GRASS SPECIES EVALUATION AT POPONDETTA IN THE NORTHERN DISTRICT OF PAPUA

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ABSTRACT

A grass species evaluation trial at Popondetta in 1967 *yielded production values on ten species of tropical grasses, some of which have potential for use in pastures in the area. There was significant variability in performance of a number of the species, some apparently producing better during the "dry" season, others during the "wet" season. The best grass on the basis of overall dry matter production was Elephant grass* (Pennisetum purpureum), *followed by* Paspalum plicatulum, Panicum maximum *cv. Guinea and* Brachiaria mutica.

INTRODUCTION

ON the wet lowlands of Papua New Guinea, very little quantitative work has been reported on the productivity of the various tropical pasture species which can grow in these regions. At Bubia, in the Morobe District, an evaluation trial has been in progress for several years and some results are now available (DASF 1969).

In view of an increased interest in cattle, both from among the indigenous people of the area, and several plantations, a grass species evaluation trial was established at Popondetta, on an area typical of the large areas of natural grasslands which are at present of little economic value. The soils of the trial area belong to the Popondetta Land System, Unit 1, and are described as unweathered, sandy volcanic soils with black topsoils; well to excessively drained (CSIRO Aust. 1964). Inherently of very low fertility, the soils support a herbage cover consisting primarily of grasses *Saccharum spontaneum,* commonly called Cane grass, and *Imperata cylindrica* commonly called Kunai, with the following species of minor importance:—

Arundinella setosa;
Coelorhachis rottboellioides;
Ophiuros tongcalingii;
Sorghum nitidum; and
Themeda australis.

The grasslands are periodically burnt by the indigenous population and this maintains the vegetation in the grassland stage of the successional sequence, and reduces the already low fertility of the soil.

The average rainfall at Popondetta is 90 to 100 in per annum with a distinct seasonal variation. The mean monthly rainfall during the "wet" season (November through to March-April) is about 11 in and is double the monthly rainfall during the remainder of the year, or "dry" season. Owing to the loose, sandy nature of the soil, short periods without rain may result in a condition of drought for the plants in the grasslands, but conversely a relatively small amount of rain during the dry season can be quite effective in promoting growth.

METHODS

Ten selected grass species were planted in a randomized block design, with three replications, the individual plot size being 10 x 10 ft. After an initial cultivation, and the hand removal of all grass rhizomes from the plots, cuttings were planted in 5 rows with a spacing of 1 ft between planting positions in the row. The planting material used varied as follows:—

Grass Species	Planting Material per Position
Paspalum plicatulum	1 small clump of stems with roots
P. conjugatum	2 eighteen-inch lengths of rooted stolon
Pennisetum purpureum	1 length of stem containing 3 nodes

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Grass Species	Planting material per Position
Panicum maximum Guinea	cv. 1 small clump of stems with roots
Setaria sphacelata Kazungula	cv. 1 small clump of stems with roots
Brachiaria ruziziensis	.... 3 eighteen-inch lengths of unrooted stolon
B. mutica	.... 3 eighteen-inch lengths of unrooted stolon
Chloris gayana	.... 2 eighteen-inch lengths of rooted stolon ..
Melinis minutiflora	.... 3 eighteen-inch lengths of rooted stolon
Cenchrus ciliaris Nunbank	cv. Seed at rate of 10 lb per acre

After the grasses had become established, fertilizer at the rate of 2 cwt per acre of Nitrophoska (15:15:15) was broadcast over the area.

Harvests were made on six occasions during the first year of growth. Within all the plots, all the grass was harvested at a height of 3 in, with the exception of the Elephant grass plots, where harvest height was 6 in. At each harvest the total plot herbage was weighed to obtain the "green weight" production, while from the three replicates a small combined sample for each species was oven-dried to determine the "dry matter" content. It had been intended to harvest all plots when, on an average, under a system of rotational grazing, they would be ready for grazing, but this was prevented by supervisional difficulties.

The sole maintenance consisted of an occasional hand-weeding.

