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NEW CLOVER CULTIVARS FOR WAIKATO DAIRY PASTURE: ESTABLISHMENT, PRODUCTION AND NITROGEN FIXATION DURING THE FIRST YEAR

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Abstract

Clover cultivars grown with ryegrass were compared in an establishment year under dairy cow grazing. There was no difference in total annual production but summer production was greater with Pawera red clover and with Kopu or Pitau white clovers. Clovers differed little in the proportion of nitrogen fixed, except during summer when values were highest for Pawera. Pawera was less prone to nematode attack than white clover cultivars but was more susceptible to clover rot.

Resident clovers and high buried seed levels (e.g., 11-91 kg/ha) made introduction of new clover cultivars difficult. Sown clovers established best (50-70% of total clover plants) when drilled into soil treated with dicamba and glyphosate.

Keywords: white clover, red clover, nematodes. nitrogen fixation, pasture renovation

INTRODUCTION

A number of alternatives to Grasslands Huia white clover are now available which could be better suited for use in dairy pastures. Goold (1985) described the potential advantages to total production and N_2 fixation from increased summer growth by Grasslands Pawera red clover and of increased winter and summer growth by Grasslands Kopu (formerly called G18) white clover. West & Steele (1985) measured 11% greater total production from pastures with Kopu than with Huia under rotational grazing by sheep in Waikato. However, these new clover cultivars have not been compared for dairying.

Dairying soils contain significant amounts of buried white clover seed (Suckling & Charlton 1978) that will compete with newly sown clovers. Competition from buried clover seed and from resident clover plants may make it difficult to ensure that renovated pastures have a predominance of the sown clover cultivar.

The aims of this study were (1) to compare new clover cultivars in their establishment year under dairy cow grazing for production, N-fixation and nematode infection, and (2) to compare pasture renovation procedures for introducing new clover cultivars.

MATERIALS AND METHODS

Clover cultivar comparisons

Site and procedure. This study was located at Number 5 Dairy, Ruakura Agriculture Centre on a Horotiu sandy loam (Typic Vitrandept). Pasture was sprayed with dicamba (3 l/ha) to kill existing clover and with glyphosate in early February 1986. Lime (2.5 t/ha) and 15% potassic superphosphate (800 kg/ha) were applied and the area was rotary-cultivated to a depth of 15 cm. Paraquat (1.5 l/ha) was applied twice prior to sowing to kill germinating seedlings. Four light irrigations were applied to reduce moisture stress during establishment.

On 4 April, the following treatments were sown (6 x 3.5 m plots) with Ellett ryegrass (at 15 kg/ha) in a randomised block design with 8 replicates (except treatments 3 and 4 which had 16 replicates):

(1) No clover sown (maintained clover-free using dicamba).
(2) No clover sown (indigenous clover established from buried seed).
(3) Huia white clover (with feather leaf-mark for identification).
(4) Kopu white clover.
(5) Pitau white clover.

(6) Aran white clover (large-leaved and of Irish origin).
(7) Pawera red clover.

Huia was sown at 3 kg/ha and the sowing rate of the other clovers was adjusted for seed weight (and % germination) to give the same seedling density/ha. The site was subjected to 24-hr grazings at 19- to 62-day intervals depending on pasture growth.

Pasture measurements. Pasture yield was assessed using an electronic pasture probe (before and after each grazing) and with occasional cuts using a lawn mower. Botanical composition was estimated by dissection of hand-clipped herbage prior to each grazing. Clover N_2 fixation was estimated using a ^{15}N isotope dilution method (Ledgard et *al.* 1985) and inorganic soil N was determined after extraction with 2M KCl (Bremner & Keeney 1965).

Clover rot (*Sclerotinia trifoliorum*) infection was observed in winter and plant infection was assessed on 23 July by visual observations of infected plants on 0.2 x 0.2 m quadrats.

Nematode measurements. Soil samples (five 25 mm diameter cores/plot) were taken from Kopu plots prior to cultivation (31 January 1986) and on 5 May and 2 September. Plant-feeding nematodes were extracted using the tray method.

Clover infection by stem (*Ditylenchus dipsacci*), clover cyst (*Heterodera trifolii*) and root knot (*Meloidogyne hapla*) nematodes was assessed on 5 May 1986 using 15 seedlings/plot; and on 2 September and 25 November using ten 25 mm diameter cores/plot to a depth of 150mm. Washed plants were stained in analine blue and nematodes were counted. Root weights were recorded.

Clover Establishment

This study was located at Number 5 Dairy on a Horotiu sandy loam and a Te Kowhai silt loam (Typic Ochraqualf), which had levels of buried white clover seed of 91 and 35 kg/ha respectively.

