Gap ecology of *Vulpia* spp. in perennial pastures

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Summary To determine the effect of canopy gap size on vulpia (*Vulpia* spp. G.C.Gmelin) and barley grass (*Hordeum murinum* L.) growth and survival, seeds of both species were sown alone or in combination in 20, 50 and 80 mm diameter circular gaps in rotationally grazed and set-stocked perennial pastures in south-western Victoria. A cohort of seeds was sown at the beginning of April and plant survival was measured every three weeks until the final harvest at the end of November 2001, thirty-three weeks after sowing.

There were significant effects ($P<0.05$) of species and gap size on vulpia and barley grass survival. Barley grass survival was greater than vulpia survival. Survival of both species decreased as the gap size decreased.

There was a significant interaction ($P<0.05$) between grazing and gap size. When compared with set-stocking, rotational grazing reduced plant survival in the large gaps. However, grazing did not affect survival in the medium and small gaps. There was also a significant interaction ($P<0.05$) between grazing and species. When compared with set-stocking, rotational grazing reduced barley grass survival, but not vulpia survival.

Sowing barley grass in combination with vulpia had no effect on vulpia or barley grass survival. It is concluded that ground cover of perennial grass is of primary importance in reducing vulpia and barley grass incidence.
Keywords Vulpia, gaps, competition, grazing management.

INTRODUCTION

Vulpia is a winter active annual grass weed that is widespread throughout southern Australia. Vulpia can severely reduce animal productivity by reducing pasture growth and quality. It also has allelopathic effects on other plant species and can cause seed damage to the hides and carcasses of stock.

Control measures have had limited success over the long-term. These measures include using herbicide (such as wintercleaning with simazine), cutting pastures for hay or silage and grazing the pasture so as to reduce seed production. The importance of gap size in the pasture canopy was measured under different grazing systems to ascertain how this grass is able to spread and dominate pastures. The aim of the study was to help identify management practices that improve the ability to control this problem weed.

MATERIALS AND METHODS

An experiment was established at Vasey in south western Victoria (mean annual rainfall 625 mm), to determine the effect of canopy gap size on vulpia and barley grass growth and survival. Circular gaps of 20 mm, 50 mm and 80 mm diameter were created in a four-paddock rotation and a set-stocked phalaris pasture, which were grazed by spring-lambing Merino ewes. The average Olsen P in 2001 was 19.3 mg kg^{-1} in the set-stocked pasture and 18.0 mg kg^{-1} in the rotationally grazed pasture. Average net herbage accumulation (kg DM ha^{-1} year) over the previous four years in the set-stocked pasture and the rotationally grazed pasture respectively was 2090 and 4070 for phalaris and 2160 and 1500 for subterranean clover.

To create gaps, soil cores were removed, sterilised and replaced. Vulpia, barley grass or a combination of vulpia and barley grass were sown in these gaps. A total of five cohorts were sown at three-week intervals from the beginning of April to the end of June 2001. Plant survival was monitored every three weeks. Tiller number, seed production and plant dry-weight were measured at the final harvest in November. In this paper, survival data from the final harvest of the first cohort is presented. A surviving plant was defined as a plant with one or more tillers attached to its roots and still in the ground. Data were analysed using REML in GENSTAT.

RESULTS

There were significant effects of species and gap size on survival ($P<0.05$). There was also an interaction between grazing and gap size and between grazing and species ($P<0.05$).

Barley grass survived better than vulpia in all treatments. Survival of both species also increased with increasing gap size (Table 1).

Grazing did affect survival, although this depended on the gap size. When compared with set-stocking, rotational grazing significantly reduced ($P<0.05$) the survival of both species in the large gaps. However, grazing had no effect on survival in the medium and small gaps.

The effect of grazing also depended on the species. When compared with set-stocking, rotational grazing significantly reduced ($P<0.05$) barley grass survival. This effect was not evident for vulpia.

Sowing vulpia and barley grass in combination when compared with sowing them alone did not affect vulpia or barely grass survival (Data not shown).

DISCUSSION

Reducing gap size in this experiment reduced both vulpia and barley grass survival. A pasture with fewer and smaller canopy gaps will impede the invasion of annual grasses. Many plants are dependent on canopy gaps for successful establishment in a pasture (Panetta and Wardle 1992). It has been demonstrated that 50% perennial cover can reduce vulpia content by more than 95% (Freckleton 1997). Competition from neighbours and other abiotic or biotic stresses during the seedling stage may severely weaken or kill the plant (Watkinson 1978). Death may also occur from accumulated stresses at a later stage in the plant's life. Barley grass and vulpia are clearly susceptible to the increased competition in the smaller gaps during this stage of their life-cycle.

