EVALUATION OF PASTURE GRASSES AND LEGUMES GROWN IN MIXTURES IN SOUTH-EAST QUEENSLAND

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ABSTRACT

The productivity and persistence of a range of tropical and temperate legumes grown in mixtures with tropical grasses were evaluated under grazing at three contrasting sites in south-east Queensland. (Nanango, 788 mm; Beaudesert 953 mm; Conondale 1343 mm annual average rainfall). Pastures were stocked at 1 beast ha^{-1} at the driest site and 1 and 2 beasts ha^{-1} at the two wetter sites for a period of four years.

The species tested were: Grasses—Nandi setaria (Setaria anceps *cv. Nandi*), Panicum coloratum *(CPI 14375, a Kabulabula type), green panic* (P. maximum *var.* trichoglume *cv. Petrie) and Rhodes grass* (Chloris gayana *cv. Pioneer*). *Legumes —Siratro* (Macroptilium atropurpureum), *Greenleaf desmodium* (Desmodium intortum *cv. Greenleaf*), *Silverleaf desmodium* (Desmodium uncinatum *cv. Silverleaf*), *glycine* (Glycine wightii *cv. Tinaroo and cv. Cooper*), *lotononis* (Lotononis bainesii *cv. Miles*), *lucerne* (Medicago sativa *cv. Hunter River*) *and white clover* (Trifolium repens *cv. Louisiana and cv. Ladino*).

Setaria was the most successful grass at Conondale. It was marginally successful at Beaudesert and failed at Nanango. Green panic was the best grass at Beaudesert and Nanango. Siratro, lucerne, lotononis and glycine were successful at Beaudesert and Nanango, the two drier sites. Siratro and glycine, except in poorly drained areas, Silverleaf desmodium and white clover were the most successful legumes at Conondale. Successful legumes at the low fertility Nanango site resulted in higher grass yields.

The results are discussed in relation to yield and persistence of sown species under two stocking rates together with the effects of legume component of grass/legume mixtures and stocking rate on the nitrogen level of the grass.

INTRODUCTION

A research program to evaluate pasture species for the dairying areas of south-east Queensland was commenced in the Gympie district in 1961 (Roe and Jones 1966) and was extended to other districts in 1965. The program comprised soil nutrient studies (Jones 1970, Rees 1972*a*, Jones 1973), small plot species evaluation under common grazing (Rees 1972*b*, Jones and Rees 1972), and assessment of improved pasture on dairy farms (Rees, Minson and Kerr 1972, Jones and Rees 1973). Productivity and persistence of the most promising species, grown in mixtures and evaluated under controlled grazing where there was no fertility transfer between treatments, are reported in this paper. The opportunity was taken to measure the effect of legumes on the nitrogen percentage of the youngest fully expanded leaf of associated grass species.

METHODS

Site characteristics and fertilizers

Three sites were selected to give a range of climate and soil types (Table 1 and Table 2). They were near Nanango, Beaudesert and Conondale. Some background data on the experimental sites, including results of soil fertility studies, is reported in the papers referred to above.

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TABLE 1

Climate, original vegetation and soils at each site and fertilizers applied

Site	Long term Annual Rainfall (mm)	Lowest ground min. temp (°C) during expt.	Original Vegetation	No. years cleared†	Soil Type	Basal fertilizer (kg/ha)				Maintenance fertilizer kg/ha	
						P	K	Mo	Lime	P	K
Nanango	788	– 9	Woodland	2	Podzolic on granodiorite	46	—	0·03	2,500*	22	35
Beaudesert	953	– 6	Woodland	2	Prairie on basalt	20	88	0·01	—	22	—
Conondale	1343	– 4	Open forest	40	Prairie on granodiorite	105	28	0·03	710*	22	—

† Not fertilized or cultivated prior to experiment.
* Lime applied to lucerne/white clover and glycine plots only.

TABLE 2

Warm season (October-March) and cool season (April-September) rainfall recorded at each site, and long term values (mm)

	Nanango			Beaudesert			Conondale		
	Cool Season	Warm Season	Annual	Cool Season	Warm Season	Annual	Cool Season	Warm Season	Annual
1965/66	320	580	900	410	550	960	460	670	1130
1966/67	300	670	970	440	780	1220	390	990	1380
1967/68	270	500	770	500	370	870	710	1260	1970
1968/69	190	300	490	250	310	560	220	330	550
1969/70	210	600	810	440	700	1140	470	880	1350
1970/71	130	920	1050	290	1200	1490	240	1550	1790
Mean (1965-71)	237	595	832	388	652	1040	415	947	1362
Long Term*	234	554	788	272	681	953	398	945	1343

* Recording stations 7-8 km from experimental sites.

