DRY MATTER YIELDS AND ANIMAL PRODUCTION OF GUINEA GRASS (PANICUM MAXIMUM) ON THE HUMID TROPICAL COAST OF NORTH QUEENSLAND

B. GROF* AND W. A. T. HARDING*

ABSTRACT

Results are presented of cutting and grazing experiments comparing common guinea grass with new accessions and a range of other tropical grasses grown with the legumes Stylosanthes guyanensis, Centrosema pubescens, Pueraria phaseoloides, Phaseolus atropurpureus, *and* Glycine wightii *or with nitrogen fertilizer. Dry matter yields of ten guinea grass varieties ranged from 14000 to 24000 lb/ac/year. The highest legume and associated grass yields were obtained with* S. guyanensis.

Effects of applied phosphorus and nitrogen on yield of guinea grass are discussed.The most efficient N application was 125 lb/ac/year, resulting in a yield increment of 38 lb dry matter per 1 lb of applied N, with a N recovery of 36% in plant tops.

A pasture mixture of guinea grass and C. pubescens *yielded 36% more liveweight gain than guinea grass only, and the application of 150 lb N/ac/year yielded 41% more liveweight gain than the grass-legume mixture.*

Liveweight gains over two years were 16% higher for rotationally grazed than for continuously grazed guinea grass.

INTRODUCTION

Guinea grass (*Panicum maximum*) remains one of the best cultivated grasses for the tropics. A tall, vigorously growing perennial with rather coarse herbage, it is native to tropical and subtropical Africa, and is naturalized in most tropical countries. It is used extensively for forage purposes in South and Central America, the Caribbean Islands, Africa and South-East Asia. Motta (1953) in a comprehensive review of the literature stressed the importance of this species in the expansion of animal production throughout the tropics.

Vicente-Chandler (1959) and co-workers in Puerto Rico obtained increases in yield and protein content with nitrogen rates up to 800 lb per acre, but efficiency of utilization in terms of dry matter produced per pound of nitrogen decreased beyond the 400 lb level. With 400 lb of N and cut at 40 day intervals, guinea grass produced 23758 lb of dry matter per acre per annum.

Richards (1965) in Jamaica recorded annual liveweight gains ranging from 722 to 1117 lb per acre from irrigated guinea grass fertilized with 139.5 lb of N per annum.

Guinea grass has played a major role in grassland improvement and livestock production in North Queensland, especially in frost free environments and on the more fertile soils of the tropical coast. In view of the economic importance of the species in this region, experiments were carried out at the South Johnstone Research Station (146° 10'E, 17° 36'S). The area has a mean annual temperature of 73.2°F and a seasonal variation of less than 10°F. The average annual rainfall of 127 in. is predominantly of summer incidence with approximately 80% being received in the first six months of the year.

Seasonal and total production of new accessions was compared with the commercially used cultivars. Herbage dry matter production of guinea grass and the

* South Johnstone Research Station, Queensland Department of Primary Industries, South Johnstone, Queensland.

effects of fertilizers or legumes on yield, N content and beef output were measured for pure grass swards and grass-legume associations.

DESCRIPTION OF VARIETIES

Guinea grass is a facultative apomict; the amount of sexual reproduction varies from 1-5% depending on the variety; on the basis of cytological evidence Warmke (1954) suggested that the different types of guinea grass be considered as agronomic varieties.

Common guinea, Hamil and coloniao cultivars

What is regarded as the common form of guinea grass has been cultivated in Queensland for many years, and is a uniform type (Officers of the Agriculture Branch, 1955). Several varieties have been introduced over the past 30 years and tested against the local variety. Some new introductions are in various stages of testing. These introductions show much variation in morphology, degree of leafiness, growth habit, time of flowering, and productivity.

There is no record of the exact origin of Hamil grass and common guinea. However, the common variety cultivated in North Queensland shows similarity to ecological races introduced from East and Central Africa. In general, these are fine-leaved and are noted for their better cool season production and tolerance of dry conditions. On the other hand, Hamil and coloniao cultivars are similar to accessions from the West African coast. They occur in areas of high rainfall and are robust, with broad leaves. The foliage is a characteristic blue-green. Dense stiff hairs on the basal leaf sheaths of Hamil grass distinguish this cultivar from coloniao which is almost entirely devoid of hairs except for a ring of soft, short hairs at each node.

