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A REVIEW OF 10 YEARS' RESEARCH WITH RED CLOVERS UNDER GRAZING IN SOUTHLAND

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Abstract

In series of trials at Grasslands Gore, over 10 years, the late-flowering tetraploid red clover 'Grassland Pawera' was more productive and persistent than other red clover cultivars. The strong summer growth of Pawera meets the need for heavy-weight lamb feed and high quality forage for conservation in intensive sheep farming systems in Southland.

Lenient. infrequent defoliation is necessary to maximise DM production and persistence of Pawera. The most compatible of the grasses evaluated was 'Grasslands Roa' tall fescue. However, 'Grasslands Nui' ryegrass will still be the major grass sown with Pawera owing to its widespread acceptance. In ryegrass mixtures, sowing rates of 5-7 kg/ha of red clover were needed to optimise establishment and subsequent yield. Evidence of oestrogenic activity of Pawera to sheep prompted Grasslands Division to select within Pawera for a low formononetin cultivar.

Keywords: red clover, Pawera, Hamua, Turoa, G21, G22, G27. oestrogenic activity, Nui ryegrass, Roa tall fescue, Maru phalaris, Southland, sheep grazing, frequency, intensity, quality. seasonal growth

INTRODUCTION

The farmed area of Southland (Lat. 46°S) is mainly flat and rolling downlands, with some steeper hill country. The area under grazing, 1.1 million ha, is approximately 8% of the national total, and contains 14% of the nation's sheep number (NZ Government Agricultural Statistics 1985). Climate of the region has been described by Garnier (1958) as humid, microthermal, and with adequate moisture at all seasons. The two main groups of soils of the occupied area are gleyed yellow-grey earths. Smaller areas of alluvial river flats and organic soils are interspersed (Rankin & Bruce 1972).

High quality pasture forage for use *in situ* or for conservation is important in all pastoral systems. However the environment in Southland does not permit the use of lucerne *(Medicago sativa* L.) for this role (Hook 1976). Traditional grazing management on ryegrass-white clover pastures has not provided enought legume content for high quality haymaking. Therefore an aggressive legume tolerant of Southland soil conditions was required.

Early trials with red clovers (*Trifolium pratense* L.) showed large potential for their use in forage systems in Southland (Harris et *al.* 1973), and led to futher investigations by Grasslands Division on red clover as a high quality summer forage for heavy weight lamb fattening or conservation. An understanding of grass-clover competition, management variations and the oestrogenic activity of red clover to ewes was required to ensure the successful use of red clovers in sheep systems.

EXPERIMENTAL METHODS AND RESULTS

Site

Unless otherwise stated all trials reported here were conducted at the Grasslands Division Regional Station, Gore, on a Waimumu silt loam.

Average annual rainfall of 918 mm is distributed evenly throughout the year (NZ

Met. Service data). Winters are colder than in other regions in New Zealand and soils become very wet because of an impervious B horizon (Rankin & Bruce 1972).

(1) Red clover cultivars

Four Grasslands red clover cultivars, Hamua, G22, Turoa and Pawera (early flowering diploid, tetraploid, and late flowering diploid, tetraploid respectively) were sown in spring 1979 as pure swards in 4 replicates. For 3 years after establishment swards were grazed from September to February at 4-, 6- or 9- week intervals to a 3-4 cm residual height.

The mean 3-year yields (kg DM/ha), averaged for the 3 grazing frequencies, were: Pawera 10200 > G22 7900 = Turoa 7600 > Hamua 6700, LSD 5%=350. The persistence of Pawera can best be seen from the yields for the third year of measurement (Table 1) where Pawera had superior production under each grazing frequency. DM figures attained from each cultivar are reflected in the plant numbers surviving 3.5 years from sowing. The superiority of Pawera is reinforced by another experiment in which these same cultivars were sown with Nui ryegrass at various seeding rate ratios of grass to clover, fully described in (2) below. Pawera outyielded the other 3 red clover cultivars both in number of plants surviving in the sward after 3 years and also in DM production. In year 3 Pawera yielded 2-3 times more clover than any of the other red clover cultivars (Table 2).

Another trial, sown in 1980, evaluated the performance of 3 early- flowering red clover cultivars, Hamua, G21 and G22 on their own and with either 'Grasslands Matua' prairie grass (*Bromus wildendowii* Kunth.) or 'Grasslands Nui' perennial ryegrass (*Lolium* perenne L.) under 2 grazing frequencies. The results of this trial are reported by Hickey & Harris (in press) and show G21 and G22 to be superior to Hamua both in DM yield (particularly in the cool season) and in persistence.