Species and Design

Three grass species were sown at each site, green panic (*Panicum maximum* var. *trichoglume* cv. Petrie), setaria (*Setaria anceps* cv. Nandi) and *Panicum coloratum* (CPI 14375, Kabulabula type), with Rhodes grass (*Chloris gayana* cv. Pioneer) as a fourth grass at Nanango. Each grass was sown with each of the legume species, or in some cases a combination of two of the legume species, listed in Table 3. Each legume/grass mixture was sown separately in plots of 0.11 ha in a randomised block design with two replicates, plots being separately fenced and water provided for cattle.

TABLE 3

Legume species sown (1965/67) *and their final density* (1970/71)

Species	Plants m^{-2} 1·0 beasts/ha	2·0 beasts/ha
(*a*) *Nanango*		
1. Lucerne (*Medicago sativa* cv. Hunter River) and	2·30	—
white clover (*Trifolium repens* cv. Louisiana and cv. Ladino)	n.m.	—
2. Lucerne and	2·42	—
Siratro (*Macroptilium atropurpureum*)	0·29	—
3. Siratro	3·90	—
4. Greenleaf desmodium (*Desmodium intortum*)	0·00	—
5. Lotononis (*Lotononis bainesii* cv. Miles)	6·93	—
(*b*) *Beaudesert*		
1. Lucerne and	10·32	7·53
white clover	n.m.	n.m.
2. Siratro	2·16	1·44
3. Greenleaf desmodium (†)	0·04	0·03
4. Silverleaf desmodium (*Desmodium uncinatum*)	0·19	0·12
5. Tinaroo glycine (*Glycine wightii* cv. Tinaroo)	1·63	1·10
(*c*) *Conondale*		
1 Lucerne	1·30	1·14
and white clover	n.m.	n.m.
2. Siratro and	1·37	1·00
Silverleaf desmodium	2·51	0·92
3. Greenleaf desmodium	1·23	0·64
4. Lotononis	1·31	0·76
5. Cooper glycine (*Glycine wightii* cv. Cooper)	2·99	1·94

n.m. not measured

† This treatment initially sown to lotononis in 1965 with apparent complete failure; resown with Greenleaf desmodium in 1966. However, in isolated sites surviving lotononis plants were persistent and productive.

Some plots were sown in the 1965/66 summer but due to both poor initial establishment and limiting seed supplies in the first season the establishment phase was not completed until the 1966/67 summer.

Management

Plots were grazed by one adult animal nine times each year commencing in November, 1967. The intervals between grazing ranged from five weeks (summer) to eight weeks (late winter/early spring). At Nanango there was one stocking rate, approximately equivalent to 1 beast ha^{-1} (low stocking), and each grazing was for four days. At Beaudesert and Conondale, there were two stocking rates equivalent to 1 beast ha^{-1} (low stocking) and 2 beasts ha^{-1} (high stocking). These were achieved by dividing main plots into subplots of 0.073 and 0.037 ha. Each subplot (Beaudesert and Conondale) was grazed with one animal for three days.

After three years of experimental grazing, the same stocking rate (1 beast ha^{-1}) was applied to plots previously under either low or high stocking at Beaudesert and Conondale. This was achieved by reducing grazing frequency and grazing with two animals on the former light stocked subplot and one animal on the former heavy stocked subplot. Thus the final 1970/71 measurements reflected the residual effect of the two stocking rates over three years, but were not influenced by different stocking rates in that season.

Measurements

Presentation herbage yields and botanical composition were measured annually in mid-summer prior to a grazing cycle. This timing would not give maximum yields of tropical legumes but it did allow reasonable expression of yield potential of both tropical legumes and lucerne. Additional samples were taken in the spring of 1970 at Conondale to measure the performance of white clover at this time of the year. Yields were measured by six scythette cuts (Hedrick and Hitchcock 1953) each of 0.9 m^2 per plot. Herbage was cut 5 cm above ground level. In the 1968/69 season, the cut material was hand-sorted into weed and sown species, but in subsequent samplings, composition was estimated by the dry-weight-rank technique (Mannetje and Haydock 1963) using 60 quadrats each of 4.0 dm^2 per plot. Inert material was classified as a separate component and yields of green material estimated on a dry matter basis. In the final year of the experiment legume density (except for the stoloniferous white clover) was measured in 20 quadrats per plot each 0.9 m^2 in area.

The nitrogen percentage of the youngest fully expanded grass leaf was measured as an indication of nitrogen status (Henzell and Oxenham 1973*a*, 1973*b*) and hence of the contribution of the associated legume to the system (Table 4). Thirty leaves were sampled and bulked in each plot and analysed for nitrogen in a Technicon autoanalyser after a Kjeldahl digest.

RESULTS

Analyses of variance were calculated separately for each site and each year. Summarised results of each yield sampling at each site are shown in figures 1 to 3 which present mean yields of dried green material for each sown pasture component and weeds over all legume treatments and over all grass treatments.

