WINTER AND SUMMER GROWTH OF PASTURE SPECIES IN A HIGH RAINFALL AREA OF SOUTH EASTERN QUEENSLAND

M. C. REES*

ABSTRACT

The persistence and seasonal distribution of growth of 134 tropical and temperate grasses and legumes were studied without irrigation over four years in a high rainfall area of south eastern Queensland. Grasses were heavily fertilized with nitrogen in addition to the molybdenised superphosphate which was applied to all species tested.

Most tropical grasses were capable of high summer dry matter production, but Setaria *spp. and* Panicum coloratum *(Kabulabula) appeared most suitable, combining persistence with production.*

Setaria sphacelata *CPI 33452 from which Narok setaria was selected, persisted better and gave higher winter dry matter yields than Nandi and Kazungula setaria and most temperate grasses. Nandi setaria survived only when no nitrogen was applied in winter. Following winter rains, temperate grasses outyielded setaria and are probably superior for winter production where irrigation is available. Phalaris hybrid was the only temperate grass to persist for four years.*

Silverleaf desmodium (Desmodium uncinatum) *and Cooper glycine* (Glycine wightii) *were the most persistent of the 31 tropical legumes tested and silverleaf desmodium and greenleaf desmodium* (D. intortum) *were the highest yielding.*

Of fifty three temperate legumes tested Ladino and Louisiana white clovers (Trifolium repens) *were the best. Annual legumes failed to re-establish in the second season due to competition from existing naturalised white clover.*

INTRODUCTION

In south eastern Queensland, tropical pastures exhibit marked seasonal growth patterns with low yields in winter (Henzell and Stirk 1963). In areas with high rainfall, attempts are made to reduce the fluctuation in feed supply by sowing oats (*Avena sativa*), ryegrass (*Lolium perenne*), and white clover (*Trifolium repens*) (Ostrowski 1966, Anon. 1970). However, even with irrigation, perennial temperate species often last only two or three years. Tropical pasture species capable of growing in the winter may overcome this problem. With this in view, a range of temperate and tropical grass and legume species was screened for summer and winter production in a high rainfall area of south eastern Queensland.

MATERIALS AND METHODS

The trials were conducted at Conondale in the Mary River valley in south eastern Queensland (26°48'S., 152°45'E., altitude 750 ft). The prairie like soil was derived from granodiorite and was deficient in molybdenum, phosphorus and lime (Roe—unpublished data). The experimental area was cleared of trees in the 1920's and was growing blady grass (*Imperata cylindrica*) and mat grass (*Axonopus affinis*) when first ploughed in September 1965. Weeds were then controlled by several discings prior to sowing the three experiments in 1966.

---

*Division of Tropical Pastures, C.S.I.R.O., Cunningham Laboratory, St. Lucia, Queensland 4067.

Mean annual rainfall between 1933 and 1964 was 49 in., 35 in., falling in the summer months (October to March inclusive). Rainfall in the five summers 1965/66 to 1969/70, was 26, 39, 50, 13 and 35 in. and in the four winters 1966 to 1969 was 15, 28, 9 and 19 in. Monthly rainfall for 1967, 1968 and 1969 is shown in Figure 1.

All species were grown in pure stands and are listed in Appendix 1.

Experiments 1 and 3, comprising two replicates, were sown in February 1966. Temperate species (experiment 2) were sown in May 1966. All plots measured 13 ft x 26 ft. Seed was hand broadcast and harrowed into moist soil. Sowing rates were adjusted on the basis of laboratory germination tests so that the recommended rates of viable seed were used for each species. Legume seed was inoculated with the appropriate strain of *Rhizobium* and lime pelleted.

An initial fertilizer dressing of 350 lb pulverised limestone and 590 lb molybdenised superphosphate per acre was disced into the soil prior to planting. Maintenance applications of 220 lb superphosphate per acre were applied annually in August. A dressing of 50 lb per acre of nitrogen (calcium ammonium nitrate) was applied to all grasses in experiments 1 and 2 after each summer and winter sampling and a dressing of 100 lb nitrogen per acre to tropical grasses in experiment 3 after each summer sampling. The total dressing in each case was 500 lb nitrogen per acre per year.

Dry matter yields of grasses and perennial temperate legumes were assessed on 5-6 week regrowths. Except for the temperate annual species, which were sampled once, at the end of the growing period, experiments 1 and 2 were sampled, grazed and fertilized together throughout the year. The tropical grasses of experiment 3 were sampled and fertilized during summer only; the first harvest was in October each year.

