Proceedings of the New Zealand Grassland Association 48: 151-156 *(1987)*

PERFORMANCE OF CAUCASIAN AND ZIGZAG CLOVERS

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Abstract

Production of two rhizomatous *clovers,* Caucasian *clover* (*Trifolium ambiguum*) and zigzag *clover* (*T. medium),* was assessed under a number of fertility regimes.

Caucasian clover annual dry matter production was of 12 t/ha for cv. Treeline on a fertile lowland soil, 8.5 t/ha for cv. Prairie on a moderately fertile hill country soil and 2.5 t/ha for cv. Prairie on a low fertility high country soil. For a 30 year old stand of zigzag clover on a moderately fertile high country soil estimated DM yields ranged from 2 t/ha under low fertiliser applications to 10 t/ha under high fertiliser rates. The stand gave a 3.2 t DM/ha response to the addition of 50 kg/ha sulphur alone. Both clovers are very persistent and appear to remain productive for several years in the absence of fertiliser applications.

INTRODUCTION

There is an urgent need to provide New Zealand pastoral farming with more persistent, phosphorus-efficient legumes, to allow hill and high country farmers to maintain animal production with lower maintenance fertiliser costs. Caucasian and zigzag clovers may have such a role for low fertility pastoral systems, in the South island hill and high country (Scott et *al.* 1985). This paper reports the productive performance of mature swards of Caucasian clover at three sites and zigzag clover at one site.

Caucasian clover *(Trifolium ambiguum)* is a strongly rhizomatous, persistent, polyploid species from subalpine habitats and continental steppes of Caucasian Russia, Turkey and Iran. Six Australian cultivars have been released: Summit, Forest (Diploid), Treeline (Tetraploid), Prairie (Hexaploid) and the more recently-bred lines Alpine (Diploid) and Monaro (Hexaploid) which have shown agronomic promise in a four year screening trial (Dear & Zorin 1985).

Zigzag clover (*Trifolium medium)* is also rhizomatous and long-lived. It grows wild throughout Eurasia. There are no cultivars but three germplasm pools have been released in the USA (Townsend 1985). Zigzag clover was included by L. Cockayne in his Central Otago plant introduction plots (Lobb 1957, Douglas 1970) and several stands have been established in the South Island high country from lines improved by L. Corkill.

EXPERIMENTAL

Caucasian Clover

Productive performance of Caucasian clover was assessed in lowland, hill country and high country sites.

Lowland. A pure sward of Treeline was established in 1973 at 6 plants/m² in Wakanui silt loam at the Forest Research Institute, Rangiora. Kept weed-free, the plants spread to form a continuous sward within 3 years. When 5 years old the sward was harvested at intervals over the full growing season 1977/78 (Stewart & Daly 1980). Below ground biomass was sampled to a depth of 80 cm.

Hill Country. In September 1974 swards of Prairie Caucasian clover and Huia white clover were established at a plant population of 40/m² in a stony Haldon silt loam at Hunua, North Canterbury where soil moisture is below wilting point from December to March each growing season. The altitude was 650 m, rainfall for 1970-74 was 800 mm per year and the soil had an Olsen P of 19.

Annual dry matter yields of three 0.25 m^2 plots of Prairie were compared to those of Huia white clover over four successive growth seasons. Long-term persistence was assessed in 1985 from five 0.1 m^2 quadrats in the Prairie plots and soil excavated to sample the rhizome and root biomass to a depth of 40 cm.

High Country. Established in 1975 by oversowing a sparse tussock grassland dominated by browntop, sweet vernal and mouse-eared hawkweed, the trial was designed to compare the performance of Maku lotus, Prairie Caucasian clover and Huia white clover at a range of establishment and maintenance P rates on an infertile Cass soil. Results from the first four years were given by Lucas et al. (1981).

Maintenance fertilizer treatments stopped after 1981 but the site continued to be grazed. In spring 1984 dry matter yields of swards based on the three legumes were assessed by cutting 0.1 m^2 quadrats. In addition, biomass was measured in the Prairie plots by cutting five 0.1 m^2 quadrats and sampling rhizomes and roots to 40 cm depth. Herbage yields were again assessed in spring 1985 for swards based on Prairie and Huia. Part of the trial area was accidently topdressed and oversown with white clover when the surrounding block was over-flown in 1984.

