EVALUATING WHITE CLOVER VARIETIES FOR THE CLARENCE RIVER BEEF COUNTRY

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ABSTRACT

Results from two trials show white clover is a successful pasture legume in a subtropical environment. Persistence is the major factor determining usefulness of white clover varieties. The Clarence ecotype of naturalized white clover is more persistent and productive than the commercial cultivars. A selection from Israel (CPI 15648) is as persistent as the Clarence ecotype and more productive.

INTRODUCTION

Naturalized white clover, adapted to a subtropical environment, can be found along the east coast of Australia from the Macleay River Valley to the Mary River Valley. In this environment white clover has been largely disregarded in the search for pasture legumes. In particular the value of naturalized white clover has been ignored.

G. P. M. Wilson (unpublished) made observations on white clover varieties, including the Clarence ecotype (O'Brien 1970) of naturalized white clover, during plant introduction studies at Grafton Agricultural Research Station N.S.W., in the 1950's. The two trials reported here were undertaken to evaluate the role of white clover in the Clarance region and to determine the most persistent and productive varieties, persistence being the continued existence of the species.

MATERIALS AND METHODS

Four commercial cultivars, Ladino, Louisiana S1, Grasslands Huia, and Irrigation, were compared with the Clarence ecotype, and with two selections from Mediterranean countries, one from Israel (CPI 15648), and the other from Lebanon (CPI 13818).

Environment

Average annual rainfall of the Clarence region is approximately 1000 mm (40") and the yearly temperature extremes may exceed 0°C-40°C (32°F-104°F). The summer growth period is long and hot, with a relatively reliable rainfall. The winter growth period, which overlaps the summer growth period, is shorter and cool, with a substantial though less reliable rainfall. The climatic data for Grafton is given in Table 1.

The monthly rainfall figures at the two trial sites are given in Table 1. The seasonal conditions are the relationship between rainfall distribution, temperature, and wind, relative to the mean situation and relevant to a particular species. The seasonal conditions as they influenced the growth of white clover can be described broadly as: 1965 drought, 1966 dry, 1967 wet, 1968 drought.

The soils of the region are of low fertility, having major deficiencies of nitrogen, phosphorus, sulphur and molybdenum. Typical available phosphorus levels range from 1-5 ppm (Bray No. 1 test). These soils are podzolic, varying in texture from sandy loams to clay loams. They can be divided into two broad groups on the basis of texture, the coarse-textured soils and the fine-textured soils.

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TABLE 1

Long term mean temperatures and rainfall for the district and actual rainfall during the experimental period at two sites

Month	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Year
Grafton-Standard period 1911–1940*													
Mean max temp. (°C)	31.7	31.1	29.6	27.7	24.4	21.6	21.4	23.0	25.9	28.1	29.9	31.0	27.1
Mean min temp. (°C)	19.6	19.4	17.8	14.7	10.8	7.9	6.6	7.4	10.3	13.7	16.6	18.3	13.6
Mean rainfall (mm)	116	106	95	80	70	62	52	24	46	57	84	89	881
Coarse-textured soils													
Rainfall (mm) 1965	78	45	6	32	32	41	185	20	77	56	93	108	772
Rainfall (mm) 1966	7	134	80	74	24	37	7	81	48	89	113	37	731
Rainfall (mm) 1967	245	100	283	58	35	408	38	43	29	112	29	68	1449
Fine-textured soils													
Rainfall (mm) 1966	9	163	64	51	19	36	5	112	27	72	100	42	701
Rainfall (mm) 1967	262	137	283	43	70	555	85	16	23	118	27	87	1706
Rainfall (mm) 1968	335	130	106	15	38	8	42	124	30	20	17	77	942

* (Standard period substantially drier than period 1931-1960 when average annual rainfall for Grafton was 999 mm). Bureau of Meteorology.