RESULTS

Initial establishment of all species was good. After the first harvest, however, some of the grasses did not recover well and a little replanting was necessary to achieve a uniform stand. This was particularly the case with Molasses grass (*Melinis minutiflora*). Regrowth of all species was satisfactory after subsequent harvests.

Table 1 summarizes the average green herbage yield per plot of 100 sq. ft, for each of the six harvests, together with the total production over the period of the trial, namely 389 days.

The first three harvests in effect cover production during the wet season of the year, while the next two harvests cover production during the dry season. Examination of rainfall data for 1967 (see *Table* 5) indicates that the last period was wetter than usual. *Tables* 2 and 3 respectively summarize the dry matter

Table 1.—Green herbage yield (lb per 100 sq. ft)

Species	Growing Period						Total	Significant Difference*
	14.11.1966-5.1.1967	5.1.1967-17.2.1967	17.2.1967-21.4.1967	21.4.1967-22.6.1967	22.6.1967-8.9.1967	8.9.1967-8.12.1967		
Paspalum plicatulum	22.4	15.7	10.7	19.0	16.3	51.7	135.8	B
P. conjugatum	10.7	18.7	13.3	11.7	9.3	12.7	76.4	D
Pennisetum purpureum	20.3	18.3	11.3	23.0	27.3	90.5	190.7	A
Panicum maximum	30.8	16.3	12.3	14.3	12.3	38.5	124.5	BC
Setaria sphacelata	14.1	23.7	9.3	17.3	12.3	26.8	103.5	C
Brachiaria ruziziensis	18.6	14.3	9.3	14.3	11.7	38.5	106.7	C
B. mutica	22.8	14.7	11.3	23.3	11.3	21.7	105.1	C
Chloris gayana	45.0	17.0	10.3	9.3	10.0	20.0	111.6	C
Melinis minutiflora	12.9	19.3	9.7	24.0	8.3	10.5	84.7	D
Cenchrus ciliaris	15.5	14.7	16.0	18.7	11.0	21.3	97.2	CD

*A significant difference in yield (at P=5 per cent) exists between species with different letters.

Table 2.—Dry matter production for the "wet" season

Species	Growing Period						Total (158 days) D.M. (lb per acre)
	14.11.1966-5.1.1967 (52 days)		5.1.1967-17.2.1967 (43 days)		17.2.1967-21.4.1967 (63 days)		
	D.M. (lb per acre)	per cent D.M.	D.M. (lb per acre)	per cent D.M.	D.M. (lb per acre)	per cent D.M.	
Paspalum plicatulum	1750	18.0	1180	17.3	840	18.0	3770
P. conjugatum	960	20.5	1480	18.2	1030	17.8	3470
Pennisetum purpureum	1120	12.7	1450	18.2	820	16.5	3390
Panicum maximum	2380	17.7	1170	16.4	980	18.3	4530
Setaria sphacelata	1070	17.3	1920	18.6	690	16.9	3680
Brachiaria ruziziensis	1610	19.8	1090	17.5	750	18.5	3450
B. mutica	2720	27.4	1170	18.4	1060	21.4	4950
Chloris gayana	3680	18.8	1160	15.6	910	20.1	5750
Melinis minutiflora	1100	19.6	1380	16.4	820	19.4	3300
Cenchrus ciliaris	1270	18.9	970	15.1	1260	18.1	3500

Table 3.—Dry matter production for the "dry" season

Species	Growing Period						
	21.4.1967-22.6.1967 (62 days)		22.6.1967-8.9.1967 (78 days)		"Dry" Season Total (140 days)	8.9.1967-8.12.1967 (91 days)	
	D.M. (lb per acre)	per cent D.M.	D.M. (lb per acre)	per cent D.M.	D.M. (lb per acre)	D.M. (lb per acre)	per cent D.M.
Paspalum plicatulum	1550	18.7	2040	28.6	3590	6060	26.9
P. conjugatum	880	17.3	1300	32.0	2180	1970	35.7
Pennisetum purpureum	1470	14.7	2360	19.8	3830	15020	38.1
Panicum maximum	1260	20.2	1660	31.0	2920	5740	34.2
Setaria sphacelata	1140	15.1	1580	29.5	2720	3510	30.0
Brachiaria ruziziensis	1220	19.5	1490	29.4	2710	5470	32.6
B. mutica	2470	24.3	1580	32.0	4050	3280	34.7
Chloris gayana	1000	24.6	1470	33.7	2470	3290	37.8
Melinis minutiflora	2270	21.7	1060	29.3	3330	1630	35.6
Cenchrus ciliaris	1710	21.0	1710	35.6	3420	3060	36.0

