QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

DIVISION OF PLANT INDUSTRY BULLETIN NO. 795

SMALL PLOT EVALUATION OF PASTURE GRASSES, LEGUMES AND FORAGES IN COASTAL SOUTH-EAST QUEENSLAND

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SUMMARY

A collection of pasture and forage plants was evaluated in a series of small plot trials at six sites in coastal south-east Queensland in search of plants with higher yields and longer growing seasons.

No lines superior to the currently used pasture cultivars of the region were identified but *Trifolium repens* cv. Haifa was shown to be high yielding and persistent, and warrants immediate use. As well, *Glycine wightii* CPI 25920 and *Vigna parkeri* CPI 37952 were considered promising and warrant further study.

I. INTRODUCTION

The development of improved pastures in subtropical coastal south-east Queensland has been based largely on introduced tropical grasses and legumes although a few temperate species are also grown. Among the tropical species available in the early 1970s were few that grew well or stood over satisfactorily into the cooler months. As a result, a serious deficiency of quality feed frequently exists by late winter–early spring.

Since fresh growth is more nutritious than stand-over feed, a need existed to seek tropical species with growing seasons that extended into the colder parts of the year. Attention was also paid to further temperate pasture plants in the hope of locating cultivars better adapted to the region.

Preliminary studies with 32 legumes and 42 grasses (table 1) at four sites in 1971–1975 suggested that more detailed studies, particularly of temperate pasture plants, were desirable. In these unreplicated plantings some of the annual *Trifolium* spp. yielded well, for example *T. spumosum* ($12{\cdot}6$ t ha^{-1}), *T. incarnatum* cv. Dixie ($11{\cdot}7$ t ha^{-1}) and *T. hirtum* cv. Sirint ($9{\cdot}1$ t ha^{-1}) although Sirint was quite hard and woody.

No tropical legumes proved superior to *Desmodium intortum* cv. Greenleaf (desmodium), *Macroptilium atropurpureum* cv. Siratro, *Macrotyloma axillare* cv. Archer (axillaris) and the glycines, but *Vigna parkeri* CPI 37952 persisted strongly and spread rapidly, combining well with the naturalized mat grass (*Axonopus affinis*).

The *Lolium* spp. were promising temperate grasses and morphological types of *Setaria anceps* cv. Narok were found to show differing frost tolerances.

As a result of these unreplicated plantings a further collection of material was assembled and these, together with some of the initial collection, were planted over a number of sites (table 2) in replicated small plot trials. This paper reports the results of these studies.

TABLE 1

LIST OF LEGUMES AND GRASSES SOWN IN PRELIMINARY STUDIES AT COOROY, BELLI, COORAN AND UPPER KANDANGA 1971-1975

Legumes	
Trifolium spumosum (bladder clover)	*Cajanus cajan* (pigeon pea)
T. incarnatum cv. Dixie (crimson clover)	*Glycine wightii* cv. Cooper
T. hirtum cv. Sirint (rose clover)	*Glycine wightii* cv. Malawi
T. hirtum cv. Kondinin (rose clover)	*Macroptilium atropurpureum* cv. Siratro
T. hirtum cv. Hykon (rose clover)	*Macrotyloma axillare* cv. Archer
T. hirtum cv. Troodos (rose clover)	*Stylosanthes guianensis* cv. Cook
T. hirtum cv. Olympus (rose clover)	*Stylosanthes guianensis* cv. Oxley
T. repens cv. Haifa	*Stylosanthes guianensis* cv. Endeavour
T. alexandrinum (berseem clover)	*Stylosanthes humilis* (Townsville stylo)
T. resupinatum (Persian clover)	*Lespedeza striata* cv. Kaloe
T. resupinatum C.P.I. 273777	*Lespedeza stipulacea* cv. Korean
T. cherleri cv. Beenong (cupped clover)	*Galactia filiformis*
T. cherleri cv. Yamina (cupped clover)	*Aeschynomene falcata*
T. semipilosum cv. Safari (kenya white)	*Desmodium heterophyllum* cv. Johnstone
T. semipilosum C.P.I. 37944 (kenya white)	*Leucaena leucocephala*
Lotononis bainesii cv. Miles	*Vigna parkeri C.P.I.* 37952
Grasses	
Panicum maximum cv. Gatton	*Pennisetum purpureum* (common elephant grass)
Panicum maximum cv. Makueni	*Pennisetum purpureum* x (Bana grass)
Panicum maximum cv. Embu	*Lolium perenne* cv. Kangaroo Valley Early
Panicum maximum cv. Sabi	*Lolium perenne* cv. Kangaroo Valley Late
P. maximum var. *trichoglume* cv. Petrie (green panic)	*Lolium perenne* cv. Colac
Setaria anceps cv. Nandi	*Lolium perenne* cv. Medea
Setaria anceps cv. Narok	*Lolium perenne* cv. Kangaroo Valley (commercial)
Setaria anceps cv. Kazungula	*Lolium perenne* cv. Tasdale
Cenchrus ciliaris cv. Gayndah	*Lolium perenne* cv. Mansfield
Cenchrus ciliaris cv. Biloela	*Lolium perenne* cv. Tasmanian No. 1
Chloris gayana cv. Pioneer	*Lolium perenne* cv. Grasslands Ruanui
Chloris gayana cv. Callide	*Lolium perenne* G.A. 40 strain
Chloris gayana cv. Katambora	*Lolium multiflorum* cv. Grasslands Paroa
Digitaria decumbens (Pangola)	*Lolium perenne* x *L. multiflorum* cv. Grasslands Manawa
Brachiaria decumbens cv. Basilisk (signal grass)	*L. perenne* x (*L. perenne* x *L. multiflorum*) cv. Grasslands Ariki
Brachiaria ruziziensis cv. Kennedy	*L. multiflorum* Lam. cv. Grasslands Tama
Panicum coloratum C.P.I. 16796	*Avena sativa* cv. Bentland
Panicum coloratum C.P.I. 14375	*Avena sativa* cv. Swan
Pennisetum clandestinum cv. Whittet	*Avena sativa* cv. Minhafer
Pennisetum clandestinum cv. Breakwell	*Avena strigosa* cv. Saia
Pennisetum clandestinum (common kikuya)	
Pennisetum purpurem cv. Capricorn (elephant grass)	

