Effect of biennial spelling from grazing of a high country, moderate input, mixed pasture

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Abstract

A 18-year trial at Lake Tekapo compared changes in proportions of species in a common mixed species pasture under two mean grazing intensities, three seasons of grazing and spelled in alternate years or unspelled. The main species changes related to season of grazing, with the effect of biennial spelling being small and ambiguous, and that of mean grazing intensities slight.

Keywords: New Zealand, high country, spelling, pasture development, perennial lupin, cocksfoot

Introduction

Overseas rangeland literature suggest the need of periodic spelling from grazing to allow plants to flower, seed and otherwise re-establish. The possible effect is understandable for annual grassland, but is less clear for a pasture of perennials. It has been occasionally suggested for New Zealand tussock grasslands, but there have been no direct investigations. It has been advocated in the initial over-sowing of legumes in hill country to allow a build up of a clover seed bank (Suckling 1951).

The 18-year trial described initially investigated the effects of spelling from grazing every second year on a mixed pasture of contending drilled species with low to moderate fertiliser input, on a high country site. In such a spelling investigation there is a need to separate what may be annual or within-season plant responses in spelling years from what may be just a reduction in the average grazing pressure over a number of years.

Methods

The trials were conducted at the Mt John trial site, Lake Tekapo, New Zealand, on an upland yellow-brown earth of moraine material on a variant of a Pukaki soil series (Webb et al. 1982). The site is at 770 m altitude and estimated annual rainfall of 650 mm and soil pH of 5.0.

The eighteen 8.3 m × 50 m fenced plots were a factorial of three spelling regimes, three seasons of grazing and two average stocking rates.

The spelling rates were: grazing every year, grazing only in odd years, or grazing only in even years, the later two treatments being in effect repeats of biennial spelling in different time cycles (scaled as every year = 0, biennial = 1).

The three grazing seasons were in December at flowering, April/May following seeding, or both (scaled as -1, 1, 0 respectively).

The two stocking rates were in the ratio of 2:3 for a week's mob-stocking with the lower rate giving c. 2 cm residual herbage in the December, every year treatment.

The number of sheep used on each occasion was adjusted so that the average annual number of grazing days over the 2-year cycles was similar across other treatments for each of the stocking rate treatments. The mean grazing across the treatments and years was 1262 grazing day ha^{-1} yr^{-1}. Each plot was scaled in subsequent years in relation to plant species composition as either: grazed in the previous year (=1), ungrazed (=0) or by cumulative sheep grazing days to that time.

The multi-species pasture mixture was of six legumes and six grasses sown in September 1991, and there were a number of resident native and adventive species.

The legume species and cultivars were: perennial lupin (*Lupinus polyphyllus*, local selection), alsike clover (*Trifolium hybridum*, local), red clover (*T. pratense* cv. 'Grasslands (G) Pawera'), white clover (*T. repens* cv. 'G. Huia'), birdsfoot trefoil (*Lotus corniculatus* cv. 'G. Goldie') and lucerne (*Medicago sativa* cv. 'Otaio').

The grass species and cultivars were: cocksfoot (*Dactylis glomerata* cv. 'G. Kara'), tall fescue (*Schedonorus phoenix* cv. 'G. Roa'), timothy (*Phleum pratense* cv. 'G. Kahu'). browntop (*Agrostis capillaris* cv. 'G. Muster'), chewings fescue (*Festuca rubra* cv. 'G. Cook') and phalaris (*Phalaris aquatica* cv. 'G. Maru').

The seeding mixture was sown using an experimental drill which gave partial cultivation before seeding. The present trial was superimposed on a previous unreported four-year trial involving over-drilling previous hieracium (*Hieracium pilosella*) dominated, depleted, unfertilised tussock (*Festuca novae-zelandiae*) grassland. The previous trial had had four years of 200 kg ha^{-1} yr^{-1} "maxi" superphosphate (0:5:0:50 N:P:K:S) This was followed by 200 kg ha^{-1} in the 1st year of the present trial and 100 kg ha^{-1} in the 6th and 8th year, and none thereafter. Sheep grazing treatments were commenced in the 2nd year, and grazing days per plot recorded.

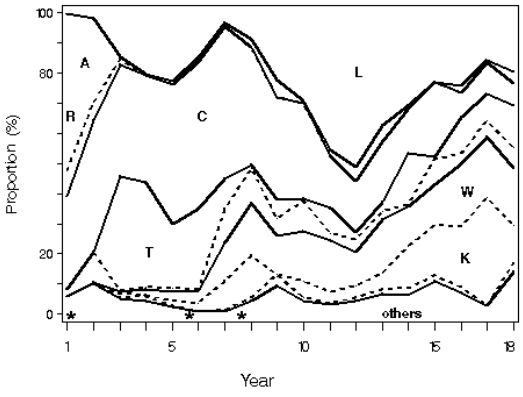

Figure 1 Changes in high country mean species proportions over an 18 years period. L = lupin; A = alsike clover; R = red clover; C = cocksfoot; T = timothy; W = chewings fescue; K = kentucky bluegrass; B = browntop, H = hieracium and other species; * = fertiliser application.

