Effects of Grazing Management on Natural Pastures in a Marginal Area of Southeastern Australia

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Highlight: *The main reason for examining grazing management as a means of controlling barley grass (*Hordeum leporinum*) was that in marginal areas between reliable cropping and true semiarid rangeland areas, it is uneconomic to consider a chemical or mechanical eradication program, particularly as there is no desirable improved grass species which can be sown as a replacement. The study shows that in this environment the removal of barley grass by heavy grazing early in the autumn may result in crowfoot (*Erodium *spp.) dominant pastures, which although productive in winter-spring, does not carry over as dry feed and also produces seed which cause damage to stock. Alternatively, hard grazing in late winter increased the proportion of barley grass in the pasture and the number of seedheads per unit area. However, this pasture may be suitable for sheep grazing, since the seedheads were formed close enough to the ground to make the areas effectively seed free areas for livestock.*

Barley grass (*Hordeum leporinum*) was introduced into Australia soon after settlement and has spread rapidly so that it is now ubiquitous in the annual pasture zone of southern Australia. It produces large quantities of feed in winter and early spring when many other species are slow growing or dormant, and when young and vegetative it is highly acceptable to sheep (Leigh and Mulham, 1966). Hence barley grass is a valuable plant in drier areas where improved grass species cannot be sown. However, at flowering the nutritive value of barley grass declines rapidly and the long barbed awns of the inflorescence can cause substantial losses to the sheep industry. For example, barley grass seeds can injure the eyes and mouths of grazing sheep (Belschner, 1965), damage skins and carcasses (Loughnan, 1964; Hartley, 1973), and cause death through bacterial infection (Seddon and Belschner, 1927), tetanus (Belschner, 1925), and fly strike (Campbell et al., 1972).

Since barley grass in the reproductive stage is a troublesome weed in all locations, various management practices have been examined to control or eradicate it. These include spraying with herbicides (Collins, 1955; Squires, 1963; Cuthbertson, 1964) and mechanically removing seed heads by mowing. Eradication may be warranted in New Zealand (Thompson, 1962; Meeklah, 1964) or in the higher rainfall areas of southeastern Australia, where it can be followed by oversowing with improved species, such as subterranean clover (*Trifolium subterraneum*)-annual ryegrass (*Lolium rigidum*) pastures. However, it would be quite impractical to eradicate it from the drier marginal cropping areas where there are no improved grass species which can be maintained as a replacement, and where improved legume pastures such as lucerne (*Medicago sativa*) (Clinton, 1968) and barrel medic (*Medicago runcatula*) (Michalk and

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Beale, 1976) are rapidly invaded by barley grass following establishment.

In many marginal areas the general approach is to avoid barley grass-infested paddocks in the late spring by moving stock to perennial dominant natural pastures and lucerne pastures of cultivation paddocks. This is not always possible and so a number of workers have considered grazing methods which, although they will not eradicate the species, may afford some degree of control in the late spring. For example, Myers and Squires (1970) substantially reduced the density of barley grass plants in an irrigated clover pasture by continuous heavy grazing from 20 days after the first watering in autumn. In a dryland pasture, severe defoliation with sheep between mid winter and early spring delayed the maturation of the pasture and reduced the height of seedheads, but did not reduce the number of seedheads (Robards and Leigh, 1967).

This report summarizes the results of an experiment which examined the effects of a range of grazing management treatments on the growth habit of barley grass in a natural rangeland pasture, marginal between cropping and semiarid (Box and Perry, 1971). The success of each management treatment was assessed by measuring changes in barley grass parameters such as seedhead height, seedhead density, and the proportion of barley grass and broadleaf species (particularly *Erodium* spp.) to total production. The effects of changes in seedheads and botanical composition are discussed in terms of the probable effects on sheep production.