TABLE 2

DETAILS OF SITES USED

	Middle Creek	Cooran	Belli	Upper Kandanga	Cooroy	Coolum Res. Station
Soil Description	Latosolic clay loam	Latosolic clay loam	Duplex red brown clay loam	Shallow black gravelly loams	Latosolic clay loams	Lowland virgin heath
Northcote Classification	Gn 3·42	Gn 3·42	Dy 5·1	Um 2·21	Gn 3·42	Um 2·2
pH	5·4	5·4	5·6	5·4	5·1 –5·2	5·2 –5·4
Acid Extractable P (ppm)	47	18	13	40	25–50	3–4
Exch K me.%	0·20	0·12	0·22	0·37	0·19–0·25	0·03–0·05
Drainage	Good	Good	Good	Good	Good	Good
Vegetation	Mat and native grasses	Mat grass	Kangaroo grass, blady grass, mat grass	Kangaroo grass, Spear grass, Forest blue grass	Mat grass	Native heath
Remarks	Site subject to frost and flooding in very wet years	Site subject to frost and flooding	Site subject to frost	Site subject to frost	Site subject to severe frosts	Floods for short periods. Mechanically drained, subject to moderate frosting

II. EXPERIMENTAL METHODS

Plantings were carried out in the Gympie–Cooroy area (lat. 26–27°S. long. 152–153°E.) using prepared seedbeds with seed and fertilizer hand broadcast into the plots, raked in and rolled with a tyre or Cambridge roller. Legume seed was inoculated with commercial peat cultures of rhizobium using 2% methyl cellulose sticker in water slurry 24 h before planting. The seed was coated with either lime or bauxite dust.

Oven-dry-matter yields were measured from 4·57 x 0·9 m strips cut from the centre of the plots at 5 cm from ground level with an autoscythe. The remainder of the plot was mown and raked off.

Two observers independently recorded the presence or absence of diseases, frost damage (nil, light, moderate, severe) flowering and seed set, weed invasion, compatibility with other species, and regeneration from seed and after cutting.

Six sites were used (table 2). At each site the soil was sampled to 10 cm prior to planting and ten 7·6 cm auger cores were combined for analysis for acid extractable P (Kerr and von Stieglitz 1938) exchangeable K (neutral N NH_4 Cl) and pH (1 : 5 soil/water).

III. WINTER SPECIES STUDIES—LEGUMES, ROOT CROPS

Methods and Results

EXPERIMENT 1 (COOROY)

Twenty-two legumes and forage plants (table 3) were sown in a four-replicate randomized block design on 7 June 1972 and 13 June 1973 in 15 m^2 plots. Legumes were sown at 17 kg ha^{-1}, oats 67 kg ha^{-1} and root crops 3 kg ha^{-1}. Establishment fertilizer was 49 kg P ha^{-1} and 63 kg K ha^{-1} on all species, with 112 kg N ha^{-1} only on oats and root crops at planting.

TABLE 3

CUMULATIVE YIELD OF VARIOUS CLOVERS AND WINTER FORAGES FOR PERIOD 13 JUNE TO 16 OCTOBER 1973 FOR EXPERIMENT I AT COOROY (t ha^{-1})

Treatment	Yield of Forage
Trifolium subterraneum cv. Clare	2·8
Trifolium subterraneum cv. Yarloop	2·3
Trifolium subterraneum cv. Seaton Park	1·3*
Trifolium subterraneum cv. Woongellup	2·3
Trifolium subterraneum cv. Mt. Barker	2·1*
Trifolium subterraneum cv. Bacchus Marsh	0·8*
Trifolium subterraneum cv. Dwalganup	1·2*
Trifolium subterraneum cv. Geraldton	1·1*
Trifolium subterraneum cv. Dinninup	1·9*
Trifolium subterraneum cv. Uniwager	1·1*
Trifolium subterraneum cv. Daliak	1·2*
Trifolium subterraneum cv. Howard	1·9
Trifolium subterraneum cv. Tallarook	1·1*
Trifolium repens cv. Louisiana	1·6
Trifolium repens cv. Grasslands Huia	1·3
T. alexandrinum (berseem clover)	0·0
T. pratense cv. Grasslands Turoa	1·1*
Brassica rapa cv. Purple Top (turnip)	2·4*
B. oleracea cv. Thousand-head (kale)	3·6
Brassica napus cv. Aphis Resistant (rape)	2·4*
Beta vulgaris cv. Long Red (mangels)	0·0
Avena strigosa cv. Saia (oats)	2·6*
	means only

