A COMPARISON OF AFRICAN CLOVERS AND TEMPERATE LEGUMES ON THE NORTH COAST OF NEW SOUTH WALES

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ABSTRACT

The African clovers Kenya white clover (Trifolium semipilosum) *and Burchell's clover* (Trifolium burchellianum) *were compared with temperate legumes in a cutting experiment on a sandstone soil near Grafton N.S.W.*

Establishment and early growth of the African clovers were very slow. However, in later seasons the production from the African clovers was as good as that from the temperate legumes. Kenya white clover was the most reliable legume over a range of seasons and showed better tolerance of dry conditions than the other species. The nitrogen and phosphorus contents of the African clovers were similar to those of the temperate legumes.

The attributes of Kenya white clover in relation to grazing and animal production are briefly discussed.

It was concluded that Kenya white clover could be a useful pasture legume on the North Coast of N.S.W.

INTRODUCTION

The native and naturalized pastures of the North Coast of New South Wales are grass dominant, with low production and quality (Brooks 1968) and, since the beef industry is based on these pastures, animal production is also low (Garden and Cohen 1975). In an attempt to overcome some of the inherent limitations of the native and naturalized pastures, considerable emphasis has been placed on testing both temperate and subtropical legumes for their suitability to the area.

The paper describes an experiment comparing two African clovers and four temperate legumes on the North Coast of New South Wales. The temperate legumes used are those which had shown some promise in earlier preliminary trials. Some of the indigenous African clovers had shown promise in Australia (Cameron 1958, 1961, 't Mannetje 1964) and their use on the North Coast of N.S.W. had been suggested (Cameron 1961).

METHODS

The experiment was carried out over five years from 1966–1971 at Fineflower, 60 km north-west of Grafton on a sandstone soil of the Bundamba-Marburg geological series (McElroy 1962). The site was a gently sloping, north-west facing ridge with a moderately well-drained podzolic soil. The topsoil was a sandy loam with a pH of 5.4.

Mean monthly rainfalls and temperatures for Grafton are given by O'Brien (1970). Rainfall recorded at the site during the experiment is shown in Table 1.

Design

A randomised block design was used with six treatments and four replications. Plot size was 5 × 4 m. The species compared and the inoculum used are shown below:

Species	Inoculum Used
Kenya white clover *Trifolium semipilosum* var. *glabrescens* CPI 31996	CB 782 + CB 778
Burchell's clover *T. burchellianum* ssp. *burchellianum* CPI 24132	CB 728
White clover *T. repens* cv. Ladino	TA1
Subterranean clover *T. subterraneum* cv. Dwalganup	TA1
Subterranean clover *T. subterraneum* cv. Woogenellup	WA67 + WU290
Barrel Medic *Medicago truncatula* cv. Jemalong	SU47 + U45

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TABLE 1
Monthly rainfall at experimental site 1966-1971

	mm					
	1966	1967	1968	1969	1970	1971
January	7	245	433	112	150	210
February	134	100	141	113	84	334
March	80	283	108	24	106	112
April	74	58	18	28	18	30
May	24	35	53	101	14	34
June	37	408	12	14	12	33
July	7	38	46	29	23	34
August	81	43	162	108	8	26
September	47	29	11	30	72	83
October	89	112	22	194	48	28
November	113	29	9	155	72	44
December	37	68	62	60	347	110
Total	730	1448	1077	968	954	1078
Subjective assessment	Dry summer	Wet winter	Wet summer	Dry autumn	Dry autumn	Wet summer
			Dry spring	Wet spring	Dry winter	Dry winter

Seed was lime-pelleted, broadcast onto a clean seedbed and raked in on 15th June, 1966. The following fertilizers were applied at sowing: 750 kg ha $^{-1}$ molybdenized superphosphate; 250 kg ha $^{-1}$ muriate of potash; 3.2 kg ha $^{-1}$ copper sulphate; 3.2 kg ha $^{-1}$ zinc sulphate; 1.6 kg ha $^{-1}$ sodium borate. Because of apparent nodulation problems, lime was applied three months after sowing at a rate of 3770 kg ha $^{-1}$. Plots were topdressed each autumn with 250 kg ha $^{-1}$ superphosphate and 125 kg ha $^{-1}$ muriate of potash.