(2) Seeding rate

Four red clover cultivars, Hamua, G22, Turoa and Pawera, were sown at 4 seeding rates, 3, 5, 7 and 10 kg/ha in combination with 4 seeding rates of Nui perennial tyegrass, 0, 5, 15 and 30 kg/ha. The trial was sown in spring 1979 and after establishment was grazed to 5 cm when mean plot height averaged 22 cm.

Increasing the clover sowing rate above 5 kg/ha increased plant numbers and DM yield, proportionally, very little (Table 3).

As the seeding rate of Nui was increased, plant numbers and DM yield of the red clovers decreased.

(3) Direct drilling

A trial investigating the introduction and subsequent production of Pawera red clover into 'run out' pasture by direct drilling in spring 1973 was reported by Ryan *et al.* (1979) and by Hay *et al.* (1978). Pasture growth rates over December-February for the Pawera-based sward averaged nearly 2 times that of the Huia-based swards (legume yield of 1500 kg/ha of red clover DM cf. 800 kg/ha white clover DM). In the fourth summer from drilling, 35% of the DM production over the summer was from Pawera.

(4) Soil fertility aspects

Pure stands of Pawera were sown in 1979 to investigate the effect of pH and potash level on DM production. pH levels of 5.0, 5.7 and 6.0 were established, by incorporating 2 rates of finely ground lime into the soil. Three levels of potash availability were established through spring/summer applications of O/O, 60/0 and 60/60 kg/ha potassium chloride. There were 3 replicates and the trial ran for 3 years, Pawera yields were the same for all treatments in all years and ranged between 11 000 and 13 000 kg DM/ha.

Soil analyses showed a marked reduction in potassium concentration from

Table 1: Red clover plant population and mean annual yield in year three under three grazing frequencies.

Cultivars	Red clover yield (kg DM/ha) Grazing Frequency			Plant nos./m^2
	4 week	6 week	9 week	
Hamua	1 400	2 100	4 900	5
G22	1 600	4 300	10000	11
Turoa	2 800	4 300	8 100	12
Pawera	3 100	7 600	12 100	19
LSD 5%		600		3

Table 2: Mean red clover cultivar plant population and annual yields in the first and third year of a trial investigating seeding mixtures and rates

Red Clover cultivars	Annual yield (kg DM/ha)		Population plant nos/m^2	
	Year 1	Year 3	Year 1	Year 3
Hamua	3950	700	160	16
G22	3100	900	165	24
Turoa	4350	1250	160	25
Pawera	5600	2330	175	3.9
LSD 5%	390	270	36	4

Table 3: Mean red clover plant population and annual yields in the first and third year of a trial investigating seeding mixutres and rates

Red Clover seeding rate (kg/ha)	Annual yield (kg DM/ha)		Population plant nos/m^2	
	Year 1	Year 3	Year 1	Year 3
3	3400	1000	100	21
5	4000	1200	140	24
7	4700	1400	180	29
10	5100	1550	230	32
LSD 5%	390	270	36	4

below 15 cm depth, especially in the plots which received no potash. Analysis of plant material showed adequate uptake of all mineral nutrients in all treatments although at the highest pH treatment manganese was low (R.A. Carran unpub. data).

(5) Companion species

Trials were sown at 2 sites, Gore and Kaweku, in spring 1975 to investigate the performance of Pawera red clover alone and with 6 companion grasses. Results from the Kaweku site have been reported by Hay & Ryan (1983). Seeding rates of the 6 grasses were adjusted to give the same number of viable seeds/m^2 as 18 kg/ha Nui perennial ryegrass. At the Gore site each plot was 10 x 10 m and individually fenced. There were 2 grazing regimes, 25 cm to 5 cm, and 18 cm to 2 cm, and 4 replicates. After a g-month establishment period grazing treatments were imposed and the trial ran for 4 years.

The yield of Pawera with each of the companion grasses and their effect on Pawera's persistence is demonstrated by the regression lines, sown grass against

sown legume, for each of the grazing regimes-firstly for the means of years 1 and 2, and secondly for years 3 and 4 (Fig. 1). High correlation coefficients were obtained for each regression. The 25 to 5 cm grazing regime did not necessarily give the highest total DM yields, but it certainly favoured the production and persistence of the Pawera component.

The fast establishing Nui and G4708 hybrid ryegrass and Matua prairie grass retarded the development of pawera within the sward; thus they had the highest sown grass yields but the lowest Pawera yields. Because the slower establishing 'Grasslands Roa' tall fescue (*Festuca arundinacea* Schreb.), 'Grasslands Maru' phalaris (Phalaris *aquatica* L.), and K1858 cocksfoot (*Dactylis* glomerara L.) were less competitive with Pawera, a higher clover association was formed with them. Roa was the best companion grass with Pawera, maintaining an equal balance of grass and clover. Although Maru initially had a high Pawera component, the increasing grass content of Maru over the years became much more competitive and reduced Pawera yield.