Sites were hard-grazed on 24 April 1986 and drilled with Ellett ryegrass (12 kg/ha) and Huia white clover (leaf-marked, 3 kg/ha) one day later. Four replicates of the following treatments were applied before hard-grazing: (1) no pretreatment, (2) glyphosate (4 l/ha on 7 April), (3) dicamba (3 Nha on 11 March) + glyphosate (4 Nha on 7 April), and (4) same as (3) + rotary cultivation on 24 April.

Four weeks after drilling, measurements of clover plants from sown seed (based on leaf markings), buried seed and resident plants were made by counting three 0.2 x 0.2 m quadrats/plot.

RESULTS

Production

Plots with different clover cultivars produced similar annual yields but the clover content varied between 20 and 39% (Table 1). Ryegrass-only plots produced 10% less ($P<0.05$) than plots with clover.

Table 1: Effect of clover cultivar on the production in a mixed sward during the establishment year and during the first spring and summer.

	kg DM/ha/yr		kg DM/ha during spring		kg DM/ha during summer	
	Total	Clover	Total	Clover	Total	Clover
Ryegrass only	11630	0	3 630	0	3 540	0
Indigenous white clover	12450	2 660	4120	540	3 790	1410
Huia white clover	12720	3 050	4 310	910	3 860	1440
Kopu white clover	12940	3 730	4 320	1 050	3 690	1610
Pitau white clover	13000	3 540	4410	1 040	3 630	1710
Aran white clover	13 360	3 330	4 460	920	3 930	1 540
Pawera red clover	13 510	5 630	4410	1 330	4 660	3 340
LSD ($P = 0.05$)	1 090	460	500	130	460	300

During summer, the total yield from red clover plots was 21% higher than from plots containing white clover, and red clover growth rates were about twice those of white clover cultivars. However, the predominance of red clover during summer was associated with a 45% reduction in ryegrass growth and this tended to reduce total production in the subsequent autumn (e.g. 40.1 vs. 48.5 kg DM/ha/day for red and white clover plots respectively).

Annual, spring and summer production from Kopu and Pitau were higher than from other white clover cultivars, with major differences becoming evident from October.

N_2 fixation

The amount of N fixed depends on the clover yield, total N concentration and proportion of N fixed. Clover cultivars differed little in total N concentration although indigenous clover generally had the highest values and Aran the lowest.

During the first 3 months of growth, clovers obtained virtually all their N from soil because of the high levels of inorganic soil N present during establishment. The % N fixed increased to about 95% during late spring for all cultivars. The only significant differences between cultivars occurred during the dry summer period when values for Pawera, Kopu and indigenous clovers were greater than those for Aran, Pitau and Huia (Fig. 1).

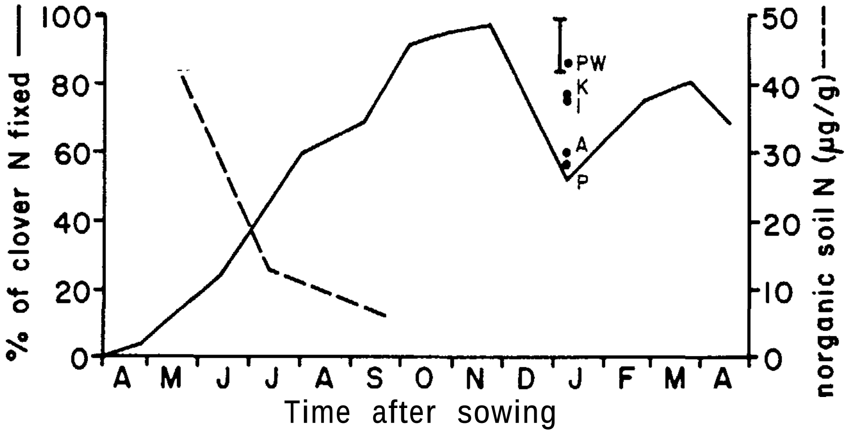

Figure 1: Changes in inorganic soil N (O-75 mm depth) and proportion of N fixed from atmospheric N_2 by Huia white clover with time after sowing. Cultivars differed in % N fixed between 10/12/86 and 10/2/87 and values are given for Pawera (PW), Kopu (K), Indigenous (I), Aran (A) and Pitau (P) for this period. The vertical bar represents LSD (P = 0.05).

Nematodes and clover rot

Immediately prior to cultivation, resident clover roots were heavily knotted with *Meloidogyne.* Soil samples from Kopu plots showed that cultivation reduced plant-feeding nematodes in the soil by over 70%.

On 5 May, red clover seedlings were less ($P<0.05$) infected by *Meloidogyne* and *Heterodera* than white clover seedlings (Table 2), and less also on 25 November by *Meloidogyne,* after reinvasion of roots during October. There was no significant difference between white clover cultivars. During winter, clover rot reduced red clover plant numbers by 19%.