Materials and Methods

Site

The experiment was carried out at Trangie in central-western New South Wales, which is on the western margin of the sheep-wheat belt and thus the western fringe of the semiarid rangeland (Michalk and Beale, 1976). The pasture studied was described by Campbell et al. (1973) as being normally barley grass dominant from autumn to late spring. The soil type is classified as an alluvial red-brown earth (Northcote Dr 2.33). When considered over a long period, the distribution of average rainfall between seasons is reasonably uniform. However, the variation of rainfall both between seasons in any year and within seasons from one year to another is very high. Also, the intensity of rainfall varies considerably within and between seasons, with the highest rainfall intensity usually occurring in summer.

Table 1. Grazing management treatments and stocking rates examined between May and September.

Grazing management	Stocking rate (sheep/ha)
1. Ungrazed control	None
2. Set stocked all year	2.5 , 3.7 , 4.9
3. Grazed from the single leaf stage of barley grass development until September	7.4 , 12.3 , 17.3
4. Grazed from the multileaf stage of barley grass development until September	7.4 , 12.3 , 17.3
5. Grazed from the tillering stage of barley grass development until September	7.4 , 12.3 , 17.3
6. Heavily grazed from late July until early September	50.0 , 125.0

Treatments

Five management systems and an ungrazed control, each replicated twice, were examined between May and September 1973 (Table 1). The treatments included:

1) Ungrazed control
2) Continuously grazed for several years
3) Grazed from the single leaf stage of barley grass development until September
4) Grazed from the multileaf stage of barley grass development until September
5) Grazed from the tillering stage of barley grass development until September
6) Heavily grazed through late winter until September.

Treatment 2 had been continuously grazed at the stated stocking rates for several years before this study, whereas the other treatment plots had not been grazed for 12 months prior to May, 1973. Treatments 3, 4, and 5 (plot size of approximately 1.2 hectares) were based on observations by Robards and Leigh (1967), and the set stocked treatment (plot size 2.4 hectares) was shown to be an effective method of barley grass control by Campbell, Robards and Saville (1972). Within each treatment a range of stocking rates was examined and is summarized in Table 1.

Pasture Measurements

Botanical composition and available dry matter were estimated by cutting five random 0.84 m^2 quadrats in each treatment plot. Samples were separated into three categories: barley grass, crowfoot, and other species. Each category was dried at 80°C for 24 hours and weighed.

The average height of barley grass seedheads and the height of crowfoot were measured by four observers each making five observations per plot with a measuring plank similar to that described by Makkink (1951). The density of barley grass seedheads in each plot was estimated by counting the number of seedheads in twenty quadrats each 25 cm × 25 cm.

Statistical Analyses

Analyses of variance for unequal subclass numbers were used to determine the effect of grazing management on total available dry matter, barley grass and crowfoot height, and the density of barley grass seedheads. Within grazing management treatments the data for the different stocking rates were averaged. The percentage contributions by weight of barley grass and crowfoot were transformed to arcsin values and analyzed in a similar way.

As stocking rates were not the same in each management system traditional methods of testing significance of interactions between main effects were unsuitable for this data. Hence, an orthogonal approach was adopted (Steele and Torrie, 1960). Within each grazing management system stocking rate was tested for linear and quadratic effects on the plant parameters.

Results

Effects of Management on Available Dry Matter and Pasture Composition

The amount of dry matter and the proportion of barley grass and crowfoot present at the spring harvest for each stocking rate within each management system are set out in Figure 1. In general, grazed plots had less dry matter available than did the ungrazed control, but the differences were not always significant. Similarly, within management systems, stocking rate had little effect on the amount of pasture available to the sheep, except in the set stocked (Treatment 2) and single leaf grazed (Treatment 3) treatments where significant linear declines in dry matter were observed with increased stocking rate ($P < 0.05$).

