Winning the war against bare ground and broadleaf weeds with grazing management – results from the Broadford Grazing Experiment 1998-2003.

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Abstract

The Broadford Grazing Experiment was conducted between 1998 and 2003. Phalaris/subclover pastures were grazed by Merino wethers. Three grazing treatments (set stocking, simple 4-paddock rotation and intensive rotation based on leaf-stage plant recovery) and two fertiliser treatments (high phosphorus and low phosphorus) were compared. Compared with the two rotation treatments, set stocking resulted in poorer phalaris persistence, a higher content of capeweed and sub clover and a higher percentage of bare ground by each autumn.

Introduction

Subterranean clover (*Trifolium subterraneum*) and some broadleaf weeds, for example, capeweed (*Arctotheca calendula*), prefer high soil fertility, and can tolerate continuous hard grazing, such as encountered under set stocking due to their prostrate growth habit. The high incidence of such annual species in set stocked pastures causes significant loss of ground cover during summer and autumn. Numerous authors (Donaghy and Fulkerson 1997, Fulkerson *et al.* 2000, Waller 2001, Tozer *et al.* 2002 Warn *et al.* 2003) have shown large increases in autumn ground cover and decreases in erosion and annual broadleaf and grass weeds from rotational grazing. In all cases, the increased ground cover was attributed to increased persistence and population of perennial grasses.

In some other experiments, where rotational grazing has been compared with set stocking, rotational grazing was associated with decreases in animal production per head or minimal increases in stocking rate (Hill and James 1999, Chapman *et al.* 2003). The varying results have stemmed from the different methodology used, such as the criteria for determining when to move stock or how many paddocks were used, and has caused confusion over the benefits of rotational grazing.

Fulkerson *et al.* (1993) demonstrated that growth, persistence and quality of ryegrass pastures were maximised by allowing tillers to reach their maximum number of leaves ("the 3-leaf stage") prior to grazing. This allowed the plant to replenish the energy reserves and allow root growth and development (Fulkerson *et al.* 1993). Warn *et al.* (2002) applied this method to phalaris-based pastures in the Broadford Grazing Experiment. In this experiment, stocking rate could be increased by up to 20% compared with set stocking by using an intensive rotation where phalaris was grazed as its tillers reached the 4-leaf stage. Up to 10% increase in stocking rate could be achieved with a simple time-based 4-paddock rotation, but only under high fertiliser rates (Warn *et al.* 2002). This paper presents data on the pasture composition and ground cover changes over time, from the Broadford Grazing Experiment.

Methods

Site details

The 12 ha site was located approximately 7 km north-west of Broadford in north-eastern Victoria (37°10'E, 144°59'N). Average temperatures are 29°C maximum/13°C minimum in summer and 13.8°C maximum/3.8°C minimum in winter. Average annual rainfall for the area is 625 mm, with a winter dominance. The average annual rainfall for the duration of the experiment is shown in Table 1.

The pasture was sown down to Sirosa phalaris (*Phalaris aquatica*), Porto cocksfoot (*Dactylis glomerata*) and Trikkala subclover in 1986. An initial grazing experiment was conducted from 1994–1997,

Table 1 Annual rainfall at the Broadford Grazing Experiment site 1994–2002.

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002
Rainfall (mm)	390	654	737	391	540	629	716	461	305

where the initial density of cocksfoot and phalaris plants were 31 plants/m² and 7 plants/m², respectively. By the beginning of the second experiment in 1998, the cocksfoot had almost completely died out after two very poor springs/dry summers in 1994 and 1997. Phalaris was the dominant perennial species for the remainder of the experiment. The experimental site was originally one paddock, and was grazed by cattle and Merino wethers at 5 DSE/ha.

Experimental Design

In 1994, 18 plots of 0.65 ha were established and subjected to either a high (25 kg P/ha) or a low (6 kg P/ha) annual phosphorus fertilizer treatment. In 1998, three additional plots were added (one for each grazing treatment) and were subjected to the low phosphorus fertiliser treatment. The design was factorial consisting of six treatments, three replicates of the low phosphorus treatments and four replicates of the high phosphorus treatments.