Measurements

Plant counts were made six weeks after sowing in ten 0.2 × 0.2 m quadrats per plot to determine percent establishment. For dry matter yield determinations two 1 × 0.4 m samples were cut with hand-shears from each plot and bulked. The harvested material was separated into "legume" and "other" components, dried, weighed and milled for chemical analysis. After sampling, all topgrowth was removed from the cut plots with an autoscythe.

During the first four years of the experiment each species was managed separately and was only harvested if there was considered to be sufficient legume growth present. Consequently, the number of times a species was cut within any one year ranged from nil to seven times. In the final year all species were harvested at the same times, these being at approximately monthly intervals during summer and autumn and two monthly intervals during winter and spring.

Chemical Analyses

Samples were analysed for nitrogen using a standard macro-Kjeldahl technique and for phosphorus by the vanado-molybdate method (Jackson 1958).

Statistical Analyses

A split-plot analysis was carried out with replications and treatments as main effects and years as sub-plots.

RESULTS

Establishment

The percentage establishment of each species is given in Table 2.

TABLE 2

Establishment of African and temperate legumes

Species	Sowing rate kg ha^{-1}	Germination test (%) (10 days at 24·5°C)	Mean plants established m^{-2}*	Establishment (% of viable seed)
Kenya white clover	4·5	27	9·9^{c}	9·3
Burchell's clover	4·5	39	26·6^{b}	18·6
Ladino white clover	5·6	77	52·5^{a}	6·9
Dwalganup subterranean clover	16·8	88	42·0^{a}	21·0
Woogenellup subterranean clover	16·8	78	42·0^{a}	19·5
Barrel medic	5·6	92	17·3^{bc}	12·9

*Six weeks after sowing.

Means with unlike superscripts are different.

($P < 0·05$ in Duncan's M.R.T.).

The larger seeded annual species established more rapidly and were more vigorous, while the African clovers were very slow and were still in an advanced seedling stage when the annual species were flowering in September, 1966.

Growth and Dry Matter Yield

Once established, growth of all species except Dwalganup subterranean clover was good in the first year. From time to time all species, but particularly Dwalganup subterranean clover, were affected by a reddening of the edges of leaflets which gradually spread to the centre of the leaflets. However, plants appeared to recover and in future years, only isolated plants of Kenya white clover were affected.

During the second and third years of the experiment considerable seedling mortality occurred which could not be explained by dry weather. Examination of plant roots revealed damage caused by root knot nematode (*Meloidogyne* spp), the two African species being less affected than the other legumes.

The African clovers in general produced well. Kenya white clover and Ladino white clover were the only species to make useful growth in the summer-autumn period and, of these, Kenya white clover was the only species to consistently produce during this period in all five years (See Figure 1).

Dry matter yields are shown in Tables 3 and 4. There were significant differences ($P < 0.01$) between species and between years for yields of legume, other and total material. The interaction between species and years was also significant ($P < 0.01$) for the three components.

The experiment was continued until September, 1971, by which time many species were invading adjoining plots making yield measurements difficult. The most effective invaders were Kenya white clover, Ladino white clover and Burchell's clover.

Chemical Composition

All legumes had a similar range of nitrogen and phosphorus contents (2–4% N and 0.18–0.30% P) and the nitrogen contents of the grasses associated with all legumes were higher than those found in native pastures at the same site (Brooks and Garden unpublished).

