Seed Rain of a Native Pasture under a Range of Grazing and Fertiliser Regimes

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The 22nd International Grassland Congress (Revitalising Grasslands to Sustain Our Communities) took place in Sydney, Australia from September 15 through September 19, 2013.

Proceedings Editors: David L. Michalk, Geoffrey D. Millar, Warwick B. Badgery, and Kim M. Broadfoot

Publisher: New South Wales Department of Primary Industry, Kite St., Orange New South Wales, Australia

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Keywords: Seed population, deferred grazing, perennial grass, annual grass, soil fertility.

Introduction

In recent years, deferred grazing (no defoliation of pastures for a period generally from spring to late summer or autumn) has been widely adopted to rejuvenate degraded native pastures in marginal land classes such as steep hill country in western Victoria, Australia. One of the important features of deferred grazing is the increase of seed production over summer and autumn, which could potentially lead to natural regeneration and improved groundcover by pasture plants (Nie *et al.* 1999). While increasing seed numbers in the soil seed bank following deferred grazing were reported (Nie and Mitchell 2006), there has been little research on seed production during deferred grazing in this environment. This study aimed to investigate the seed rain (the fall to the ground of wind-dispersed seeds) of native pastures under various deferred grazing and fertiliser regimes. Seed population and composition in the soil seed bank are important contributors to the productivity, botanical composition and persistence of permanent pastures.

Methods

The experiment was established in spring 2002 on a south-facing steep hill side (slope ~13º) of a farm (143º08'E, 37º25'S) 10 km east of Ararat, Victoria, Australia. There were 2 main factors studied in this experiment: deferred grazing and soil fertility. Three deferred grazing strategies were implemented annually; short-term deferred grazing (SD; no defoliation October to January, long-term deferred grazing (LD; no defoliation from October to autumn break, a significant rainfall event in autumn, early winter) and optimised deferred grazing (OD; grazing determined by morphological development of pasture grasses). The fertiliser levels were no fertiliser (NF) and single super-phosphate at 50 kg P/ha plus lime at 2000 kg/ha applied in year 1 (2002) only (F). These 3 grazing strategies and 2 fertiliser levels formed six core treatments: 1) SDNF - short-term deferred grazing, no fertiliser; 2) LDNF - long-term deferred grazing, no fertiliser; 3) ODNF - optimised deferred grazing, no fertiliser; 4) SDF - short-term deferred grazing, plus fertiliser; 5) LDF - long-term deferred grazing, plus fertiliser; 6) ODF - optimised deferred grazing, plus fertiliser. Two additional treatments were no grazing in year 1, no fertiliser (NG) and the other grazed continuously, no fertiliser (CG - control). The eight treatments were applied in 600-800 m^2 plots in a randomised complete block design (RCB) with three replicates. Full details of the site and experiment were given by Nie *et al.* (2011).

Seed rain was monitored in the summer (December – February) of 2004-05 using five seed traps per plot. The seed traps were randomly located in the plots and each consisted of a 10 cm diameter PVC tube installed to 15 cm depth in the ground and level with the ground surface . A 10 cm diameter funnel attached to a 4.5 cm diameter plastic jar was placed within each PVC tube to collect seeds. The jars were drilled with holes at the base to ensure that any rain water drained. A 20 cm x 20 cm weld mesh (2.5 cm x 2.5 cm grids) was placed over the seed trap opening and secured with two metal pegs for seed protection. Seed collected from the traps was removed monthly, bulked for each plot, dried and stored for analysis. Seeds were then counted and dissected into six categories - native grass, exotic perennial grass, annual grass, onion grass, broadleaf and legume. Data were analysed by Analysis of Variance using GENSTAT V12.1 (VSN International, Hemel Hempstead, UK). A RCB model was used to analyse the overall effects between all treatments and a deferred grazing by fertiliser factorial model was used to compare the interactions.