The first introduction of coloniao guinea grass was grown at the Queensland Department of Primary Industries' Research Station at South Johnstone in the 1930's. This introduction (Q1202) was received from Molokai Island, Hawaii, where it was introduced from Brazil. Since then, several direct introductions of this variety have been made from Brazil.

Creeping guinea grass cv. Embu (Q8132)

This is a distinctly different growth form and perhaps, as suggested by Bogdan (1965), a different subspecies of *P. maximum*. It was introduced from Kenya in 1965. The height of foliage is 3½ to 5 ft. The stems are fine with the exposed portions covered with scattered short hairs.. They are ascendent or creeping, rooting freely at the nodes. This guinea grass forms a dense leafy mat under grazing.

The leaf sheaths are covered with tubercle based hairs. The bases of leaf sheaths and stolons are purple. The leaf blades are broad at the base and up to 12 in. long, glabrous on the lower surfaces, and glabrous or with scattered hairs on the upper surfaces. The panicles are 6-9 in. long, with glabrous spikelets, tinged with purple. The fertile florets are 3-3.5 mm long, with very fine transverse wrinkles.

C.P.I. 37910

This ecotype of East African origin represents a group of morphologically similar accessions, which are noted for their vigorous cool season production. They are of medium height, the foliage reaching heights of 6 to 8 ft. Practically the whole surface is covered with hairs including the exposed stem. A fine dense hair growth on the leaf blade gives a "furry" feel while the hairs on the leaf sheath are slightly more bristly. The hairs at the nodes and on the collar are longer and more dense. The nodes are densely pubescent and swollen. The panicles are approximately 10-12 in. long and 6 in. wide. The spikelets have a purplish tinge and are covered with short dense hairs.

EXPERIMENTAL RESULTS

Guinea grass varieties under cutting

In a cutting experiment conducted over two seasons annual dry matter yields of ten guinea grass varieties ranged from 13964 to 24586 lb per acre. This was achieved with an input of 200 lb N, 21.5 lb P, 50 lb K per acre and five cuts a year.

No significant differences occurred in total yields between the varieties Hamil, coloniao, Q8260, common, C.P.I. 37910 and 37912. The former three are robust, whilst C.P.I. numbers 37910, 37912 and common guinea are of medium height and fine-leaved.

Herbage dry matter production was affected by season and variety. The robust or "giant" guinea grasses, Hamil and coloniao, produced most of their dry matter yields during the summer wet period. The medium guinea grasses, in particular, C.P.I. 37910 and to a lesser extent Q8132 and common guinea were superior to the robust types in the cool season (Figure 1).

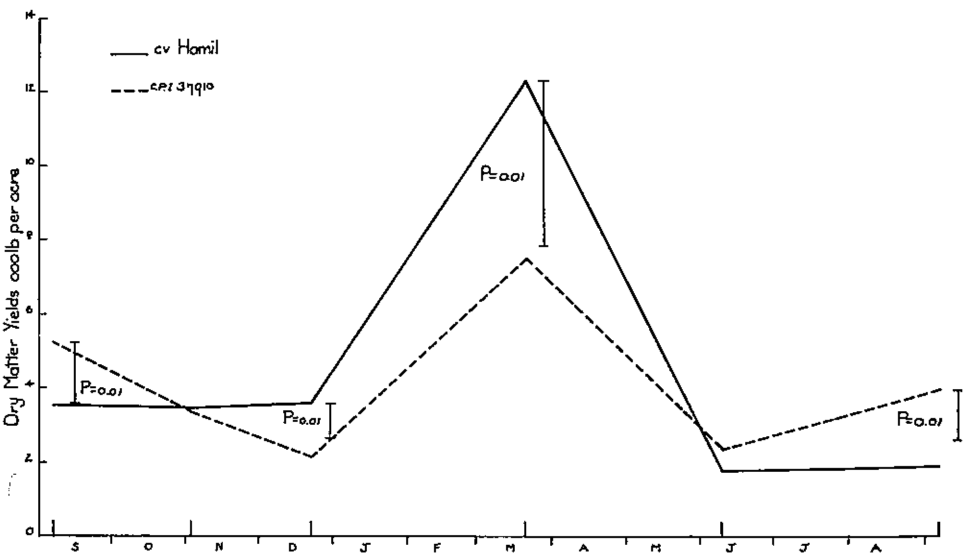

FIGURE 1

Seasonal fluctuation of dry matter yield of cv. Hamil and a medium growth form of guinea grass C.P.I. 37910.