Two herbage samples, each from 10 sq ft, were cut per plot and dried at 80°C before weighing. Tropical species were sampled to a stubble height of 3 in. and temperate species to 2 in. After sampling, the plots were grazed by cattle to remove the bulk herbage, and any ungrazed material mown to sampling height.

RESULTS

Experiment 1. Cold tolerant introductions of Setaria sphacelata.

Table 1 shows the winter and summer dry matter yields of *S. sphacelata* cv. Kazungula, Nandi and CPI 33452 and the growth rates of these cultivars for periods of maximum growth in summer and also minimum growth in winter. The more productive temperate grasses in the adjacent experiment 2, sampled at the same times and given the same grazing and fertilizer treatments as experiment 1, are included in this table for comparison.

The winter dry matter production from four frost tolerant setaria introductions CPI 33452, 33453, 32930 and 32848 were not significantly different but were all higher than that of kazungula ($P < 0.01$). The most frost tolerant setaria was CPI 32930. The highest winter yielding setaria, CPI 33452, had a significantly greater ($P < 0.01$) mean growth rate during the April to September period (29 lb dry matter per acre per day) than Kazungula (19 lb). Nandi and CPI 32714 setaria gave less winter yield than Kazungula and died after the second winter.

The winter growth rates of *Setaria* spp. and *Phalaris* spp. were less affected by dry weather than were the ryegrasses which responded immediately to winter rainfall. However the growth rate of Kangaroo valley ryegrass exceeded that of CPI 33452 on two occasions only in June-July 1967 and in August 1968.

TABLE 1

Winter and summer dry matter yields and the growth rates during periods of maximum setaria growth in summer and minimum setaria growth in winter for cultivars of S. sphacelata *and the best temperate grasses*

Species	Winter Production (April-September Inclusive) Lb Dry Matter/Ac.				Summer Production (October-March Inclusive) Lb Dry Matter/Ac.			Growth Rates (lb D.M./acre/day)					
								Period of Minimum Setaria Winter Growth			Period of Maximum Setaria Summer Growth		
	1966	1967	1968	1969	(40 days) 1966/67	1967/68	1968/69	1967	1968	1969	1966/67	1967/68	1968/69
S. sphacelata cv. Kazungula	N.S.	5090	1600	2910	3740	13880	3650	6	7	18	94	132	47
S. sphacelata cv. Nandi	N.S.	4310	2360	NIL	3230	8310	N	4	0	0	81	100	N
S. sphacelata CPI 33452	N.S.	6130	3320	4880	3510	11690	4630	10	21	35	88	101	59
Phalaris hybrid	6950	8550	2280	3290	1730	5687	*	16	14	22	43	45	*
Priebe prairie grass	6040	5730	3820	710	*	2530	NIL	20	30	NIL	NIL	5	NIL
Tall fescue (Kentucky 31)	5380	7250	2740	*	2980	5380	*	13	10	NIL	75	18	*
Kangaroo Valley ryegrass	6140	5510	4390	N	*	930	N	23	51	N	N	5	N
Italian ryegrass	5010	5980	4270	N	*	820	N	18	44	N	N	5	N

* = negligible growth not sampled
N = Not present
NS = Not sampled

In the summer, compared to the other accessions, Nandi and CPI 32714 had low yields in the 1967/68 summer owing to death of plants after heavy frosting in August 1967. In summers with adequate rainfall (1967/68 and 1968/69), Kazungula had higher peak growth rates than CPI 33452 and reached 130 lb dry matter per acre per day in January 1968 (Fig. 1). All *Setaria* spp. responded immediately to rainfall in summer but not in winter. The death of some plants of Kazungula occurred in the springs of 1967, 1968 and 1969.

