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EVALUATION OF NEW ZEALAND BRED WHITE CLOVER CULTIVARS UNDER ROTATIONAL GRAZING AND SET STOCKING WITH SHEEP

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Abstract

The four New Zealand bred white clover cultivars, Tahora, Huia, Pitau and Kopu were evaluated for two years under a high stocking rate in self contained sheep grazed farmlets comparing year round rotational grazing with set stocking.

Tahora was clearly superior under set stocking, yielding 50% more than Huia and 140% more than Pitau and Kopu. Under rotational grazing all performed well with only Kopu showing a 20% advantage.

An unseasonal early summer drought in the second year showed all cultivars to be highly susceptible to moisture stress at this time under rotational grazing. Large scale death of clover occurred reducing clover content to 2-3% in autumn with no recovery by mid winter. Under set stocking, although severely wilted, all clovers quickly recovered to their former level following rain. The management implications are discussed.

Keywords: Tahora. Huia, Pitau. Kopu, grazing management, drought, cultivar choice.

BACKGROUND

Fifteen years ago there was only one general purpose white clover (*Trifolium repens* L.) cultivar developed in New Zealand, Grasslands Huia. Now there are four. Each new cultivar was bred to differ in morphology and use, broadly ranging from the small-leaved, densely branched Grasslands Tahora, for sheep grazing on hill country (Williams *et al.* 1982), to the large-leaved lax types in Grasslands Pitau (Barclay 1970) and Grasslands Kopu (Van den Bosch *et* al. 1986) with improved winter activity for higher fertility cattle systems. Nevertheless because white clover is such a 'plastic' species, able to adapt to a wide range of environmental and management conditions, each cultivar may be suitable for other purposes, making the choice of cultivar for specific situations difficult.

THE EVALUATION SYSTEM AND MEASUREMENTS

In order to gain basic information on their reaction to grazing management, the four white clover cultivars were introduced into part of an eight year old small self-contained farmlet trial established in spring 1978, which compared three grazing systems and three pasture species mixtures under a common stocking rate of 22.5 ewes and lambs/ha, at Palmerston North. In 1984 one pasture mixture was replaced by a new pasture containing each cultivar sown in separate subplots at 3 kg/ha with Grasslands Nui and Grasslands Ariki perennial ryegrass (16 kg/ha). After one year of establishment under frequent on-off grazing, they were incorporated into the normal farmlet management and measurements for the year round rotationally grazed (RG) and continuously set stocked (SS) systems taken for the following two years.

The populations were sampled monthly for stolon and herbage characteristics by removing twenty, 50mm diameter pastures plugs for each cultivar, and recording ryegrass tiller numbers, clover growing point numbers, leaf (including petiole) and stolon dry weight (DW), area per leaf and leaves per growing point. Clover content of the pastures were determined separately by ground level cuts and botanical dissection. Total pasture yield to ground level was assessed weekly by capacitance probe.

PASTURE CHARACTERISTICS AND CLIMATE

As both systems operated at the same stocking rate and management practices (Fig. 1), total pasture consumption was similar, averaging around 11.5 t DM/ha. Defoliation by grazing removes predominantly the leaf portion of white clover, and most stolon remains intact below grazing height (< 3% stolon DW or grazing points removed/grazing -- unpub. data). As a consequence it is the post grazing residual pasture biomass and its structure that can influence white clover performance. For instance residual yields were similar for both systems (Fig. 1), but in RG pastures clover growing points and ryegrass tillers were half the density of SS pastures (tillers -- 6450 RG cf 10730 SS; growing points -- 2570 RG cf 5160 SS). RG pastures were open with considerable bare ground following grazing, particularly in stress periods when residual yields were low. This was of great significance in the second year which had an uncharacteristically early summer drought and wet autumn, the reverse of the more normal pattern of moist summer and dry autumn of the first year. Large contrasts in the seasonal pattern of pasture growth between years resulted (Fig. 1).