Rainfall varied widely at each site during the experiment (Table 2). All sites experienced ground temperatures below 0°C (Table 1). The Nanango site was severely frosted each winter with negligible carry over of green material on tropical grasses and Siratro. Frosting was more variable at Beaudesert and Conondale, some years having almost complete kill of top growth and other years with only light leaf death.

Nanango

Rhodes grass was the most productive grass in the first three years ($P = 0.05$). In the fourth year rhodes grass and green panic were equally productive (Figure 1), significantly outyielding *Panicum coloratum* ($P = 0.01$). Setaria was a virtual failure following the dry 1968/69 summer.

Lucerne yields were highest in the first season, with yields in excess of 1,000 kg ha^{-1} but poor thereafter (Figure 1). Lucerne yields from the lucerne/Siratro mixture followed a similar pattern but were slightly lower than from lucerne alone. Violet root rot caused some death of lucerne and Siratro plants early in the experiment (Jones, Alcorn and Rees 1969) but was of less importance in later years. Lotononis yielded well with all grasses when there was good spring and early summer rain but its yield in February 1969 was very low following dry conditions during spring. Seedling regeneration was common during the cooler months. Siratro performance was similar with all grasses, being poor in the first three seasons but increasing in the fourth and wetter summer. Seedling regeneration occurred in every summer. When associated with setaria it produced its highest yield in the final season—1100 kg ha^{-1}. Greenleaf failed after producing only low yields in the first season. White clover did not persist except in damp situations.

TABLE 4

Nitrogen percentage of youngest fully expanded leaf.

Mean of grasses grown with:	Nanango			Beaudesert			Conondale		
	December 1968	January 1970	December 1972	December 1968	November 1969	December 1970	April 1968	December 1968	April 1970
Lucerne	3·39	1·57	1·05						
Lucerne/Siratro	2·69	1·53	1·10						
Lucerne/white clover				2·57	2·31	1·71	1·78	2·14	1·89
Siratro	2·29	1·41	1·35	2·20	2·19	1·50			
Siratro/Silverleaf							1·91	2·07	1·96
Miles lotononis	2·45	1·61	1·26				1·81	1·90	1·92
Greenleaf desmodium	2·25	1·51	0·97	2·11	2·11	1·46	2·16	2·29	1·78
Silverleaf desmodium				2·19	2·17	1·44			
Cooper glycine							2·16	2·23	2·23
Tinaroo glycine				2·15	2·04	1·52			
L.S.D. P = 0·05	0·49	0·20	0·12	0·22	0·14	0·15	0·23	0·28	0·26
Mean over legume treatments									
Green panic	3·08	1·81	1·29	2·22	2·14	1·41	2·26	2·30	2·24
P. coloratum	2·64	1·54	1·11	2·09	2·07	1·41	1·99	2·34	1·99
Nandi setaria				2·43	2·30	1·74	1·64	1·73	1·65
Rhodes grass	2·12	1·23	1·03						
L.S.D. P = 0·05	0·38	0·16	0·09	0·17	0·11	0·11	0·18	0·22	0·20
Mean over stocking rates									
2·0 beasts/ha				2·28	2·21	1·56	1·98	2·16	2·04
1·0 beasts/ha				2·21	2·12	1·49	1·94	2·09	1·89
L.S.D. P = 0·05				n.s.	0·09	n.s.	n.s.	n.s.	0·07