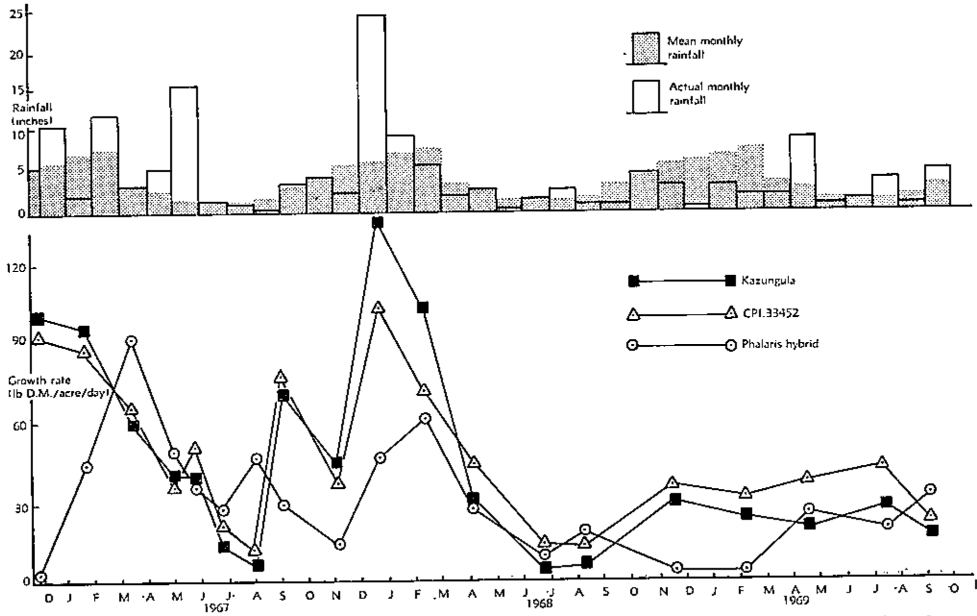

Figure 1. Monthly rainfall and the growth rates for 5-6 week regrowths of *Setaria sphacelata* cv. Kazungula and CPI 33452 and *Phalaris* hybrid.

The leaf spotting fungal parasite *Pericularia trisa* was the only disease recorded and occurred in March 1969 on the regrowth of all setaria introductions and cultivars present at this time. Kazungula and CPI 33452 showed 20-25 lesions per leaf. Other introductions appeared less susceptible with approximately 5 lesions per leaf. The disease was also present at this time on cultivars of *S. sphacelata* in the tropical species trial where Nandi appeared more susceptible than Kazungula or CPI 33452.

Kazungula CPI 33452 and CPI 33453 remained weed free until the experiment terminated four years after sowing, but some plants of CPI 32930 and CPI 32848 died in dry conditions of 1968/69, and *Paspalum dilatatum* later invaded open swards.

Cattle preferred CPI 33452 and CPI 32930. These introductions produced less stem material in the five weeks regrowth than Nandi and Kazungula.

Experiment 2. Temperate species

Temperate grasses

All grasses sown in Experiment 2 produced dense weed free swards except *Phalaris tuberosa* GB 81.

Phalaris hybrid (*P. tuberosa* x *P. arundinacea*), Priebe prairie grass (*Bromus unioloides*), tall fescue (*Fetusca arundinacea* cv. Demeter and cv. Kentucky 31), Kangaroo valley ryegrass (*L. perenne*) and Italian ryegrass (*L. multiflorum*) produced the highest winter yields, with *Phalaris* spp. and *Festuca* spp. being the most reliable under fluctuating soil moisture conditions (Table 1).

All cocksfoot (*Dactylis glomerata*) cultivars produced low yields in the first winter and died in the first summer (1966/67). The annual Wimmera ryegrass (*L. rigidum*) regenerated poorly in the second winter (1967) and failed to re-establish in later years. Kangaroo Valley ryegrass, tall fescue (cv. Demeter and cv. Kentucky), Phalaris hybrid allopolyploid and *P. arundinacea* persisted for only three winters but phalaris hybrid was a dense weed free sward when the experiment was terminated after five years. Prairie grass (*Bromus unioloides*) re-established successfully in the fourth winter from seed produced in previous years.

All rye grasses and prairie grass were eaten by cattle in preference to tall fescue and *Phalaris* spp.

Temperate legumes

Most of the 53 legumes of Experiment 2 were established successfully and produced weed free swards. However *Medicago scutellata, T. usambarense* and *Vicia atropurpurea* failed due to low sward density and *Lotus corniculatus, L. edulus, L. maroccanus, M. lupulina* and *T. fragiferum* failed due to poor vigour.

White clover cultivars were the most persistent legumes, and produced the highest dry matter yields. None were superior to Ladino and Louisiana in combining establishment vigour with high summer and winter dry matter production and persistence (Table 2).

