FREQUENT GRAZING BY SHEEP REDUCED CAUCASIAN CLOVER COVER AND RHIZOME MASS IN RYEGRASS PASTURE

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ABSTRACT
The responses of hexaploid Caucasian clover (*Trifolium ambiguum*) to four contrasting grazing regimes were compared with white clover (*T. repens*) in a high endophyte hybrid ryegrass pasture on a fertile lowland site. After two years, frequent grazing reduced Caucasian clover cover to 10% compared with 25.5% in infrequently grazed treatments (mean spelling time 25 days). Similarly, Caucasian clover rhizome plus root dry weight was reduced by frequent grazing (78 g DM/m^2 sampled to 100 mm depth compared with 322 g DM/m^2). White clover was encouraged by frequent defoliation (21% cover) in contrast to Caucasian clover. Ryegrass tiller number was reduced from 5720/m^2 in the infrequently and leniently grazed treatments to 4150/m^2 in the frequently severely grazed treatment. These results show that in lowland ryegrass pastures on high fertility sites, the stoloniferous growth form of white clover may be superior to the rhizomatous strategy of Caucasian clover when grazing by sheep is frequent throughout spring, summer and autumn.

KEYWORDS
Caucasian clover, cover, grazing frequency, grazing intensity, rhizomes, ryegrass, *Trifolium ambiguum*, white clover

INTRODUCTION
Caucasian clover is recognised in New Zealand and Australia for its potential as a persistent legume for low input pastoralism in high altitude rangeland (Allan and Keoghan, 1994; Virgona and Dear, 1996). Seed of hexaploid Caucasian clover cultivars will soon be available in commercial quantities and sowings are likely to be promoted beyond the well demonstrated rangeland niche. The current limitations of agronomic and management information for a wider range of environments and farm production systems will then be rapidly exposed.

Experiments on fertile lowland sites have been reported by Stewart and Daly (1980) who showed monthly cutting produced less tetraploid Caucasian clover than two monthly cuts; Sheaffer *et.al.* (1992) showed hexaploid Caucasian clover was an aggressive competitor against *Lotus corniculatus* under lenient rotational grazing by sheep; Petersen *et al*. (1994a) showed a moderate reduction in yield with six cuts per growing season compared with three cuts in pure clover but concluded that Caucasian clover is tolerant of frequent and close defoliation.

None of these lowland experiments challenged Caucasian clover with frequent intensive grazing in the presence of aggressive pasture grasses and grazing tolerant legumes. An experiment with four contrasting grazing treatments was therefore designed to compare Caucasian clover with white clover in a dense ryegrass sward of high endophyte status on a fertile soil.

MATERIALS AND METHODS
This grazing experiment is located on a flat site (11m a.s.l.) at Lincoln University (43ß 39'S, 172° 28'E). The Templeton sandy silt loam has variable depth (600mm - 1500mm) over gravel, pH 5.4 and Olsen P 16.

Rainfall was supplemented with irrigation to ensure pasture production did not cease during dry summers. The site received a total of approximately 900mm rain plus irrigation in both years (1993/94 and 1994/95). Mean soil temperatures at 100mm depth ranged between 19.5°C in February and 40°C in July.

Hexaploid Caucasian clover (*Trifolium ambiguum* M. Bieb. cv Monaro) was sown on 22 March 1989 for seed production investigations which were abandoned because of the vigour of adventive white clover (*T. repens* L. cv Huia) which established from seed reserves in the soil. Hybrid ryegrass (*Lolium x boucheanum* syn. *L. hybridum* cv Marsden) with a high level of lolium endophyte (*Acremonium lolii*) infection was direct drilled into the clover turf in spring, 1992. After grass establishment the area was rotationally grazed by sheep in 1992/93.

Grazing trial plots (52m x 10m) were separately fenced in early spring 1993 and two replicates of four grazing treatments were applied in spring, summer and autumn of 1993/94 and 1994/95. All plots were grazed to a low pasture mass of 700 kg DM/ha each winter.