The relative importance of shoot or root competition in reducing barley grass and vulpia survival can not be determined from this experiment. However, competition for water was unlikely to have reduced barley grass and vulpia survival, since after the autumn break, the soil remained wet throughout the season.

Soil tests showed that nutrients were not limiting. The average Olsen P in 2001 was 19.3 in the set-stocked pasture and 18.0 in the rotationally grazed pasture.

Light competition is likely to have had the greatest effect in reducing plant survival, particularly in the small gaps. Although not quantified, it was observed that canopy closure occurred much faster in smaller and medium sized gaps than the large gaps. This is consistent with other research, where gap closure was faster in smaller gaps (Arnthórstóttir 1994).

The effect of grazing on survival depended on the species sown. Fewer barley grass plants survived in the rotationally grazed pastures than in the set-stocked pastures. However, grazing did not significantly affect vulpia survival. Although Table 1 shows that vulpia survival was lower in rotationally grazed pastures, there was much variability in the data, and the overall effect of grazing management on vulpia was not significant.

Table 1. Effect of grazing system and gap size (large, medium or small) on vulpia and barley grass survival. Results are expressed as % of seeds sown on 5th April 2001, which yielded a live plant after thirty-three weeks. Rot: denotes rotational grazing. SS: denotes set-stocking.

	Percentage survival	
	Vulpia	Barley grass
Rot large	18.3	30.0
Rot medium	10.0	26.7
Rot small	1.7	5.1
SS large	48.3	66.7
SS medium	28.8	46.6
SS small	11.5	27.1

The LSD (0.05) value is 7.6 for the same level of grazing and 22.6 for the same level of gap size for the grazing-gap size interaction. The LSD (0.05) value is 8.1 for the same level of grazing and 22.8 for the same level of species for the grazing-species interaction.

The results presented here are from one cohort at the final measurement time. Rotational grazing significantly reduced both vulpia and barley grass survival at other measurement times for this cohort and other cohorts.

The effect of grazing on vulpia and barley grass survival also depended on the gap size. When compared with set-stocking, rotational grazing reduced survival in the large gaps, but not the medium and small gaps. Plants in these gaps may have died because of inadequate access to light, independent of the grazing system. In the large gaps, plants may have greater access to light, which may be the reason for the grazing system being able to influence plant survival. Grazing can affect vulpia and barley grass survival through altering the defoliation interval and intensity and changing competitive relationships within the sward (Lemaire and Agnusdei 2000).

Rotational grazing increases phalaris content compared with set-stocking by increasing tiller size and consequently, plant biomass and height (Cullen *et al.* 2000, Dowling *et al.* 1998, Lodge 1998, Quigley *et al.* 2000). Increased phalaris growth may increase the rate and extent of canopy gap closure in the rotation. Thus vulpia and barley grass in the rotation may experience greater light deprivation throughout the growing season.

Rotational grazing may also decrease annual grass presence by increasing the amount of perennial ground cover at the break of season. This will decrease gap availability and increase competition for water, nutrients and light at a time when vulpia seedlings are emerging. A reduction in perennial cover has been directly related to an increase in the annual content of pastures (Garden and Bolger 2001). Increased ground cover at the autumn break may be one of the main mechanisms through which rotational grazing can reduce vulpia survival.

Although vulpia was the focus of this experiment, barley grass was included as it is a dominant annual species in south-western Victoria. It is important to study vulpia's interaction with perennial and annual species when researching vulpia ecology. Barley grass survival was greater than vulpia survival. Barley grass produces larger seeds and seedlings and grows into a larger plant than vulpia. This may help barley grass to capture water, light and nutrients more effectively than vulpia. The maximum size of a plant and seed weight have been strongly correlated with a plant's competitive ability (Freckleton and Watkinson 2001).

In this experiment, sowing vulpia and barley grass together when compared to sowing them alone did not reduce vulpia or barley grass survival. Perennial competition is more effective than annual competition in reducing vulpia survival (Peart 1989).

ACKNOWLEDGMENTS

Many thanks to Gavin Kearney for help with the statistical analysis and to the CRC for Weed Management Systems and the DNRE for funding this project.

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