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A WHITE CLOVER BRED FOR SOUTHERN REGIONS

KH. Widdup, M.J. Hickey, D.R. Stevens and D.L Ryan
Grasslands Division, DSIR, Gore

Abstract

Between 1975 and 1982, 320 white clover lines from overseas and New Zealand were evaluated for agronomic potential in southern regions of New Zealand.

Two distinct types showed promise. Persistent ecotypes with small leaves and many stolons had an active spring-summer growth pattern suited to the climate of Otago-Southland. Productive types ('Grassland Huia' selections, Mediterranean and French material) had larger leaves with fewer stolons, competed well with grass, were tolerant to leaf diseases but lacked persistence.

In 1983, a hybridisation programme combined the desirable features of both persistent and productive types. The best F1 and F2 hybrid lines had a dense morphology, produced 20% greater spring-summer yields than the standard Huia and showed good leaf disease tolerance. In 1985, 58 superior plants were selected and polycrossed. The bulk seed from this isolation formed a new we-release cultivar called Southern selection.

The selection is being compared with Huia in wards under rotational grazing at Gore. In the 1987/88 year, the selection produced 9% greater spring-summer and annual clover yields than Huia. Improved clover herbage yield was a consequence of rapid stolon development over spring. Grass and total herbage yields from the two clover-based pastures were similar. The trial will be continued in order to obtain long-term production data

Keywords: white clover, 'Grasslands Huia', Southern selection. ryegrass, breeding, productivity, persistence

INTRODUCTION

Four white clover (*Trifolium repens* L.) cultivars have been bred to fit a range of farming conditions in New Zealand. Until the 1970s, 'Grasslands Huia' was relied upon for all conditions in New Zealand. Despite Huia's adaptability, its agronomic performance was inadequate under some conditions.

Winter productivity in the North Island was improved in 'Grasslands Pitau' (Barclay 1970). The small leaved, densely branched 'Grasslands Tahora' is superior to Huia under sheep grazing in hill country (Williams *et al.* 1982). 'Grasslands Kopu' is a large leaved, lax type of white clover which gives improved year-round growth in higher fertility cattle systems in the North Island (Van den Bosch *et al.* 1986).

Southern regions of New Zealand also require a well adapted white clover to sustain pasture productivity. A regional breeding programme has concentrated on improvement of early-spring production and summer performance, when climatic conditions are optimum, to increase nitrogen (N) fixation and herbage quality (Widdup 8 Williams 1982; Widdup 8 Turner 1983). Other important objectives have been persistence under intensive grazing and tolerance of leaf diseases.

This paper describes the breeding steps and early grazing results of a white clover selection developed for Otago-Southland.

BREEDING PROGRAMME

Identification of useful genetic materlal

Between 1975 and 1982, 320 white clover lines from New Zealand and overseas were evaluated for agronomic potential in this region. The lines were tested in 5 trials as spaced plants or small field plots. Each trial lasted 3 years.

The clover lines with potential could be divided into either persistent or

productive groups (Widdup 8 Boleyn 1986). The persistent group was small-leaved ecotype material collected from lowland areas of Southland and North Island hill country. These environments are characterised by moderate to low fertility, cool temperatures and intensive rotational or continuous grazing by sheep, i.e. conditions that combine to shift emphasis from yield to persistence (Corkill et *al.* 1981). Surviving clovers have adapted to these conditions by developing densely branched stolons, small leaves and short petioles to give a low harvest index (Williams & Caradus 1979).

Climatic pressures have also affected the seasonal growth pattern of the ecotype clovers. The ecotypes were more active in spring and summer than Huia (Fig. 1) when conditions are optimum for growth and N fixation. However, the ecotypes were slow to establish, produced poor cool-season yields, but their performance improved over time (Widdup 1984).

The second group of promising lines consisted of selections from Huia, 'Grasslands Pitau' and French lines, and some hybrids between New Zealand and Mediterranean plants (Widdup & Boleyn 1986). In contrast to the ecotypes, these productive types are characterised by large leaves, long petioles and few but thick stolons with a consequent high harvest index This enables them to compete effectively with erect-growing grasses. However, their lack of stolon branching can lead to poor persistence under intensive sheep grazing (Williams & Caradus 1979).

The productive larger-leaved types generally grow on into autumn (Fig. 1), but this can be at the expense of spring growth (Widdup 1984). Increased cool-season activity is an advantage in mild climates such as Northland but leads to little more autumn-winter growth in cool climates. However, some early-autumn growth of high quality feed would be beneficial in Otago-Southland, for finishing lambs and tupping ewes.

