Germination biology of button grass (*Dactyloctenium radulans*) (R.Br.) P.Beauv.: An emerging summer grass weed in cotton farming systems

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Key findings

- The random survey found that button grass infests approximately 45% of cotton fields.
- The species shows a high level of physical seed dormancy.
- Seedlings of this species can survive a moderate level of water stress.
- Southern populations of this species are sensitive to saline conditions.

Introduction

Weeds are detrimental to any crop production system and heavy infestations can lead to a significant yield reduction. Button grass (*Dactyloctenium radulans*) (R.Br.) P.Beauv is a native, widely spread summer grass weed species found in many crops in Australia. Due to its early emergence and vigour, it can outcompete many crops. It is also found in non-cropped areas and tolerates a wide range of climates and habitats. *D. radulans* is difficult to control, and has a dormancy period (DPIRD 2017). Despite the ecological significance of *D. radulans* in Australian cropping systems, very limited information is available on its germination and emergence. The objectives of this study were to assess the current level of infestations of *D. radulans* both in dryland and irrigated cotton farming systems and also to investigate the germination biology for future phenology/biology studies of this species.

Methodology

Survey locations

In the 2017–18 cotton seasons, a survey was conducted in cotton fields located in the Darling Downs, the McIntyre region (southern Queensland), Macquarie (central), Murrumbidgee, and Lachlan River (northern NSW) areas. A total of 43 commercial cotton fields were visited. The *D. radulans* infestations at each field were evaluated based on an ecological scale. Only mature *D. radulans* seeds were collected. A representative population from a farm located at Darlington Point (under southern cotton region) was collected in early February 2018 and used for this study.

Dormancy test

The germination and dormancy of non-scarified seeds was examined at laboratory conditions (12 hours light/dark cycle at 28/22 °C for 12 days) within five days of seed collection. *D. radulans* is known to have dormant seeds and therefore 100% germination was not expected. Hence, the proportion of germinated seeds was incorporated as a parameter into the event–time analysis model. After 12 days, non-germinated seeds were incubated with a tetrazolium chloride solution to evaluate seed dormancy.

Optimising seed scarification techniques

Different scarification techniques, including potassium nitrate (KNO_3), gibberellic acid, absolute ethanol, sulfuric acid (H_2SO_4; concentration 98%), and hot and cold water were used to test breaking dormancy. A series of different concentrations and durations of these scarification methods was applied.

Germination biology of *D. radulans*

The *D. radulans* germination biology was examined through controlled environment experiments, where different environmental factors, including salinity using sodium chloride (mM), osmotic potential or water stress using polyethylene glycol (PGE 600) and durations of waterlogging conditions were imposed on seeds to observe the *D. radulans* adaptive and persistent ability. The incubated seeds were observed at 12 hours light/dark cycle at 28/22 °C for 12 days. A simple linear regression and a non-linear log-logistic dose response model (Seefeldt et al. 1995) were applied where it was appropriate.

Results and discussion

In the northern regions such as the Darling Downs, Dalby, Pittsworth, Goondiwindi, St George, 47% of cotton farms had a *D. radulans* infestation (Table 1). In the southern valleys a total of 42% of cotton fields had a *D. radulans* infestation. The *D. radulans* incidence was often found to be very high in the northern regions such as Pittsworth, Jondaryan, St George and Goondiwindi compared with the southern regions (Figure 1).

Table 1. Number of cotton farms visited and the levels of *D. radulans* infestations.

Location		Total farms surveyed	Farm infested (%)
Southern region	Griffith, Darlington Point, Coleambally, Carrathool, Hay, Hillston	12	42
Northern region	Dalby, Pittsworth, Jondaryan, Nandi, Boggabilla, Mungindi, St George, Goondiwindi	31	47

The time–event analysis model indicated that only 6% of seeds were germinated by 14 days without any seed scarification. The tetrazolium chloride confirmed that 90% of non-germinated seeds were viable (data not shown), which indicates that the species has a high level of seed dormancy.

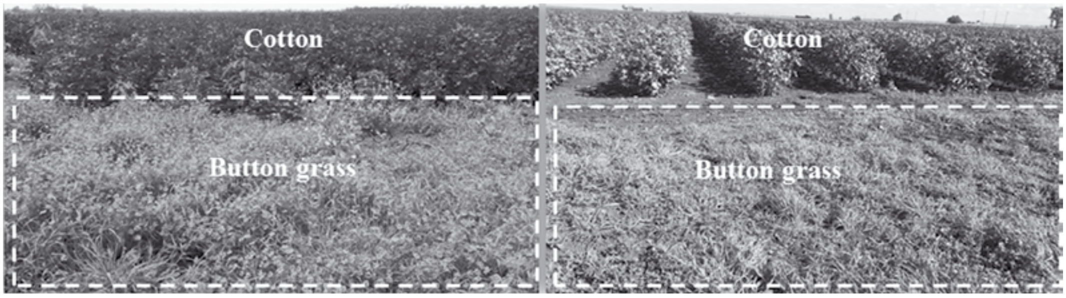

Figure 1. Photos depicting the pressures of *D. radulans* at two different cotton fields located in the northern cotton region.

