Production of grazed tropical grasses in different agroecosystems in Puerto Rico: I. Humid mountain[1]

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ABSTRACT

A field experiment was conducted at the Corozal Experiment Substation in the humid mountain region of Puerto Rico to evaluate the production and persistence of tropical grasses, *Brachiaria humidicula, Cynodon dactylon* cv. Bermuda, *C. nlemfuensis* var. *nlemfuensis* cv. Star, *Digitaria pentzii* cv. Slenderstem, *D. decumbens* cv. Transvala, *C. plectostachyus* cv. Star and *Panicum maximum* cv. Makueni in small plots grazed at 5- to 7-week intervals for 2 years. *P. maximum* cv. Makueni was the most productive grass the first year, with a mean of 1.71 ton/ha dry forage per grazing period, but it was not statistically different (P=0.05) from *B. humidicola* and *C. dactylon* cv. Bermuda. *D. pentzii* was the least productive. Production of all grasses, except *P. maximum* cv. Makueni, decreased during the short cool days in December and January. *B. humidicola* was the most productive grass the second year, with a mean of 1.73 ton/ha of dry forage, followed very closely by *P. maximum* cv. Makueni. Again *D. pentzii* cv. Slenderstem was one of the least productive, and *C. nlemfuensis* did not persist. Mean production of all grasses decreased during the drier periods; however, the crude protein content was higher. Total annual forage production was similar in both years, with means of 15.8 and 15.1 ton/ha dry forage, but much lower than the reported yields of these cultivars under cutting management in Puerto Rico.

INTRODUCTION

The production of numerous introduced grasses has been evaluated in small plots under cutting conditions of the humid region of Puerto Rico. *Panicum maximum* cv. Guinea and PR PI 3622 produced over 40,000 kg/ha of dry forage with intensive cutting management at Gurabo (11). *P. maximum* cv. Makueni PR PI 12917 has been as productive as Guinea under high fertilizer levels in the humid mountain region at Corozal (19). Guinea is among the highest producers of dry matter under grazing management in this region (22), but Makueni has yet to be evaluated there under grazing conditions.

Brachiaria humidicola PR PI 9626 was one of the most productive of the *Brachiaria* species at cutting intervals of 30, 45 and 60 days, and

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compared very favorably with other recognized high-yielding grasses in Puerto Rico (14), but it has not been evaluated under grazing. *Cynodon plectostachyus* PR PI 11212, *C. plectostachyus* PR PI 11487 and *C. nlemfuensis* var. *nlemfuensis* PR PI 2341 have been three of the most productive grasses under cutting in different trials in the humid region (13, 15, 18, 20), although the latter has not been very productive in some cases (12, 17, 19). Under grazing in small plots *C. nlemfuensis* var. *nlemfuensis* produced yields comparable to those obtained in a large scale grazing experiment, but *C. plectostachyus* did not tolerate intensive grazing after the second year (7).

Digitaria pentzii PI 11537 and *D. decumbens* PR PI 6439 are also highly productive grasses under cutting (15, 17, 19) and the latter has produced high yields and persisted well for 2 years under intensive grazing (8).

These outstanding grasses need further evaluation to determine their performance under the complexity of grazing conditions: selective grazing, regrowth after defoliation, trampling, soil compaction, uprooting and persistence of the stand. Different techniques have been suggested to evaluate forage germplasm in small plots (2, 3, 6, 21), but one of the simplest and least costly is the "mob grazing" technique, which is used for screening large numbers of accessions under common grazing by a large number of animals for a short period of time (4).

The objective of the present investigation was to evaluate the production and persistence of selected grass species adapted to the humid mountain region of Puerto Rico subjected to grazing in small plots.

MATERIALS AND METHODS

The experiment was conducted at the Corozal Agricultural Experiment Substation, lat. 18° 21′ N and long. 66° 22′ W, at an elevation of 215 m, in the humid mountain region of Puerto Rico. Mean annual rainfall is 1760 mm, well distributed throughout the year, and mean daily temperature is 25° C, with seasonal variations of about 4° C.