While the effects of grazing management and stocking rate on pasture quantity were small, their effect on botanical composition was large and significant. It was noted generally that where the imposed treatment decreased the proportion of barley grass in the pasture there was a corresponding increase in the proportion of crowfoot ($r = -0.688$). The heavy late winter grazing (Treat-

GRAZING MANAGEMENT	STOCKING RATE (sh.ha⁻¹)	DRY MATTER (kg ha⁻¹)
UNGRAZED CONTROL	0	7120
SET STOCKED	2.5	5360
	3.7	6310
	4.9	3460
SINGLE LEAF GRAZING	7.4	6220
	12.3	4630
	17.3	4110
MULTILEAF GRAZING	7.4	5280
	12.3	5390
	17.3	4390
TILLER GRAZING	7.4	6810
	12.3	5800
	17.3	6600
HEAVY LATE WINTER GRAZING	50.0	5830
	125.0	5290
		SE = 10.1

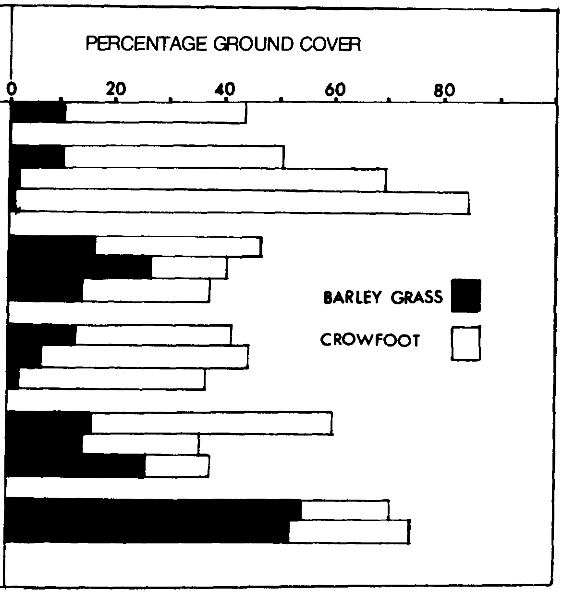

Fig. 1. *Available dry matter and the contribution of barley grass and crowfoot to total ground cover at the spring harvest for stocking rates within management systems.*

ment 6) significantly increased the proportion of barley grass ($P < 0.01$), and at the same time reduced the contribution of crowfoot ($P < 0.01$) when compared with multileaf grazed (Treatment 4) treatments were similar, both reducing the proportion of barley grass relative to the ungrazed control. In these treatments stocking rate was important, with the higher rates causing the biggest reduction in the proportion of barley grass (Fig. 1), although an increase in crowfoot with increased stocking rate was observed only in the multileaf grazed treatment. On the other hand, grazing at the tillering stage (Treatment 5) significantly reduced the proportion of crowfoot as stocking rate was increased.

Effects of Management on Barley Grass Seedhead Density and Height

The effects of grazing management on barley grass seedhead density and height are presented in Table 2. Where the imposed treatment significantly reduced the proportion of barley grass in the pasture, there were also corresponding reductions in the number of seedheads per unit area. Conversely, where treatments increased the contribution of barley grass to pasture production, there was a corresponding increase in the number of seedheads relative to the ungrazed control. Both the multileaf grazing and set stocked treatments reduced seedhead density, the reduction being magnified as stocked rate increased. The remaining treatments increased density relative to the ungrazed control, with the most significant increases occurring in the heavy late winter grazing. In this treatment stocking rate played a significant role in increasing seedhead density.

Table 2. Density (plant/m²) of barley grass, height (cm) of barley grass seedheads, and the height (cm) of crowfoot in natural pasture at Trangie, N.S.W., by grazing management method stocking rates (sheep/ha).

Grazing management and stocking rate	Barley grass Density (plants/m²) (cm)	Barley grass Height	Crowfoot height (cm)
Ungrazed control	109.2	42.1	31.3
Set stocked			
2.5	167.8**	45.0**	39.0
3.7	37.4**	38.2**	46.4
4.9	4.8**	20.6**	45.1
Single leaf grazing			
7.4	148.4	43.6**	37.7*
12.3	168.0	33.0**	17.4*
17.4	118.4	30.6**	19.1*
Multileaf grazing			
7.4	104.8	42.1**	28.2
12.3	82.4	35.7**	38.9
17.3	37.2	27.8**	33.8
Tiller grazing			
7.4	173.6	47.9	37.3**
12.3	117.2	42.4	38.9**
17.3	141.2	42.7	23.8**
Heavy late winter grazing			
50.0	161.0*	26.5	NA
125.0	251.4*	24.0	NA
Standard error	31.1	4.1	5.2

* and ** indicate significant linear effect of stocking rate within grazing managements at the 5 and 1% levels respectively.