Among the scarification techniques, chemical scarification with H_2SO_4 broke more seed dormancy and stimulated germination most effectively, followed by seeds treated with KNO_3 (2M>1M), absolute ethanol (100%) and others. The fitted model suggests 4–5 minutes of scarification with H_2SO_4 is required to achieve maximum (90%) germination, indicating that the species has physical dormancy (Figure 2). Therefore, in the subsequent experiments, seeds were scarified with H_2SO_4 for four minutes.

A sigmoid response was observed in the *D. radulans* seed germination for salt concentrations. Germination was greater than 50% in a sodium chloride (NaCl) concentration of 12.5 mM (Figure 3). The model suggests that more than 50% seed germination was reduced by 25 mM NaCl to a maximum inhibition at 100 mM NaCl. This study revealed that *D. radulans* seeds from the southern region can germinate in low saline conditions, but are sensitive to medium to high saline conditions.

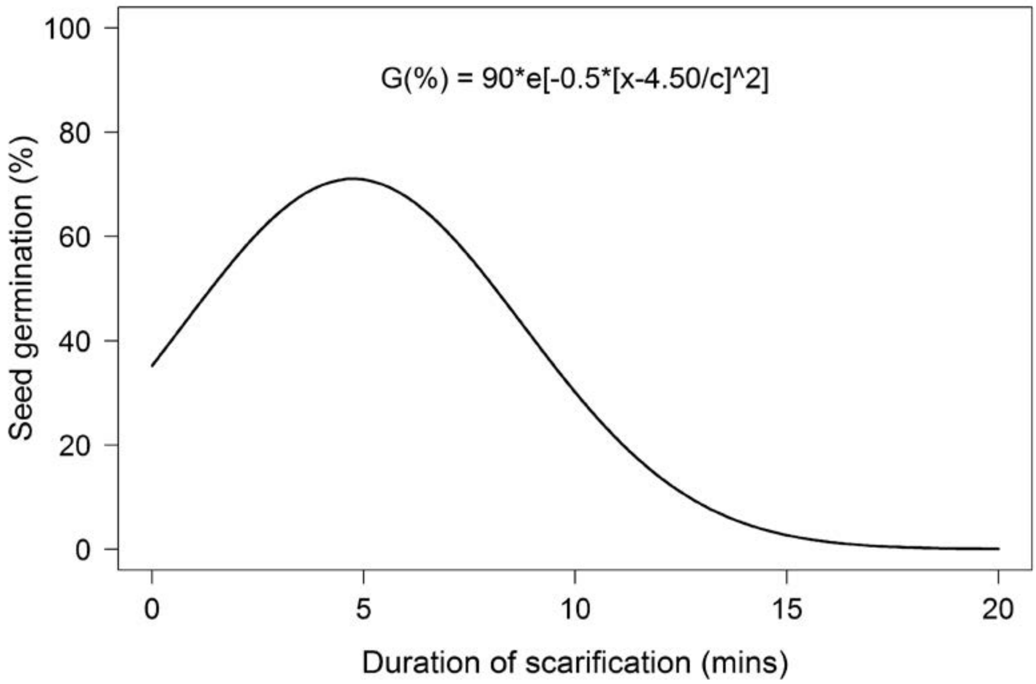

Figure 2. Effect of scarification time with sulfuric acid (H_2SO_4) on *D. radulans* seed germination after 12 days of incubation at 28/22 °C alternating day/night temperature. The solid line represents a three-parameter Gaussian model fitted to the data.

The *D. radulans* seed germination and growth decreased with increased water stress (Figure 4). For the irrigation water with osmotic potential –0.01, –0.2, –0.4 and –0.6 megapascals (MPa), the seed germination rate was 24%, 21%, 14% and 6% respectively. It is assumed that seeds can germinate under moderate to high stress water conditions, which can occur temporarily between rainfall or irrigation events at the start of the cotton season in the southern region.