* Yields are from one harvest only

TABLE 4

SEASONAL, TOTAL AND MEAN ANNUAL RAINFALL FOR VARIOUS CENTRES (mm)

Centre	Coolum Research Station				Middle Creek*			Upper Kandanga		Cooran			Cooroy			Eumundi-Belli		
Year	1973	1974	1975	1976	1973	1974	1975	1971	1972	1973	1974	1975	1971	1972	1973	1973	1974	1975
Season																		
Spring .. .. (Sep–Nov)	350	456	384	247	314	394	333	153	718	293	385	251	179	427	374	395	477	397
Summer .. .. (Dec–Feb)	574	1 071	566	501	699	1 334	521	1 009	716	589	1 224	448	1 307	1 103	703	744	1 541	398
Autumn .. .. (Mar–May)	521	809	578	1 202	188	712	230	430	401	132	606	181	252	603	220	279	848	328
Winter .. .. (Jun–Aug)	865	177	265	125	831	140	241	135	152	759	120	227	189	72	839	912	133	207
Total ..	2 310	2 513	1 793	2 075	2 032	2 580	1 325	1 727	1 987	1 773	2 335	1 107	1 927	2 205	2 136	2 330	2 999	1 330
Mean ..	1 721 (50 years)				1 499 (55 years)			1 182 (57 yrs)		1 360 (81 years)			1 627 (81 years)			1 665 (76 years)		

Source—Bureau of meteorology—unpublished data.
* Nearest recording station is Pomona.

Dry weather (table 4) during the 1972 and 1973 winter restricted plant growth markedly and no yields were obtainable in 1972. In 1973 thousand-head kale produced 3·6 t ha^{-1} dry matter, Clare subterranean clover 2·8 t ha^{-1}, Saia oats 2·5 t ha^{-1} and Purple Top turnip and Aphis Resistant rape 2·3 t ha^{-1} dry matter (table 3), over a 125 day growing period from sowing. Kale and rape were severely defoliated by aphids (*Aphis craccivora*) whilst several subterranean clover cultivars were affected by powdery mildew (*Oidium* sp.).

Experiment 2 (Cooran 1973–1975)

Ten legumes (table 5) were sown in 12·4 m^2 plots in a three-replicate randomized block design on 11 May 1973 at 6·7 kg ha^{-1} seed with *Setaria anceps* cv. Narok at 1·7 kg ha^{-1} as the companion grass. Establishment fertilizer was 49 kg P ha^{-1} and 63 kg K ha^{-1} dressing in the spring of 1974 and 1975.

Above average rainfall (table 4) provided excellent growing conditions in 1973–1974, but below average rainfall in 1975 restricted growth. The high production of Haifa white clover (table 5) ($P < 0·05$) largely resulted from high late-winter/spring yields. In comparison, the dry matter production of the white clover cultivars Ladino and Louisiana was higher in the late summer period. Dixie crimson clover was exceptionally high yielding in the first spring (1973) ($P<0·05$) but this growth response was not repeated in subsequent seasons. Safari (Kenya white clover) established slowly, making most growth during November to January in all years. Production declined quickly in late summer. The Clarence Valley ecotype Q 14333 was essentially a spring grower and yielded poorly outside this season.

TABLE 5

Cumulative Dry Matter Yield of Clover, Narok Setaria and Other Species for Period 11 May 1973 to 3 December 1975 for Experiment 2 at Cooran (t ha^{-1})

Treatment	Yield of Herbage			
	Clover	Narok	Other Species	Total
Trifolium incarnatum cv. Dixie (crimson clover)	8·4	1·2	10·2	19·8
Trifolium repens cv. Haifa	11·7	1·7	4·7	18·1
Trifolium repens cv. Ladino	8·7	1·6	3·7	14·0
Trifolium repens cv. Louisiana	9·8	2·9	4·5	17·2
Trifolium repens Clarence Valley ecotype Q14333	7·7	1·7	7·3	16·7
Trifolium spumosum (bladder clover)	4·8	2·4	9·1	16·3
Trifolium alexandrinum (berseem clover)	4·0	2·9	11·0	17·9
Trifolium semipilosum cv. Safari	4·8	3·0	10·3	18·1
Trifolium hirtum cv. Sirint (rose clover)	3·0	1·0	13·2	17·2
Trifolium resupinatum (persian clover)	1·8	2·3	12·6	16·7
Nec diff 5%	1·7	..	2·9	..
	..	ns	..	ns
1%	2·4	..	4·1	..

ns F test not significant

Experiment 3 (Coolum Research Station, 1973–1976)

Nineteen legumes (table 6) were sown in 20-m^2 plots in a three-replicate randomized block design on 27 April 1973. Subterranean clovers were sown at 11 kg ha^{-1} and white clovers at 4 kg ha^{-1}. Twenty-two legumes (table 6) were sown in 20-m^2 plots in a three-replicate randomized block design on 3 April 1974.