The C.P.I. 37910 variety significantly ($P < 0.01$) outyielded seven other varieties including cvs Hamil and coloniao in the June to September period of 1966 and 1967.

Creeping guinea cv. Embu (Q8132) maintained the highest nitrogen and phosphorus percentages throughout the season, it had the lowest total annual yield of the ten varieties but no significant differences were recorded between Embu, Hamil, coloniao and common guinea grasses over the June to September period. Yield data, N and P percentages for this experiment are summarised in table 1.

Under grazing, presentation yields of common guinea and cv. Embu were 15800 and 13800 lb dry matter per acre per year. Embu had consistently higher phosphorus percentages and slightly higher nitrogen percentages except at the June harvesting date (Table 2).

TABLE 1

Annual and cool season yields of dry matter, mean nitrogen and phosphorus contents of dry matter in plant tops of ten varieties of guinea grass with 200 lb N/ac over five cuts in the 1966/67 season at South Johnstone Research Station

Variety	Source	Dry matter yield in lb/ac: Total per annum	Dry matter yield in lb/ac: Mean of two cool seasons (June to September)	%N	%P
cv. Hamil	Australian Commercial	24,586	2,720	1.50	0.12
cv. Common	Australian Commercial	21,646	3,091	1.52	0.11
Q8260 (coloniao type)	Nigeria	21,531	2,240	1.45	0.11
cv. coloniao	Brazil	20,728	2,257	1.47	0.12
C.P.I. 37910	Kenya	20,564	4,589	1.56	0.11
C.P.I. 37912	Kenya	20,075	2,859	1.67	0.11
Q8213 (coloniao type)*	Puerto Rico	19,036	1,690	1.52	0.13
C.P.I. 37909 (type 1)	Kenya	18,634	2,347	1.40	0.11
C.P.I. 37909 (type 2)	Kenya	15,523	2,600	1.40	0.12
Q8132 cv. Embu	Kenya	13,964	3,108	1.82	0.16
	L.S.D. P = 0.01	6,158	1,508		
	P = 0.05	4,560	1,117		

Q — Queensland Department of Primary Industries Plant Introduction Number
C.P.I. — Commonwealth Plant Introduction Number
* — A 48 chromosome hexaploid type

TABLE 3

Increments in dry matter and leaf area index of three guinea grass cultivars in July/August

Weeks after defoliation	Mean	Common Guinea		cv. Hamil		cv. Coloniao	
		s.e.	s.e.	s.e.	s.e.	s.e.	s.e.
3	Dry Wt (g/sq. ft)	3.08 ± 0.34		1.92 ± 0.39		2.70 ± 0.42	
	L.A.I.		0.33 ± 0.03		0.26 ± 0.05		0.36 ± 0.06
5	Dry Wt (g/sq. ft)	5.48 ± 0.72		4.39 ± 0.34		3.62 ± 0.56	
	L.A.I.		0.93 ± 0.12		0.30 ± 0.03		0.57 ± 0.09
6	Dry Wt (g/sq. ft)	7.12 ± 1.05		5.44 ± 0.62		6.00 ± 0.80	
	L.A.I.		0.85 ± 0.12		0.87 ± 0.10		0.76 ± 0.10
7	Dry Wt (g/sq. ft)	12.63 ± 2.01		5.89 ± 0.67		6.76 ± 0.74	
	L.A.I.		1.18 ± 0.18		0.69 ± 0.08		0.96 ± 0.10
8	Dry Wt (g/sq. ft)	13.65 ± 1.72		8.10 ± 0.96		9.12 ± 1.17	
	L.A.I.		1.70 ± 0.22		0.95 ± 0.11		1.15 ± 0.15

TABLE 2

Seasonal presentation yields, nitrogen and phosphorus contents of common guinea and creeping guinea grass cv. Embu in a grazed sward with legumes on a krasnozem soil