Results

On average, SD and LD increased the number of seeds from perennial and annual grasses by over 3 times and 72% respectively, compared with the control (Table 1). OD reduced the number of seeds from perennial and annual grasses by 16% and 60%, respectively, compared with CG. The seed rain from legumes, broadleaf weeds and onion grass (*Romulea rosea*) was highly variable between treatments. There were no significant effects of deferred grazing and fertiliser application on the seed numbers from these species. There were significant (P<0.05) interactions between deferred grazing and fertiliser application on perennial and annual grass seed numbers (Fig. 1). For perennial grasses, there was a slight decline in the seed number when grazing was changed from SD, LD to OD without fertiliser, but declined sharply with fertiliser. A similar trend was observed for annual grasses with fertiliser; however, the seed number was dramatically increased for LD, compared with SD and OD, without fertiliser.

Conclusion

Deferred grazing strategies and, to a lesser degree fertiliser application, considerably altered the seed numbers of

Table 1. The seed population (seeds/m^2) of perennial grasses (PG), annual grasses (AG), legume, onion grass (OG) and broadleaf weeds under various deferred grazing and fertiliser regimes.

Treatment	PG	AG	Legume	OG	Weed
SDNF	535	4159	467	187	221
LDNF	357	9959	25	144	136
ODNF	263	925	17	348	110
SDF	1764	7048	51	42	594
LDF	603	2575	0	17	59
ODF	51	1842	25	255	76
NG	255	4550	0	441	25
CG	187	3446	8	611	272
s.e.m.	214.9**	1481.4*	153	173.6	156.5

** *P<0.01;* * *P*<0.05. SD – short term deferred grazing; LD – long term deferred grazing; OD - optimised deferred grazing; NF – no fertiliser application; F – fertiliser applied; NG – no grazing in year 1; and CG - continuous grazing.

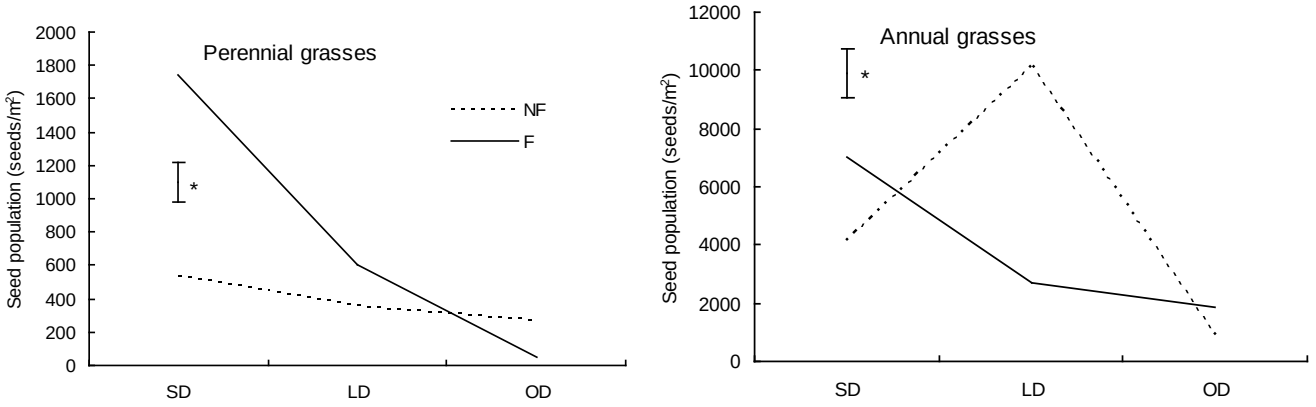

Figure 1. Interactions between deferred grazing strategies and fertiliser on the seed populations of perennial and annual grasses (SD – short term deferred grazing; LD – long term deferred grazing; OD - optimised deferred grazing; NF – no fertiliser application; F – fertiliser applied; $^*P$<0.05).

perennial and annual grasses in the seed rain. LD and SD increased both perennial and annual grass seed population in the seed rain whereas OD dramatically reduced the annual grass seed numbers, and to a much lesser degree the perennial grass seed numbers. Fertiliser application could help to increase perennial grass seed production and reduce annual grass seed population when SD and LD were implemented. The seed numbers of legumes, broadleaf weeds and onion grass present in the seed rain were highly variable. Further research is necessary to establish relationships between the seed rain and soil seed reserve, which could have a significant impact on the density and composition of native pastures.

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