Zigzag Clover

The stand of zigzag clover, which was established in the mid 1950s by H. Sievwright on a moderately fertile Pukaki soil at Holbrook Station, survived for 20 years without fertilizer, despite an invasion by mouse-eared hawkweed. The stand was stratified in terms of zigzag clover populations and hawkweed cover and applied fertilizer in 1975 (Scott pers. comm.). Superphosphate at 0, 50, 100, 200 and 400 kg/ha and elemental sulphur at 0, 20 and 50 kg/ha were randomly applied, in combination to the strata in August 1983. Dry matter production in November 1983 and February 1988 was estimated using a capacitance probe.

RESULTS

Caucasian Clover

Caucasian clover was very productive in the fertile lowland soil, moderately productive at the dry hill country site and less so in the infertile high country environment (Table 1). Rhizome and root biomass built up in these mature stands and reached a maximum of 17.5 t DM/ha at Hunua. The underground biomass to annual DM yield ratio rose from 1.04 in fertile Wakanui soil to 2.73 in the infertile Cass high country yellow brown earth soil.

Table 1: Site descriptions, dry matter yields, rhizome and root biomass of mature Caucasian clover wards in Canterbury.

Locality	Rangiora F.R.I.	Doctors Range Hunua	Rangitata Valley Mesopotamia
Altitude m	30	650	700
Rainfall mm	650	600	1000
Soil	Wakanui	Haldon	Cass
Olsen P	19-25	16	6
pH	5.9	5.7	5.2
Cultivar	Treeline	Prairie	Prairie
Sward Age (yrs)	5	12	6
Herbage yield (kg/ha)	12120	7520	2020
S.E.M.		651	106
Summer/Autumn yield (kg/ha)		1000	500
Underground Biomass (kg/ha)			
Rhizomes		12100	4930
Roots		5410	560
Total	12600	17510	5510
S.E.M.		2070	
Underground:Top Ratio	1.04	2.33	2.73

Production of Prairie Caucasian clover and Huia white clover growing without maintenance superphosphate for four years in a Haldon hill country soil is shown in Figure 1. Little difference between the two clovers was noted during establishment, however over the next three years Prairie outyielded Huia by an average of 2.6 t DM/ha/yr. Dry matter production by Prairie was maintained at 4.7 t/ha in the fourth year while that of Huia declined to 1.3 t/ha. By January 1984, Caucasian clover had invaded and dominated white clover plots. Ungrazed Prairie plots yielded 6.6 t DM/ha.

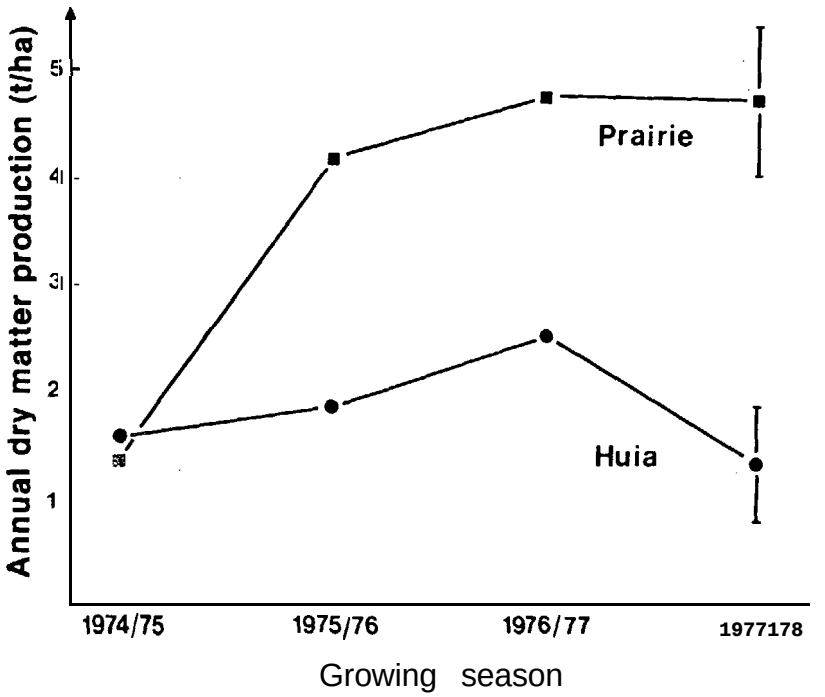

Figure 1: Dry matter production of Prairie Caucasian clover and Huia white clover grown without maintenance superphosphate in a Haldon soil at Hunua, North Canterbury. Vertical bars represent standard errors of the means.