TABLE 2

Seasonal dry matter yields (lb dry matter per acre) for the more productive temperate legumes

Species	Winter* 1966	Summer† 1966/67	Winter* 1967	Spring 1967
M. sativa cv. Canberra Hay	1870	3820	N	N
Hunter River	1050	5120	N	N
Rhizoma	420	5200	N	N
T. repens—Louisiana	1920	3030	2740	530
Ladino	1520	3440	2060	800
CPI 19434	1470	1390	2890	T
15648	1390	3810	2160	950
13818	900	1580	2680	T
19433	640	3600	2610	500
T. pratense N.Z. Giant	1550	5430	920	N
T. hirtum (Sirint)	2950	N	N	N
M. tribuloides (173)	2680	N	N	N
M. littoralis (Harbinger)	2170	N	N	N
T. spumosum	2080	N	N	N
T. formosum	1980	N	N	N
V. dasycarpa	1820	N	N	N
T. alexandrinum (Berseem)	1730	N	N	N

*Winter = April-September inclusive
†Summer = October-March inclusive
N = Not present
T = trace

The lucerne cultivars (*M. sativa*) were as productive as white clover in the first winter and produced more dry matter in the 1966/67 summer. They continued to yield well until March 1967 when most plants died suddenly due to waterlogging. There were no obvious differences between cultivars in their tolerance to these conditions.

No annual species re-established from seed in the second winter, although all flowered and set seed in the first winter. Some seedlings of Barrel Medic 173 (*M. truncatula*) and *V. dasycarpa* emerged but were smothered by the dense and prolific growth of naturalised white clover.

Experiment 3. Tropical species

Tropical grasses

Yields during establishment and the 5-6 weeks regrowths in autumn and spring of the most productive grasses are shown in Table 3. *S. splendida* and Nandi and Kazungula setaria established most rapidly, prevented weed invasion and maintained a high level of dry matter production over four years of testing. *Panicum coloratum* CPI 16796 (Kabulabula) produced more dry matter than *Setaria* spp. after the first year, particularly in dry weather. These grasses maintained the original sward density five years after sowing. Green panic (*P. maximum* cv. Petrie) showed poor vigour in the springs of 1966 and 1967. Sward density was reduced after a very wet season in the first half of 1967. Scrobic (*P. commersonii*) showed a high growth rate for a short period late each summer. It was the least frost tolerant of the grasses tested.

TABLE 3

Seasonal dry matter yields over 5-6 week regrowths for the more productive tropical grasses (lb dry matter per acre)

	Establishment	Spring 1966	Late Summer	Winter 1967	Spring 1967	Autumn 1968	Spring 1969
Date of Sampling	22/4/66	8/11/66	9/3/67	6/7/67	10/11/67	20/5/68	21/10/69
S. sphacelata cv. Kazungula	4670	2340	3355	1080	1170	*	960
S. sphacelata cv. Nandi	3210	4135	3645	1080	1220	450	1050
S. splendida	3960	1800	3950	1480	1160	520	720
P. coloratum CPI 16796	3570	1475	4390	1790	3035	*	1710
P. coloratum CPI 14375	1430	750	3190	990	2160	1090	780
Scrobic	2630	*	3750	Nil	Nil	740	Nil
Green Panic	2430	*	3860	1560	*	*	*
L.S.D. (5%)	1300	1155	1501	956	641	1386	1542

* = negligible yield not sampled

P. coloratum CPI 17078, *P. maximum* cv. Gatton, *P. maximum* CPI 28275, CPI 16062 and CPI 16793 failed to establish.

Tropical legumes

All 31 tropical legume species sown in Experiment 3 as pure swards in February 1966 established successfully. They suffered strong competition from weed species, chiefly *P. dilatatum*, *Verbena bonariensis*, *Axonopus affinis* and *Sida* spp. By November 1966, *Alysicarpus vaginalis*, *Cassia rotundifolia*, *Clitoria ternatea*, *Phaseolus lathyroides*, *Dolichos biflorus*, *D. lab lab* and *D. baumanii* had disappeared. Two years after sowing in the summer of 1967/68, the only species persisting were *T. semipilosum*, *greenleaf desmodium* (*Desmodium intortum*), silverleaf desmodium (*D. uncinatum*), most of the 12 cultivars of *Glycine wightii*, a few plants of siratro (*P. atropurpureus*) and *Lotononis bainesii*.

The most vigorous and persistent legumes were silverleaf desmodium, Cooper glycine (*G. wightii*) and greenleaf desmodium. However some plants of greenleaf desmodium died during the dry conditions in 1968/69.

L. bainesii competed successfully with mat grass (A. affinis) until March 1967. Most lotononis plants died at this time and no re-establishment occurred.

