Summer Dormancy Expression in the Australian Native Grass *Elymus scaber*

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Introduction

Complete summer dormancy is associated with plant senescence in late spring-summer even though soil moisture is non-limiting. The trait is well understood in exotic temperate grasses for persistence in environments which experience frequent summer droughts (Annicchiarico *et al.* 2011). However, the trait appears to be uncommon in Australian native grasses (Culvenor 2009). The C_3 native perennial grass, *Elymus scaber*, is broadly adapted across a wide range of climatic zones and soil types in south eastern Australia (Johnston *et al.* 2001) and has been described as displaying strong summer dormancy (Mitchell *et al.* 2001). However, the reports of dormancy were not tested under conditions of non-limiting soil moisture. Therefore the dormancy aspect of its growth habit over summer may be confused with drought avoidance, causing leaf senescence in response to drying soil.

This study tested the hypothesis that *E. scaber* exhibits traits consistent with complete summer dormancy, by placing a range of populations of the species under three irrigation regimes (after Norton *et al.* 2006). For *E. scaber* to demonstrate complete summer dormancy, it would show no new growth over summer irrespective of the irrigation treatment.

Methods

Naturally occurring *E. scaber* plants were collected from the localities of Canowindra, Ganmain, Holbrook, Panuara and Wagga Wagga in NSW. The study was done under a rainout shelter in a randomised split plot design with four replicates. Mainplots were one of three irrigation treatments: complete summer watering (CSW), summer drought (SD) and summer drought broken by a simulated mid summer storm (SS). Subplots were each of the five populations of *E. scaber* listed above, each a row of five spaced plants. Irrigation treatments were applied from 7th November 2011 at which time the SS treatment was not watered for 75 days before receiving 45 mm of irrigation to simulate a summer storm. The SD treatment was not watered for 114 days until 5th March 2012. The CSW treatment was irrigated to maintain a constant soil moisture level. All irrigation treatments were monitored using gypsum blocks, with sensors at 10 cm, 20cm and 70 cm deep. Senescence of above ground herbage of individual plants was assessed weekly from the first week in November to the second week of December using visual ratings (after Norton *et al.* 2008). Plants that retained no green material were rated 0, while plants retaining full green leaves and stems were rated 9. Tillering in response to irrigation was visually scored on the proportion of new tillers present, compared to senesced tillers from the previous spring. A score of 0 represented no new tillers and 9 represented 80% of visible tillers being newly formed. Data were analysed using binomial generalised mixed models (Genstat V11.1; VSN International Ltd, Hemel Hempstead).

Results

All five populations of *E. scaber* demonstrated similar and increasing levels of herbage senescence during the Nov-Dec sampling period ($P<0.001$), irrespective of the irrigation treatment (data not shown). By mid-December, only a small amount of green material could be observed in the stems of mature tillers in all populations. No green leaf material was retained.

There was a significant interaction between *irrigation* and *time of assessment* in the development of new tillers ($P<0.05$; Table 1). Following 38 days of constant moist soil conditions, signs of new tiller development was observed in the CSW treatment. With no irrigation, the SD treatment produced less tillers and stayed relatively constant, while the CSW treatment resulted in a steady increase in tiller production with time. The SS treatment showed similar scores with the SD treatment for the first 75 days of no irrigation. After the mid-January simulated rain event, there was a significant increase in tiller formation from *E. scaber* plants in this treatment (Table 1). New tillers produced by plants in the SS treatment increased at a rate which paralleled the tiller production observed in the CSW treatment.

Table 1 Predicted mean tillering scores (logit transformation) for three water treatments of complete summer watering (CSW), summer drought (SD) and mid summer storm (SS) for the summer period of 2011/2012.

	Dec 2011	Jan 2012	Feb 2012	Mar 2012	Average s.e.d of interaction
CSW	-1.4	-1.0	-0.7	-0.4	0.25
SD	-2.2	-1.8	-1.8	-1.6	
SS	-2.1	-1.1	-1.1	-0.7	

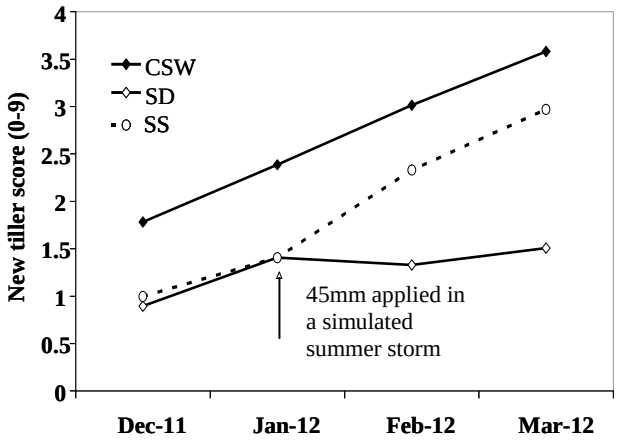

Figure 1. Back-transformed data from Table 1 illustrating new tiller development in *E. scaber* plants under three irrigation treatments CSW, SD and SS.

There were signs of new tiller production in the SD treatment by the March assessment date following irrigation after 114 days of drought conditions. There was no significant population x irrigation effect (P=0.269).

Conclusion

Complete senescence occurred in each of the populations by early December under all irrigation treatments. However, under continuous irrigation or under the conditions of a simulated mid-summer storm, a proportion of new tillers developed, presumably from buds associated with mature tillers from the previous spring. This would indicate incomplete summer dormancy in *E. scaber* in contrast to strong summer dormancy as previously described (Mitchell *et al.* 2001; Johnston *et al.* 2001). *Elymus scaber* appears similar to phalaris in its summer dormancy, in which a percentage of buds associated with mature tillers respond to moisture during the summer (Hoen 1968). Investigation of the bud dynamics in *E.scaber* would give further insight into the survival mechanisms of this species and its adaptation to drought.

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