Fertiliser Treatments (1994–2003)

Low phosphorus (LP) plots received 6 kg P/ha/year, and high phosphorus (HP) plots received 25 kg P/ha/year both as single super phosphate. In 2001, soils in the HP treatment reached an average Olsen P of 16 mg/kg. Fertiliser rates in this treatment were reduced to a maintenance rate of 10 kg P/ha/year for 2001 and 2002. No fertiliser was applied to any treatment in 2003. Fertiliser was applied in March each year. No other fertiliser or lime was applied throughout the experiment

Grazing Treatments (1998–2003)

In 1998, the following grazing systems were introduced to the site:

Set Stocking: Stock had access to the entire plot all of the time.

Simple Rotation: Plots were permanently divided into four subplots, and a rotation was introduced based on time (2 weeks on/6 weeks off, except in spring, where the rotation was 1 week on/3 weeks off).

Intensive Rotation: Plots were divided by adjustable electric fences to give a maximum of 20 paddocks. Rotation interval was based on the leaf appearance rate for phalaris for different times of the year. Phalaris was allowed to re-grow to the 4-leaf stage before the paddock was grazed. Stock were moved every Monday and Friday throughout the entire year and the size and number of the paddocks were adjusted to provide the different rotation lengths. Rotation length varied from 20 days in spring to 70 days in summer. The winter and autumn rotation lengths were dependent on the timing of the autumn break and the leaf appearance rates, which varied from year to year.

Composition measurements (1998–2003)

Pasture composition was measured in June, August and October each year using the "Dry Weight Rank" method (t'Mannetje and Haydock 1963). Measurements were taken across the same transect for each plot. Only the June measurements are presented.

Stocking rate, feeding and weed control

Stocking rate was adjusted in winter each year to maintain the same annual average sheep liveweight across treatments. No supplementary feeding was required from 1998–2002 In the summer of 2002/03, sheep were destocked and fed supplements in a spare area, as the pasture availability fell below 500 kg DM/ha and/or ground cover fell below 70%. The stocking rate carried in each treatment is shown in Figure 1. Herbicides and insecticides were not used. The odd plant of Paterson's curse (*Echium plantagineum*) that appeared was removed by hand.

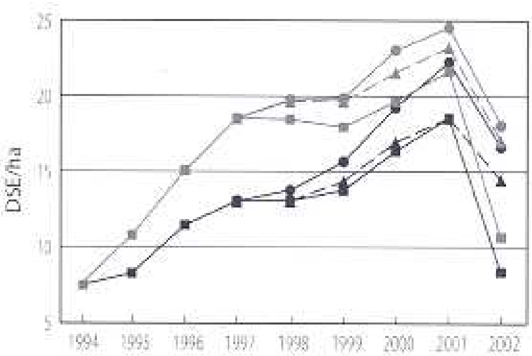

Figure 1 Average yearly stocking rate (DSE/ha) at the Broadford Grazing Experiment site 1994–2002.

Results and Discussion

The dominant species in the pasture were phalaris, sub clover, capeweed and annual grasses including silver grass (*Vulpia* spp.), barley grass (*Hordeum leporinum*) and soft brome (*Bromus hordeasus*). There were no significant differences in annual grass content between grazing or fertiliser treatments. The amount (kg DM/ha) of phalaris, capeweed and sub clover varied significantly between grazing and fertiliser treatments.

Phalaris

Phalaris availability in both the simple and intensive rotational grazing treatments was significantly greater ($P<0.05$) than the set stocked treatments for the duration of the experiment (Figure 2a). The difference in phalaris mass between treatments increased with time. Phalaris thrived in the rotational grazing treatments and declined significantly over time in the set stocked treatments. The difference in phalaris mass between fertiliser treatments was not significant.

