

Productivity of caucasian clover based pastures under irrigation

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Abstract

Grasslands Kara cocksfoot, Grasslands Nui ryegrass, Grasslands Roa tall fescue, Grasslands Gala grazing brome and Grasslands Maru phalaris were sown as single grass species with either white or Caucasian clover during December 1993, on a Lismore stony silt loam in Canterbury. Plots were irrigated and rotationally grazed by sheep. Total herbage produced during the first measurement period (September 1994 to July 1995) averaged 13.6 t DM/ha. All white clover-based swards produced similar yields, but with Caucasian clover, phalaris-based swards produced the most and ryegrass and grazing brome the least. Production tended to be lower from pastures sown with Caucasian than white clover (12.9 cf. 14.2 kg DM/ha). During the second measurement period (July 1995 to May 1996) total production was similar with both legumes. When evaluated over both measurement periods, phalaris and tall fescue gave the highest and cocksfoot and ryegrass the lowest production when sown with white clover, while cocksfoot and grazing brome were the lowest-producing swards with Caucasian clover. Ten months after sowing, white clover contributed in excess of 40% of the DM in all swards except with ryegrass and grazing brome where it contributed 20%. The proportion of white clover then declined in all pastures over the following 20 months, ryegrass-based swards having the highest (10%) and cocksfoot the lowest (1%). When sown with Caucasian clover the legume content of swards increased during the 12 months from spring 1994 in swards containing phalaris, tall fescue and grazing brome. The proportion of legume in cocksfoot swards declined continuously from 22 to 4% over the 20 months while it increased continuously from 4 to 28% with ryegrass. The legume content in 10-month-old pastures was higher when sown with white than with Caucasian clover but this ratio was reversed by 28 months. This occurred with all pasture types but was most pronounced with ryegrass and cocksfoot pastures. The present experiment shows Caucasian clover can make a major contribution in irrigated pastures in Canterbury.

Keywords: *Bromus stamineus*, *Dactylis glomerata*, *Festuca arundinacea*, grazed pastures, herbage production, *Lolium perenne*, *Phalaris aquatica*, *Trifolium ambiguum*, *Trifolium repens*

Introduction

Caucasian clover (*Trifolium ambiguum* M. Bieb) has displayed a high level of persistence (Woodman *et al.* 1992) and competitiveness (Allan & Keoghan 1994) in South Island hill and high country pastures. The below-ground rhizomes of Caucasian clover ensure its persistence is retained under a range of grazing management conditions (Allan & Keoghan 1994); swards at Mesopotamia in the Rangitata valley are in excess of 20 years old (Lucas pers. comm). Furthermore, it has demonstrated production that was superior to that of Grasslands Huia white clover and Grasslands Maku lotus under conditions of low soil fertility (Daly & Mason 1987).

Irrigated ryegrass-based pastures in Canterbury tend to have a relatively low clover content, with annual legume content averaging 12% (Moss 1987) in old irrigated pastures. Increasing the quantity of legume in such swards would give corresponding improvements in animal performance (Stevens *et al.* 1993).

The present experiment evaluates the performance of Caucasian clover and its compatibility with a range of commonly used pasture grasses under irrigated conditions in Canterbury.

Methods

The trial area at the Winchmore Research Station in Canterbury, on a Lismore stony silt loam, was treated with Roundup and Granstar to remove resident pasture. Five grasses were direct drilled during December 1993 together with either white clover (*Trifolium repens* L.), or Caucasian clover. The grass species sown were cocksfoot (*Dactylis glomerata* cv. Grasslands Kara), ryegrass (*Lolium perenne* cv. Grasslands Super Nui), tall fescue (*Festuca arundinacea* cv. Grasslands Roa), grazing brome (*Bromus stamineus* cv. Grasslands Gala) and phalaris (*Phalaris aquatica* cv. Grasslands Maru). The grass species were the main plots and included in the treatments a mixed combination with phalaris, tall fescue and grazing brome. Each of the grass species

was divided as a split plot with one half in Caucasian clover, cv. Endura and the other in white clover, cv. Grasslands Huia. Grass plots were 300 m² and were individually fenced. There were four replicates, all of which were irrigated by the border-strip method, receiving six and four applications during years one and two respectively.

All plots received 200 kg/ha superphosphate and 5 kg/ha Thimet 20G phorate insecticide at sowing. Plots also received 6.3 kg/ha diazinon insecticide during August 1994 for grass grub (*Costelytra zealandica*) control and 250 kg/ha superphosphate annually.

