

Seed rain of *Microlaena stipoides*

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Abstract

Microlaena stipoides (*Microlaena*) is a native grass that is recognised as being of increasing importance in natural grazing systems in south-eastern Australia. Critical to its wider use is understanding how it spreads, particularly through seed production as the precursor to seedling recruitment. Pitfall funnel seed traps were used to measure reproductive potential of a vegetation community via seed rain. The abundance and weight of *Microlaena* seed in the seed rain of a grazed native grass pasture was measured over nine months (November 2010 to July 2011) at Chiltern, north-east Victoria. During the period of the experiment 544 mm of rainfall was received, above average summer rainfall. The primary dispersal method for *Microlaena* seed is by gravity. Within six dense swards of *Microlaena* nine seed rain traps were established. The traps were set out in a 3 x 3 pattern with a spacing of 0.4 m between trap centres. Phenological growth stage of the *Microlaena* was recorded. Over the measurement period a total of 265 seeds were collected; equivalent to 23 kg seed/ha. The peak period of seed production, in terms of both weight and number, was from late December to early January. The average seed germination of 60% was recorded 17 weeks after collection. These low seed yields, combined with climate and competitive risks suggest that few seedlings are likely to establish and persist as plants in any one year. Used in conjunction with other monitoring methods, these results offer a valuable insight about the dynamics of an individual species, and can contribute to the development of appropriate management strategies to maintain populations of *Microlaena* within grazed pastures.

Key Words

Seed rain, native pasture, weeping grass, native grass

Introduction

Microlaena stipoides var. *stipoides* (Labill.) R.Br. (*Microlaena*) is a tufted C3 perennial grass with a short rhizome. *Microlaena* has a wide geographic distribution throughout southern Australia, particularly in the temperate high rainfall tableland areas (> 550 mm AAR) of south-eastern and western Australia, however there is little known about this grass in grazed communities. *Microlaena* produces highly digestible green growth year round (Waters et al. 2000). This perennial species has an important role in the stability of grazed native pastures.

Microlaena has a relatively large seed, of ~5 mg (Kew 2008), with awns that are straight or slightly curved and are not hygroscopic (Groves and Whalley 2002). The primary means of seed dispersal is via gravity (Groves and Whalley 2002). The size and shape of the seed would limit the dispersal of seed to close to the parent plant.

Seed dispersal is a component of plant life history that is important for many species but not well

understood (Schott 1995). Seed rain has been defined as the release of seed from the parent plant once the seed has matured (Jensen 1998). Seed rain can be used as an indicator of the reproductive potential of a plant community or species (Page et al. 2002) the rate of recruitment and the rate that plant populations change. A greater understanding of the life history and flowering phenology of *Microlaena* in southern Australia will contribute to techniques to encourage the spread of this species.

Methods

The experiment was at Chiltern (S36°12', E146°35') in north-east Victoria, on an existing native grass pasture dominated by *Microlaena*. The site was an acidic (pH_{CaCl2} 4.2), low fertility (Colwell P 10 mg/kg), Red Kurosol soil (Isbell 1996). Nine seed rain traps were placed in a 3 x 3 pattern with 0.4 m between the trap centres, within each of six replicated dense swards. Each seed trap used a PVC pipe (100 mm diameter, 150 mm high) fitted into an augured hole, with a funnel (130 mm) placed in the pipe with the funnel rim 10-20 mm above the soil surface. At the bottom of the funnel the seed was caught in a delnet bag (60 x 80 mm) that was above soil level. Seed samples were collected and bags changed fortnightly from November 2010 to July 2011. The phenological stage of *Microlaena* was recorded at the time of seed collection, as vegetative, stem elongation, ear emergence, seed maturity, falling or seed fallen. These data were combined into 3 phases: (i) vegetative; (ii) stem elongation – ear emergence; (iii) seed maturity – seed fall. *Microlaena* seeds from each sample were germinated in 90-mm disposable petri dishes with 1 sheet of Whatman No 181 filter paper, moistened with 10 mL of distilled water, placed on the laboratory bench during May 2011 when no further seed fall was evident. A Poisson generalised linear mixed model was fitted to the seed numbers (per date per trap) with fixed effects of sward + position + date + random effects. Dates when no seed was collected were removed from the fitted data as the main focus of this study was on when seed fell. Average seed weights were calculated for each date and transformed (\log_{10}) to ensure the residuals were normally distributed. When seed was present, differences in the average seed weight over the fifteen collection dates of the experiment were determined using a linear mixed model with the fixed effect as date and the random effect as sward. Statistical analyses were done using Genstat V13 (Payne et al. 2010).