(6) Growth periodicity

Pawera produced 3000 kg DM/ha more than ryegrass–white clover pasture in summer, but pasture outproduced Pawera in the other seasons (Fig. 2). A third treatment in this 3-year trial was Pawera overdrilled each autumn with a winter annual. This sward mixture was intermediate in DM production for each season, apart from winter, when it outproduced both Pawera and pasture.

(7) Oestrogenic activity

Three trials at Gore between 1976 and 1981 addressed the question of Pawera's phyto-oestrogenic activity to ewes. The first of these (Kelly et al. 1979) showed that ewes grazing pure red clover swards secreted significantly more cervical mucus than ewes grazing ryegrass-white clover pasture.

The second trial studied the possibility of permanent infertility. Sixty Romney ewes, which had grazed a pure sward of Pawera red clover for 13 weeks in 1977 (lambing to weaning) and another 60 Romney ewes which had never been exposed to red clover, were flushed and mated on ryegrass–white clover pasture the following autumn. At mid-pregnancy they were slaughtered and reproductive information obtained. The ewes which had been on Pawera during the previous lactation had a higher returns-to-service, lower ovulation rates and conception, but no differences in the number of live multiple foetuses (Table 4).

Trial 3 was a 1 ha self-contained farmlet system set up in spring 1977 to study ewe fertility when Pawera was used as the principal legume in Nui ryegrass-clover swards. The control was Nui-Huia pasture. There were 2 replicates and the trial ran for 3 years. Returns-to-service and in lambing percentage did not differ. As lambs were slaughtered when a 15 kg carcass weight was attained, there were no differences in meat yield.

Table 4: Reproductive data from 120 ewes, half of which had grazed a pure Pawera sward continuously during the previous lactation.

	Eggs shed per ewe	Returns-to-service cycle		Mean conception per ewe	Multiple Foetuses	
		Second	Third		Twins	Triplets
Control	1.97	7	2	1.70	41	8
Pawera	1.88	13	3	1.57	49	3

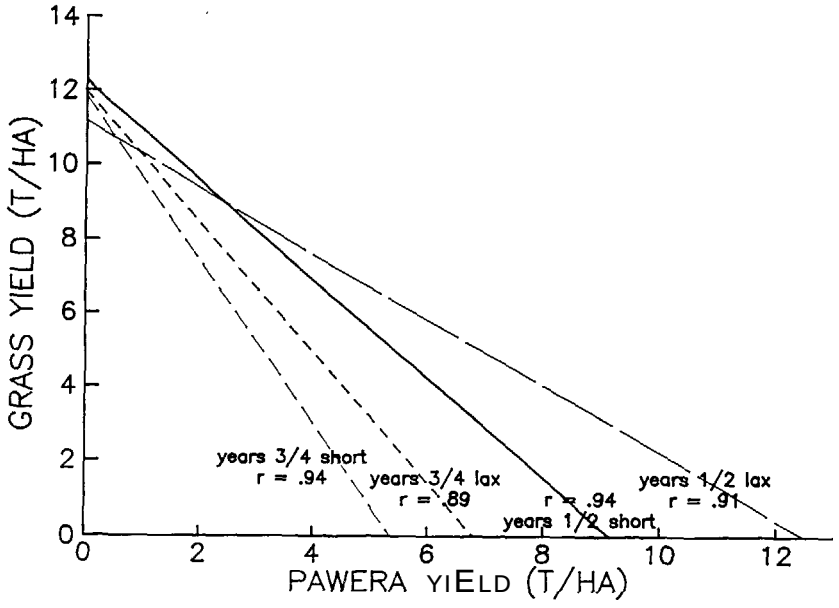

Figure 1: Hat-vested yield of sown companion grass (Y) and Pawera red clover (X) in various mixtures meaned for years 1 and 2, and years 3 and 4. under 2 defoliation regimes at Gore.