Individual grass and clover plants were counted 7 weeks after sowing to assess establishment rates. Herbage dry matter (DM) production was measured by assessing pre- and post-grazing herbage masses. This began during September 1994 and involved placing a 0.25 m² quadrat on an area visually assessed as representative of the measurement area. then cutting the herbage to ground level with a shearing hand-piece. Cut herbage was then washed to remove extraneous material before drying. Plots were cut at 3- to 6-weekly intervals during spring-summer-autumn and 8- to 10-weekly intervals during winter.

Once in spring and autumn a representative sample of herbage was cut 5 mm above ground level from each plot, and the botanical composition assessed. Volunteer white clover was included in the legume from the Caucasian clover plots.

Plots were grazed individually within replicates by mob stocked sheep for 2 to 3 days per grazing.

Results

Seedling counts

Counts taken 7 weeks after sowing indicated a lower percentage of Caucasian than white clover plants in their respective sown plots (Table 1).

The ratio of clover to grasses was similar for all grasses except when sown with ryegrass, in which circumstance the percentage of both white and Caucasian clover plants was considerably reduced. White clover seedlings from buried seed equated to 3% of the clover plants present in the Caucasian clover plots.

Herbage production

Total herbage produced during the first measurement period averaged 13.6 t DM/ha (Table 2). When grasses were sown with white clover there was no significant difference in total production between pasture types ($P < 0.05$), but when sown with Caucasian clover, phalaris-based swards produced the most and ryegrass and grazing brome the least. Overall production tended to be lower from pastures sown with Caucasian than white clover (14.2 cf. 12.9 t DM/ha).

Table 1 Percentage of plants present 7 weeks after sowing (%)

Sown grass	White		Sown clover		
	Grass	White	Grass	White	Caucasian
Cocksfoot	43.7	56.3	52.6	2.7	44.7
Ryegrass	59.5	40.5	72.0	1.8	25.4
Phalaris	47.6	52.4	56.8	0.8	42.4
Tall fescue	48.9	51.1	55.4	1.8	42.8
Grazing brome	48.9	51.1	56.0	0.0	44.0
Mixed grasses	49.1	50.9	54.4	0.2	45.4

Table 2 Total DM production during measurement periods 1 (September 1994 to July 1995) and 2 (July 1995 to May 1996) (t DM/ha).

Sown grass	White		Sown clover	
	period 1	Caucasian	White	Caucasian
Cocksfoot	14.2	12.9	11.4	11.9
Ryegrass	12.9	12.3	12.2	15.0
Phalaris	14.5	14.6	14.8	14.1
Tall fescue	14.4	12.6	15.1	14.5
Grazing brome	14.5	12.1	13.9	12.9
Mixed	14.5	13.1	14.5	15.0
Lsd $P < 0.05$	2.14	2.14	2.29	2.29

Table 3 Total DM production during measurement periods 1 and 2 combined (September 1994 to May 1996) (t DM/ha).

Sown grass	Sown clover	
	White	Caucasian
Cocksfoot	25.6	24.9
Ryegrass	25.1	27.4
Phalaris	29.2	28.8
Tall fescue	29.4	27.1
Grazing brome	26.4	25.0
Mixed	29.0	28.1
Lsd $P < 0.05$	3.3	3.0

During the second measurement period cocksfoot and ryegrass swards had the lowest levels of production when grasses were sown with white clover. When sown with Caucasian clover, cocksfoot and grazing brome were the lowest- and ryegrass and the mixture the highest-producing swards. Overall total DM production was similar under both legumes.

Over the combined 20-month period phalaris, tall fescue and the mixed sward produced the highest and cocksfoot and ryegrass the lowest herbage DM with white clover as the companion legume. In the Caucasian clover-based swards phalaris, tall fescue and the mix were again the highest producers along with ryegrass, while cocksfoot was the lowest. The grazing brome-based swards produced significantly more when sown

with white than with Caucasian clover, but the opposite applied with ryegrass.

Botanical composition

In the white clover-based swards the percentage of legume was highest 10 months after sowing. It then exceeded 40% of the DM in the cocksfoot, tall fescue, and phalaris pasture and about 20% in the ryegrass and brome pastures (Figure 1). The proportion of white clover then declined in all pastures over the following 20 months. This decline was gradual in ryegrass and brome but rapid in all other treatments during the summer and autumn of 1995. In 28-month-old pastures the proportion of white clover was highest in ryegrass-based swards at 11% and lowest in cocksfoot with less than 1%.