Table 4.—Comparison of "wet" and "dry" season yields

Species	"Wet" Season (158 days)			"Dry" Season (140 days)			6th Harvest (91 days)			Total Production	
	D.M. (lb per acre)	Per cent of Average Yield*	Daily Production of D.M. (lb per acre)	D.M. (lb per acre)	Per cent of Average Yield*	Daily Production of D.M. (lb per acre)	D.M. (lb per acre)	Per cent of Average Yield*	Daily Production of D.M. (lb per acre)	D.M. (lb per acre)	Per cent of Average Yield*
Paspalum plicatulum	3770	96	23.9	3590	115	25.6	6060	124	66.6	13420	112
P. conjugatum	3470	88	22.0	2180	70	15.6	1970	40	21.6	7620	63
Pennisetum purpureum	3390	87	21.5	3830	123	27.4	15020	306	165.1	22240	185
Panicum maximum	4530	109	28.7	2920	94	20.9	5740	117	63.1	13190	110
Setaria sphacelata	3680	94	23.3	2720	87	19.4	3510	72	38.6	9910	83
Brachiaria ruziziensis	3450	89	21.8	2710	87	19.4	5470	112	60.1	11630	97
B. mutica	4950	126	31.3	4050	130	28.9	3280	67	36.0	12280	102
Chloris gayana	5750	139	36.4	2470	79	17.6	3290	67	36.2	11510	96
Melinis minutiflora	3300	82	20.9	3330	107	23.8	1630	33	17.9	8260	69
Cenchrus ciliaris	3500	90	22.2	3420	110	24.4	3060	62	33.6	9980	83

*The yield of each species expressed as a percentage relative to the average yield of all species.

Table 5.—Rainfall at Popondetta

Rainfall	Growing Period					
	14.11.66-5.1.67 (52 days)	5.1.67-17.2.67 (43 days)	17.2.67-21.4.67 (63 days)	21.4.67-22.6.67 (62 days)	22.6.67-8.9.67 (78 days)	8.9.67-8.12.67 (91 days)
Rainfall over growth period (points)	2,132	1,514	2,685	1,047	1,249	3,400
Mean daily precipitation (points)	41.0	35.2	42.6	16.9	16.0	37.4
Approximate average mean daily precipitation for same period over 14 years (points)	41	37	34	20	12	29

production and percentage dry matter for both the wet and dry season. Both the wet and dry seasons production are compared in *Table* 4, while *Table* 5 shows the rainfall received over the period of the trial.

DISCUSSION

An analysis of the green herbage yields (see Appendix), done on individual plot yields, indicated significant differences between yields of some of the species, between the harvest periods, and also an interaction of the species yields with time of harvest. Yield of Elephant grass was superior to all others, followed by *Paspalum plicatulum,* Guinea grass and Rhodes grass (*Chloris gayana* "common" var.). The indigenous *Paspalum conjugatum,* which is used for grazing purposes on several properties, was inferior in yield to most other species.

As the moisture percentage of the herbage varies between species and harvests, a more reliable guide to the actual production is given by the dry matter yields recorded in *Tables* 2, 3 and 4. The production of the different species varies throughout the year; for example, it is noted that yields from Elephant grass were significantly greater than the other species for only the final two harvests. Indications were that this grass needed a longer establishment period and the accumulation of dry matter was favoured by the longer growth periods. However, of prime consideration in pasture production is the palatability of the herbage, and because of this, harvests of Elephant grass should be more frequent, as the palatability of this species in the final harvest was at a low level, as indicated by the hardness of stem and high percentage dry matter. In this regard Elephant grass showed a large degree of variability, with a variation in percentage dry matter from 12.7 at the first harvest to 38.1 per cent at the final harvest. At the final harvest a more accurate indication of digestible herbage would have been given by separating and weighing the leafy foliage as distinct from stemmy material.