Although heavy late winter grazing significantly increased seedhead density, it also significantly reduced seedhead height relative to the control. Stocking rate appeared to be unimportant in producing this result, but in early grazed treatments (Treatments 2, 3, and 4) where small reductions in height were observed, the results were influenced significantly by stocking intensity.

In general, crowfoot height showed little response to either grazing management or stocking rate, and there was no consistent relationship between the height of barley grass and crowfoot. Variable results were observed in all treatments, except in the single leaf and tiller grazings in which crowfoot height was significantly reduced by increasing the stocking rate.

Discussion

In the drier, marginal cropping areas of central western New South Wales, grazing management as a means of controlling barley grass is considered more practical than complete elimination by herbicides or mechanical means because barley grass is a valuable contributor as one of the major components of natural pasture, except when the mature awned seedheads are troublesome to stock. Also, if the rapid invasion of barrel medic (Michalk and Beale, 1976) or lucerne pastures (Clinton, 1968) by barley grass can be taken as an indication, elimination by any means will only be temporary.

In this study the quantity of dry matter produced by the pasture was relatively unaffected by grazing management. However, there were marked effects on botanical composition and on the development and flowering of species, particularly barley grass. Thus, pastures were created which, although similar in quantity, probably had different potentials for animal production.

The proportion of barley grass in the pasture was lower in the continuously set stocked plots and the plots grazed at the multileaf stage. However, in general a reduction in barley grass was associated with an increase in the proportion of crowfoot ($r = -0.69$). The effect of this change on subsequent animal production is not known, but it may be that the barley grass was replaced by an equally undesirable species. Crowfoot has a long sharp seed, which although not as much of a problem in wool as barley grass seed, may more readily penetrate the skin and enter the underlying tissue (Cannon et al., 1973). Observations at Trangie (J. M. Thompson, unpublished data) have shown that in lambs slaughtered at the end of spring, the ratio of crowfoot to barley grass seeds penetrating the skin and lodging in the carcass was 3:1.

Grazing in late winter at high stocking intensities resulted in the greatest production of barley grass. Several factors could have been responsible for this increase, but the most likely appears to be the increased tillering that was recorded in this experiment and described elsewhere (Burt, 1966; Robards and Leigh, 1967). Increases in tiller number, stimulated by grazing, have also been noted by Aitken (1962) and Booysen et al. (1963), although data for production or changes in pasture composition were not given.

Increases in the proportion of barley grass in the pasture were observed in treatments grazed at the single leaf and tillering stages of development, but these increases were small compared with those observed for the heavy late winter grazing. At the single leaf stage sheep selected dead material and warm season species (for example *Chloris acicularis* and *Chloris truncata*) in preference to the newly germinated barley grass seedlings (Myers and Squires, 1970). These results support those of Burt (1966), who reported that because sheep remove leaf material only, grazing at the single leaf stage was ineffective in barley grass control and had no effect on the growing point which, at this stage, is below the ground surface. By the tillering stage, other pasture components, particularly crowfoot, had developed to the multileaf stage, hence making physical separation by sheep difficult, a condition Myers and Squires (1970) report as adverse to selective grazing.

Although seedhead density is stimulated by certain grazing management, particularly heavy late winter grazing, Smith (1968) suggested that such management practices may reduce seed infestation in sheep. That is, the decrease in height of seedheads may be enough to make the areas effectively seed free for livestock in the year of treatment, even though there may be no advantage in subsequent years (Cornish and Beale, 1974). Thus sheep have access to a larger portion of "seed free" pasture. In this experiment a delay in the onset of flowering in the late grazed treatment confirmed results reported by Burt (1966) and Smith (1968) that there would be a reduction in seedhead height. The quality of such a pasture may be increased above that of the other treatments, since Robards and Leigh (1967) reported that heavy late grazing produced a pasture with higher nitrogen and in vitro digestibility levels than those observed in ungrazed or lightly grazed pastures.

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