DISCUSSION

In this study the best pasture species were setaria, white clover and desmodium. Green panic and buffel grasses failed to persist. This result was obtained in a high rainfall area and is different from those reported by Jones and Rees (1972) for a 30 in. rainfall area where the best species were green panic, buffel grass, lucerne and siratro. Cooper glycine and Kabulabula *Panicum coloratum* were suitable for both rainfall areas.

Experiments 1 and 3 demonstrate that there are many tropical grasses capable of producing high summer yields in high rainfall areas of south eastern Queensland. Although differences in growth rate and total yields were obtained between different setaria cultivars in the summer (table 1 and figure 1), these differences are probably of little practical significance since the main factor limiting milk production in this area appears to be the quantity of feed available in the winter (Rees, Minson and Kerr—unpublished data).

The setarias that were more frost tolerant grew better during the winter than Kazungula, thus providing more green standover feed and young winter regrowth. Although this result is different to the results of Hacker (1972), who showed that the dry matter yields of frost tolerant setaria in winter were less than those of Kazungula, it contributed to the release of Narok setaria which was derived from CPI 33452 after selection for increased frost tolerance and winter growth (Hacker 1969). The results obtained here with CPI 33452 which was the highest yielding cultivar in winter should be applicable to Narok.

During the winter, ryegrass grew rapidly following rain whereas the response with *Phalaris* spp. and setaria was poor. Where irrigation is available, ryegrass would probably be the highest yielding winter species but has the disadvantages of poor persistence. In the absence of irrigation, *Phalaris* spp. and setaria had similar growth with phalaris appearing better in the autumn and spring but with poor summer growth compared with setaria (Fig. 1).

The persistence of some cultivars of setaria appeared to be related to the application of fertilizer nitrogen in the winter. Nandi and Kazungula setaria which received fertilizer nitrogen only in the summer persisted well (Experiment 3), but where nitrogen was applied during the winter, Nandi and CPI 32714 died after two years, and Kazungula was also adversely affected. This detrimental effect was possibly caused by nitrogen stimulating growth at the expense of root reserves which were not adequately replaced in the frost sensitive plants.

Recent evidence suggests that pelleting with rock phosphate dust would have created a more favourable environment for the alkali producing rhizobia around the seeds of some of these species than lime which was used (Norris 1967, 1971), but since the seeds were planted two days after lime pelleting and all species appeared effectively nodulated after emergence, it is unlikely that lime pelleting of these species affected their evaluation in this experiment. The poor performance of tropical legumes may be attributed to competition from *P. dilatatum* and mat grass and to frequent light grazings. Under these conditions no species except those being sown commercially were successful. The most successful temperate legumes were white clovers and the dominance of a naturalised strain of this legume in the pasture possibly prevented the annual legumes, barrel medic 173 and *Vicia dasy-*

carpa from regenerating. Thus the existence of this naturalised white clover prevented a fair assessment of other temperate legumes which might in other circumstances have proved suitable.

This study has shown that some tropical pasture species are capable of growing not only in summer but also in the winter and these should provide a useful addition to winter feed supplies especially where irrigation is not available.

ACKNOWLEDGEMENTS

I wish to thank Mr. J. Ahern, O.B.E., for use of land, equipment and cattle, Mr. R. Roe of the C.S.I.R.O., Division of Tropical Pastures for helpful advice in planning and running the experiments, and Messrs. M. Graydon and K. Scorey for technical assistance. Finally I thank the Australian Dairy Produce Board for financing the project.

REFERENCES

ANON (1970)—"Sown Pastures and Seed Production in Queensland." (Queensland Department of Primary Industries: Brisbane.)

HACKER, J. B. (1969)—Division of Tropical Pastures. C.S.I.R.O. Annual Report 1969-70. pp. 74-5.

HACKER, J. B. (1972)—Seasonal yield distribution in setaria. *Australian Journal of Experimental Agriculture and Animal Husbandry*. In press.

HENZELL, E. F., and STIRK, G. B. (1963)—Effects of nitrogen deficiency and soil moisture stress on growth of pasture grasses at Samford south east Queensland. 1. Results of field experiments. *Australian Journal of Experimental Agriculture and Animal Husbandry* **3**: 300-6.

JONES, R. J. (1963)—Genus *Setaria*—East African collecting expedition, May 11th to August 17th, 1963. *Plant Introduction Review* **1**: 6a-9a.

JONES, R. M., and REES, M. C. (1972)—Persistence and productivity of pasture species at three localities in the thirty inch rainfall zone of south eastern Queensland. *Tropical Grasslands* **6**. (In press.)