Results

Rainfall in February 2010 of 199 mm was considerable above the long term average of 39 mm (Figure 1) then March to May rainfall of 49 mm was below the long term average of 158 mm. Mean daily temperatures ranged from 29°C in February to 3°C in June.

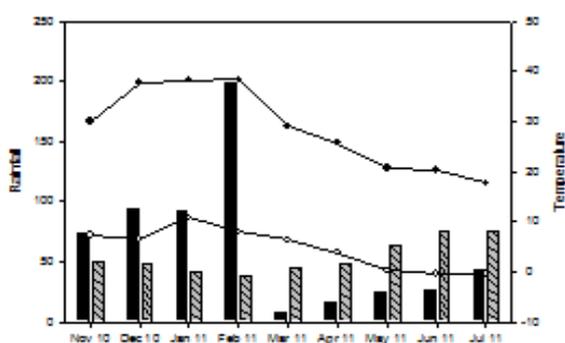


Figure 1. Rainfall (solid bars) and long-term average rainfall (hatched bars, mm, 115 years, Jeffrey et al. 2001), maximum (π) and minimum (\bullet) monthly temperatures ($^{\circ}$ C) for the period of the study. Data from hourly readings recorded with an automatic weather station located at the site.

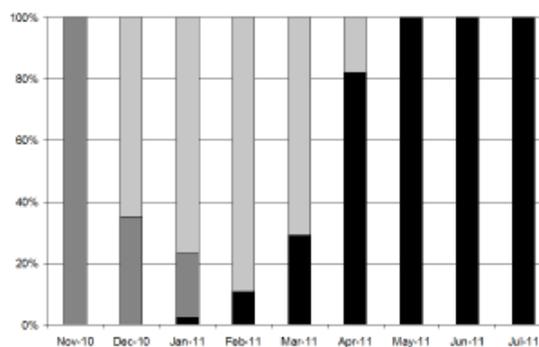


Figure 2: Percentage of *Microlaena* plants in each of 3 phenological stages: vegetative (solid bars); stem elongation – ear emergence (dark grey bars); seed maturity – seed fall (light grey bars) from November 2010 to July 2011

Phenological development showed a clear pattern, with plants moving from stem elongation and ear emergence in November, though to seed maturity and seed fall through summer (December, January

and February) then all plants were vegetative by May (Figure 2).

Only 265 seeds were collected from November to May, representing a total seed yield per sward of 8-37 kg/ha. There was a highly significant effect of date on seed number ($P < 0.001$). Most seed was collected from late December to early January (Figure 3). The average seed weight was 6.23 mg. There was a highly significant effect of date on seed weight ($P < 0.001$). The average germination of fresh seed was 60% (Table 1). The highest germinations recorded for periods when only small numbers of seed were collected in late March and early April. During the period of greatest seed fall, the highest germinations were recorded for the seed collected during January. These data needs to be treated cautiously due to the low sample numbers.