Sowing rates were as for 1973 (greater lotus 4 kg ha^{-1}). All legumes sown previously except Safari white clover and greater lotus were planted on 18 April 1975 in the same manner as in 1973. This experiment was allowed to continue in 1976. Twenty legumes (table 6) were sown in a three-replicate randomized block design on 9 June 1976 as pure swards. Sowing rates were as for 1973. Establishment fertilizer consisted of 50 kg ha^{-1} of a "Wallum mix" made up as follows: 625 kg superphosphate, 125 kg muriate of potash, 625 kg agricultural limestone, 8 kg copper sulphate, 8 kg zinc sulphate, and 280 kg sodium molybdate. Maintenance dressings of 37 kg P ha^{-1} and 63 kg K ha^{-1} were applied each autumn and spring in two separate applications. Following heavy flooding early in 1974, 63 kg K ha^{-1} and 23 kg P ha^{-1} were applied on 1 October 1974.

Rainfall in 1973 and 1974 was above average (table 6). Heavy rain in July 1973 flooded the experiment for 4 days. Further flooding occurred for up to 2 days, five times during April and May 1974. Heavy rain in April 1975 severly dislodged many newly planted seeds. The rainfall for 1975 and 1976 was above average; most rain was received in the first 4 months and winter and spring were dry. The spring of 1976 was exceptionally dry and little plant growth occurred.

TABLE 6

ANNUAL DRY MATTER YIELDS OF LEGUMES FROM ANNUAL RESOWINGS FOR EXPERIMENT 3, COOLUM RESEARCH STATION (t ha^{-1})

Treatment	1973	1974	1975a	1975	1976a	1976
Trifolium subterraneum cv. Clare ..	2·1*	0·06	1·4	1·1	0·0	1·6
Trifolium subterraneum cv. Yarloop ..	3·6	0·2	2·6	1·0	0·0	0·0
Trifolium subterraneum cv. Seaton Park	2·2*	0·2	1·7	0·6	0·0	1·3
Trifolium subterraneum cv. Woogenellup	4·8	0·01	1·0	1·5	0·0	2·0
Trifolium subterraneum cv. Mt. Barker	4·7	0·03	2·5	0·9	0·0	2·1
Trifolium subterraneum cv. Bacchus Marsh	3·7	0·3	0·9*	1·0	0·0	1·9
Trifolium subterraneum cv. Dwalganup	1·8*	0·0	2·0	0·06*	0·0	..
Trifolium subterraneum cv. Geraldton ..	1·6	0·0	0·8*	0·3*	0·0	0·0
Trifolium subterraneum cv. Dinninup ..	2·5*	0·3	1·6	0·2*	0·0	..
Trifolium subterraneum cv. Uniwager ..	1·6*	0·0	1·3	1·0*	0·0	..
Trifolium subterraneum cv. Daliak ..	1·4*	0·1	0·5*	0·1*	0·0	..
Trifolium subterraneum cv. Howard ..	1·9*	0·1	1·2*	1·0	0·0	..
Trifolium subterraneum cv. Tallarook ..	4·8	0·0	1·3*	0·2*	0·0	..
Trifolium alexandrinum (berseem clover)	2·0*	..	..	..	..	..
Trifolium semipilosum cv. Safari ..	1·1*	0·3	5·2	..	0·0	0·3
Trifolium repens Clarence Valley Q14333	3·9	0·7	3·0	1·4	2·0	0·0
Trifolium repens cv. Ladino	3·8	1·5	4·2	5·1	4·6	1·7
Trifolium repens cv. Grasslands Pitua ..	..	..	..	..	..	1·5
Trifolium repens cv. Louisiana	..	1·2	5·0	3·8	7·1	1·0
Trifolium repens cv. Haifa	4·2	2·1	5·6	4·9	4·7	1·6
Trifolium repens cv. Grasslands Huia ..	5·1	0·2	2·4	3·7	5·5	1·6
Trifolium repens cv. Ulmarra	..	..	..	..	..	2·0
Trifolium pratense cv. Grasslands Turoa	..	0·0	1·4	4·7	0·0	1·7
Trifolium pratense cv. Grasslands Hamua	..	0·0	3·0	2·7	0·0	1·3
Lotus pedunculatus (greater lotus) ..	..	0·0	2·7	..	..	..
Nec diff 5%	ns	0·5	1·2	1·4	2·7	means
1%	ns	0·6	1·6	1·8	3·9	only

* Not included in analyses of variance owing to insufficient data. Means given here for comparison only.

ns F test not significant:—Not sown

1975a perennial growth from 1974

1976a perennial growth from 1975

Over all years Yarloop, Bacchus Marsh, Woogenellup, Mt Barker and Tallarook were the most consistent yielders among the subterranean clovers (table 6). However, yields were poorly distributed with much of the production recorded from fewer than three harvests. In addition, the greater portion of the yield came from early spring. Many cultivars were susceptible to root rots and powdery mildew. These conditions effectively shortened the growing season of many subterranean clovers.

By comparison, all *Trifolium repens* cultivars yielded well and persisted strongly. Yields of white clover were generally higher and with a longer growing season than subterranean clover. Little difference existed between Ladino, Louisiana, Haifa and Grasslands Huia except that Haifa gave the earliest production (August-October).