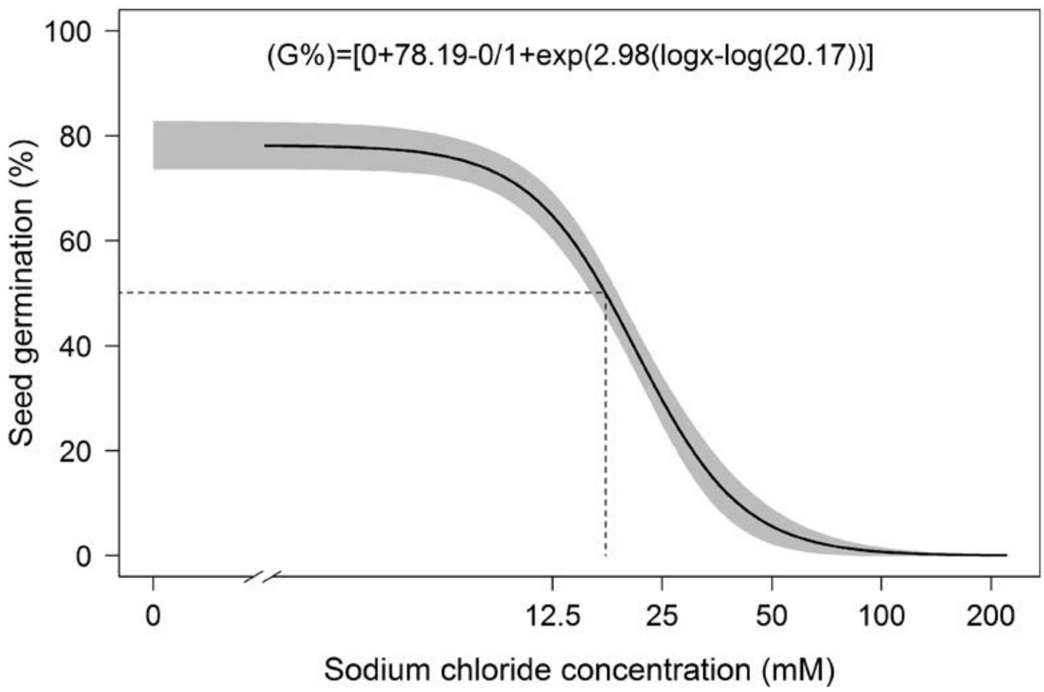

Figure 3. Effect of sodium chloride concentration on germination of scarified seeds of *D. radulans* after 12 days of incubation in light/dark at 28/22 °C alternating day/night temperature. The solid line represents a three parameter non-linear log-logistic model fitted to the data with a confidence span.

Seed germination was not significantly affected from being submerged for up to 2 days (>50% germinated) (Figure 5). However, the germination rate declined significantly (75%) after five days of being submerged – the lowest emergence rate in this experiment. This lower seed emergence might be due to lower oxygen and carbon dioxide accumulation or toxic gases produced from anaerobic decomposition. The effect from the longer submergence might also be osmotic stress on small seeds preventing germination.