Sown legume and total yields for spring 1984 are presented in Table 2 for swards established at Mesopotamia Station. Three years after maintenance superphosphate was discontinued, spring production by Prairie was 1.6 t DM/ha compared with 0.4 t/ha for Maku lotus and Huia white clover. Prairie contributed 27.3% of total sward yield. Grass production in swards based on Prairie (4 t/ha) and Huia (3.2 t/ha) was significantly better than in those sown in Maku lotus (1.9 t/ha).

Table 3 gives sown legume and total yields in spring 1985 for Prairie and Huia-based plots in the Mesopotamia trial. Spring growth of Prairie was 0.85 t/ha (26.2% of total yield) four years after maintenance superphosphate was discontinued. Equivalent Huia white clover swards produced only 0.4 t/ha (11.2% total DM yield). However, plots which received only one application of superphosphate (125 kg/ha) in 1980 showed little difference in yields between Prairie and Huia. Grass growth with Huia white clover was 39.4% higher than with Prairie where annual maintenance P had been applied till 1981.

Table 2: Herbage mass of legume-based wards at Mesopotamia Station on 17.12.84, after three years without maintenance superphosphate.

	DM kg/ha		
	Sown Legume	Sown Legume	Total
Prairie		1620 (27.3)'	5935
S.E.M.		143	435
Maku		440 (13.9)	3160
S.E.M.		136	425
Huia		460 (12.4)	3720
S.E.M.		122	629

'Figures in parentheses are percent contribution of legumes to total yield

Table 3: Herbage mass of clover-based wards at Mesopotamia Station on 16.12.65, four years without maintenance fertilizer (kg DM/ha).

Oversown clover	Prairie		Huia	
Superphosphate	Clover	Total	Clover	Total
125 kg Annually until 1961	850 (26.2)'	3247	395 (11.2)	3510
S.E.M.	205	363	165	505
SP once in 1960	555 (16.1)	3062	765 (20.3)	3766
S.E.M.	175	357	120	183

'Figures in parentheses are percent contribution of legumes to total yield.

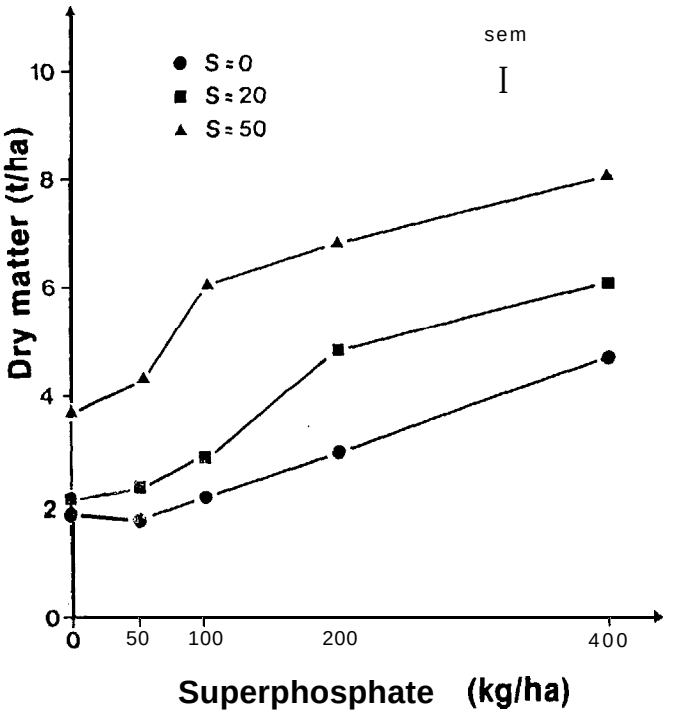

Figure 2: Response of zigzag clover-dominant swards at Holbrook Stations to increasing rates of superphosphate and sulphur in t/ha, four months after application. Vertical bar represents standard error of the means.