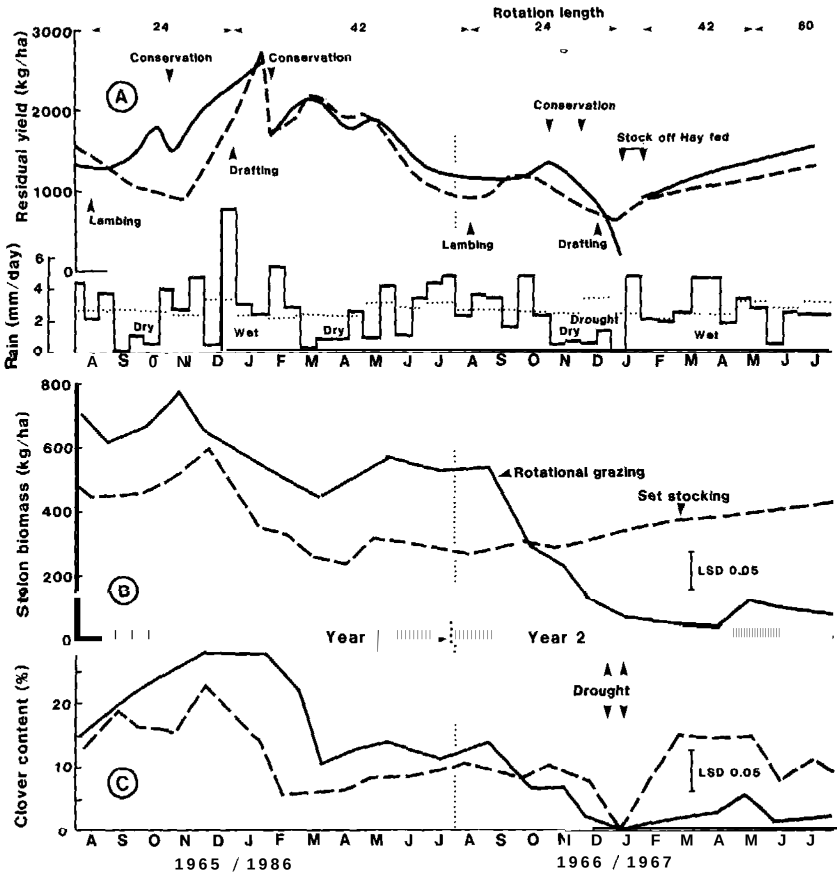

Figure 1 (a): Management practices, post grazing residual DM yields and rainfall distribution (30 year average rain/day) for the two year evaluation period, and the effect of management on white clover stolon biomass (b) and clover content (c).

CULTIVAR PERFORMANCE

Production

For all characters measured there was a strong interaction between cultivar and grazing system (P<0.001) (Table 1).

Table 1: Mean characteristics of four white clover cultivars growing in mixed pastures under rotational grazing (RG) or set stocking (SS) by sheep over two years, on the basis of (a) stolon characters, and (b) biomass/unit area.

Cultivar	(a) Area/leaf (cm^2)		Leaves per growing point		Stolon size (g/m)		(b) Leaf DW (kg/ha)		Stolon DW (kg/ha)		Growing points (m^2)		Clover content (%)	
	RG	SS	RG	SS	RG	SS	RG	SS	RG	SS	RG	SS	FIG	SS
Tahora	2.09	1.30	2.90	1.72	0.46	0.46	490	420	510	660	3750	10480	13.3	20.6
Huia	2.75	1.15	2.67	1.71	0.63	0.56	450	260	450	370	2750	4720	11.0	13.1
Pitau	4.08	1.30	2.76	1.46	0.77	0.64	460	170	470	260	2230	2660	15.1	7.0
Kopu	5.56	1.66	2.66	1.42	0.88	0.61	590	160	420	240	1530	2540	19.5	7 3
LSD 0.05		0.35		0 14		0.76		64		54		110		2.6

Overall, SS resulted in fewer, smaller leaves per growing point and thinner stolons than for RG (Table la). As expected, leaf and stolon size Increased from Tahora through to Kopu under RG, but under SS, leaf size was greatly reduced to a more uniform size, with only Kopu having slightly larger leaves. The reduction in stolon size under SS was correlated with reduction in leaf size (r = 0.47***). Leaves per growing point were similar for all cultivars under RG, but under SS were reduced to a greater extent in the larger leaved Pitau and Kopu.

Comparison of cultivars under RG showed that the relative advantage of larger leaves was largely offset by lower growing point density, resulting in similar clover content, only Kopu showing to advantage (Table 1 b). Stolon biomass (DW) was also similar, the only difference was that Tahora was higher than Kopu. These trends were reversed by SS. The small leaved cultivars, Huia and particularly Tahora, had higher growing point numbers under SS, and as leaf size and leaf number per growing point did not differ substantially among cultivars, this resulted in Tahora having much greater leaf biomass than the other cultivars, particularly Pitau and Kopu.