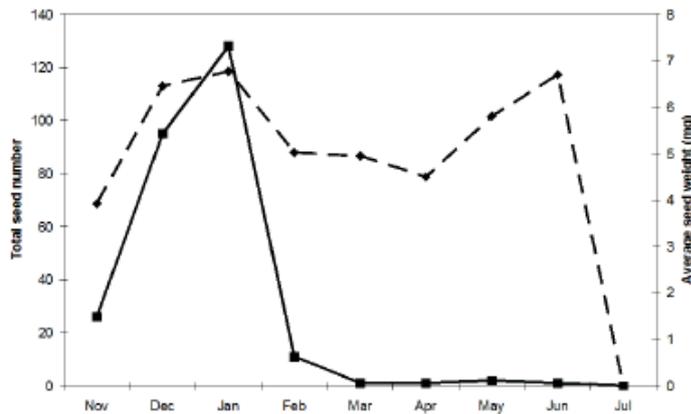


Figure 3. Total number (< left axis) and average weight (♦ dashed lines, mg, right axis) of seeds collected in the sward seed rain traps from November 2010 to July 2011.

Table 1. Number of *Microlaena* seeds, germinants and germination percentage (% , after 20 days) of seed collected in seed rain traps.

| Date of seed collection | Number of seeds | Number of germinants | Germination percentage |
|-------------------------|-----------------|----------------------|------------------------|
| 3-Dec-10 | 18 | 6 | 33 |
| 16-Dec-10 | 25 | 15 | 60 |
| 13-Jan-11 | 25 | 17 | 68 |
| 26-Jan-11 | 25 | 15 | 60 |
| 9-Feb-11 | 8 | 3 | 38 |
| 22-Feb-11 | 3 | 1 | 33 |
| 24-Mar-11 | 1 | 1 | 100 |
| 7-Apr-11 | 1 | 1 | 100 |

Conclusion

This study has quantified the amount of *Microlaena* seed rain in a native pasture and showed this is mostly in summer, before autumn rainfall is normally expected. Seed abundance was unexpectedly low, with an average yield of 23 kg seed/ha, though this still equates to 370 seeds/m². Over the period of the experiment, seasonal conditions were favourable for seed production. These seed yields were less than those recorded from seed production areas that are fertilised and irrigated of 287-2200 kg/ha (Cole and Johnston 2006).

The average seed weight (6.23 mg) recorded in this study was heavier than reported (4.97 mg) by Kew (2008) but within the range of caryopsis weights (1.29-6.66 mg) recorded by Davies et al. (2005). The lower values were probably of non-viable seed. The higher seed weight recorded in this study maybe a result of the wet summer conditions and a low number of seeds per head. The overall germination percentage recorded in this study was lower than expected but this may be due to the low

sample size or some dormancy effects that require further investigations. Other research has demonstrated low seed dormancy and high germination percentages (> 80%) (Clarke and French 2005; Clarke et al. 2007; Johnston et al. 1998).

The primary means of *Microlaena* seed dispersal is via gravity (Groves and Whalley 2002). The size and shape of the seed would limit the dispersal of seed to close to the parent plant. The method used in this study is considered to accurately record the seed rain of a *Microlaena* pasture.

These low seed yields and low germination percentages, when considered in the context of variable climates and the competitive environment of native grass swards suggest that few seedlings are likely to establish and persist as plants in any one year. Jones (1996) believed that *Microlaena* maintains healthy populations of plants of a range of ages by being able to regenerate by re-sprouting and by re-establishing from seed under grazing. Our results indicated the re-establishing from seed maybe comparatively less important. This combined with the reports that the species is slow to establish from seed (Huxtable and Whalley 1999; Jones 1996; Nie et al. 2008; Reed et al. 2008; Simpson and Langford 1995) indicate that appropriate grazing management need to be implemented on *Microlaena* dominated pastures to ensure the maintenance of adult plants, as recruitment events may have a very low likelihood of success.

Used in conjunction with other monitoring methods, these results offer a valuable insight about the dynamics of an individual species, and can contribute to the development of appropriate management strategies to maintain populations of *Microlaena* within grazed pastures. Further studies are required into seed predation and its effects between the period of seed rain and seed germination.