L.S.D.—least significant difference
n.s.—not significant

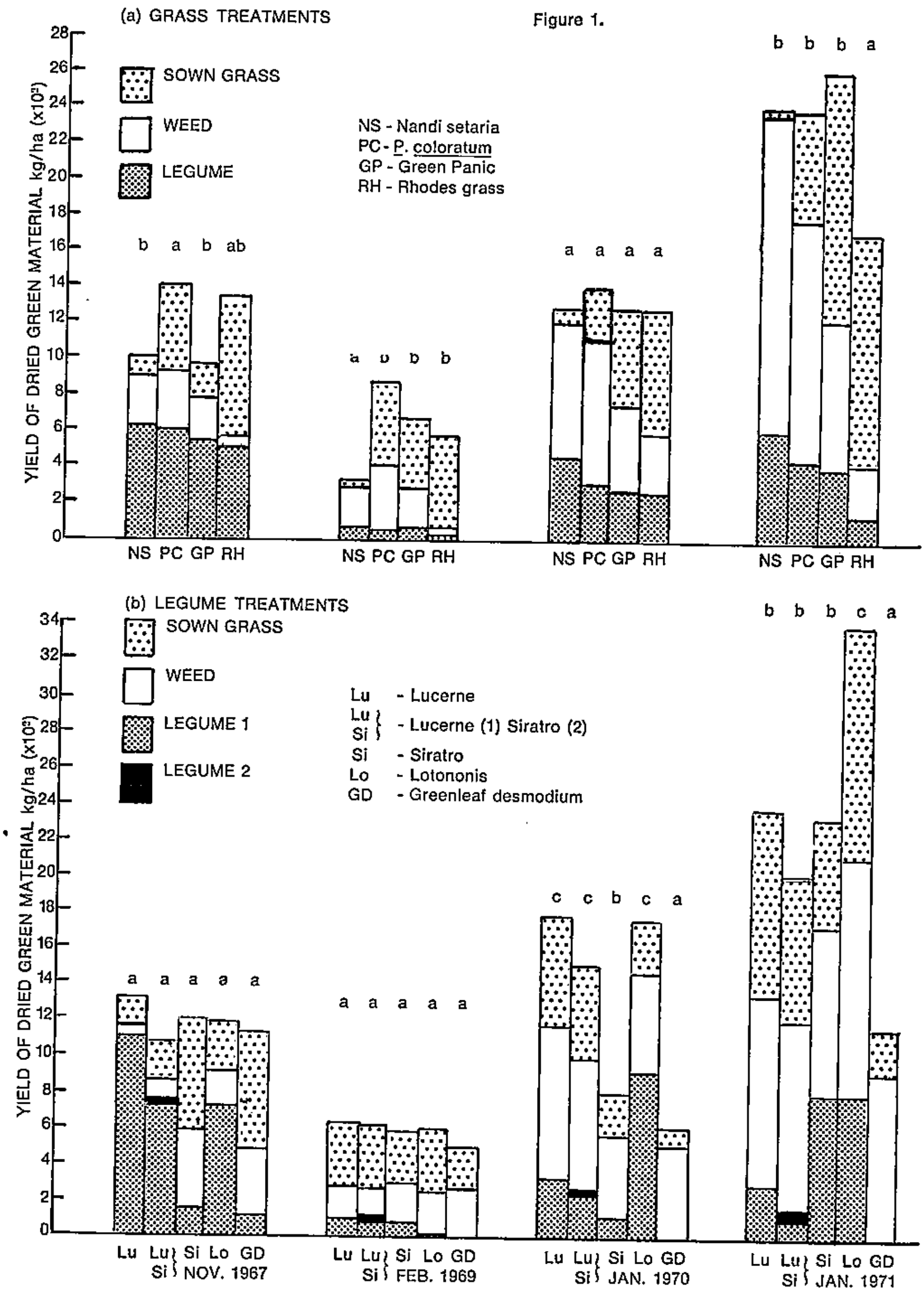

FIGURE 1

Nanango—(a) Grass treatments—presentation herbage yields averaged over all legume treatments and (b) Legume treatments—presentation herbage yields averaged over all grass treatments. Total yields for treatments headed with the same letters are not significantly different ($P > 0.05$).

Weed yields were always lowest on Rhodes grass plots (P = 0.01) and usually highest on setaria plots. By the end of the experiment Rhodes grass comprised 30% of total weed yield in plots not sown to Rhodes grass. The main weed species was *Eragrostis parviflora. Verbena* spp. and *Erigeron floribundus* were widespread, and *Lepidium hyssopifolium* and *Rhagodia nutans* were favoured on plots with good legume growth.

In the last two years total yields were influenced more by legume than grass species whereas in the first two years the reverse occurred (Figure 1). Greenleaf desmodium was absent and the total yields of desmodium treatments were lower (P = 0.01) than total yields of mixtures with lucerne, lucerne/Siratro and Siratro, which in turn had a significantly lower total yield than lotononis mixtures (P = 0.01). Rhodes grass mixtures had consistently the lowest legume yields (P = 0.05) while setaria mixtures, which were without setaria in later years, had the highest legume yields (Figure 1).

There were consistent differences between the nitrogen percentages of the youngest fully expanded grass leaves from different species; that of green panic was consistently the highest (P = 0.05, Table 4). Grasses associated with lucerne, which was the highest yielding legume, had a higher leaf nitrogen percentage initially. In the later stages of the experiment, lotononis and Siratro were the most productive legumes and leaf samples of associated grasses contained higher nitrogen contents (P = 0.05).

Beaudesert

Nandi setaria established satisfactorily with all legumes but other grasses produced sparser stands. Lotononis was sown initially but failed and Greenleaf desmodium was substituted for it in a re-sowing of the legumes. Subsequently lotononis reappeared and grew well on small areas of lighter textured soils. Establishment of all legumes was slow because of dry conditions, and dry matter yields at the first sampling (December 1967) were less than 200 kg ha^{-1}. Lucerne, Siratro and glycine were successful but poor establishment and survival of Greenleaf and Silverleaf desmodium under dry conditions resulted in sparse swards and low yields even in following wet seasons (Table 3, Figure 2).

Green panic yields increased relative to the other grasses and at the final sampling its dry matter production, averaged over all legumes, was in excess of 2400 kg ha^{-1} (Figure 2).