Cutting Date	Common Guinea			Creeping Guinea		
	Dry Matter Yield lb/ac	N	P %	Dry Matter Yield lb/ac	N	P %
Sept. 9, 1966	2,800	2.45	0.16	3,400	2.63	0.21
Nov. 11, 1966	3,400	1.61	0.08	1,800	2.13	0.12
Jan. 1, 1967	5,200	1.38	0.10	3,300	1.54	0.16
June 6, 1967	4,400	1.18	0.10	5,300	1.14	0.15
Total	15,800			13,800		

Dry matter and leaf area increments of cv. Hamil, coloniao and common guinea were compared during an 8 week growth period in the cool season of 1963 (Table 3). Common guinea produced higher dry matter and leaf area increments than the two mainly summer producing cultivars.

In another clipping trial, fertilized with 200 lb N, 21.5 lb P, 50 lb K per acre, cut five times per annum, both Hamil and common cultivars were significantly outyielded by the stoloniferous grass *Brachiaria decumbens*. Common guinea was also

TABLE 4

Annual yields of dry matter of two cultivars of guinea grass and eight other tropical grasses under cutting at South Johnstone

Species	Dry matter in lb/ac
Brachiaria decumbens C.P.I. 1694	32906
B. mutica (para)	26388
Digitaria decumbens (pangola)	25028
Panicum maximum cv. Hamil	24579
B. ruziziensis Q6975	22613
B. ruziziensis Q6973	21733
B. ruziziensis Q6976	21082
B. ruziziensis Q6972	19586
P. maximum cv. common	19280
B. ruziziensis C.P.I. 30623	17828
L.S.D. $P = 0.01$	7020
$P = 0.05$	5199

outyielded by pangola (*Digitaria decumbens*) and para grass (*B. mutica*) (Table 4). The tufted grasses, cv. Hamil and common guinea, were adversely affected by the imposed cutting height of 2 inches. This effect was marked in the months following the wet season and in the cool months.

Grass-legumes mixtures

The performance of five tropical legumes *Stylosanthes guyanensis* subsp. *guyanensis* cv. Schofield, *Centrosema pubescens, Pueraria phaseoloides, Phaseolus atropurpureus* cv. Siratro and *Glycine wightii* cv. Tinaroo, each in association with guinea grass, adequately fertilized with P (43 lb P/ac) was studied in grazed swards on a granitic soil. Under these conditions presentation yields obtained in the second

TABLE 5

Yields of dry matter and nitrogen of five tropical legumes in association with guinea grass on a granitic soil during the five wet season months January to May, 1966

Associated legume	Grass			Legume			Total	
	Dry matter Yield lb/ac	N %	N Yield lb/ac	Dry matter Yield lb/ac	N %	N Yield lb/ac	Dry Matter lb/ac	N lb/ac
Stylosanthes guyanensis cv. Schofield	2,726	0.65	17.72	2,427	1.70	41.27	5,153	58.99
Centrosema pubescens	2,034	0.56	11.39	1,520	2.22	33.74	3,554	45.13
Pueraria phaseoloides	2,286	0.55	12.58	1,039	1.74	18.08	3,325	30.65
Phaseolus atropurpureus cv. Siratro	2,974	0.62	18.44	981	1.76	17.26	3,955	35.70
Glycine javanica cv. Tinaroo	2,812	0.52	14.62	343	1.87	6.41	3,155	21.03
L.S.D. P = 0.01	2,220		13.39	1,176		21.59		33.76
P = 0.05	1,526		9.20	808		14.83		23.20

summer season following establishment indicated the superiority of stylo over the four other legumes in terms of dry matter (Table 5). Stylo also produced greater yields of nitrogen than puero, siratro and Tinaroo glycine.

The effect of fertilizers on dry matter production

Apart from nitrogen, soils of the coastal region are grossly deficient in phosphorus, and inadequate supplies of this element can limit the successful establishment and persistence of grass and legume species. Repeated fertilization is necessary for consistent high production.

Responses to phosphorus applied at planting were general under various soil fertility conditions, in pure stands and also in guinea grass-legume mixtures. On a granitic soil there was a significant response to 22 lb P/ac by the guinea grass as well as the legumes, but not to higher applications (Table 6).