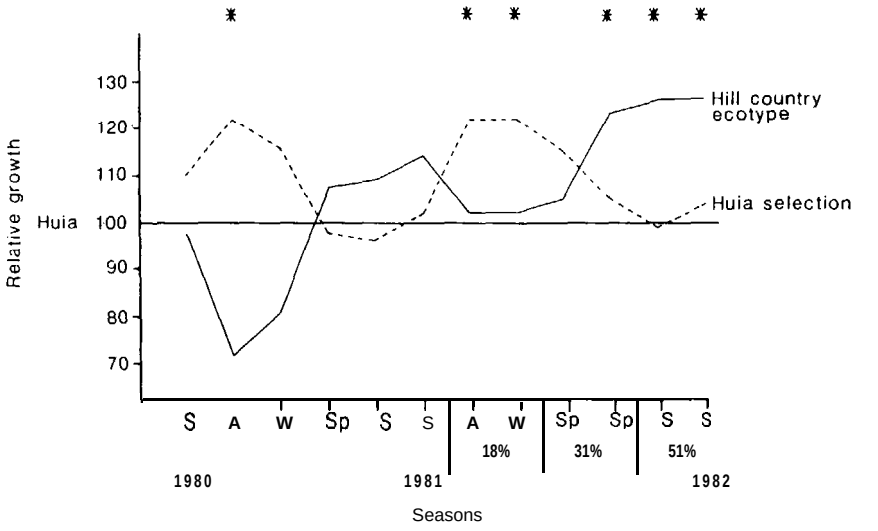

Figure 1: Seasonal herbage production from two contrasting clover lines relative to Huia. S = summer, A = autumn, W = winter, Sp = spring.
Seasonal production as a percentage of annual production is indicated
* = Significantly better than Huia at $P<0.05$
(from Widdup 8 Boleyn 1986).

Hybridisation of clover types

The persistent and productive clover types complement one another in many important traits, e.g. seasonal growth pattern, competitive ability with grass, persistence under grazing and tolerance to leaf diseases.

In 1983, 80 F1 hybrid lines from pair crosses were produced with the objective of combining the desirable features of both clover types. These were evaluated as spaced plants for their genetic potential. The average growth of the hybrids was similar to that of Huia in all seasons. However, 24 lines yielded significantly more than Huia in all seasons. More importantly, the superior lines were 20% better in spring-summer. In the third year, which reflects persistence, these lines remained up to 15% better than Huia. The performance of two lines of contrasting parentage (Table 1) indicated the variation between the better hybrid lines. The line based on Major, a cultivar from France, was larger leaved and produced greater cool-season yields than the line based on selected Huia material.

The best hybrids varied in morphology but had an overall plant type similar to that of Huia (Table 1). In general, the hybrids showed greater tolerance than Huia to the foliar diseases rust (Uromyces *trifolii* Hedw.) and sooty blotch (*Mycosphaerella killianii* Petr.) which are prevalent in this region.

Pitau yielded more than Huia in the first autumn-winter but this was not sustained (Table 1). Tahora yielded less than Huia in all seasons, particularly the cool seasons.

Table 1: Performance of Fl and F2 white clover hybrid lines relative to 'Grasslands Huia' (=100)

	Seasonal Yields[1]						Plant[2] type	Disease[3] tolerance
	Summer		Autumn/Winter		Spring			
	1984	1987	1984	1987	1984	1987		
F1 (spaced plants)								
Huia selection x Southland ecotype	116	138	129	104	116	114	3.1	0.7
'Major x Southland ecotype	120	110	125	122	117	114	2.7	0.5
Mean (24 best lines)	119	115	129	115	120	108	2.9	1.9
Huia	100	100	100	100	100	100	2.8	2.8
Pitau	113	90	134	109	100	80	2.0	2.1
Tahora	87	83	77	70	96	80	3.5	1.5
LSD (P<0.05)	15	19	15	20	13	17	0.3	1.1
F2 (Sown with grass)	1985	1988	1985	1987	1985	1987		
Huia Selection x Southland ecotype	103	140	81	83	88	118		
'Major' x Southland ecotype	106	135	99	117	94	128		
Mean (24 best lines)	98	134	85	103	88	109		
Huia	100	100	100	100	100	100		
Pitau	78	84	102	87	70	53		
Tahora	78	112	81	47	91	78		
LSD (P<0.05)	30	46	31	40	36	38		

[1] Visual score of clover herbage expressed as a percentage of Huia = 100

[2] 1 = erect, large leaved, few stolons
5= prostrate. small leaved, many stolons

[3] 1 = little infection
4 = heavy infection

All F1 hybrid plants were open pollinated and seed representing the F2 progenies collected. These lines had greater within-line variation than F1 lines and were expected to closely indicate the final yield potential of a pre-release cultivar selected from this material. The F2 lines were evaluated for seasonal clover yields and persistence in small plots sown with grass and periodically grazed by sheep (Table 1). The corresponding best 24 F2 lines contained to produce greater (but not significantly) yields than Huia by the final spring-summer. The lack of statistical difference between lines was a result of the large variation in the F2 material. However, lines with a trend for better spring-summer yields were still identified.