In pasture sown with Caucasian clover the legume content tended to increase during the 12 months from spring 1994 in all grass swards except cocksfoot (Figure 2). The percentage of clover in cocksfoot swards declined from 22 to 4% over the 20 months, while the ryegrass percentage increased continuously from 4 to 28% over this time. The percentage of clover was static in the tall fescue at 20% and the grazing brome at 15% over this period.

The percentage of legume in pastures at 10 months of age was higher when sown with white clover than with Caucasian clover (40% cf. 15%) but lower in white than Caucasian clover at 28 months (5% cf. 17%). This occurred with all pasture types but was most pronounced in ryegrass and cocksfoot swards. The reduction in the percentage of legume in swards that occurred over time where white clover was sown was largely made up for

by a percentage increase in sown grasses (Figure 1). This occurred in all swards except where tall fescue was sown, when the percentage of unsown species also increased substantially over time. When sown with Caucasian clover, the proportion of the sward as sown grasses tended to decline over time when ryegrass, brome or the grass mixture was sown but it tended to increase when cocksfoot and phalaris were used (Figure 2). The percentage as cocksfoot increased to 99 and 95% when sown with white and Caucasian clover respectively (Figures 1 and 2). Where tall fescue was sown as a single grass species it represented less than 50 and 25% of the DM produced when sown with white and Caucasian clover respectively, while unsown species produced more than 45% of the dry matter from these two pasture types.

Discussion

In comparison with Caucasian clover, white clover-based swards produced a greater percentage of legume 10 months after sowing. However, the legume content in white clover pastures then declined but it increased in Caucasian clover swards such that from 16 months until the last measurement date at 28 months the legume content was considerably higher in Caucasian than white clover swards. Stevens *et al.* (1993) showed that increasing the legume content of pastures improved animal growth rates. Caucasian clover-based swards during the second year were superior to those based on white clover, giving the potential for higher animal performance.

Figure 1 Sward botanical composition, white clover plots.

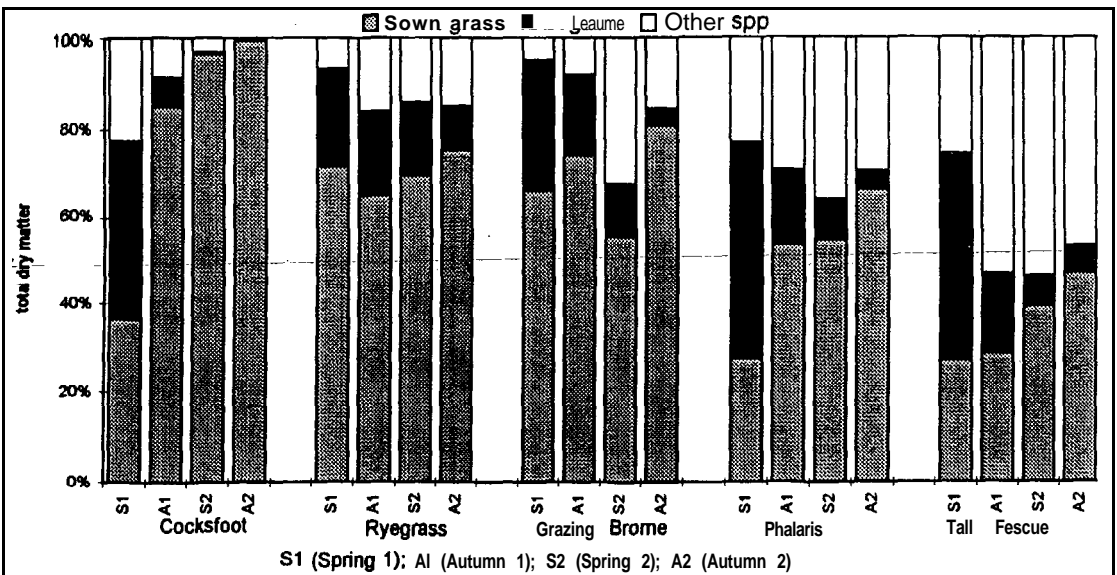
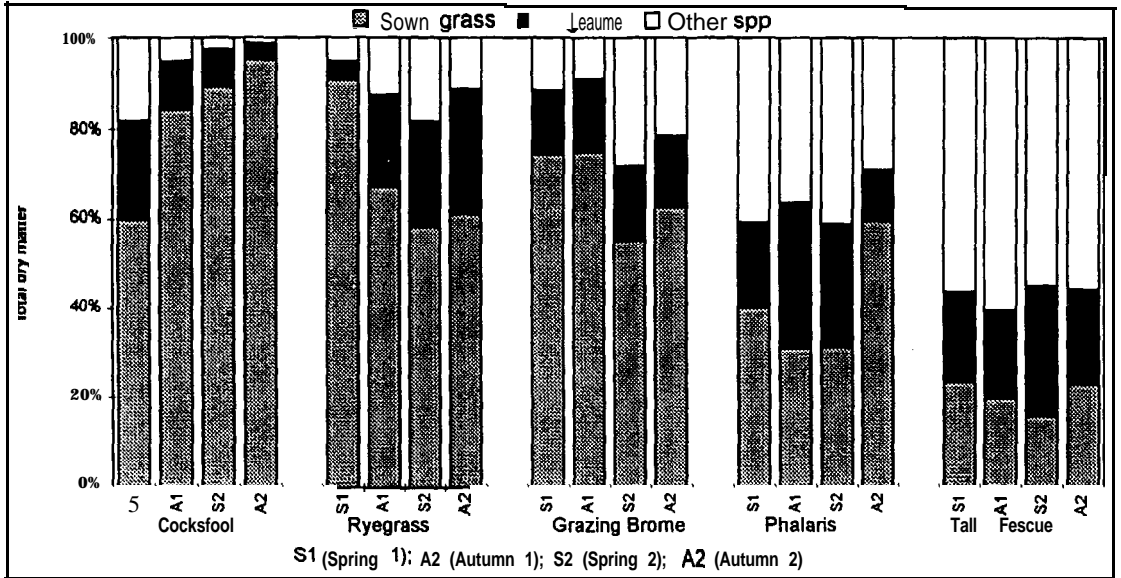