TABLE 6
Establishment yields of guinea grass with Centrosema *and* Pueraria *at five levels of P on a granitic soil*

Applied P lb/ac	Dry matter yields lb/ac		Total Grass and legume lb/ac
	Guinea grass	Centresoma Pueraria	
0	58	206	264
22	1922	692	2614
44	1710	636	2346
66	2840	442	3282
88	3320	744	4064
L.S.D.			
P = 0.01	1637	393	2008
P = 0.05	1167	280	1432

Rates of nitrogen (as urea, 46%N) of 0, 125, 250, 375 lb per acre and phosphorus (as superphosphate, 9.6%P) of 0, 96 and 144 lb per acre were superimposed on a pure stand of guinea grass established on a krasnozem soil derived from basalt originally under rainforest. The fertilizer treatments were arranged in four randomized blocks and they were applied in five equal split dressings throughout the season.

Guinea grass responded to fertilizer nitrogen at 125 and 250 lb N/ac, but in total yield there was no response to P and no P x N interaction. The efficiency of applied nitrogen decreased with increasing rate of application, with the optimum efficiency of utilization occurring at 125 lb N per acre (Table 7).

TABLE 7
The effects of applied nitrogen on the yield and nitrogen content of guinea grass and the efficiency of nitrogen utilization

Nitrogen lb/ac/year	Dry matter yield lb/ac/year	lb dry matter per lb of increment of N	Per cent recovery of nitrogen in D.M.	N in dry matter %
0	13494	—	—	1.10
125	18232	38.26	35.86	1.06
250	20393	27.60	32.56	1.18
375	20393	18.40	24.46	1.33
L.S.D.				
P = 0.01	2244			
P = 0.05	1680			

Phosphate applications had a seasonal effect. This response became significant at the May, August and November sampling dates when cumulative applications of phosphorus reached 57.6, 86.4 and 115.2 lb per acre respectively (Table 8).

TABLE 8

Seasonal effect of P application on the yield of guinea grass

May 1963		Aug. 1963		Nov. 1963	
Cumulative levels of P lb/ac	D.M. lb/ac	Cumulative levels of P lb/ac	D.M. lb/ac	Cumulative levels of P lb/ac	D.M. lb/ac
0	3104	0	1923	0	2552
38.4	3403	57.6	2030	76.8	2825
57.6	3589	86.4	2213	115.2	3067
L.S.D.					
P = 0.01	454		329		481
P = 0.05	340		247		360

