

PERFORMANCE OF A HILL COUNTRY WHITE CLOVER SELECTION

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Abstract

A white clover variety selected for New Zealand moist hill country was compared with three other white clover varieties in hill country at Ballantrae. Small plots of the hill country selection, Grasslands Huia, Grasslands Pitau, and the resident Ballantrae white clover were planted into paddocks receiving high or low superphosphate applications and three different managements — rotational grazing by cattle, rotational grazing by sheep, or set-stocked sheep for most of the year.

Numbers of white clover stolons, white clover dry matter (DM) and total DM production, and proportion of white clover in cut herbage were determined twice yearly for three years. After one year of grazing the hill country selection consistently had approximately double the stolon numbers of Huia, a significantly higher proportion of clover in the herbage than Huia and clover DM yields 25-63% higher than Huia. These differences were not affected significantly by either management or soil fertility.

Pitau and the local Ballantrae white clover were at no time more productive than Huia and frequently were poorer, although stolon numbers of the Ballantrae clover were usually higher during the trial and almost matched the selected variety after three years.

The hill country selection is being multiplied for pre-release testing.

INTRODUCTION

Strong clover growth is essential for hill country improvement. Responses to superphosphate, nitrogen fixation and high pasture quality for animals are all function of clover content of pasture (Suckling, 1965). However, even relatively improved New Zealand hill country pastures often have a low legume content (Suckling, 1975). Existing New Zealand white clover (*Trifolium repens* L.) cultivars available until now are of intermediate leaf size bred for high fertility lowland. Davies & Levy (1931) indicated that for poorer land where sheep grazing predominated smaller leaved types would probably be more useful. A plant collection made from hill country farms (Suckling & Forde, 1978) showed that New Zealand moist hill country was dominated by small leaved white clover. Furthermore it was shown that intermediate leaved white clovers had failed to persist after oversowing, e.g. at Te Awa (Forde and Suckling, 1977).

The potential of small leaved white clover populations collected from moist hill country for breeding a hill country cultivar was demonstrated by Williams & Caradus (1979). Accordingly, a plant selection programme was carried out using the collection of Suckling & Forde (1978) as base population. This

paper summarises the performance of an early selection from this population at one site under three grazing managements and two fertility levels.

METHODS

The experimental hill country selection (HC) used in this study was C3938 based on 34 parent plants selected for density, small leaves, stolon spread, and consistent seasonal productivity at Palmerston North. This was the first stage of a progeny testing programme in which progenies have subsequently been grown in hill country pastures of low fertility. HC was developed on the basis of parent phenotype in lowland in order to get material of the selected plant type into testing as soon as possible.

HC was compared in this trial with 'Grasslands Huia', 'Grasslands Pitau', and a resident line of seed (B) collected from seed heads at the trial site, Ballantrae, the Grasslands Division hill country research area near Palmerston North.

Plots were planted with mature seedlings in June 1977 in six paddocks involving a factorial combination of three grazing managements and two fertility levels: set stocked sheep (SSS), rotationally grazed sheep (RGS), rotationally grazed cattle (RGC) at high and low fertility (HF, LF). Details of the treatments have been described by Lambert *et. al.*, (in prep).

Plots were located on 'between-track' slopes of approximately 30° in NE-SE aspects. There were four replicate plots within each farmlet. The plots were 600 x 750mm arranged so that a single grazing cage could fit over each replicate. Plants were inserted on a 120 x 125mm grid with 20 plants per plot. At the start of the trial pastures were dominated by 'low-fertility tolerant' grasses (mainly browntop, *Agrostis* spp; sweet vernal, *Anthoxanthum odoratum* L.; crested dogtail, *Cynosurus cristatus* L.) contributing about 46% of annual yield. Ryegrass, *Lolium perenne* L. contributed 21% and other 'high-fertility responsive' grasses (mainly Yorkshire fog, *Holcus lanatus* L.; cocksfoot, *Dactylis glomerata* L.) 11%. Weeds contributed 6% and legumes (white clover, red clover, *T. pratense* L.; subterranean clover, *T. subterraneum* L.; *Lotus pedunculatus* Cav.; suckling clover *T. dubium* Sibth.) 16%. Botanical composition and production of pastures was influenced by fertiliser and management treatments (Clark *et. al.*, in prep.; Lambert *et. al.*, 1982).