TABLE 2

Persistence of white clover varieties—Plant populations per 0.04 *square meter (square link)*

Varieties	Coarse-textured soil				Fine-textured soil		
	Seedling Establishment July 1965	Perennials Surviving May 1966	Seedling Regenration July 1966	Perennials Surviving May 1967*	Seedling Establishment July 1966	% Surviving Perennials May 1967	% Surviving Perennials May 1968
Israel	60	3.2	15	4.5	55	100	50
Clarence	55	1.5	30	2.0	45	100	15
Lebanon	50	1.5	15	0.4	35	100	40
Louisiana Sl	65	0.3	10	1.0	65	100	15
Irrigation	—	—	—	—	35	100	50
Grasslands Huia	75	1.0	5	0.3	55	100	15
Ladino	45	1.8	5	0.2	55	100	15
Seasonal Conditions	drought	dry		wet	dry	wet	drought

* Includes some early germination from residual hard seed (1965 seed set).

The coarse-textured soils are derived from granite (New England bathylith) and sandstones (Clarence-Moreton Basin). The site representing these soils is typical of the major topographic situation, the undulating hills with shallow, yellow podzolic soils. The pastures on these soils are dominated by native grasses which are similar in floristic composition to the pastures of the southern spear grass region of S.E. Queensland.

The fine-textured soils are derived from shales (Clarence-Moreton Basin) and metamorphic material (Fitzroy beds, basement rock under the Clarence-Moreton Basin). The site representing these soils is typical of one of the two major topographic situations, the gently sloping colluvial-alluvial country with deep, yellow podzolic soils. The other major topographic situation on these soils is the intermediate ridges with deep, red podzolic soils. The performance of white clover in situations such as the intermediate ridges was studied in complimentary trials. The pastures of these soils are short grass pastures dominated by carpet grass with associated paspalum and native grasses. They are similar to those of the dairy pasture zone of S.E. Queensland.

Experimental design and sampling

Six replications of randomised blocks were sown in each of the two trials. Plot size was 3.66 m by 2.74 m (12' x 9') of which the centre 1.83 m by 0.91 m (6' x 3') was sampled. Cuts were made with an autoscythe with attached catching tray. Date of sampling was determined subjectively.

In this environment regeneration from seed is essential for the maintenance of strong stands of white clover. Therefore, heavy sowing rates were used to stimulate regenerating stands, to provide a realistic test of the varieties. Seed produced in the first year was returned to the plots to allow seedling regeneration.

The trial on coarse-textured soils was sown at 22.4 kg/ha (20 lb/acre) of seed, with 516 kg/ha (4 cwt/acre) molybdenised superphosphate plus a basal dressing of potassium, copper, zinc and boron. It was topdressed each year with 258 kg/ha (2 cwt/acre) plain superphosphate. The trial was not cut between the completion of clover growth and the regeneration of clover in the next year. The clover was subject to invasion by native grasses during the summer growth periods, providing severe conditions for survival as perennial plants and for seedling regeneration of the clover.

The trial on fine-textured soils was sown at 16.8 kg/ha (15 lb/acre) of seed, with 387 kg/ha (3 cwt/acre) molybdenised superphosphate plus the same basal dressing and maintenance dressing as for the other trial. The rates of superphosphate selected were commercial rates, based on results of field trials (unpublished). In contrast to the coarse-textured soil trial, this trial was grazed after each cut, and over that part of the second summer growth period when no clover growth occurred. Dung was removed after each grazing. Grasses invaded the plots during the second summer. There were no observable differences between cut and grazed portions of the plots.

RESULTS

Persistence

The Clarence ecotype and the selection from Israel were the most persistent varieties. The former maintained adequate plant density by seedling regeneration, whereas the latter was outstanding in its ability to survive as perennial plants and to produce large quantities of seed from which seedling regeneration occurred.

The decline in plant populations over the successive summer periods can be seen by comparing seedling numbers with the numbers of perennial plants surviving in the next year (see Table 2). Even in the wet summer of 1966/67 plant populations declined on the coarse-textured soils.

The commercial cultivars produced relatively little seed in both trials. The levels of seed production in this environment are illustrated in table 3. That such levels

were inadequate for continued regeneration of the commercial cultivars is demonstrated by the overall decline in plant populations and lower seedling regeneration on the coarse-textured soils (see Table 2). A similar decline was observed on the fine-textured soils.