Clover establishment

The pasture renovation studies showed negligible establishment of sown clover with no pretreatment of existing pasture (Table 3). Glyphosate reduced resident clover plants by about 40% and dicamba killed almost all plants. Germination of buried seed was most at the site with a high buried seed load, and was increased 5-7 fold by recent cultivation. In the most favourable treatment (dicamba + glyphosate + drilling), less than 70% of recently established clover plants had been derived from sown seed.

Table 2: Nematode populations/g root on white clover (average of all cultivars) and red clover on 3 occasions.

	Meloidogyne			*Heterodera*		
	5 Mav	2 Sept	25 Nov	5 May	2 Sept	25 Nov
White clovers	78	0.9	97	372	205	16
Red clover	6	0.0	59	191	120	11
Stat. sign.	**	NS		*	NS	NS

Table 3: Effect of pasture renovation procedure on establishment (4 weeks after drilling) of white clover from sown and buried seed and on survival of resident clover. Data refer to a Horotiu soil and a Te Kowhai soil with 91 and 35 kg buried seed/ha respectively (values in parentheses are standard errors).

Treatment prior to drilling	Sown clover (plants/m^2)		Buried seed (plants/m*)		Resident (stolons/m^2)	
Horotiu soil						
No pretreatment	10	(9)	28	(14)	552	(66)
Glyphosate	47	(11)	36	(9)	291	(37)
Dicamba. glyphosate	98	(23)	99	(23)	5	(5)
Dicamba. glyphosate, rotary cultivate	13	(7)	439	(67)	0	(1)
Te Kowhai soil						
No pretreatment	0	(1)	2	(3)	523	(74)
Glyphosate	44	(27)	34	(11)	254	(30)
Dicamba. glyphosate	112	(68)	54	(15)	4	(4)
Dicamba, glyphosate. rotary cultivate	3	(3)	315	(56)	0	(1)

DISCUSSION

The clover cultivars had no effect on total annual yields for the establishment year, as observed by others (Widdup & Turner 1963; van den Bosch et al. 1986). However, the newer, large-leaved clovers maintained a larger clover component in the sward. The improved summer growth of Kopu and Pitau white clovers, and of Pawera red clover in particular, is valuable for maintaining high feed quality and can increase milk production during this period (Rogers et al. 1982).

Nitrogen inputs into the soil depend on clovers fixing atmospheric N_2. The pattern of N fixation by the clover cultivars generally reflected that for dry matter production. However, there were two exceptions, when N_2 fixation decreased and uptake of soil N increased: (1) initially, due to high soil inorganic N (following cultivation and fallowing), and (2) during summer because of dry soil conditions. The decline in the proportion of clover N fixed during summer was greatest with Huia and least with Kopu and Pawera. This coincided with greater summer production so that Kopu, and Pawera in particular, fixed more N than other clovers. Eltilib & Ledgard (1987) examined 4-year-old swards and found that Kopu fixed 35% more N than Huia. They attributed this, in part, to Kopu being less competitive with ryegrass for soil N uptake. Increased N_2 fixation will lead to increased cycling of N via the grazing animal and a proprotion of this will be available for uptake by grasses. Cycling of N via death and decay of stolon material is unlikely to be much different between Kopu and Huia white clovers because they had similar numbers of stolons/m^2 (253 and 262 respectively in March 1987).

The relative advantage of clover cultivars can be influenced by their tolerance to nematode or fungal attack. For example, West & Steele (1986) attributed the poorer production by Pitau and Huia, compared with Kopu, to greater susceptibility to stem nematode. In the present study, stem nematode was absent but other root-feeding nematodes were present. However, numbers of root-feeding nematodes were greatly reduced by cultivation prior to sowing and the low level of infection was unlikely to have influenced establishment or production. In contrast, infection of red clover by clover rot reduced plant density during the first winter after establishment. Although white clover cultivars were little affected by clover rot, observations on 4-year-old pure clover plots near Hamilton showed that Pitau and Huia were badly affected whereas Kopu was unaffected (R. N. Watson, unpublished data).

Introduction of new clover cultivars during pasture renovation is fraught with the problem of competition from resident clover and from buried clover seed. Buried seed levels at 8 sites on Ruakura dairy farms were 11-91 kg/ha, which are higher than those reported by Suckling & Charlton (1978). The pasture renovation studies showed that there is no benefit from drilling new clovers into untreated hard-grazed pastures because no sown clover is likely to establish. Establishment of sown clover was best (50-70% of total clover) when seed was drilled after treatment of pasture with dicamba and glyphosate.

CONCLUSIONS

New clover cultivars provide the potential for improved seasonal production and increased N_2 fixation. Before this potential can be utilised it is necessary to establish new swards dominated by these cultivars. The clover establishment study revealed that the pasture renovation procedure is important if an introduced cultivar is to make up more than half the total legume content of a sward.

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