Sites were sprayed with 2,4,5-T before planting, to remove resident legumes. Plants were not inoculated before insertion and be assumed to have been nodulated predominantly with resident Ballantrae rhizobial strains.

All replicates remained under cages for seven months after planting and were hand-trimmed to aid establishment. From January 1978 the cages were removed for grazing. Approximately twice yearly all plots were hand-trimmed, stolon populations counted on one quadrat 160 x 120mm per plot, and the cages replaced. Several weeks later the cages were removed and dry matter (DM) yield was determined on each plot by trimming a single quadrat 230 x 200mm. Subsamples were dissected to obtain botanical composition

and on two occasions white clover leaf area (Williams *et al.*, 1964) and cyanogenic potential (Corkill, 1940) were determined on 25 individual leaves per sample. Observations were continued for three years on a twice yearly basis.

RESULTS AND DISCUSSION

CYANOGENIC POTENTIAL AND LEAF SIZE (TABLE 1)

Relative leaf sizes of the varieties were shown most clearly at HF with cattle grazing, where plants could best express their growth potential. There was a clear gradation in leaf size from the largest, Pitau, to Huia, HC, and B. In other treatments Huia and Pitau plots differed little in leaf size, especially after four years. HC and B plots were clearly smaller leaved than Huia and Pitau in 1979 and by 1981 the differences were small.

TABLE I: PROPORTIONS OF CYANOGENIC LEAVES (%) AND MEAN LEAF SIZES (CM*) AFTER TWO AND FOUR YEARS.

	SSS		RGS		RGC	
(a) % cyanogenic May 1979	LF	HF	LF	HF	LF	HF
Huia	52	68	82	88	96	98
Pitau	82	56	77	93	81	99
B	16	24	7	25	5	27
HC	51	70	56	66	47	89
(b) % cyanogenic April 1981						
Huia	18	63	74	42	56	98
Pitau	10	22	51	23	56	92
B	7	12		10	26	27
HC	26	18	46	45	58	59
(c) Leaf area (cm ²) May 1979						
Huia	1.01	0.99	1.37	1.12	1.42	2.03
Pitau	1.24	0.91	1.09	1.06	1.56	2.53
B	0.76	0.66	0.69	0.60	0.83	0.94
HC	0.84	0.85	0.63	0.73	1.02	1.42
Standard error ± 0.13						
(d) Leaf area (cm ²) April 1981						
Huia	0.61	1.03	0.78	0.83	1.13	1.62
Pitau	0.55	0.78	0.67	0.81	1.16	1.80
B	0.49	0.71	0.59	0.56	0.81	0.87
HC	0.50	0.80	0.61	0.70	0.76	1.31
Standard error ± 0.10						

Changes in proportion of cyanogenic leaves between 1979 and 1981 gave an indication of changes in plot composition. The resident Ballantrae white clover was largely acyanogenic, whereas Huia and Pitau contained a high proportion of cyanogenic plants and HC was intermediate. Under HF cattle grazing the varieties maintained their proportions of cyanogenic leaves between 1979 and 1981, although HC dropped slightly. Therefore under this treatment the plots largely retained their integrity. In general, low proportions

of cyanogenic leaves in 198 I were associated with small leaf sizes, and many plots had similar leaf sizes by this time. Because one possible source of such change was contamination by resident white clover, and results were consistent with high levels of contamination in 198 I, data were analysed only up to 1980.

STOLON NUMBERS (TABLE 2)

At the beginning of grazing, seven months after planting, there were 60% more stolons at HF than at LF. However with grazing this difference disappeared.

