolving late emergence strategies. Delayed emergence is a costly strategy to avoid weed control techniques, as late emergence in a competitive crop reduces weed growth and seed production (Zimdahl 2004, Borger and Hashem 2018). Therefore, it is reasonable to assume that not all populations of brome and barley grass develop this strategy.

ACKNOWLEDGMENTS

This research was funded by the Grains Research and Development Corporation project 'Seed bank biology of emerging weeds' UA00156. Thanks are due to the growers who donated the weed seed, and to Nerys Wilkins and Dave Nicholson for assisting with this trial.

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