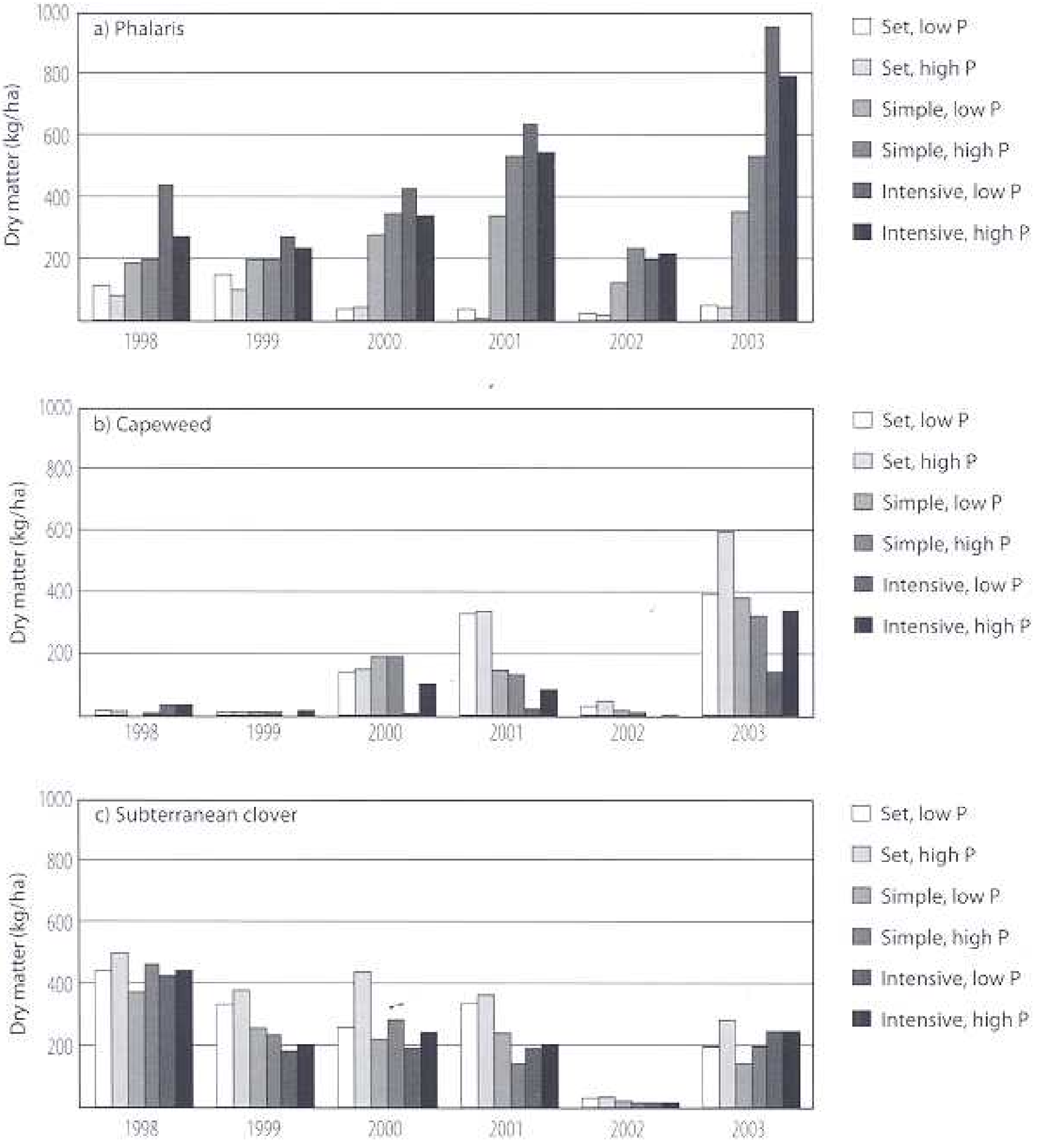

Figure 2 Pasture species availability (kg DM/ha) under various grazing and fertiliser treatments at the Broadford Grazing Experiment site in June from 1998–2003 for a) phalaris; b) capeweed; and c) subterranean clover.

Capeweed

Capeweed availability began to increase in the set stocked and simple rotation plots in 2000. It was significantly higher ($P<0.05$) in set stocked plots compared to both rotations in 2001 and 2002, and the intensive rotation only in 2003 (Figure 2b). Very high capeweed levels were recorded, particularly in set stocked plots in 2003. This can be explained by the large amounts of bare ground resulting from the 2002 drought. There were no significant differences in capeweed mass between fertiliser treatments, although capeweed tended to be higher in the HP treatments.