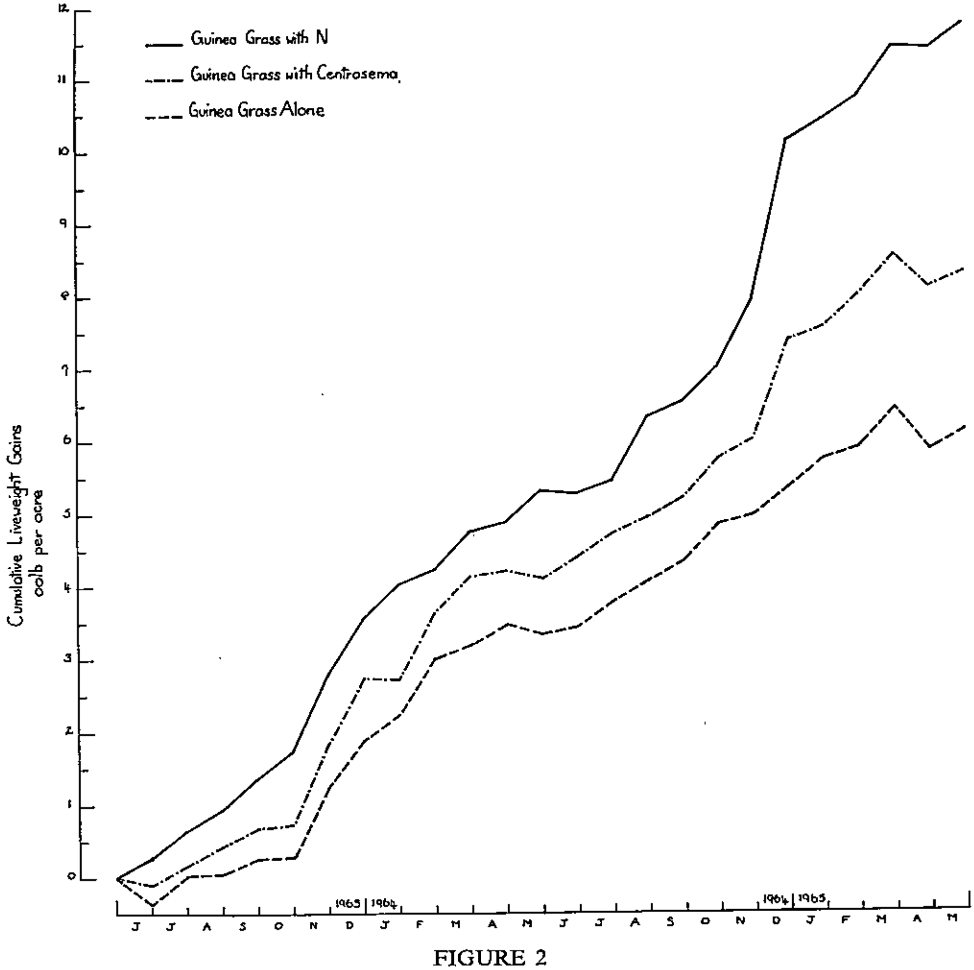

FIGURE 2

Cumulative monthly liveweight gains on pure guinea grass, guinea-*Centrosema* and guinea grass fertilized with nitrogen.

ANIMAL PRODUCTION

Legume versus fertilizer nitrogen

The relative merits of a legume based guinea grass pasture and pure guinea grass sward with and without nitrogen addition were studied under rotational grazing by beef cattle at Utchee Creek, near South Johnstone. Each pasture treatment consisted of two 4 acre paddocks grazed on a rotation of two weeks on and two weeks off. The stocking rate of 1.7 beasts per acre was uniform for all treatments.

In the first year annual liveweight gain was increased from 334 lb per acre per annum on grass alone to 411 lb per acre by the inclusion of *Centrosema pubescens* into the pasture. A further increase to 532 lb per acre liveweight gain was obtained by the addition of 150 lb N per acre. Corresponding liveweight gains for pure grass, grass-*Centrosema* and grass with N were 279, 426 and 647 lb per acre in the second year (Figure 2). Each pound of applied N produced an average of 1.8 lb of liveweight gain.

In another trial the pasture consisted of duplicate sets of three 1 acre paddocks, each grazed on a rotation of one week on and two weeks off at two beasts per acre throughout the season. Fertilizer was applied in the form of urea in six split dressings of 25 lb N per acre. The mean daily growth rate of two groups of steers was 2.86 (s.e.: 0.36) lb/acre/day during the December to March period and 1.24 (s.e.: 0.19) lb/acre/day from March to December. Total liveweight gain was 645 lb/acre/annum.