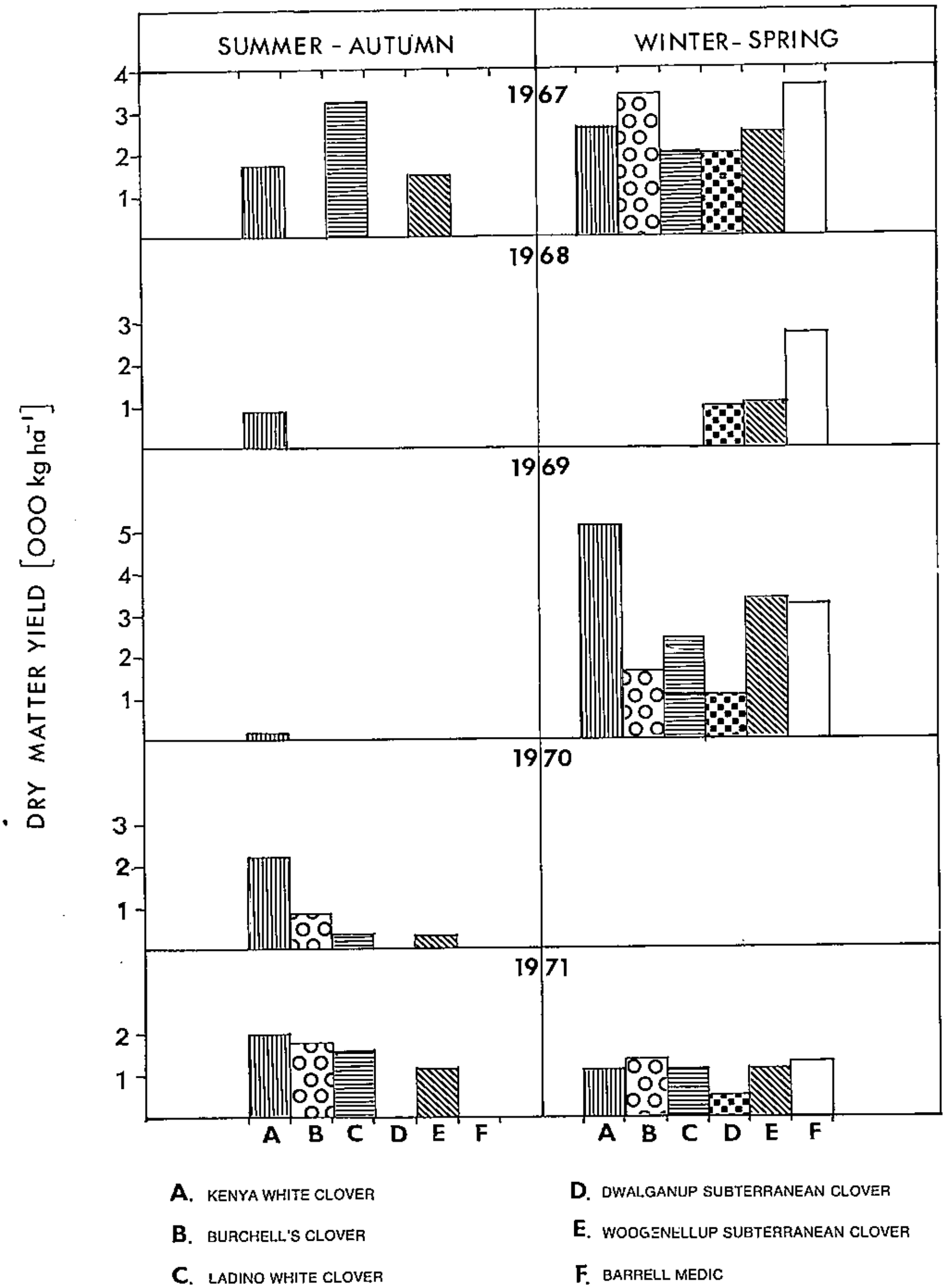

FIGURE 1

Dry matter production of African and Temperate legumes.

TABLE 3

Dry matter yield of African and temperate legumes, Fineflower 1967–71

	kg ha^{-1}					
	1967	1968	1969	1970	1971	mean
Kenya white clover	4303^{b}	864^{b}	5264^{a}	2203^{a}	2971^{a}	3121^{a}
Burchell's clover	3422^{b}	*	1623de	854^{b}	3076^{a}	2068^{b}
Ladino white clover	5252^{a}	*	2394^{cd}	345^{b}	2613^{a}	2476^{ab}
Dwalganup subterranean clover	1999^{c}	943^{b}	1027^{e}	34^{b}	474^{b}	896^{c}
Woogenellup subterranean clover	4012^{b}	1061^{b}	3360^{b}	303^{b}	2200^{a}	2187^{b}
Barrel medic	3656^{b}	2707^{a}	3212^{bc}	12^{b}	1268^{b}	2171^{b}

Means with unlike superscripts within the same column are different ($P < 0{\cdot}05$ in Duncan's M.R.T.).
*No cuts taken. Missing data used for analysis.