Subclover

Subclover availability was generally higher in the HP treatment, although this difference was only significant ($P < 0.05$) in the year 2000 (Figure 2c). Subclover was significantly higher ($P < 0.05$) in the set stocked treatments compared to both rotations in 1999, 2000 and 2002.

Autumn ground cover and the relationship between phalaris, subclover and capeweed

Autumn ground cover was lowest in the set stocked treatment, followed by the simple rotation and intensive rotation respectively (Figure 3). Ground cover fell below 70% in all treatments in the summer of 2002/2003. As a result sheep were removed from plots and fed in a sacrifice (spare) area. The trigger

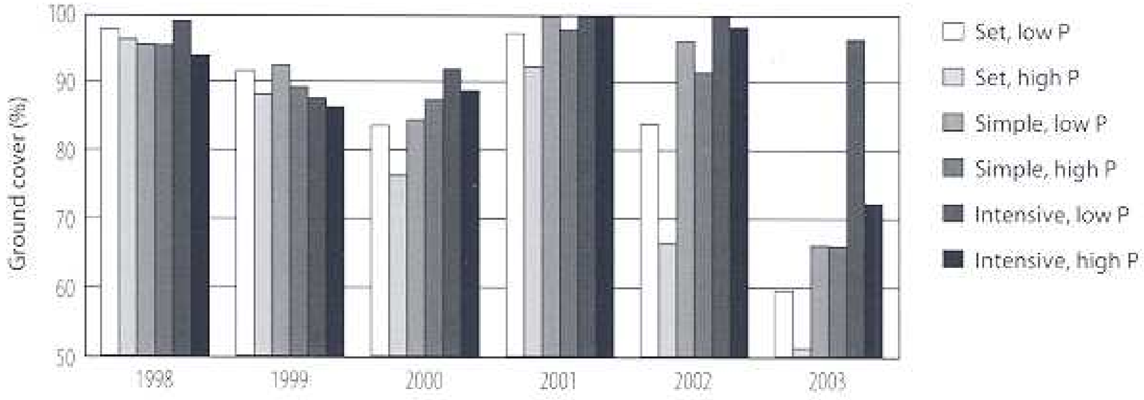

Figure 3 Ground cover (%) under various stocking-rate and fertiliser treatments at the Broadford Grazing Experiment site in March from 1998–2003.

to destock was when ground cover fell below 70%. During this time, the HP set stocked plots were the first to reach 70% ground cover in late December. The simple rotation plots did not reach this level until 25 days later on average. The LP intensive rotation treatment was the last to be destocked in late February, 66 days after the HP set stocked treatment. Hence the implementation of rotational grazing and the associated changes in pasture composition, can reduce the risks and costs usually encountered in a drought year.

In the set stocked treatment, the smaller phalaris plants and greater bare ground in autumn resulted in a higher level of capeweed and sub clover in winter. In contrast to set stocked plots, high production of phalaris in the intensive rotation plots resulted in good autumn ground cover and low production from capeweed and sub clover. However, while the sub clover production was lowest in the rotation treatments, it still ranged from 30–40% of the composition, which was adequate to satisfy animal requirements. Although, the simple rotation had more capeweed and bare ground than the intensive treatment, phalaris production and persistence was significantly higher than the set stocked treatment.

Conclusion

The results show that even at high stocking rates, the use of rotational grazing (with rest periods based on leaf-stage) will allow perennial grasses to persist, and the amount of broadleaf weeds and bare ground can be kept to a minimum. Compared with set stocking, a simple 4-paddock rotation will maintain acceptable ground cover and lower broadleaf weed levels, although the pasture and animal production was not as high as in the intensive rotation treatment. Rotational grazing allowed stocking rate to be increased, yet the risks generally associated with running more stock (poor perennial grass persistence, bare ground, broadleaf weeds, drought destocking) were reduced. An additional financial benefit attributed to the rotation, was the better persistence of phalaris. Hence if phalaris pastures are well managed, there is no need for costly renovation.

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