References

- Clarke S and French K (2005). Germination response to heat and smoke of 22 Poaceae species from grassy woodlands. *Australian Journal of Botany* 53, 445-454.
- Clarke S, Stevens J, Ryan M, Mitchell M, Chivers I and Dixon K (2007). Enhancing native perennial grass germination for sustainable pasture systems. In *Native grasses for a thirsty landscape*. Proceedings of 5th Stipa National Native Grasses Conference on the Management of Native Grasses and Pastures. FLFR University of Melbourne, Dookie Campus, Mudgee, NSW.
- Cole IA and Johnston WH (2006). Seed production of Australian native grass cultivars: an overview of current information and future research needs. *Australian Journal of Experimental Agriculture* 46, 361-373.
- Davies CL, Waugh DL and Lefroy EC (2005). Variation in seed yield and its components in the Australian native grass *Microlaena stipoides* as a guide to its potential as a perennial grain crop. *Australian Journal of Agricultural Research* 56, 309-316.
- Groves RH and Whalley RDB (2002). Grass and grassland ecology in Australia. *Flora of Australia* 43, 157-182.
- Huxtable CHA and Whalley RDB (1999). Emergence and Survival of Three Native Grass Species Sown on Roadsides on the Northern Tablelands, New South Wales, Australia. *Australian Journal of Botany* 47, 221-235.
- Isbell RF (1996). 'The Australian Soil Classification.' CSIRO Publishing: Melbourne, Australia.
- Jeffrey S, Carter J, Moodie K and Beswick A (2001). Using spatial interpolation to construct a comprehensive archive of Australian climate data. *Environmental Modelling and Software* 16, 309-330.
- Jensen K (1998). Species composition of soil seed bank and seed rain of abandoned wet meadows and their relation to aboveground vegetation. *Flora* 193, 345-359.

Johnston WH, Clifton CA, I.A. C, Koen TB, Mitchell ML and Waterhouse DB (1998). Native perennial grasses for productive sustainable pastures in southern Australia. Final report project SCS10 Land and Water Resources Research and Development Resources Project. Research and Development Corporation Canberra. NSW Department of Land and Water Conservation, Wagga Wagga, NSW.

Jones CE (1996). Pastoral value and production from native pastures. *New Zealand Journal of Agricultural Research* 39, 449-456.

Kew RBG (2008). Seed Information Database (SID) Version 7.1. Available from:
<http://data.kew.org/sid/>

Nie ZN, Miller S, Moore GA, Hackney BF, Boschma SP, Reed KFM, Mitchell M, Albertsen TO, Clark S, Craig AD, Kearney G, Li GD and Dear BS (2008). Field evaluation of perennial grasses and herbs in southern Australia. 2. Persistence, root characteristics and summer activity. *Australian Journal of Experimental Agriculture* 48, 424-435.

Page MJ, Newlands L and Eales J (2002). Effectiveness of three seed-trap designs. *Australian Journal of Botany* 50, 587-594.

Payne RW, Murray DA, Harding SA, Baird DB and Soutar DM (2010). 'GenStat for Windows (13th Edition).' VSN International, Hemel Hempstead, UK.

Reed KFM, Nie ZN, Miller S, Hackney BF, Boschma SP, Mitchell ML, Albertsen TO, Moore GA, Clark SG, Craig AD, Kearney G, Li GD and Dear BS (2008). Field evaluation of perennial grasses and herbs in southern Australia. 1. Establishment and herbage production. *Australian Journal of Experimental Agriculture* 48, 409-423.

Schott GW (1995). A seed trap for monitoring the seed rain in terrestrial communities. *Canadian Journal of Botany* 73, 794-796.

Simpson P and Langford C (1995) Putting it together - managing native grass based pastures and introduced pastures on a whole farm basis. In *Proceedings of the Community Grasses Workshop*. Eds A Curtis, J Millar, pp. 44-52, Charles Sturt University, Johnstone Centre of Parks, Recreation and Heritage. Report No. 39: Albury.

Waters C, Whalley W and Huxtable C (2000) 'Grassed Up: guidelines for revegetating with Australian native grasses.' NSW Agriculture, Dubbo.