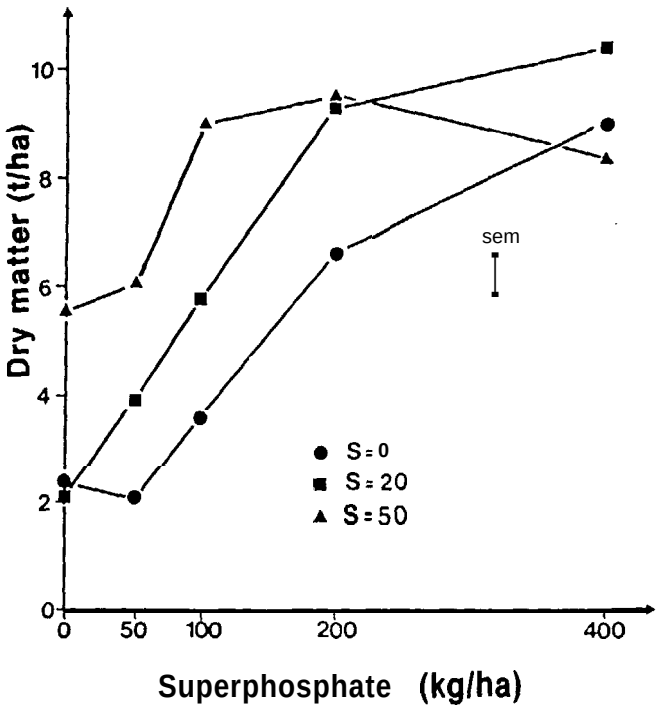

Figure 3: Response of zigzag clover-dominant swards at Holbrook Station to increasing rates of superphosphate and sulphur, 2 years and 7 months after application. Vertical bar represents standard error of the means.

DISCUSSION

Production and persistence

A mature sward of Caucasian clover growing in fertile soil can be as productive as one of red or white clover (Table 1). At Hunua in a drought-prone, medium fertility Haldon soil, Caucasian clover was twice as productive as Huia white clover (Figure 1). Dear and Zorin (1985) also found that Caucasian clover persisted and produced much better than white clover in a droughted environment.

Without maintenance fertiliser, Prairie Caucasian clover yielded 8.5 t/ha in its twelfth year at the Hunua hill country site, where the Haldon soil has a moderate P but low sulphate-S status (Tonkin et al. 1982). In this soil, Caucasian clover appears to be making use of the natural soil fertility and surviving drought by means of its rhizome mass and deep tap roots. Dear and Zorin (1985) found Caucasian clover cultivars to be well-adapted to cold winter and dry summers at an upland New South Wales site, with similar production figures to those measured in the present study, at Hunua.

Prairie Caucasian clover was the most productive legume in the ninth year of the Mesopotamia trial (Table 2). Maku lotus and Huia white clover declined compared to their performance when maintenance P was applied (Lucas *et al.* 1980). Dry matter yields of up to 10 t/ha for the Holbrook zigzag clover sward can be compared with yields of 8 t DM/ha/yr in the U.S.A. (Townsend 1985). The performance graphed in Figure 3 was achieved by a 30 year old sward which had received little fertiliser in the first 20 years and suffered invasion by mouse-eared hawkweed. The continuing slow

spread of zigzag clover through the trial area demonstrates the persistence of the species. There is no other information on production of zigzag clover in this country.

Both Caucasian and zigzag clovers produce stout taproots and large networks of rhizomes which confer tolerance to drought and grass grub attack. In Caucasian clover the proportion of total biomass contributed by rhizomes and roots increased as soil and climate conditions became more severe. This appears to be an adaptation for survival in cold, infertile environments.

Fertiliser responses

With establishment and maintenance superphosphate, Prairie Caucasian clover was initially less productive than Maku lotus and Huia white clover (Lucaset *al.* 1980). However, Prairie swards persisted and by the ninth year outyielded the other two legumes by 1.2 t DM/ha during spring (Table 2).

Zigzag clover on a Pukaki soil responded to addition of both elemental sulphur and superphosphate. Sulphur alone at 50 kg/ha increased dry matter production by 3.2 t/ha in the second season after application (Figure 3). Two hundred kg/ha of superphosphate raised herbage production by 4.4 t/ha. Little increase in dry matter yield occurred above 200 kg/ha of superphopshate. Zigzag clover persisted well without maintenance fertiliser but responded productively to moderate additions of sulphur and superphosphate at the high country site.

CONCLUSIONS

The role of Caucasian and zigzag clovers as spring/early summer producers suitable for low fertility, high country soils (Scott eta/. 1985) can be extended to soils of moderate natural fertility. On such soils, 6-8 t DM/ha/yr could be expected from these rhizomatous clovers with infrequent fertiliser application.

The results presented here were obtained from small areas of mature swards. There is also little agronomic information to assist with the establishment and management of farm-scale stands. A further constraint is the present lack of commercial seed supplies.

Four cultivars of Caucasian clover have been released in Australia, with the bred lines Alpine (diploid) and Monaro (hexaploid) considered to be agronomically superior. There are no cultivars of zigzag clover.

In view of the potential role of Caucasian clover and zigzag clover, further work must be done on seed increase, establishment and management of swards in hill and high country pastoral systems.

Acknowledgements

A.H. Nordmeyerand D. Scott for their cooperation at two field sites and R.J. Lucas, who materially assisted in the preparation of this paper.

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