TABLE 4

Total dry matter yield of legume and other material, Fineflower 1967–71

	kg ha^{-1}					
	1967	1968	1969	1970	1971	Mean
Kenya white clover	6514^{b}	4835^{a}	8331^{a}	6051^{a}	8713^{a}	6889^{a}
Burchell's clover	4503^{c}	*	2604de	3888^{b}	8618^{a}	4467^{bc}
Ladino white clover	7763^{a}	*	3437^{cd}	3891^{b}	7843^{a}	5272^{b}
Dwalganup subterranean clover	2619^{d}	1510^{c}	1913^{e}	635^{c}	5451^{c}	2426^{d}
Woogenellup subterranean Clover	4886^{c}	1538^{c}	4745^{b}	4354^{b}	8775^{a}	4859^{b}
Barrel medic	4002^{c}	2984^{b}	4064^{bc}	632^{c}	6655^{b}	3667^{c}

Means with unlike superscripts within the same column are different ($P < 0{\cdot}05$ in Duncan's M.R.T.).
*No cuts taken. Missing data used for analysis.

DISCUSSION

The slow establishment of some of the African clovers has been noted previously (Date 1971, Jones *et al.* 1974). With Kenya white clover, Jones and Date (1975) argue strongly against this being a failure of nodulation and consider that many of the yellowing and reddening symptoms ascribed to poor nodulation are in fact due to infection by Rugose Leaf Curl. The leaf reddening and the manner in which most affected plants recovered in this experiment fits the same pattern. Grylls *et al.* (1972) found that Kenya white clover was more susceptible to infection by Rugose Leaf Curl than either Burchell's clover or white clover.

Since this experiment was established, research has shown that *Rhizobium* strain CB782 used alone is effective and persistent in nodulation of Kenya white clover under field conditions (Jones and Date 1975) and this strain is used commercially.

Yield of legume material in this experiment showed quite large variations from year to year. This is a reflection of the environment, especially rainfall, and is a typical pattern with introduced legumes in this area (O'Brien 1970).

The African clovers were at least as productive as any of the legumes tested, Kenya white clover proving to be the more reliable and productive over a range of seasons. This appears to have been the case wherever these two species have been compared in Australia (Cameron 1961, 't Mannetje 1964, Jones *et al.* 1974). The African clovers, particularly Kenya white clover, were more tolerant of dry conditions than the other species, and Kenya white clover was able to respond better to rainfall during the summer-autumn period (See Figure 1).

The performance of the annual legumes, apart from Dwalganup subterranean clover, was better than expected, as these species normally have poor survival and production in this area (Kemp 1975). It is felt that the management of the trial, whereby grass cover was maintained on most plots during summer and early autumn, may have contributed to seedling survival during dry periods. Although maintenance of grass cover is not normally conducive to seedling regeneration of temperate legumes, the fact that grass yields were low (see Tables 3 and 4) may have allowed the grasses (a mixture of native tussock species and naturalized carpet grass and paspalum) to protect seedlings without providing strong competition for the legumes.

The persistence of Ladino white clover is also normally poor in this environment. However, the cutting management referred to above may have assisted the survival of perennial plants of Ladino white clover during summer dry periods, normally a critical stage for Ladino because of its low seed production compared with the better adapted naturalized white clover and cv. Haifa (O'Brien 1970). Another factor which may have contributed to the persistence of the Ladino white clover is the likelihood of cross-fertilisation and hybridization with both naturalized white clover and cv. Haifa present in areas close to the experiment (O'Brien 1970).

The effect of the lime application on soil pH and legume growth is unknown. However, this factor could be important and may be another reason for the better than usual persistence of the temperate legumes.

Since the completion of the experiment in 1971 the experimental area has been opened to free grazing by cattle. Kenya white clover and Ladino white clover have persisted and continued to invade adjoining areas while the other legumes have largely remained within the sown plots. Both African clovers appear to be acceptable to cattle and are grazed in preference to adjoining native and naturalized pastures.

The digestibilities of African clovers, although lower than white clover, are higher than tropical legumes and can be regarded as satisfactory (Jones 1973, Jones *et al.* 1974). Where animal production from Kenya white clover based pastures has been measured, it has proved very satisfactory (Wilson 1974, Jones and Jones 1975).

Kenya white clover appears to be a useful pasture legume on the North Coast of New South Wales. The ability of Kenya white clover to grow in less well grazed pastures and to have better summer production (Jones 1973) is a distinct advantage when compared with naturalized white clover (*Trifolium repens*) in this environment. Although the white clover used in this experiment, Ladino, does have some summer production it is not regarded as an adapted species in this area (O'Brien 1970) and is only recommended for temporary pastures.

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