TABLE 2: RELATIVE STOLON NUMBER FOR HF (LF = 100), RGS (SSS = 100), PITAUI, B, HC, (HUIA = 100).

Date	Grazing HF months	HF	RGS	RCC	PITAUI	B	HC
Jan 1978	0	160**	102	49**	74*	143**	125*
May 1978	4	113	126	107	84	94	139*
Nov 1978	10	87	79	40**	58*	136	215**
March 1979	15	112	111	103	56*	153**	207**
Nov 1979	22	95	70	so*	61	135	249**
July 1980	30	130	71	85	110	183**	229**

*, ** Significantly different from control ($P < .05, 0.01$).

Surprisingly, before any grazing had occurred RGC plots carried only half the number of stolons of the sheep grazed plots. This difference reappeared each subsequent spring and was probably the result of differences in sward structure or soil compaction between cattle and sheep grazing. In other seasons in which stolons were counted no significant differences between managements were recorded. No interaction between fertility and management occurred for stolon number except at the last count when the LF-RGS paddock became atypically grass dominant.

Initial stolon numbers were consistent with the respective morphologies of the varieties. Pitau, the largest leaved, had the lowest stolon density while HC and B were small leaved and had significantly more stolons than Huia. With grazing the stolon number of HC increased to twice that of Huia. Pitau continued to have fewer stolons except for the last count where contamination by other white clovers had occurred.

Interactions between variety and management occurred at all spring and summer counts, while in summer 1979 a variety x management x fertility interaction occurred. Figure 1 shows a typical spring result with varietal differences largest under SSS and smallest under cattle grazing.

Because continued stolon production is essential for survival of white clover (Beinhart 1963) the more numerous stolons of HC compared with the other varieties can be expected to confer a large advantage in persistence on this selection.

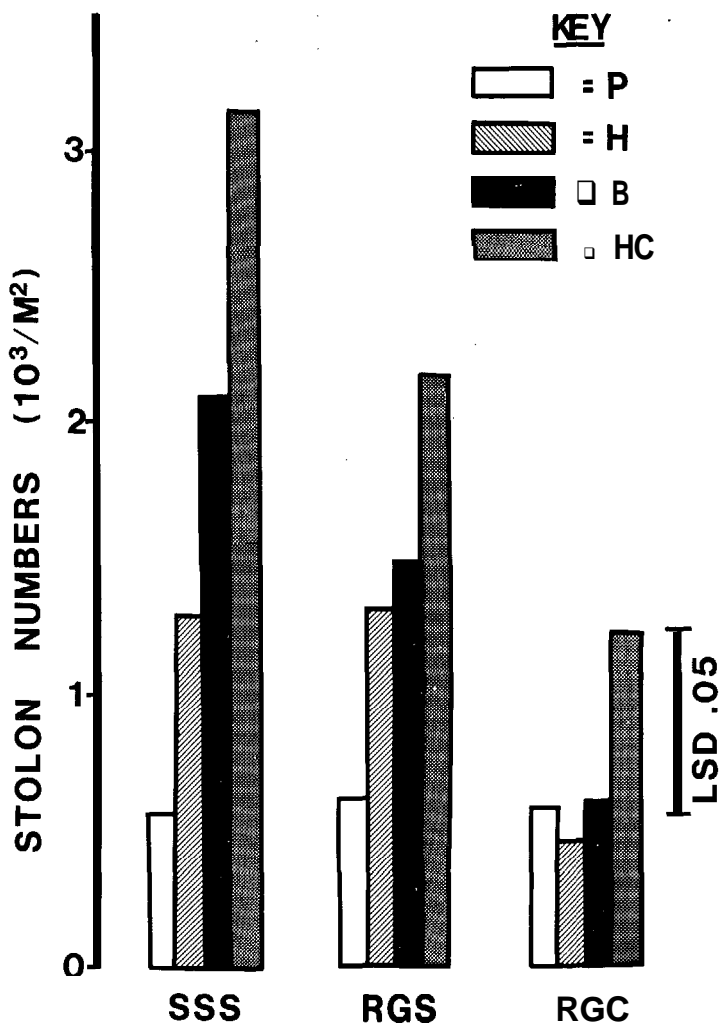


FIG. 1: Stolon number for four varieties of white clover under three management systems, November, 1978. P, Pitau; H, Huia; B, local Ballantrae variety; HC, hill country selection; SSS, set stocked sheep; RGS, rotationally grazed sheep; RGC, rotationally grazed cattle.