Comparison of biomass of cultivars between managements showed that Tahora, through the large increase in growing point numbers, was able to maintain leaf biomass under SS at the same level as under RG. All other cultivars declined, particularly Pitau and Kopu (-70%). The net result was a 60% decrease in Kopu content, and a 50% increase in Tahora content in SS pastures relative to RG pastures.

Persistence

The normal pattern of changes in white clover stolon biomass and plant population (Hay et *al.* this proceedings) shows a decline in stolon DW in spring as older mature stolons die and decay in response to the increase growth demand. This causes large plants to break up into several smaller units which then grow and branch over summer to re-establish their original values. This is more pronounced under RG than SS. During the period of plant break-up and re-establishment, the population is sensitive to stress, as illustrated by reaction of the stolon biomass to the contrasting rainfall patterns between the two years.

Over the exceptionally wet summer of year 1 (+ SO%), pasture growth could not be adequately controlled and the normal spring increase in stolon biomass (October-November) was reversed over summer (December-April) (Fig. 1 b) through stress imposed by grass competition. This resulted in a sharp decline in clover content in autumn (Fig. lc) as the short dry period in March-April adversely affected the weakened population. The effect was proportionally more pronounced in the higher density SS pastures.

The converse, more severe effect of drought occurred in year 2. The normal spring decline in stolon biomass (October) occurred under RG, and the immediate onset of the unusual late spring early summer drought (November-mid January, 30% normal rainfall) caused massive losses of stolon. All cultivars were equally affected. Stolon between rooted growing points withered and died, as large plants broke up into several small ones. This occurred chiefly in the open spaces between grass plants presumably as a result of high soil temperatures. Stolon death was not observed under SS and little bare ground developed despite withering of grass herbage. The dense mat of tiller bases covering the soil would have maintained cooler surface conditions and protected the stolons from direct radiation. The SS clover, despite total wilting of herbage in January, recovered quickly following rainfall in late January.

By midwinter there was no recovery of any of the cultivars under RG, although the greater stolon density of Tahora could be expected to aid more rapid recovery. The pastures, though high yielding were totally grass dominated, possibly due to high level of soil N mineralisation stimulated by the accumulation of dead plant material during the dry period (Hoglund and Brock 1978). Similar effects occurred at Lincoln under RG where successive spring droughts caused a permanent reduction of up to 70% clover content each year (Hoglund 1985). A normal late summer autumn drought may be less devastating, possibly as the clover plants would be larger and better established and therefore better able to withstand the stress.

IMPLICATIONS

These results suggest that while rotational grazing allows greater expression of the growth potential of white clover, it reduces its ability to withstand moisture stress. Set stocking showed the converse. Set stocking, or at least some period of SS, particularly through spring to increase pasture density, would reduce the effects of droughts should they occur, and enhance summer clover growth (Hay 1984). This was borne out on the third management farmlet (not reported), in which SS from lambing to drafting increased pasture density from 7060 to 13460 ryegrass tillers/m and 3480 to 4500 clover growing points/m* by mid summer, with resulting good recovery of all cultivars to 20-30% of yield by April of the second year.

For management systems which do not or cannot include SS, such as cattle systems, drought management remains a problem. If high soil surface temperature is the critical factor then plant cover must be maintained. The onset of potential drought conditions needs to be recognised early and decisions made to reduce or remove grazing pressure as far as possible, particularly on better pastures, by feeding supplement on poorer pastures that may need renewal. Selection of white clover cultivar does not appear to offer much help in this respect.

RECOMMENDATIONS

Under predominantly set systems Tahora would be the best cultivar, with Huia a poor second. While they may persist, neither Pitau or Kopu would prove productive.

With predominantly rotationally grazed systems, the choice is not so clear. While Kopu performed the best, all cultivars did well. Where grazing is with sheep (and possibly deer), and/or where moisture stress occurs, Tahora may be the best owing to its higher stolon density. With cattle and/or where droughts are unlikely to occur, Pitau and Kopu would be favoured.

The final decision remains with the practitioner afler due consideration of the balance of environmental conditions and managerial requirements.

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