Safari made active growth only in mid-summer, remaining yellow and unthrifty for the remainder of the year. Highest yields were recorded in 1975, a year of low rainfall. Both 1973 and 1974 were extremely wet and Safari performed very poorly.

IV. WINTER SPECIES—GRASSES

Experiment 4 (Coolum Research Station, 1973–1976)

METHODS

Eight winter grasses (table 7) were sown at 9 kg ha^{-1} (oats 56 kg ha^{-1}) in 20-m^2 plots in a three-replicate randomized block design on 4 May 1973, 3 April 1974, and 18 April 1975. Ten winter grasses were again sown at the same seeding rates in a four-replicate randomized block design on 10 June 1976 in 20-m^2 plots. Basal fertilizer application and sowing methods for experiment 4 were the same as for experiment 3. All grasses received 112 kg N ha^{-1} as urea at planting (except in 1975 and 1976) with 85 kg N ha^{-1} after the first two harvests. Nitrogen was omitted at planting in 1975 but was applied at 112 kg N ha^{-1} on 19 May 1975. In 1976 all grasses received 56 kg N ha^{-1} as urea at planting only.

RESULTS

TABLE 7

CUMULATIVE DRY MATTER YIELDS OF GRASSES, EXPERIMENT 4 COOLUM (t ha^{-1})

Treatment	1973	1974	1975
Lolium rigidum cv. Wimmera (ryegrass)	4·3	1·7	2·2
Lolium perenne X (*Lolium perenne* X *Lolium multiflorum*) cv. Grasslands Ariki (ryegrass)	4·7	0†	1·0
Lolium multiflorum Lam. cv. Grasslands Tama (ryegrass)	4·4	1·3	1·14
Lolium multiflorum cv. Grasslands Paroa (ryegrass)	4·4	1·0	1·1
Lolium perenne cv. Kangaroo Valley (ryegrass)	5·0	1·9	2·2
Phalaris tuberosa cv. Australian phalaris	4·8	0·7	0·34*
Bromus uniloides (Priebe prairie)	4·7	0·3	0·7*
Avena strigosa cv. Saia (oats)	2·4*	0·0	0·1*
Nec diff 5%	ns	0·7	0·6
1%	ns	1·0	0·8

* Not included in analyses of variance owing to insufficient date. Means given here for comparison only.
† Ariki did not germinate
ns F test not significant
1973 yields represents growth from 4 May 73 to 1 Nov 73; in 1974, from 3 Apr 74 to 20 Oct 74; in 1975, from 18 Apr 75 to 4 Nov 75.

Climatic conditions affecting this experiment have already been described for experiment 3. There were no differences between the total yields of any ryegrasses in 1973. Wimmera and Kangaroo Valley were the highest yielding in 1974 and 1975. No growth could be measured in 1976 due to dry weather (table 7). The hybrids Grasslands Tama and Grasslands Paroa were extremely susceptible to leaf rust and it is questionable whether the material on offer would have been acceptable to livestock. Australian phalaris was least susceptible to rust and established slowly. Saia did not tolerate the wet conditions at sowing and rarely survived long enough to produce worthwhile yields.

V. TROPICAL SPECIES STUDIES

Methods and results

EXPERIMENT 5 (BELLI 1973–1975)

Eight tropical legumes (table 8) were sown on 9 January 1973 in a three-replicate randomized block design in 12·4-m^2 plots at 6·7 kg ha^{-1} seed with *Panicum maximum* cv. Gatton at 1·1 kg ha^{-1} as the companion grass. Establishment fertilizer was 49 kg P ha^{-1} and 63 kg K ha^{-1}, and each spring 25 kg P ha^{-1} and 63 kg K ha^{-1} were applied as a maintenance dressing.

EXPERIMENT 6 (SKYRING CREEK, 1973–1975)

Seven tropical grasses (table 9) were sown on 22 January 1973 in a three-replicate randomized block design in 12·4-m^2 plots at 1·6 kg ha^{-1} seed with either a legume mixture of Siratro and Greenleaf at 4 kg ha^{-1} or nitrogen fertilizer applied at nil or 112 kg ha^{-1} during February, May and August of each year. Establishment fertilizer was 49 kg P ha^{-1} and 63 kg K ha^{-1} during September 1973; during November 1974, 25 kg P ha^{-1} and 63 kg K ha^{-1} was applied as a maintenance dressing.

Above average rains at both sites ensured favourable conditions for plant growth. Wet weather during establishment at Skyring Creek followed by surface soil crusting prevented rapid emergence. Dry weather during the autumn of 1973 (table 4) slowed growth markedly.

TABLE 8

CUMULATIVE DRY MATTER YIELDS OF LEGUME, GRASS, GRASS + LEGUME, FOR PERIOD 9 MAY 73 TO 24 NOV 75 IN EXPERIMENT 5 (BELLI) (t ha^{-1})

Treatment	Sown Legume	Gatton panic	Total
Desmodium intortum cv. Greenleaf	17·0	10·9	27·9
Glycine wightii CPI 25920	11·9	13·0	24·9
Macrotyloma axillare cv. Archer	10·4	12·2	22·6
Macroptilium atropurpureum cv. Siratro	8·8	12·8	21·6
Glycine wightii cv. Malawi	8·4	11·7	20·1
Glycine wightii cv. Clarence	7·1	13·5	20·6
Glycine wightii cv. Cooper	6·1	15·2	21·3
Glycine wightii cv. Tinaroo	5·5	14·6	20·1
Nec diff 5%	4·3	ns	ns
1%	5·9	ns	ns

ns F test not significant

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The winter was mild at both sites during 1973 but in 1974 all species were heavily frosted. Greenleaf was least frost affected at Belli with most legumes dropping all their leaves but stolons remaining alive. Heavy frosts during June and July of 1974 at Skyring Creek severely burnt all grasses.