Figure 2 Sward botanical composition, Caucasian clover plots.



Total DM production tended to be higher initially in swards sown with white clover but as the content of legume decreased in white clover- and increased in Caucasian clover-based swards, total DM production was similar. Lucas *et al.* (1981) also found Caucasian clover slow to establish, but Patrick *et al.* (1994) considered this was possibly owing to poor nodulation associated with low inoculation levels, and stressed the importance of inoculation technique and especially the use of an appropriate inoculant. The Caucasian clover in the present experiment was well nodulated.

The Caucasian clover content of ryegrass pastures was initially low but it then increased continuously until after 28 months, when measurements ceased, it was higher in this pasture than in any other, and apparently increasing, while the content had stabilised in all other swards. The content of white clover was initially lower in ryegrass swards than in all others, reflecting the rapid establishment of ryegrass compared with other grasses, which was achieved at the expense of clovers as shown by Praat *et al.* (1996).

When sown with Caucasian clover, swards containing phalaris produced more DM than did cocksfoot or grazing brome pastures, but not more than ryegrass. Phalaris and tall fescue produced more than did swards containing cocksfoot or ryegrass when sown with white clover and assessed over 22 months post-establishment. However, the tall fescue swards contained 45 and 57% of unsown species in the white and Caucasian clover swards respectively.

Ryegrass, which along with cocksfoot and grazing brome was one of the poorest producers during the first measurement year, was subsequently one of the best producers along with phalaris and tall fescue in the second year. The performance of ryegrass may have been disproportionately enhanced by the use of insecticide to control grass grub, as both phalaris and tall fescue are tolerant of this pest (Kain & Atkinson 1977). In the absence of grass grub control Thomson *et al.* (1988) showed that phalaris and tall fescue produced more DM than ryegrass in Taranaki.

Swards sown with cocksfoot became dominated by that species to such an extent that 28 months after sowing they contained 99 and 95% cocksfoot when sown with white or Caucasian clover respectively. Conversely, these swards had an extremely low legume content and lower DM production than swards based on the alternative grasses. This indicates it is less suitable for use with irrigation than are the other grasses. The lower DM production from the cocksfoot swards may reflect a reduction in soil nitrogen resulting from the reduced legume content of these swards. However, further monitoring of the cocksfoot swards is essential to determine the ability of Caucasian clover to increase over time. Retaining legumes in cocksfoot swards has always been a challenge.

Most research with Caucasian clover in New Zealand has been in the South Island high country on low fertility soils and in drought-prone climates where it has outperformed swards established with white clover (Lobb

1957; Daly & Mason 1987). It can tolerate heavy frosts (Dear & Zorin 1985) and is persistent under a range of grazing systems (Allan & Keoghan 1994). The present experiment indicates Caucasian clover can also make a major contribution in irrigated pastures in Canterbury.

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