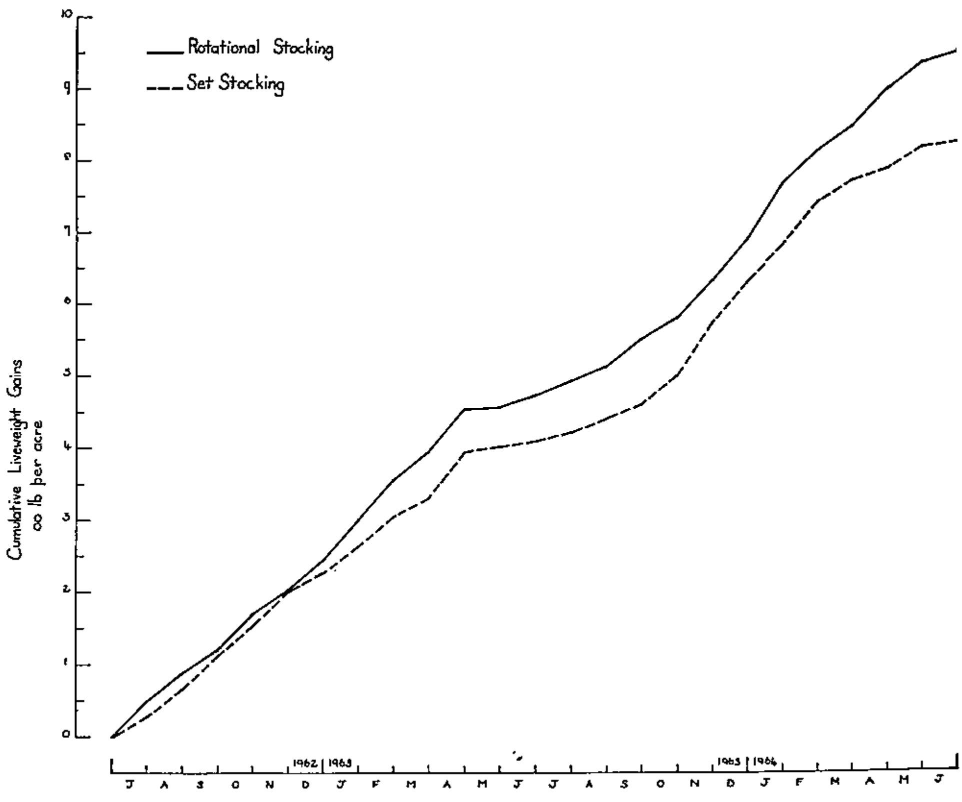

FIGURE 3
Cumulative liveweight gains on guinea grass pasture under two systems of grazing.

Rotational and continuous grazing

Two grazing systems were compared on a guinea grass-centro pasture established on a krasnozem soil at Utchee Creek. An area of 16 acres was under continuous grazing and two sets of 4 acre paddocks were grazed on a rotation of two weeks on and two off. Liveweight gains of beef cattle were recorded over a period of two years. The average stocking rate was 1.4 beasts per acre. Accumulative liveweight gain was higher on rotationally grazed guinea grass than under continuous grazing, with the main differences occurring in favour of the rotational during the wet season months. The cumulative liveweight gains for two years were 958 lb per acre for the rotational grazing treatment and 832 lb per acre for continuous grazing (Figure 3).

DISCUSSION

In spite of more productive and very useful introductions such as pangola grass and signal grass (*Brachiaria decumbens*) guinea grass still retains its pre-eminent position among tropical grasses in North Queensland. Although these stoloniferous species, are better adapted to heavy fertilization with nitrogen and intensive utilization, the compatibility and long term persistency of guinea grass with *Centrosema, Pueraria* and *Stylosanthes* in grazed swards, the wide range of adaptibility of the species, its good response to fertilizer and ease of establishment from seed, are distinct advantages in favour of guinea grass.

The wide range of distribution of guinea grass in the tropics has resulted in the isolation of many ecotypes and the introduction of these provided material for the selection of variants adapted to pasture and ecological conditions in North Queensland.

The rapid growth rate in summer and subsequent deterioration is one of the problems associated with the management and optimum utilization of tropical forage grasses.

C.P.I. 37910 showed superior growth potential over the June-September period. Resistance to stresses, whether arising from moisture or relatively large diurnal changes in temperature during the cool dry season, and the more even distribution of dry matter yield throughout the season are the main features of this variety.

C.P.I. 37910 produced 47% of its total yield in the wet season. The robust growth forms represented by cultivars Hamil, coloniao and Q8213, Q8260 guinea grasses showed a marked periodicity in growth, 64 to 73% of their total dry matter yield being produced in the wet season.

In addition to cool season productivity, the leafy medium growth habit of C.P.I. 37910 and the sward forming habit of cv. Embu would allow more latitude in their management resulting in the better utilization of wet season growth. The testing of both varieties under pasture conditions as substitutes for the commercially used cultivars is recommended.

The role of tropical legumes in increasing yields of dry matter and nitrogen of guinea grass pastures was demonstrated. The increase in total nitrogen yields obtained by including stylo, centro, or puero in the pasture was directly related to legume yield. Stylo, which is well suited to soils derived from granite and other poor parent material, significantly outyielded four other legumes in the second season following establishment. Centro and puero are slow to establish and as a result contributed less nitrogen and dry matter to the grazing system than stylo. Both *Phaseolus atropurpureus* cv. Siratro and *Glycine wightii* cv. Tinaroo were found unsuited to the same edaphic conditions and 100 in. or more rainfall.

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