TABLE 3

Dry weight of mature seedheads of white clover varieties on fine-textured soils in December 1966

Variety	kg/ha
Clarence	1590
Israel	1140
Louisiana S1	790
Lebanon	600
Irrigation	300
Ladino	80
Grasslands Huia	50
Least significant difference	290

Production

The production in the third year of each trial, (see Tables 4 and 5) was affected dramatically by the persistence of the varieties. The selection from Israel was superior to all other varieties, in its production in the third year. The production of the Clarence ecotype was better than that of the cultivars Louisiana S1, Ladino, Grasslands Huia, and Irrigation, because of better seedling regeneration.

Louisiana S1 production approximated that of the Clarence ecotype more closely than the other cultivars, but the Clarence ecotype was distinctly better on the coarse-textured soils. There was a tendency for Louisiana S1 to produce more in the spring than the Clarence ecotype, under favourable conditions, but the latter had better autumn production.

That Irrigation and Ladino have been selected for production in the summer growth period was noticeable during the favourable summer of 1966/67, on the fine-textured soil. This contrasts with the natural selection for growth in the winter growth period in this region.

Cultivation had a marked effect on production in the first year. In both trials the production in the first year was considerably better than in the following year, even though in the following year seasonal conditions were more suitable for the white clover.

The coefficients of variation for regenerating plots (Tables 4 and 5) were very high. The high variability was due to the unequal decline in perennial plants and uneven seedling regeneration. The first cut for 1968 (Table 5) was mostly from perennial plants, its coefficient of variation was 114%. Micro-environmental differences caused uneven decline of these plots e.g. the survival of perennial plants of the Israel plots ranged from 30% to 75%, while the Clarence ecotype ranged from 5% to 35% and Irrigation 40% to 60%.

DISCUSSION

Application of the results depends on whether the aim is to select a variety suitable for temporary or permanent pasture. In a temporary pasture higher yields in the first year may be sufficient to compensate for poor persistence. For a temporary pasture in the more favourable situations of the Clarence Valley, either of the cultivars Louisiana S1 or Ladino, or a mixture of these two, would be suitable. For the selection of a variety suitable for a permanent pasture the production from plots

TABLE 4

Dry matter yield of white clover varieties on coarse-textured soil (kg/ha)

Variety \ Period	April-Sept. 1965	Sept.-Dec. 1965	Total 1965	May-Oct. 1966	May-July 1967	July-Sept. 1967	Total 1967
Israel	507	210	717	356	287	1653	1940
Clarence	373	93	466	140	270	649	919
Lebanon	184	159	343	29	77	310	387
Louisiana Sl	393	82	475	13	34	278	312
Grasslands Huia	169	203	372	33	18	114	132
Ladino	269	356	625	88	7	103	110
Least significant difference (P=0.05)	186	137	251	163	276	484	690
Coefficient of Variation	50	64	42	126	201	79	92
Seasonal Conditions		drought		dry		wet	

TABLE 5

Dry matter yield of white clover varieties on fine-textured soils (kg/ha)

Variety \ Period	May-Sept. 1966	Oct.-Dec. 1966	Dec.-Jan. 1966	Total 1966	Jan.-May 1967	Jun.-Aug. 1967	Sept.-Oct. 1967	Total 1967	Mar.-Jun. 1968	July-Oct. 1968	Total 1968
Israel	2361	5899	1066	9326	1400	1189	731	3320	65	1072	1137
Clarence	1964	4324	273	6561	1712	1232	866	3810	24	544	567
Lebanon	1216	4499	1213	6928	933	1040	759	2732	52	345	397
Louisiana S1	2421	7166	1144	10731	1271	1870	708	3849	18	500	518
Irrigation	993	4994	1409	7396	1633	414	543	2588	6	145	151
Grasslands Huia	1192	4767	781	6740	1807	374	456	2637	9	108	117
Ladino	2412	6435	1569	10416	1453	842	1086	3381	2	99	101
Least significant difference (P=0.05)	641	1268	312	1571	286	283	289	612	34	303	332
Coefficient of Variation	30	20	25	16	17	24	33	16	114	64	66
Seasonal conditions			Dry				Wet			Drought	

modified by persistence is more important than production in the first two years. The Clarence ecotype has a better combination of persistence and production than the commercial cultivars and is therefore more suitable for use in permanent pastures.