Very high yields of Greenleaf desmodium recorded at Belli (table 8) came largely from the first two years' growth and more particularly over the summer months. In contrast, glycines were higher yielding in late summer and autumn, with *Glycine wightii* CPI 25920 tending to equal and at times surpass the growth of Greenleaf towards the end of the second year. Almost 2 years after sowing, the productivity of Greenleaf desmodium was declining whilst that of the glycines was increasing.

Whilst Greenleaf desmodium and *Glycine wightii* CPI 25920 were high yielding, both legumes recorded significantly higher final plant populations than all others except Tinaroo and Malawi glycines (table 9).

TABLE 9

GRASS AND LEGUME CROWN POPULATIONS, EXPERIMENT 5, (SOWN JAN 1973) TAKEN AT CONCLUSION OF TRIAL, 19 SEP 1975 ('000 plants ha^{-1})

Treatment	Gatton panic	Legume
Macrotyloma axillare cv. Archer	1 227 (2·229*)	320 (1·138)
Desmodium intortum cv. Greenleaf	1 227 (2·229)	1 776 (2·681)
Glycine wightii cv. Cooper	1 150 (2·157)	727 (1·715)
Glycine wightii cv. Clarence	1 057 (2·068)	474 (1·382)
Glycine wightii cv. Tinaroo	978 (1·989)	1 227 (2·229)
Glycine wightii cv. Malawi	804 (1·805)	1 131 (2·138)
Macroptilium atropurpureum cv. Siratro	795 (1·794)	439 (1·333)
Glycine wightii C.P.I. 25920	727 (1·715)	1 391 (2·373)
Nec diff 5%	ns	0·617

* Figures in brackets show .. $\sqrt{x + \frac{1}{2}}$ transformation of plants per quadrat used for analyses of variance.
ns F test not significant

At Skyring Creek the yield response to nitrogen by all grasses was highly significant ($P<0·01$) whilst the contribution by legumes over the short duration of the experiment was minimal (table 10).

Gatton panic was the only grass showing tolerance to heavy frosting whereas populations of common guinea, Hamil grass and Makueni guinea were significantly reduced (table 11).

Although the populations of Greenleaf were significantly higher ($P < 0·01$) in Gatton panic, Narok setaria and Makueni guinea grass treatments at establishment, this effect was not evident at the conclusion of the trial. Siratro populations in Sabi panic and Gatton panic were significantly lower at establishment, but only the Siratro in the Gatton panic failed to thicken up by the conclusion of the experiment (table 12).

TABLE 10

CUMULATIVE YIELD OF GRASS, LEGUME AND WEED FOR ALL TREATMENTS, EXPERIMENT 6, (MIDDLE CREEK) FOR PERIOD 22 JANUARY 1973 TO 31 OCTOBER 1974 (t ha^{-1})

Treatment	Legume	Yield of Sown Grass			Total	Yield of Weed		
		Nil N	N Treated	Legume Mixture	Grass plus Legume	Nil N	N Treated	Legume Mixture
Panicum maximum cv. Gatton	4·0	5·1	24·3	5·5	9·5	3·3	0·1	1·8
Panicum maximum var. *trichoglume* cv. Petrie (Green panic)	4·0	2·7	13·7	2·2	6·2	5·8	2·1	4·3
Panicum maximum cv. Makueni	4·6	1·5	13·6	3·8	8·4	4·6	3·3	2·4
Panicum maximum (Common guinea)	1·6	6·2	22·8	10·1	11·8	2·8	1·3	0·6
Panicum maximum cv. Hamil	3·9	4·6	15·3	5·0	8·9	3·3	2·4	1·2
Setaria anceps cv. Narok	6·7	0·0*	0·0	0·0	0·0	6·8	10·1	3·0
Panicum maximum (Sabi panic)	4·2	2·5	21·8	4·2	8·4	6·7	0·5	3·0
Nec diff 5%	4·1	5·4	5·4	5·7	5·7	2·4	2·5	2·5

*Narok setaria failed to germinate

TABLE 11

Grass Crown Populations, Experiment 6, Skyring Creek (Sown 22 January 1973) Taken After Winter of 1973 and 1974 ('000 plants ha^{-1})