Setaria productivity was comparable to other grasses at the first sampling but declined during the dry seasons. In 1968/69 survival (22 percent) of setaria plants with lucerne was poorer (P = 0.05) than with other legumes. In subsequent years weed yields in setaria/lucerne plots were about twice those in other setaria plots. In wetter years re-establishment from seed increased the density but at the final sampling its yield, averaged over all legumes, was significantly less than green panic (P = 0.05). When associated with lucerne the yield of setaria was less than with other legumes (P = 0.05).

White clover made only a small contribution to the yield of the lucerne/clover mixture. Yields of lucerne increased at each sampling except the final one. Production from Siratro and Tinaroo glycine increased in the final wet season.

In each year, weed yield averaged over all legumes was lowest with green panic (P = 0.05). The important weeds were couch grass (*Cynodon dactylon*), Rhodes grass (*Chloris gayana*), *Verbena bonariensis* and *Sida* spp.

There were no consistent effects on total forage production due to a particular grass or legume but at the final sampling, in a wet season, mixtures with Siratro produced significantly higher yields of total forage (P = 0.05, Figure 2) and with a lower weed component than other legume treatments.

Heavier stocking reduced the yield of sown species, and total forage on offer (P = 0.05, Table 5) and also the density of sown legumes as measured at the final sampling (Table 3).

TABLE 5

Effect of stocking at 1·0 and 2·0 beasts/ha on the presentation yields of total herbage and pasture components at Beaudesert and Conondale (kg D.M/ha)

	Sown tropical legumes+		Lucerne		White Clover Sown		White Clover Unsown		Sown grass		Weed		Green Herbage	
Stocking rate—Beasts/ha	1·0	2·0	1·0	2·0	1·0	2·0	1·0	2·0	1·0	2·0	1·0	2·0	1·0	2·0
Beaudesert														
January 1969	217	87***	690	353***	0	0	0	0	730	480**	510	342***	1475	928***
December 1969	115	40***	865	566***	6	22ns	118	115ns	688	317***	698	548**	1748	1109***
February 1971†	732	498***	214	204ns	0	0	9	2ns	2260	1891*	1445	1800***	4338	4139ns
Conondale														
December 1969	585	399**	16	76ns	702	750ns	112	273***	1967	1364***	778	725ns	3513	2870**
November 1970	127	55*	101	36*	528	753**	268	518***	575	453***	302	269ns	1317	1338ns
January 1971†	863	455*	198	109*	429	453ns	174	312***	2341	2316ns	1064	1332	4395	4435ns

ns——not significant * P = 0·05; ** P = 0·01; *** P = 0·001. (Significance levels are for main stocking rate effect.)

†—common stocking rate in final summer when stocking rate differences are a residual effect of previous years.

+Siratro, Silverleaf desmodium, Greenleaf desmodium and Tinaroo glycine at Beaudesert and Siratro/Silverleaf desmodium, lotononis, Greenleaf desmodium and Cooper glycine at Conondale.

