Seed rain of Microlaena stipoides

Meredith Mitchell[1,5], Jim Virgona[2], Joe Jacobs[3] and David Kemp[4]

[1] Future Farming Systems Research, Department of Primary Industries, RMB 1145, Chiltern Valley Road, Rutherglen, Vic 3685 Email meredith.mitchell@dpi.vic.gov.au
[2] School of Agricultural and Wine Sciences, Charles Sturt University, Locked Bag 588, Wagga Wagga NSW 2678 Email jvirgona@csu.edu.au
[3] Future Farming Systems Research, Department of Primary Industries, 78 Henna Street, Warrnambool, Vic 3280 Email joe.jacobs@dpi.vic.gov.au
[4] School of Agricultural and Wine Sciences, Charles Sturt University, PO Box 883, Orange NSW 2800 Email DKemp@csu.edu.au
[5] Future Farm Industries CRC, The University of Western Australia M081, 35 Stirling Highway, Crawley WA 6009

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.

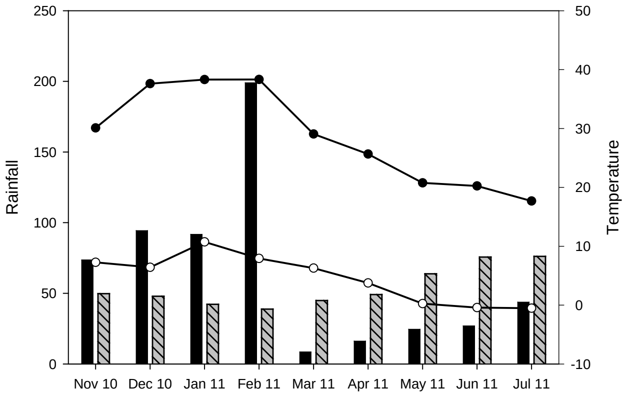

Figure 1. Rainfall (solid bars) and long-term average rainfall (hatched bars, mm, 115 years, Jeffrey et al. 2001), maximum (▲) and minimum (•) monthly temperatures (°C) for the period of the study. Data from hourly readings recorded with an automatic weather station located at the site.

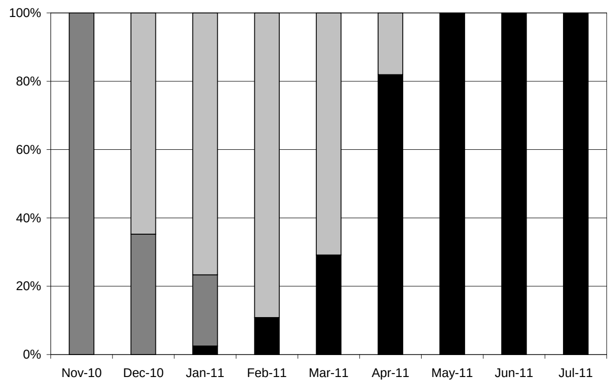

Figure 2: Percentage of Microlaena plants in each of 3 phenological stages: vegetative (solid bars); stem elongation – ear emergence (dark grey bars); seed maturity – seed fall (light grey bars) from November 2010 to July 2011

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.

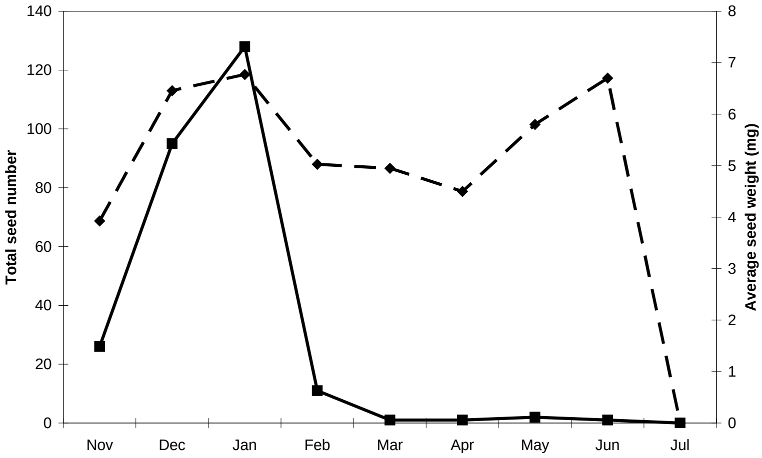

Figure 3.Total number (■ left axis) and average weight (♦ dashed lines, mg, right axis) of seeds collected in the sward seed rain traps from November 2010 to July 2011.

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/m^2**.** 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.

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