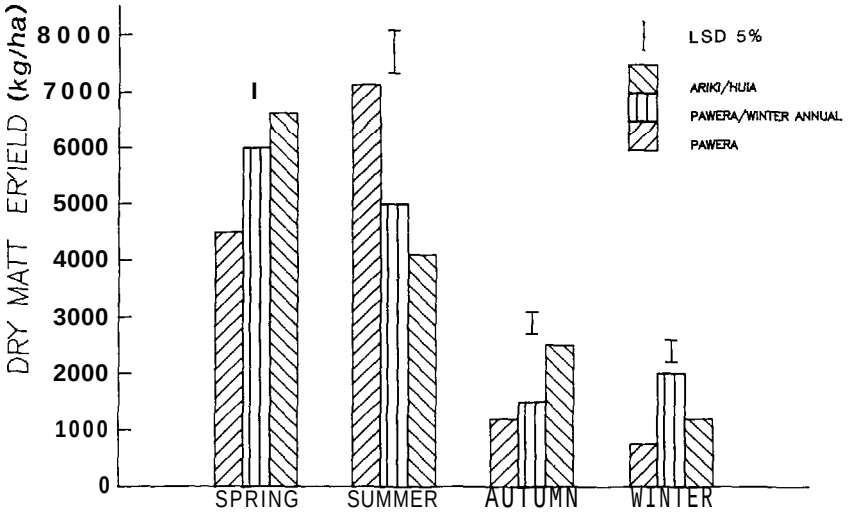

Figure 2: Seasonal DM production from 3 sward types at Gore. (Data mean of two years; from Hay et al (1978).

DISCUSSION

These trials clearly defined an important role for red clover in boosting the quality and quantity of summer forage in Southland. Pawera, the late flowering

tetraploid red clover, was consistently the best performed cultivar (Tables 1 and 2). The strong summer production (Fig. 2) enables high quality hay crops to be taken (Hook 1976), or will sustain high lamb growth rates through the summer (Jagusch et *al.* 1961). This is increasingly important for heavy-weight lamb production, though the benefits of Pawera were not utilised in the farmlet studies reported here. Required lamb liveweights were achieved by early February before Pawera dominance occurred through February and March.

Red clover productivity and persistence are maximised by lenient, infrequent grazings (Table 1, Fig. 1). However, Southland sheep farmers generally set stock their pastures from lambing until weaning and often over the summer as well. Thus the present red clover component of pasture swards does not express its growth potential. Further repeated grazings in autumn deplete carbohydrate reserves (Hay 1985; Ryan, unpub.), diminishing the ability of red clover to recover from grazings at this time, thus reducing the plant population. Persistence is further reduced by winter treading damage to exposed red clover crowns, which allows the invasion of bacterial and fungal pathogens (Carr 1971). These problems are particularly severe on early-flowering red clovers such as Hamua, G21 and G22. The superior performance of Pawera indicates that late flowering and polyploidy in red clovers are positive, and possibly necessary, attributes for plant survival and production in both pure or grass swards in Southland.

The competition study showed that persistence and DM production were greatest where Pawera was sown with a slow establishing companion grass such as Roa tall fescue, Maru phalaris or to a lesser extent K1858 cocksfoot (Hay 8 Ryan 1983). The cool-season growth of Maru can complement the late-summer productivity of Pawera, though frequent grazing increases the density of Maru, severly diminishing Pawera growth. Roa was the best companion grass for Pawera; it was less competitive at establishment and gradually increased in density with time while Pawera plant density and yield remained high.

Ryegrasses establish fast and compete too vigorously with red clovers. Their frequent use in pasture mixes makes it imperative in summer to use lenient, infrequent grazing rotations of around 45 days, to a stubble height of 4-5 cm, on red clover based pastures. This management will realise the greatest potential from the red clover. Seeding rates of 5-7 kg/ha gave optimum establishment and yield. The good moisture regime in Southland ensured the success of direct drilling Pawera into permanent ryegrass pastures, in contrast to the problems encountered by Campbell *et* al. (1983) in the Manawatu.

Unlike lucerne, pH had no effect on DM yield of red clover (R.A. Carran pers. comm.). The fertility study suggests that red clover has a greater ability to exploit potassium from greater depths of the soil profile than the shallower rooted ryegrass–white clover (J.H. Hoglund, pers. comm.). These attributes of red clover may have important implications for farmers who are not applying any phosphatic fertiliser to their pastures.

The studies on the oestrogenic activity of red clover revealed a definite short-term effect on production of cervical mucus, which is the main agent for impairing sperm transport through the cervix to the uterus and fallopian tubules, to effect fettilisation (Kelly et *al.* 1979). The data in Table 4 indicate that exposure to pure swards of red clover may permanently affect ewe fertility, but this did not occur when red clover was grown in association with grass (Davies 8 Maller 1970). Pawera conserved as hay, was shown by Hay *et al.* (1978) to be safe for breeding ewes, as the formononetin content of Pawera dropped from 1.0% of DM to 0.2% which is acceptable according to Marshall (1973).

Grasslands Division has initiated a programme to select within Pawera for a low

formononetin population. After 6 generations of selection, a new cultivar, G27, was put under evaluation. Data are promising from the first year of a trial at Palmerston North, in which the reproductive performance of Romney ewes on pure swards of G27 and Pawera is being compared with that on a ryegrass-white clover sward (R.G. Keogh pers. comm.). As the oestrogenic activity of Pawera has deterred many farmers from realising the benefits of red clover in their farming systems, the release of G27 in the near future will encourage farmers once again to use this important forage legume.

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