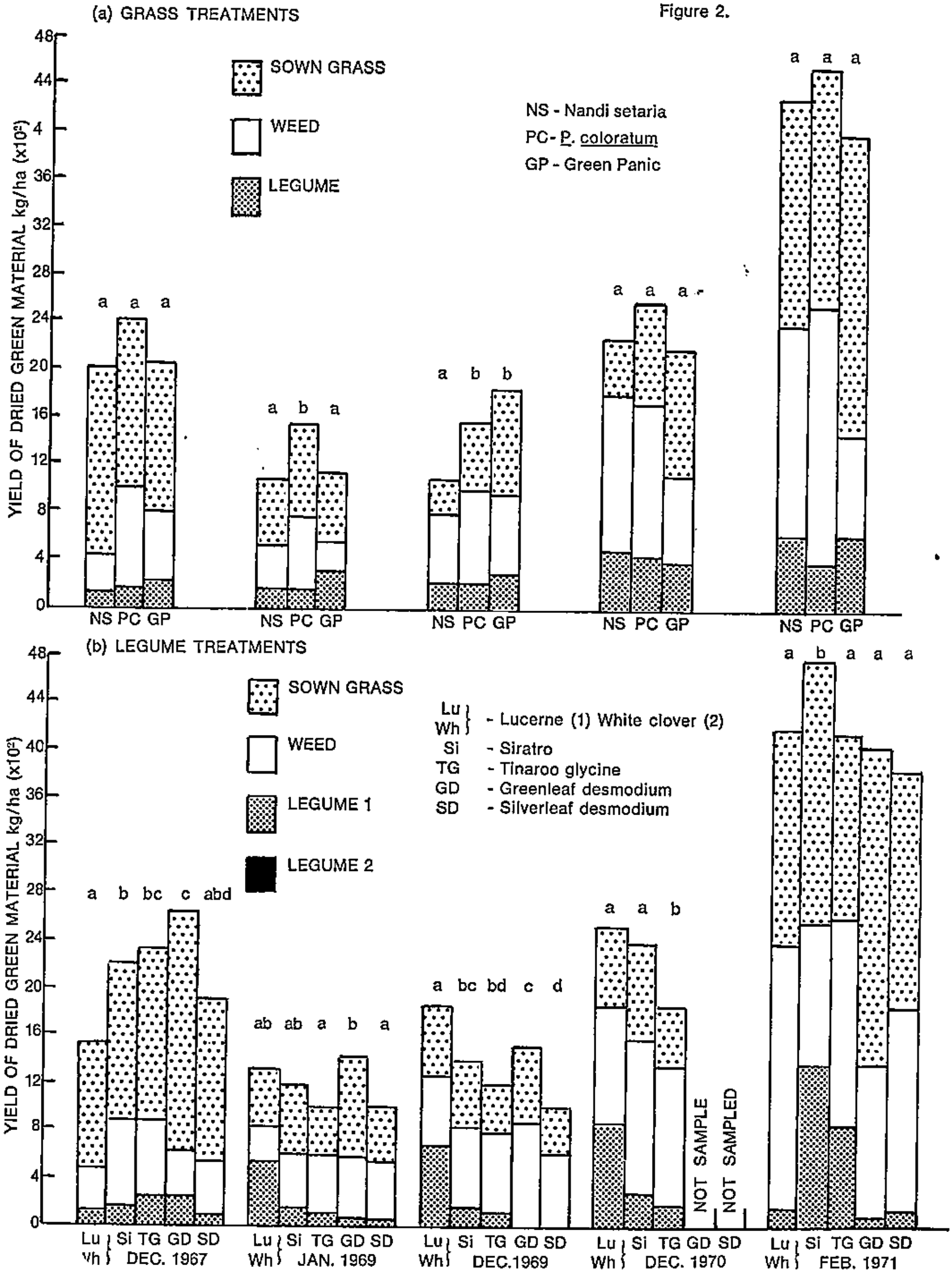

FIGURE 2

Beaudesert—(a) Grass treatments—presentation herbage yields averaged over all legume treatments and (b) Legume treatments—presentation herbage yields averaged over all grass treatments. Total yields for treatments headed with the same letters are not significantly different (P > 0.05).