CLOVER DRY MATTER (TABLE 3)

Visual estimations of clover DM at the start of grazing treatments indicated that clover growth reflected stolon numbers. HF plots had approximately 90% more clover than LF, and cattle plots had estimated clover yields approximately half those of sheep plots, despite absence of grazing. After five months cattle grazing gave 59% more clover DM than sheep grazing. Subsequently, no effect of management or fertility was recorded until the last winter cut, 32 months after grazing began. At this time, large responses to HF (95% more clover DM) and cattle grazing (115% more clover DM than SSS) were recorded.

TABLE 3: RELATIVE CLOVER DM YIELDS FOR HF (LF = 100), RGS, RGC, (SSS = 100), PITAU, B, HC, (HU1A = 100).

Date	Grazing months	HF	RGS	RGC	PITAU	B	HC
June 1978	5	107	98	159**	121	53**	100
Jan 1979	12	98	66	70	74	90	146**
May 1979	17	102	88	129	110	93	163**
Dec 1979	23	158	99	83	45**	69	153**
Sept 1980	32	195*	116	215*	91	60*	125*

*, ** Significantly different from control ($P < 0.05, 0.01$).

HC was significantly better than Huia at all cuts after the first, ranging from 25% better in winter 1980 to 63% better in autumn 1979. B, on the other hand, was usually inferior to Huia, although this difference reached statistical significance only occasionally. Pitau was inferior in spring and summer but similar in yield to Huia in cool seasons.

Although stolon numbers of HC were generally more than double those of Huia, DM advantages were closer to 50%. This reflects the smaller leaf size and prostrate growth of the HC line which also has a low harvest index (Caradus & Williams, 1981).

CLOVER CONTENT

Fertility or management had no significant effects on % clover DM until the winter season 32 months after the start of grazing, when the cattle plots (31%) had double the clover content of the sheep treatments (15%). Clover content was also higher at HF (25%) than under LF (16%) but this was principally the result of an atypically low content under LF-RGS. No fertility effect was apparent with SSS but with cattle a small fertility response was recorded.

Among the clover varieties, HC was better than all others after 12 months' grazing (Table 4).

TABLE 4: CLOVER CONTENT (% DM) FOR FOUR WHITE CLOVER VARIETIES

Date	Grazing months	HUIA	PITAU	B	HC
June 1978	5	8.6	8.6	4.1**	8.0
Jan 1979	12	25.5	22.4	24.9	39.3**
May 1979	17	14.5	16.3	14.5	23.5**
Dec 1979	23	16.0	8.8	11.3	25.6**
Sept 1980	32	21.5	18.1	15.0*	26.3

*, ** Significantly different from Huia (P < 0.05, 0.01).

TOTAL HERBAGE DM

Significant differences in total herbage DM between LF and HF were recorded at the two early summer cuts (January and December 1979). At the second of these cuts cattle grazing produced significantly less DM than sheep grazing. No other effects of fertility or management were measured.

Varietal differences in total DM were recorded only twice. In the second summer HC plots outproduced all others under SSS while with other managements they were similar in yield to Huia. Pitau plots were significantly poorer than Huia plots in the second summer and autumn.

CONCLUSIONS

Varietal comparisons made in this trial have shown that Pitau failed to persist except under cattle grazing at HF. Pitau clearly cannot be recommended for hill country.

The hill country selection had greater stolon densities than all other lines. This improved clover yields and could be expected to also improve persistence. On the basis of these results a hill country selection is being multiplied for pre-release testing.

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