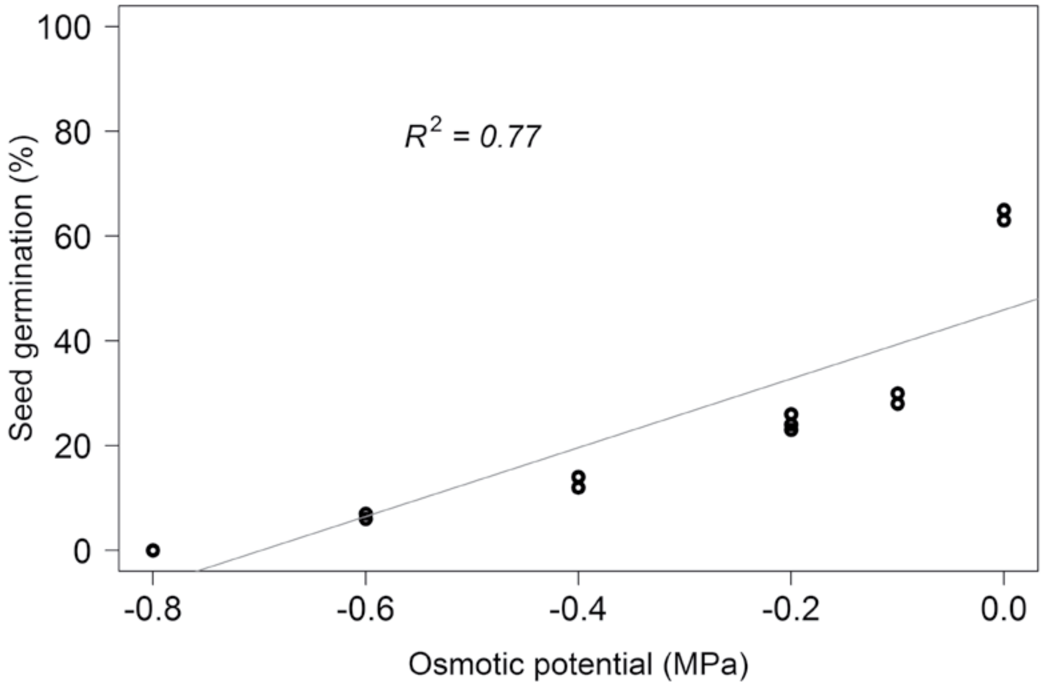

Figure 4. Effect of osmotic potential on *D. radulans* scarified seed germination after 12 days of incubation in light/dark at 28/22 °C alternating day/night temperature. The solid line represents a linear model fitted to the data. The circles represent the experimental data.

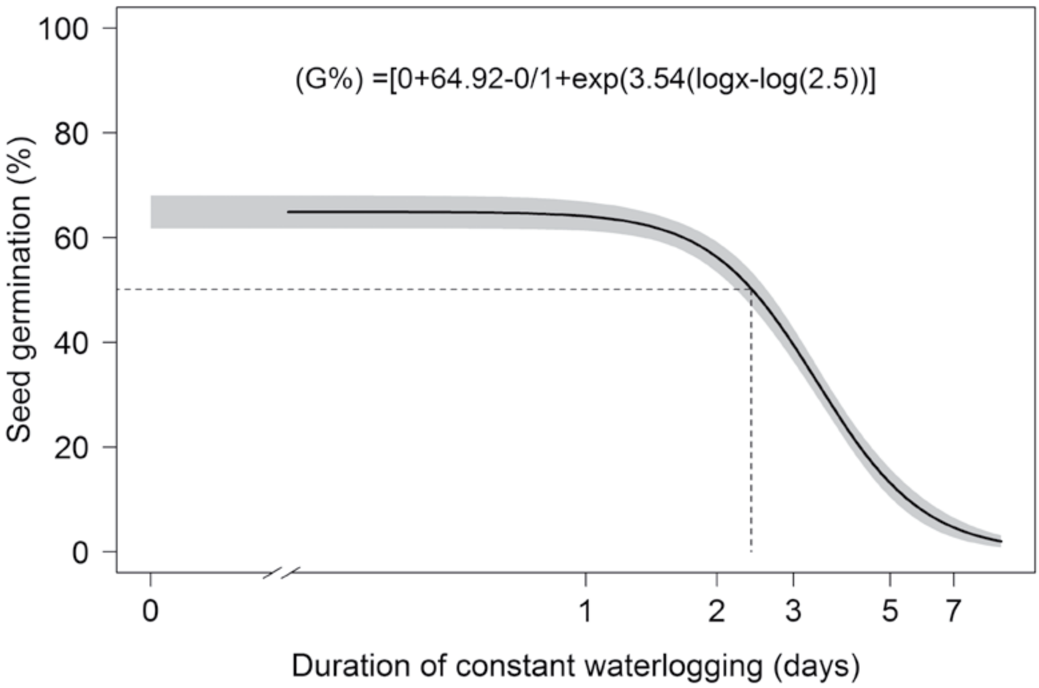

Figure 5. Effect of constant waterlogging on *D. radulans* scarified seed germination incubated in light/dark at 28/22 °C alternating day/night temperature. The solid line represents a three parameter log-logistic model fitted to the data with a confidence span.

Crop protection

Conclusion

The wide spread of *D. radulans* might be due to its dormancy mechanisms – dormancy is the capacity of seeds to remain in a suspended state in unfavourable conditions. We established that physical dormancy has a major influence on seedling emergence timing. Once dormancy is broken, environmental conditions determine the rate of germination. Populations of *D. radulans* from the southern region are moderately tolerant to water stress, but sensitive to saline conditions during germination. Germination behaviour can also differ among seeds produced in different seasons, years and locations, although additional research is required for this to be established. The study of phenology and current level of herbicide sensitivity in different populations of *D. radulans* are under way. These results will provide a benchmark for better understanding the persistence of *D. radulans* as an emerging weed in cotton farming systems and contribute to developing an effective management tool.

References

DPRID 2017, 'Button grass', Department of Primary Industries and Regional Development: www.agric.wa.gov.au/crop-weeds/button-grass, accessed 20 January 2018.

Seefeldt, SS, Jensen, SE & Fuerst, EP 1995, 'Log-logistic analysis of herbicide dose-response relationship', *Weed Technology*, vol. 9, pp. 218–227.

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