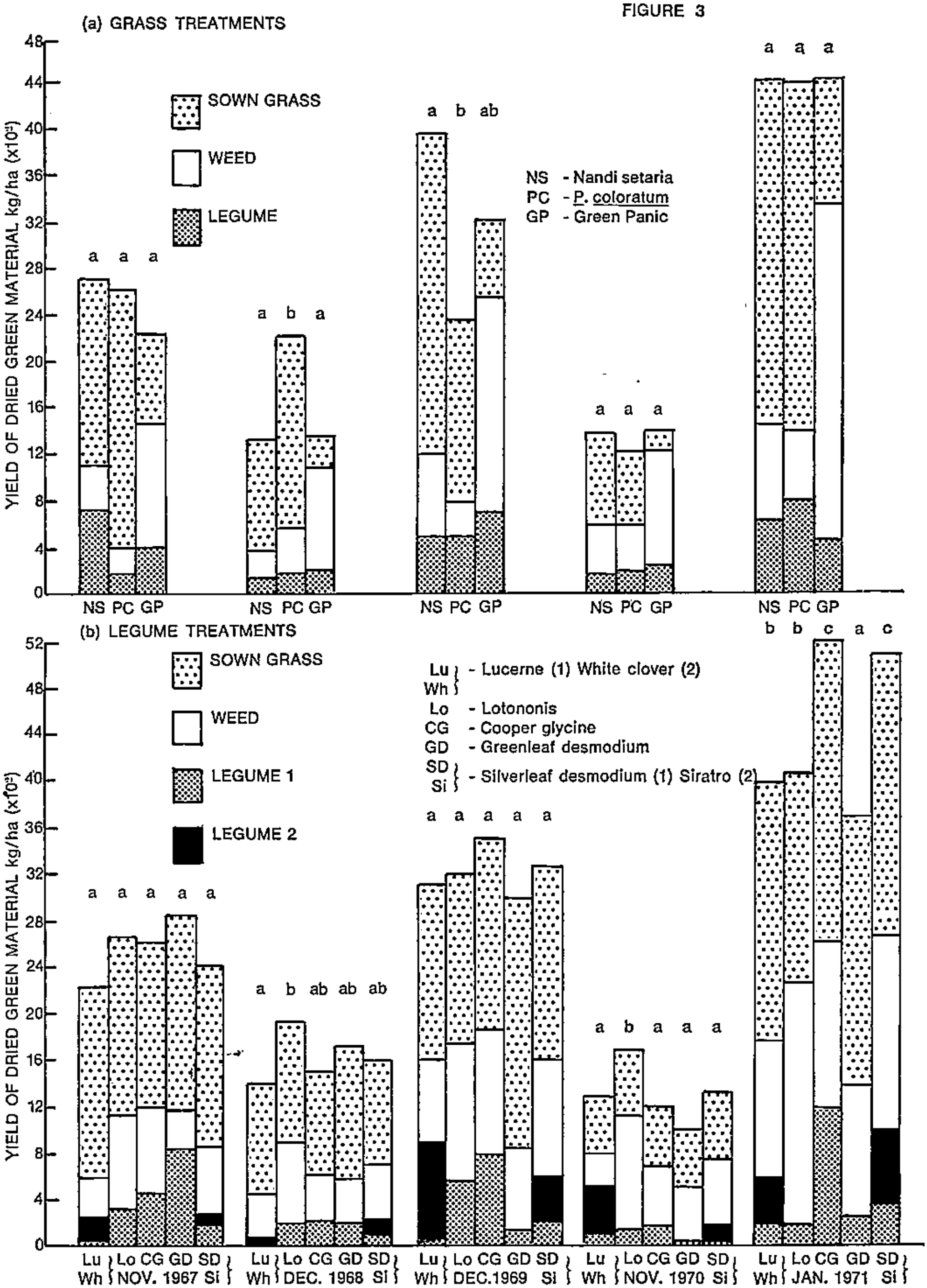

FIGURE 3

Conondale—(a) Grass treatments—presentation herbage yields averaged over all legume treatments and (b) Legume treatments—presentation herbage yields averaged over all grass treatments. Total yields for treatments headed with the same letters are not significantly different ($P > 0.05$).

The level of nitrogen in the youngest fully expanded leaves was highest in Nandi setaria (P = 0.05). There was more nitrogen in these leaves when lucerne was the associated legume (P = 0.05, Table 4).

Conondale

All grasses initially produced dense swards, and early growth was vigorous, particularly that of *P. coloratum*. Satisfactory stands of all legumes developed except for lucerne/white clover. White clover was observed on all treatments so that some of it on the lucerne/white clover plots was probably naturalized.

Green panic died in poorly drained areas during the wet 1967 winter. Consequently its yield was less than that of the other grasses. Setaria and *P. coloratum* were persistent and productive throughout (Figure 3).

Cooper glycine overall produced high legume yields, particularly in wet seasons. Under these conditions Silverleaf desmodium/siratro were also productive, Siratro being the more important at the end of the experiment. Greenleaf desmodium produced the highest yield at the first sampling but after the dry summer of 1968/69 and frosting it failed to regain density and vigour. Lucerne density was reduced markedly in the wet 1967 winter and although it declined only slowly thereafter, there were insufficient plants to produce high lucerne yields. White clover outyielded lucerne at each sampling (P = 0.05) but some of its production was presumably from naturalised strains.

Dry matter production from weeds remained relatively constant with time on setaria and *P. coloratum* treatments. It was higher with green panic after some of the grass died on wet areas and remained higher on green panic plots throughout the experiment (P = 0.01, Figure 3). There was usually more weed associated with lotononis than with other legumes, and this difference was significant at the final sampling (P = 0.01). The chief weeds were *Verbena bonariensis*, couch grass (*Cynodon dactylon*), carpet grass (*Axonopus affinis*), and on low lying areas, paspalum (*Paspalum dilatatum*).

Heavy stocking significantly reduced grass yields measured in December 1969 and November 1970 (P = 0.001). At the final sampling, after all treatments had been stocked at the low rate during the previous growth period, there was no significant reduction in grass yield due to previous heavy stocking (Table 5). With tropical legumes, yields at all samplings were reduced by heavy stocking (P = 0.05, Table 5) as was final density (Table 3). White clover yield on the other hand was increased by the heavier stocking (P = 0.001, Table 5).

Nitrogen percentages of grass leaf reflected the main trends in the quantity of legume on offer (Table 4). The highest grass leaf nitrogen levels were usually associated with glycine, which was consistently high yielding. Similarly Greenleaf desmodium was also associated with high grass leaf nitrogen levels before the drought in 1968/69. Lucerne/white clover was associated with high grass leaf nitrogen only after good white clover growth.

DISCUSSION

Both wet and dry seasons were experienced during the four years of the experiment, so that species were tested over a range of climatic conditions in each region. The persistence of the species, as well as their yielding ability was, therefore, taken into account in the rating of their performance.

Evaluation procedures

The botanical measurements, although not absolute measurements of productivity, were sufficient to document the important botanical changes as affected by site, species and stocking rate.

The best species at the two drier sites were those selected as best in small plot trials under common grazing on adjacent or similar areas (Jones and Rees 1972). The persistence and productivity of tropical legumes at Conondale in this experiment was better than recorded in adjacent small plot trials (Rees 1972*b*), but the same legumes and grasses were best in both trials.