Date	23 October 73				8 November 74			
Treatment	Nil N	N Fertilized	Legume Mixture	Treatment Means	Nil N	N Fertilized	Legume Mixture	Treatment Means
Panicum maximum cv. Gatton ..	27 (2·714*)	27 (2·712)	27 (2·712)	27 (2·712)	26 (2·584)	26 (2·591)	26 (2·644)	26 (2·606)
Panicum maximum var. *trichoglume* cv. Petrie (green panic)	23 (2·281)	23 (2·339)	24 (2·431)	23 (2·344)	15 (1·524)	21 (2·121)	20 (2·029)	19 (1·891)
Panicum maximum cv. Makueni ..	19 (1·868)	25 (2·544)	25 (2·544)	23 (2·319)	11 (1·095)	16 (1·581)	16 (1·581)	14 (1·419)
Panicum maximum (common guinea)	30 (3·050)	29 (2·902)	27 (2·712)	29 (2·885)	23 (2·349)	19 (1·897)	25 (2·457)	22 (2·234)
Panicum maximum cv. Hamil ..	25 (2·471)	35 (3·582)	30 (2·965)	30 (3·006)	23 (2·271)	22 (1·187)	22 (2·206)	22 (2·221)
Panicum maximum (Sabi panic) ..	25 (2·544)	31 (3·079)	26 (2·647)	28 (2·757)	21 (2·064)	23 (2·271)	24 (2·402)	22 (2·245)
Nec diff 5%	..	0·832	..	0·480	..	0·889	..	0·513
1%	..	1·116	..	0·645	..	1·193	..	0·689
Mean Count	25 (2·486)	29 (2·860)	27 (2·666)	..	20 (1·981)	21 (2·108)	22 (2·220)	..
Nec diff 5%	..	0·330	..	..	..	0·363	..	..
1%	..	0·456	..	..	..	0·487	..	..

* Figures in brackets show $\sqrt{X + \frac{1}{2}}$ transformation of plants per m^2 used for analyses of variance. Narok setaria not included in analyses because it failed to germinate

TABLE 12

LEGUME CROWN COUNTS (m^{-2}) SKYRING CREEK (EXPERIMENT 6)

Treatment	23 Oct 73		8 Nov 74	
	Greenleaf desmodium	Siratro	Greenleaf desmodium	Siratro
Panicum maximum cv. Gatton	5·17	1·96	6·37	2·77
Setaria anceps cv. Narok	5·57	2·77	6·37	3·97
Panicum maximum cv. Makueni	5·57	2·77	5·94	3·53
Panicum maximum cv. Hamil	3·97	5·59	5·57	3·97
Panicum maximum var. *trichoglume* cv. Petrie (green panic)	3·97	3·17	5·57	3·97
Panicum maximum (Sabi panic)	3·97	2·39	5·17	3·59
Panicum maximum (common guinea) ..	3·57	2·77	5·09	3·59
Nec diff 5%	0·231	0·266	ns	0·275
1%	0·324	0·373	ns	0·385

ns F test not significant

VI. DISCUSSION

Temperate Legumes

The *Trifolium repens* cultivars were the most productive and persistent. The better seed production of Haifa over Ladino, Louisiana and Grasslands Huia (O'Brien 1970) could be expected to provide better regeneration. However, there is some evidence (Ebersohn and Stillman, unpublished) (Irwin and Jones 1977) that disease may be having an important influence on seedling regeneration and more particularly on stolon growth in the wetter coastal areas.

Ladino and Louisiana white clovers persisted better than Haifa over the summer and autumn and were slightly higher yielding. All four white clover cultivars have a significant role to play in the provision of a greater spread of herbage from August until late autumn.

The lower dry matter yields of the Clarence Valley ecotype (Q14333) were due mainly to its rapid decline in productivity from December until August. In fact it acted more as an annual despite claims of perenniality (O'Brien 1970) under favourable seasonal and soil fertility conditions. These results suggest it has no role as a pasture species in this region.

The prolific growth, high production, rapid growth response to moisture, and generally good persistence of white clover (Ostrowski 1972) where irrigation or high rainfall is available, emphasises the value of this species in south-east Queensland. Consequently, white clover is the main legume used in irrigated pastures in the sub-tropics (Jones *et al.* 1968); following rain or irrigation in autumn, it will provide feed much earlier than annual species which generally have to be resown and grown from seed.

The high spring yields of bladder, crimson and rose clovers in the preliminary studies is in keeping with results commonly reported in the literature. However, some major disadvantages of these clovers are their lack of adequate winter growth (Cameron 1961), high degree of hard seededness (Cameron 1958; Bailey 1966), shorter growing period, and intolerance of warm weather. In southern Australia these plants have been generally restricted to marginal rainfall areas.

The extraordinarily high yields, particularly for *T. hirtum* and *T. spumosum,* were in part unusable because of woodiness. A review of literature suggests lower palatability of some strains when not well grazed and this has been observed from time to time in southern Queensland (R. G. Wilson, personal communication). Despite evaluation of annual clovers in southern Queensland since the early 1950s, they have not proved successful either in pasture or for annual forage crops.

The generally lower productivity, disease susceptibility, poorer persistence and relatively shorter period of active growth of subterranean clover makes it unsuitable in the region.

Safari white clover did not live up to its earlier expectations of high yields and good persistence (Shaw and Quinlan 1976). It generally performed poorly, exhibiting worthwhile growth only in mid-summer. It may be of significance that at Coolum in both years in which Safari performed poorly, above-average rains were received whereas highest yields were recorded in a year of low rainfall. Its highly variable establishment and low productivity in the early years will limit its ready acceptance. At this stage it appears to have limited use in the region particularly for cool season production.