The two factors in the experimental design were grazing frequency (set stocked (S) v rotational grazed (R) with 4 day grazing durations and about 25 day spells) and grazing intensity, hard(H) and lax (L). Set stocked pasture masses ranged between 600 and 1000 kg DM/ha for set stock hard (SH) and 1500 - 2500 kg DM/ha for SL. Rotationally grazed treatments had pre and post-grazing pasture masses of 2000 and 600 kg DM/ha for RH and 3000 and 2000 kg DM/ha for RL.

Caucasian clover was sampled from the three replicates of the four row sub-plots within each of the main grazed plots. White clover was sampled from pasture areas immediately adjacent to the Caucasian clover sub-plots. Underground biomass was sampled by taking eight cores (50mm diameter x 100mm deep) per sub-plot in August 1995. Autumn data presented in Table 1 are means of point analyses in March, April, and May, 1995.

RESULTS
Sward characteristics in the second autumn and on 1 October 1995 in early/mid spring two years after grazing treatments started are given in Table 1. The severity of the SH treatment is indicated by reduced ryegrass cover % and tiller numbers and the invasion of weeds into the "overgrazed" pasture. There was also significantly more bare ground in SH plots in autumn and both lax grazed treatments had a high proportion of dead leaf and reproductive stem in autumn.

After the first year of grazing Caucasian clover had similar cover % to white clover in SH and was superior to white clover in the other three treatments. The botanical composition rankings changed during the second year. Table 2 shows that Caucasian clover had about half the white clover cover % in set stocked treatments with SH being most severely affected. In contrast Caucasian clover survived the smothering effect of high pasture mass in RL better than white clover. The underground Caucasian clover biomass values were proportional to leaf cover %. In SH, root plus rhizome yield was most depleted.

DISCUSSION

The results presented in this paper were not expected because we perceived rhizomes to be the ultimate grazing avoidance strategy for very palatable pasture species. The depletion of Caucasian clover rhizomes and roots under a frequent severe grazing regime is perplexing as there are large areas in eastern Turkey where Caucasian clover maintains a strong presence in spite of having been grazed intensively for millennia (A.H. Nordmeyer pers. comm.). Furthermore, Peterson *et al*. (1994b) showed that frequent defoliation of a Caucasian clover monoculture had little effect on below ground biomass.

The depletion of rhizomes and roots under severe frequent grazing for the full growing season from spring to early winter suggests that persistence of Caucasian clover may be compromised under this extreme management. Further work is required on the effect of less extreme more typical grazing management. For instance, New Zealand sheep farmers usually set stock ewes and lambs in spring but rotationally graze for the rest of the year. This sheep farming grazing regime which includes summer and autumn rotational grazing should suit the apparent need for Caucasian clover to be spelled so it can recover and/or maintain its underground biomass.

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Table 1

Effect of grazing on ryegrass tiller number/m_2, and cover % for grassand weeds in autumn 1995 and on 1 October 1995.

		SH	SL	RH	RL	sed
Autumn	tillers/m^2	3180	5400	3790	4600	350
	grass %	59.3	80.	61.6	77.6	3.5
	weed %	16.8	2.8	5.7	2.5	-
October 1995	tillers/m^2	4150	5750	5700	5710	780
	grass %	55.3	68.9	56.3	72.0	3.3
	weed %	24.1	4.1	8.1	5.6	-

Table 2

Effects of grazing on Caucasian clover and white clover cover % on 1 October 1995 and Caucasian clover underground biomass in August 1995 after two years of grazing treatments. (P = 0.007 for S versus R contrast for biomass).

	SH	SL	RH	RL	sed
Caucasian clover cover %	7	13	28	23	2.2
White clover cover %	18	24	26	14	2.8
Caucasian clover underground biomass (g DM/m^2 to 100mm depth)	50	106	373	270	49.8