Recurrent droughts place severe limitations on the persistence of white clover. Hot dry spells between rains, short duration droughts, are a normal part of this sub-tropical environment. Spring droughts are common, and winter-spring droughts occur about one year in five. Summer droughts, as experienced in the past five years, occur at irregular intervals.

Natural selection has acted upon gentic variation within the varieties of the northern European type introduced into the Clarence region to produce a climatic ecotype adapted to this sub-tropical environment. This ecotype behaves mainly as a winter annual, but will respond to favourable conditions and persist as perennial plants.

The Clarence ecotype is a free-seeding, early-flowering plant which can have a protracted flowering period. These characters allow seed to set even under heavy grazing, while in poor seeders, such as Ladino, flowering is virtually eliminated at heavy grazing pressures. Seedling regeneration following adverse weather conditions is assisted by a high percentage of hard seed in the Clarence ecotype.

Louisiana S1 is a cultivar selected from a climatic ecotype which is similar to the Clarence ecotype, but from slightly higher latitudes. Louisiana S1 is nearer in production to the Clarence ecotype than the other cultivars, but it is not as adapted to adverse conditions in this subtropical environment.

Ladino is a cultivar from the "giant" type which is distinct from the northern European type. Ladino is not as persistent as the Clarence ecotype in this environment. However, hybridisation with naturalised white clover can occur (Hutton 1968, O'Brien 1970) and selection of more productive adapted varieties may result from the incorporation of the "giant" character.

The Mediterranean type is relatively new in Australia. Although introductions of this type have been studied for 15-20 years, it is only recently that detailed testing has been undertaken.

Natural selection in the Mediterranean environments has adapted the selection from Israel to persist as perennial plants in that winter growth period environment. It is more perennial than the other varieties tested in the Clarence region, where white clover also is adapted to the winter growth period. Not only is the Israel selection strongly perennial but it seeds well. This allows adequate seedling regeneration for the maintenance of stand density, and spread in dung. Its persistence is equal to that of the Clarence ecotype.

The selection from Israel is the most productively persistent variety tested, possibly due to the higher survival of perennial plants. Therefore it is a valuable gene source for hybridisation with naturalized white clover. It is probably a better gene source than varieties from the "giant" type or the northern European type.

Commercial release of the selection from Israel is desirable.

Application

A complimentary series of trials investigating the persistence and production of legumes and grasses have been conducted in the Clarence region. Results from these complimentary trials indicate that white clover is more widely adapted to the differing environmental conditions, and more readily established, than the other legumes suitable for the subtropical environment of the Clarence region. Therefore, on farms where environmental conditions vary considerably, white clover is more suitable for pasture improvement than the other species.

Low-cost, extensive property development by oversowing legumes can quickly achieve a high proportion of the potential production, and appears to be the most economical means of development in the Clarence region. Additions of winter-spring

feed have a higher economic value than similar additions in the summer, in a subtropical environment. Duncan (1967) valued additions to the winter-spring feed supply at twice that of summer feed.

The Clarence ecotype and the selection from Israel have a significant role to play in low-cost, extensive property development and in the provision of winter-spring feed. This particularly applies on the fine-textured soils, where white clover grows better than on the coarse-textured soils, However, the results also show that the Clarence ecotype, and the selection from Israel, will be important in any sowings on coarse-textured soils.

Large scale property development is going on in the Clarence Valley and in similar areas of the subtropical environment. These developers require the best available white clover now, not at some future date. It will be some years before the selection from Israel can be increased into commercial quantities, meanwhile commercial areas of the Clarence ecotype are available for development as seed production areas. Efforts have been made to encourage seed production of the Clarence ecotype for local needs and a very good potential market has been developed.

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