NEAL-SMITH, C., KAWANABE, S., and BATH, D. (1965)—*Setaria sphacelata*—Autumn—winter performance of East African high altitude ecotypes in the Berry (Lat. 34° 48'S) region of New South Wales. *Plant Introduction Review* **2**: 48-52.

NORRIS, D. O. (1967)—The intelligent use of inoculants and lime pelleting for tropical legumes. *Tropical Grasslands* **1**: 107-21.

NORRIS, D. O. (1971)—Seed pelleting to improve nodulation of tropical and subtropical legumes. 2. The variable response to lime and rock phosphate pelleting of eight legumes in the field. *Australian Journal of Experimental Agriculture and Animal Husbandry* **11**: 282-9.

OSTROWSKI, H. (1966)—Tropical pastures for the Brisbane district. *Queensland Agricultural Journal* **92**: 106-16.

[Accepted for publication October 29, 1971]

APPENDIX 1

Species sown in Experiments

Experiment 1. Cold tolerant introductions of *S. sphacelata*

S. sphacelata cv. Kazungula
cv. Nandi
CPI 33452
CPI 33453
CPI 32930
CPI 32848
CPI 32714

Experiment 2 Temperate species

(a) Grasses

Dactylis glomerata (Brignoles, Currie, Grasslands, CPI 23717, S143, G.L. 31, G.L. 32, G.L. 33, G.L. 34 and G.L. 35) *Bromus unioloides* (Priebe).
Ehrharta calycina, Festuca arundinacea (Demeter, Kentucky, CPI 10339).
Lolium rigidum (wimmera), *L. multiflorum* (Italian), *L. perenne* (Kangaroo, Valley and Victorian). Long rotation ryegrass CPI 31999, short rotation H1 ryegrass, *Phalaris tuberosa* (GB 81 and Commercial) *P. arundinacea,* phalaris hybrid (*P. tuberosa* x *P. arundinacea*), phalaris hybrid allopolyploid.

(b) Legumes

Medicago sativa (Rhizoma, Dry area, African, Creeping glebe, Du Puits, Barker, Hairy Peruvian, Hunter River, A.Y. Giant upright, Canberra hay).
M. truncatula (Barrel 173), *M. littorales* (Harbinger), *M. lupulina, M. soleirolii, M. scutellata, Lotus maroccanus, L. edulus, L. corniculatus* (Viking). *Trifolium semipilosum, T. subterraneum* (Bacchus Marsh), *T. usambarense* (CPI 25377), *T. alexandrinum, T. incarnatum, T. cherleri* (CPI 14549, Yamina and Beenong), *T. hirtum* (Kondinin, Sirint, Hykon and 1359A), *T. fragiferum* (Palestine), *T. pratense* (N.Z. Giant and Montgomery), *T. repens* (Ladino, Louisiana, CPI 15648, 19433, 13818, 19434). *T. formosum* (CPI 14936), *T. parviflorum, T. xerocephalum* (CPI 14946), *T. spumosum, T. desvauxii, T. globosum* (S17), *T. clypeatum* (CPI 14925), *T. nigrescens* (CPI 29116), *T. velivolum* (CPI 14934), *T. stellatum* (CPI 19929), *T. pilulare, Hosachia subpinnata.*

Experiment 3 Tropical Species

(a) Grasses

Cenchrus ciliaris (Molopo, Biloela, Nunbank, Tarewinnabar).
Digitaria macroglossa (CPI 16267).
Panicum maximum (CQ 583, CPI 16062, 28275, 16793, Gatton, Petrie).
P. coloratum (SCS 383, CPI 17078, 14375, 16796).
Paspalum commersonii (Paltridge).
S. sphacelata (Nandi, Kazungula).
S. splendida (CPI 15899).

(b) Legumes

Alysicarpus vaginalis, Cassia rotundifolia CPI 16358, *Clitoria ternatea* (CQ 389), *Desmodium intortum, D. uncinatum, Dolichos axillaris* (CPI 25361 and CPI 17814), *D. lab lab* (Rongai), *D. biflorus.*
D. baumanii (CPI 24972).
Glycine wightii (Cooper, Clarence, Tinaroo, CPIs 17673, 18419, 30362, 28278, 25333, 27835, 17185, 25423, CQ 700, CQ 358).
Lotononis bainesii (CPI 16833), *L. angolensis* (CPI 26293), *Phaseolus atropurpureus* (Siratro), *P. lathyroides* (CQ 520 and CPI 26667), *P. bracteatus* (CPI 27404), *Vigna marina, T. semipilosum.*