Results suggest that legumes species can be evaluated with one standard tussock grass. Even the stoloniferous Rhodes grass at Nanango gave the same yield ranking of associated legume species as did two effective companion tussock grasses (green panic and *P. coloratum*) and an ineffective grass (Nandi setaria). At Nanango and Beaudesert the grasses that allowed the greatest legume bulk also allowed the greatest weed invasion. Whether a 'strong' or 'weak' grass is chosen for any situation could therefore depend not only on the species of legume and its grazing management requirements, but also on the type and aggressiveness of potential weeds.

Only very large changes in legume yield, which were readily detected by conventional yield sampling, affected the nitrogen percentage in the youngest fully expanded leaf of the companion grass. The lower leaf nitrogen percentages associated with the lower stocking rate were probably due to a greater dilution of nitrogen in the higher grass yield. At any one site there was almost always a consistent ranking of grasses in order of their leaf nitrogen percentages. However, this ranking differed between sites but was again inversely related to grass yields at each site.

Legumes

Of the legumes, lucerne and lotononis were successful at Nanango, but not at the wettest site. This suggests that lotononis has a place in areas drier than those suggested by Bryan (1961). The light-textured surface soil at the Nanango site is probably a requisite for success. Siratro was persistent and productive at all three sites except on the poorly drained areas at Conondale. It is a more effective legume under a wider range of conditions than species such as white clover, lotononis, lucerne and Desmodium which are more limited by climate and soil type.

Seedling regeneration of Siratro and lotononis was conspicuous at the two dryer sites. In an adjacent experiment at Nanango, Jones (1973) recorded an increase in Siratro density from 3 to 14 plants m^{-2} during two wet years. There was some seedling regeneration of white clover and this was probably responsible for the invasion of naturalised white clover at Conondale. No regeneration from lucerne seed was observed although at times considerable seed was set under the grazing management used. There was very little or no seed set on Desmodium species at any site due to frosting. This suggests that seedling regeneration may have an important role in maintaining Siratro, lotononis and white clover in grazed pastures, whereas lucerne and *Desmodium* spp. did not regenerate from seed to replace plants that died due to disease and waterlogging (lucerne) or dry conditions (*Desmodium* spp.).

Legume yield and density were reduced by the higher stocking rate at Beaudesert and Conondale with the important exception of white clover, as would be predicted from cutting experiments (Jones, 1974). At Conondale the yield of this legume was favoured by heavier stocking in plots where this species was invading. This higher yield persisted into the final sampling as a residual effect of the differential stocking rates of previous years.

Grasses

Nandi setaria was suited to conditions at Conondale, allowing satisfactory legume growth with little weed invasion, but was unsatisfactory at Nanango. Green panic on the other hand was much better at the two drier sites and less suited to Conondale, particularly on poorly drained areas. *Panicum coloratum* grew well at the two wetter sites but is a difficult species to manage as it runs to head rapidly following a spring growth flush.

Summary of findings

The species best suited to each site were as follows:

1. *Nanango* (annual rainfall 788 mm; mean during the experiment, 832 mm).
   Grasses—Green panic and Rhodes grass.

Legumes—Lotononis and Siratro, with lucerne until the stand was reduced by root diseases.

2. *Beaudesert* (annual rainfall 953 mm; mean during experiment, 1040 mm).
   Grasses—Green panic and *P. coloratum*; Nandi setaria only marginal.
   Legumes—Lucerne, Siratro and Tinaroo glycine.
3. *Conondale* (annual rainfall 1343 mm; mean during experiment, 1362 mm).
   Grasses—Nandi setaria, *P. coloratum* and green panic (except on poorly drained areas).
   Legumes—Cooper glycine and Siratro (except on poorly drained areas), white clover and Silverleaf desmodium.

Green panic and Siratro were the most widely adapted species and were productive at all sites, but at the wettest site both were adversely affected where drainage was impeded. At Beaudesert production from Nandi setaria was high initially but the dry summer of 1968/69 killed many plants, particularly where this grass was associated with lucerne. The density subsequently increased from self-sown seed and in the final wet season production was high. The mortality during the dry season was probably related to soil conditions, accentuated by competition from lucerne.

A high stocking rate (2 beasts ha^{-1}) reduced the yield of both grasses and legumes, particularly the latter, except for white clover at the wettest site. Naturalized white clover was prominent at the wettest site, particularly in the heavier stocked pastures.

ACKNOWLEDGEMENTS

We are indebted to Mr. A. P. Beatty, Mr. R. Harrison and Mr. J. Ahern, O.B.E., on whose properties the experiments were conducted, Mr. J. Kerr for assistance with statistical analysis, Mr. R. Williams, Mr. G. Bunch and Mr. M. Graydon for technical assistance, and to Mr. M. P. Robins and Mr. A. D. Johnson for chemical analyses. The financial support of the Australian Dairy Produce Board is gratefully acknowledged.

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(Accepted for publication May 26, 1976)