Because of the two distinct seasons at Popondetta, production has been considered as "wet" or "dry" season. However, rather exceptionally heavy rains occurred during October, when 13.78 inches of rain were recorded, compared with the average of about 7.25 inches, and this resulted in the mean daily precipitation over the final growth period being equivalent with that usually received during the wet season. Consequently the final harvest has not been included in the total of dry season yield, and is recorded separately.

An examination of the wet season yields (see *Table* 2) indicates a greater than average production from Rhodes grass and Para grass (*Brachiaria mutica*) but this appears to be rather an indication of their more rapid establishment and early growth after planting. With these exceptions, production from all the species is fairly uniform. There are only minor differences between the percentage dry matter for the various species, all being in the range 16 to 21 per cent with the exception of Elephant grass, which has a very low 12.7 per cent, comparable with some of the values obtained at Bubia (DASF 1968), and the Rhodes grass with the rather high value of 27.4 per cent dry matter.

Greater variation between species becomes apparent during the dry season, both with respect to yields and percentage dry matter (see *Table* 3). The yields of Rhodes grass, *P. conjugatum,* Guinea grass, the *Setaria* sp. and *Brachiaria ruziziensis* are considerably reduced in comparison with their wet season production. Although having a much lower relative percentage dry matter content, Elephant grass is the only species showing much improvement in dry season over the wet season yield.

Only in the final harvest, covering the period of an early commencement to the following wet season, have outstanding yield differences between the various species become apparent. This is indicated in comparison with total wet and dry season yields in *Table* 4. Notable increases in yield are shown for Elephant grass and to a lesser degree for *P. plicatulum,* Guinea grass and *B. ruziziensis*. The best comparison of the productive capacity of the grass species in the various periods is given by the "per day" D.M. production figures. This remains substantially the same throughout the year for some species while in other cases there is significant variation between the seasons. Reasons for a

substantially larger value in the sixth harvest, for some species, may indicate those species which—

(*a*) need a longer establishment period before their full productive capacity is realized; and

(*b*) perform better under a system of less frequent defoliation.

The high D.M. content of all species at the final harvest, however, indicates that in this case, and also probably for the fifth harvest, harvesting had been delayed beyond the optimum time of cutting.

CONCLUSIONS

The results of this evaluation trial, although derived from values for only one year of production, give some indication of the potential of several tropical grasses for pasture production on the volcanic sands of the Popondetta area. A number of species appear far superior to the volunteer *Paspalum conjugatum* that has been utilized as pasture on several properties. In spite of the low fertility soil and seasonal nature of the rainfall, some of the species have produced quite substantial amounts of dry matter per acre, although yields do not approach the values reported from a similar trial at Bubia near Lae (DASF 1969). Reasons for this may be attributed to Bubia having—

(*a*) a higher initial soil fertility;
(*b*) more uniform rainfall;
(*c*) regular fertilization; and
(*d*) higher planting density of cuttings.

ACKNOWLEDGEMENTS

Thanks are due to Mr Stephenson Ino, Agricultural Assistant, for help with the field work and to Mr C. Edwards, Senior Pasture Agronomist, Bubia, for arranging the dry matter determinations.

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(Accepted for publication July, 1970.)

APPENDIX

As the variance of the plot yields was heterogeneous, the plot yields (x) were transformed by obtaining the square root ($\sqrt{x}$), and the analysis of variance was then carried out on this transformed data. The sum of the square roots of the individual plot yields ($\Sigma\sqrt{x}$) for each treatment is tabulated below.

Species	$\Sigma\sqrt{x}$
Paspalum plicatulum	82.3
P. conjugatum	63.6
Pennisetum purpureum	94.6
Panicum maximum	78.3
Setaria sphacelata	73.3
Brachiaria ruziziensis	73.3
B. mutica	74.5
Chloris gayana	74.0
Melinis minutiflora	65.9
Cenchrus ciliaris	70.6

Least significant difference at 5 per cent = 7.4.
Least significant difference at 1 per cent = 9.7.