Selection of a new synthetic cultlvar

In 1986, 58 parent plants were selected from the best F1 lines. The selection was based on the performance of both the F1 and F2 lines. The plants were cloned and open pollinated in a polycross block Seed was collected from individual plants to form 58 progenies for further evaluation. Those parent plants with outstanding progeny (high breeding value) will be selected as elite parents for a new synthetic cultivar.

Bulk seed from the polycross isolation, named Southern selection, was sown in a grazing evaluation to assess its merit in a pasture sward under intensive sheep grazing.

AGRONOMIC PERFORMANCE OF THE SOUTHERN SELECTION

Method

The trial established at Grasslands, Gore in spring 1986 compared Huia and the selection in pasture mixes with 'Grasslands Nui' perennial ryegrass (*Lolium perenne* L.) under 2 grazing management systems: rotational grazing (4- to 6-week intervals) all year; or spring set-stocked followed by rotational grazing. Each plot was fenced separately and sown with a white clover at 3 kg/ha and perennial ryegrass at 15 kg/ha

Herbage yield was measured before each grazing by cutting representative quadrats to 2-3 cm. Botanical composition was determined from plot sub-samples. Clovers were sampled in September and December 1987 for stolon characteristics by destructive harvest of pasture plugs and recording stolon growing points, stolon length and stolon dry weight.

Results for the first year after a 6-month establishment period with the two clovers under rotational grazing are presented.

Results and Discussion

The selection yielded more than Huia during spring and summer and significantly more over the year (Table 2). Autumn-winter yields were similar. The result was consistent with the growth of individual breeding lines. The relative differences in clover yields between the selection and Huia were the same under both grazing managements, although spring yields from both clovers were less in the spring set-stocking management than all-year rotational grazing.

Both the Southern selection and Huia pastures contained similar amounts of stolon material at the beginning of spring (Table 3). However, during spring the selection developed greater stolon numbers, length and weight per m^2 than Huia. The set-stocked treatment showed similar trends except that the selection's stolon numbers increased 4-fold compared with Huia's 2-fold increase. This has also been shown for 'Grasslands Tahora' which developed more stolon material than Huia in a grazing trial at Gore (Ryan 1989). However, Tahora failed to produce greater leaf and petiole yields as the greater quantity of leaves did not compensate for their smaller size. In contrast, the Southern selection produced leaves of similar size and weight to those of Huia (Table 1) and therefore the greater quantity of leaves from a

Table 2: First year seasonal and annual white clover, ryegrass and total herbage yields (kg DW/ha) under rotational grazing.

White clover	Summer	Autumn/winter	Spring	Annual
Huia	3481	729	1480	5891
Southern selection	3784	788	1813	6165
LSD (P<0.05)	405	ns	126	383
Ryegrass				
Huia	1818	2882	1230	5930
Southern selection	1661	2801	1171	5633
LSD (P<0.05)	ns	ns	ns	ns
Total Herbage				
Huia	5685	4035	3257	12958
Southern selection	5712	3825	3215	12752
LSD (P<0.05)	ns	180	ns	ns

Table 3: Clover morphology measurements from rotationally grazed plots *in September* and December 1987.

	Stolon growing points/m^2		Stolon length m/m^2		Stolon dry weight g/m^2	
	Sept	Dec	Sept	Dec	Sept	Dec
Huia	3411	8435	61	90'	'32	48
Southern selection	3903	12644	52'	707	30	6
LSD (P<0.05)	1288	4940	23	26	10	15

larger number of growing points resulted in higher clover yields in late spring–summer.

Grass yields with the selection were lowerthan with Huia, but not significantly. Total annual herbage yields were also similar (Table 2). The low grass production in this first year was a consequence of three previous-years' cropping. Widdup 8 Turner (1983) found that white clover types with high stolon dry weights increased nutrient cycling in pasture over time and this increases grass production. Therefore herbage yields should be best with the selection in the long term.,

These early results indicate that the Southern selection is well adapted to the climate and farming pracitces of southern regions:

Acknowledgements

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