Temperate Grasses

The poor performance by most temperate grasses in the coastal lowland environment highlights the difficulties experienced by farmers in growing temperate species. Despite the failure of oats at Coolum through adverse weather, oats must still be considered a premier forage in coastal south-east Queensland in the light of its proven value as a reliable, high yielding, fattening forage crop. Perennial ryegrass and the annual Wimmera showed most promise as alternatives to oats. They were more rust resistant than other ryegrasses.

Sirocco phalaris was slower establishing than ryegrass but was leafier, broader leaved, apparently free from leaf rust, and more tolerant of dry weather. It appeared better adapted to the coastal lowland environment than ryegrass, and certainly warrants further study.

Tropical Legumes

The experiments at Belli, Skyring Creek and Upper Kandanga confirmed that Greenleaf desmodium, Siratro and the commercial glycines were not surpassed in their adaptability and productivity in the region. The marginally better yields of legumes in association with Makueni guinea compared to all other treatments were due to Makueni having the lowest grass population and hence offering least competition to the legume.

High yields and dense populations of *G. wightii* CPI 25920 (Belli) suggest that it merits more attention as a possible replacement for the commercial cultivars Cooper and Clarence. This accession makes better autumn growth than Cooper, flowers earlier than Tinaroo and has superior spring growth. The later maturity of CPI 25920 as against Clarence and Cooper would extend the growing season by at least 3 weeks. The earlier nodulation reported by Diatloff and Ferguson (1970) may be an advantage in overcoming the slowness to establish exhibited by commercial glycine cultivars. CPI 25920 has been consistently higher yielding than Clarence or Cooper in a wide range of trials in Queensland. This was the case at Lawes and Lansdown (Edye 1977), Kairi (R. W. Walker, K. A. Shaw and J. E. Ferguson, personal communication) and Cooroy (P. E. Luck, personal communication).

Edye and Kiers (1966) found, among other introductions, CPI 25920, Tinaroo and Cooper to be more stoloniferous than Clarence, which may be an advantage in maintaining or increasing plant density, particularly in times of stress. However, despite the apparently improved performance of CPI 25920 over current glycine cultivars, a review of literature indicates a number of other introductions which may also have superior performance to some existing cultivars. There is a need for some further assessment of glycines, in particular for less fertile soils (Shaw, personal communication) such as solodics (Lowe, personal communication) and podzolics.

Vigna parkeri CPI 37952 proved to be hardy and persistent at Cooroy although it was a small, low growing plant. However, Luck (1971, unpublished data) found *V. parkeri* CPI 37952 and CPI 25378 both very persistent hardy legumes in a poorly drained clay loam soil at Eumundi over a 4-year period. Cook (1975, unpublished data) found CPI 25378 and CPI 28703 persistent, although lacking bulk over a 3-year period at Gympie. Best growth was recorded in periods of high rainfall, and although frost susceptible, recovery in spring was excellent. On the other hand, in the lower rainfall sub-coastal Biloela environment, two other accessions of *V. parkeri* (CPI 28281 and 37951) had little value as pasture species (Cameron and Mullaly 1969).

V. parkeri may have a role as a pasture legume in low-lying wet areas which are otherwise unsuitable for any other existing commercial species. There is a need to determine productivity and animal performance, particularly in the wet coastal lowland areas of Queensland.

Tropical Grasses

Among the tropical grasses tested, Gatton panic, common guinea and Sabi panic were all high yielding. However, Gatton panic proved more compatible with legumes and exhibited better cold tolerance. The poor performance of Makueni guinea over the winter when severely frosted, is in contrast to its better cool season performance reported by Mackay (1974). Indeed, despite its reputation for better cool season performance in the tropics, its tolerance to frosting was inferior to Gatton panic.

The results of the limited testing of *Brachiaria decumbens* cv. Basilisk and *Brachiaria ruziziensis* cv. Kennedy in preliminary studies suggest that they are unsuitable in areas subject to frosting. Both grasses recovered much more slowly in the spring after heavy frosts compared to Narok setaria. Growth was generally slow during periods of moisture stress, indicating a need for high rainfall.

It seems that Whittet kikuyu seedlings are not vigorous enough to withstand competition from mat grass, thus accounting for the slow establishment and ground coverage observed at Belli and Cooroy in preliminary studies. This suggests the need for a well prepared, weed free, fertile seedbed for optimum rate of kikuyu spread when sown from seed. Both strains of kikuyu showed similar performance when fully established.

Forage Crops

The results of the limited testing of forage crops show that the root crops are very susceptible to aphid attack. Although their yields were comparable to oats, the latter is a more reliable crop.

VII. CONCLUSIONS

The general conclusion from these experiments is that existing commercial cultivars are superior to most other lines in their respective environments. Greater emphasis should be placed on manipulating existing species with management tools such as irrigation and fertilizer. However, there is a need to have a closer look at specific problems such as low lying wet, and heavily frosted, areas.

VIII. ACKNOWLEDGEMENTS

The author wishes to thank Messrs T. Lagon (Upper Kandanga), S. Leitch (Skyring Creek), E. Otto (Middle Creek), T. Gallaher (Cooran), B. Beeston (Cooroy), G. Simpson (Cooroy), M. Brown (Belli), Coolum Research Station for provision of experimental sites, Biometry branch for statistical analyses and the Australian Dairy Board for financing the project.

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(Received for publication 17 February 1978)

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