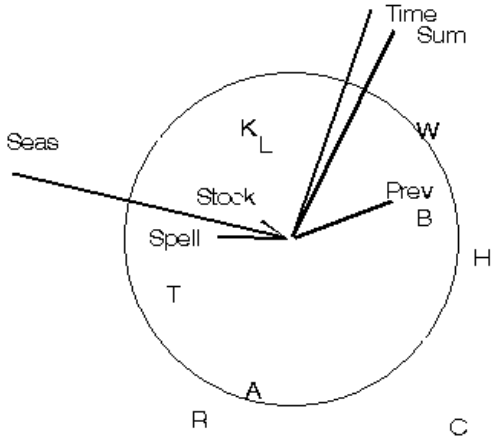

Figure 2 Canonical analysis between principal species (letter coding) and treatment variables (vectors). Species coding as for Fig. 1.

Table 1 Treatment means and significance for main treatment effects in percentage pasture composition of principal species over 18 years. Coding as in Methods, * = significance at 5%, ** = significance at 1%.

	Spelling			Season			Graze	
	Every	Bien.	Cycle	Sum.	Both	Aut.	Low	High
Lupin	24	20		15	22	27**	20	23
Cocksfoot	28	29**	**	42	29	15**	31	27*
Timothy	12	11		9	8	17**	11	12
Chewings fescue	13	10**	*	10	16	8**	11	11
Alsike clover	6	7		7	6	6	7	6
Red clover	1	1		1	1	1	1	1
Kentucky bluegrass	4	12**	**	7	9	12*	9	9
Browntop	2	1**	**	2	1	1	1	1
Hieracium	2	1**		2	2	0**	1	1

Pasture composition of plots were determined each year prior to grazing from visual scoring of species biomass rank order and estimated ratio of abundance of fifth to first (Scott 1989). Seedling establishment in initial and subsequent years were not investigated as such, only the changing composition of the total vegetation.

The results are given in terms of the effect of the different treatments on the principal species composition of pasture either as changes in mean composition across all treatments over time (Fig. 1), as canonical analysis between species, treatments and time (Fig. 2), and as ANOVA of treatment means and interactions for the principal species (Table 1).

Results and Discussion

All species showed significant (P = 0.05) trends and fluctuations over the years (Fig 1). This is shown by the length of the time (time) vector in the canonical analysis between species and treatments, and the closeness and similar length of cumulative sum (sum) of grazing days (Fig. 2).

The second major factor on species composition was the season of grazing (seas), with a lesser effect of biennial spelling (spell) and a minor effect of the two different stocking (stock) rates as indicated by their short vectors (Fig. 2, Table 1). In the relationships the different species (letter codings) were about equally determinant as indicated by their similar displacement and dispersion from the origin.

The principal pasture legume was lupin which tended to increase over time, though in an unexplainable bimodal form with maximums in the 5th and 12th year. The three grazing treatments of summer, both summer and autumn, and autumn were regarded as a gradient in grazing effects. Lupin increased in proportions within this gradient i.e. greater in treatments which were autumn grazed (Table 1, Fig. 2). On a shorter time scale it also tended to be greater in plots grazed (not spelled) in the previous year.

The trial was also a further example of the potential of lupin as a pasture legume for a class of high country sites.

All the treatments went through an initial clover dominant stage in the first two years, dominated mostly by alsike clover, with some red clover and occasional white clover. There were no trends relative to the treatments. Alsike clover was subsequently absent for a number of years but later reappeared in small proportions, as has been the experience in other trials

The subsequent increase in the grass component probably related to the build-up of soil nitrogen from the earlier legume phase.

Cocksfoot was the principal grass species. It formed greater proportions in the following year in treatments grazed previously in early summer (December) rather than later. It also tended to make up higher proportions in the lower stocking rate treatments and in plots grazed the previous year.

Cocksfoot persisted longer and was a larger pasture component in this trial than in several adjacent trials (Scott 2001). It appeared to develop a more tussocky habit with periodic spelling and the dead leaf bases giving more protection to growing points in subsequent grazing periods.

Cocksfoot, together with chewings fescue, timothy and browntop, did show significant difference between the three spelling treatments, but those were mainly due to some unexplained difference between the two biennial spelled cycles. In general the composition of the treatments grazed every year was intermediate between those two.

In that sense the trial failed in its objective of determining the effects of periodic spelling. The indication from this trial is that the effects are not large, and that further discrimination would probably require establishing a common base pasture over more years before superimposing differential spelling treatments.

The different stocking rate treatments had only small effects on pasture composition in this trial. They had been imposed in case it was necessary to distinguish between short-term and long-term mean stocking rate effects with periodic spelling.

There was difficulty in consistently differentiating the proportions of three of the taller grass species at the plot scale in early summer: timothy, phalaris (both sown), and tall oatgrass (*Arrhenatherum elatius)* (seed spread from adjacent trials). Observation later in the season on spelled plots indicated that they were predominated by timothy, with a small component of phalaris in the initial year, and a small component of tall oatgrass in subsequent years. There was a significantly greater proportion of timothy in the autumn grazed treatments.

There was similar difficulty in consistently assessing proportions of three of the smaller grass species: chewings fescue (sown), kentucky bluegrass (resident vegetatively spreading, and concentrated in one group of three adjacent plots) and browntop (sown and resident). They were increasing over time. Chewings fescue made up lower proportions and kentucky bluegrass higher proportions in autumn grazed treatments.

The conclusion from the trial were that a need for periodic spelling is probably not an issue in pasture maintenance, and the continuing potential of perennial lupin as a rangeland low-input pasture legume.

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