TABLE 1.—*Identification of grass cultivars*

Grass number	Species	USDA PI[1]	PR PI[2]
1	*Brachiaria humidicola*	299496	9626
2	*Cynodon dactylon* cv. Bermuda	293611	11212
3	*C. nlemfuensis* var. *nlemfuensis* cv. Star	—	2341
4	*Digitaria pentzii* cv. Slenderstem	300935	1153
5	*D. decumbens* cv. Transvala	299752	6439
6	*C. plectostachyus* cv. Star	341818	11487
7	*Panicum maximum* cv. Makueni	349676	12917

[1] United States Department of Agriculture plant introduction number.
[2] University of Puerto Rico Agricultural Experiment Station plant introduction number.

The soil is a Corozal clay (Aquic Tropudults) with 20 p/m available P (Bray 1) and 80 p/m exchangeable K in the top 20 cm. The soil was limed at a rate of 2,240 kg/ha 2 months before planting.

A randomized block design with four replications and seven grass cultivars (table 1) in 8×8 m plots was established in the field March 1981. These grasses were fertilized with a 15-5-10 fertilizer at a rate of 1,600 kg/ha/year divided in four equal applications throughout the year.

All plots were grazed at 5- to 7-week intervals to a height of about 15 cm from the ground, with a group of 35 adult animals for a period of 1 to 2 days. The forage offered in each plot was determined by sampling before and after grazing, with the pair quadrats method described by Rivera and Rodríguez (7). Green forage was weighed in the field, and samples were taken and dried at 55° C in a forced air oven for 48 hours to determine dry matter content. Monthly hand-plucked forage samples were composited by replicates of each grass treatment, dried at 55° C in a forced air oven, ground in a Wiley mill to pass a 1-mm screen and analyzed for N content with a Technicon Autoanalyzer. Crude protein (CP) was calculated as N × 6.25. The procedure was repeated over 2 consecutive years providing information for 12 grazing dates for each year.

RESULTS AND DISCUSSION

Panicum maximum cv. Makueni, *Brachiaria humidicola* and *Cynodon dactylon* cv. Bermuda were the most productive grasses (table 2) grazed the first year of experiment from 5 August 1981 to 3 August 1982 (P=0.05). *C. nlemfuensis* cv. Star production was intermediate and *C. plectostachyus* cv. Star, *Digitaria decumbens* cv. Transvala and *D. pentzzi* were the least productive (P=0.05).

The production of all grasses decreased during December 1981 and January 1982 (table 2), except for *P. maximum* cv. Makueni, even though rainfall was exceptionally high at the end of the year (table 3). In the humid mountain region of Puerto Rico short days and cooler weather are the most important factors associated with relatively low yields from December to April (22), whereas higher yields are associated with higher ambient temperature during the remaining months (15). In 1982, however, most grasses recovered earlier than usual (in February), except for *B. humidicola* and *D. pentzii* cv. Slenderstem. Grass production in general declined again in May because of a decrease in rainfall in April (fig. 1). *P. maximum* cv. Makueni showed good adaptation and the capacity to grow in this critical period during the first year of the experiment.

Table 4 shows that during the second year, from August 3, 1982, to August 24, 1983, *B. humidicola* was the most productive grass, followed very closely by *P. maximum* cv. Makueni (P=0.05). *C. dactylon* cv. Bermuda, *C. plectostachyus* cv. Star and *D. decumbens* cv. Transvala

TABLE 2.—*Mean dry forage on offer of tropical grasses under grazing in the humid region at Corozal, Puerto Rico, 1981-1982*

Grass number	Grazing dates: Aug. 5 1981	Sept. 9 1981	Oct. 7 1981	Nov. 8 1981	Dec. 10 1981	Jan. 28 1982	Feb. 24 1982	Mar. 31 1982	May 3 1982	Jun. 3 1982	Jul. 30 1982	Aug. 3 1982	Mean per grazing	Total per year
	ton/ha													
7	3.85 a[1]	1.91 a	2.27 a	1.25 ab	0.35 ab	1.84 a	2.65 a	0.97 ab	1.86 a	0.82 b	0.98 b	1.54 a	1.71 bc	20.5 a
1	3.73 ab	1.21 a	0.44 b	1.33 a	1.30 b	0.65 b	0.75 c	2.14 a	0.58 b	2.46 a	2.17 a	1.94 abc	1.47 ab	17.6 ab
2	2.40 abc	2.40 a	1.08 b	1.25 ab	0.86 a	0.66 b	2.10 ab	1.89 ab	0.48 b	1.32 b	1.05 b	2.26 ab	1.48 ab	17.7 ab
3	2.77 abc	2.11 a	0.92 b	0.84 abc	0.75 ab	0.69 b	1.37 bc	1.65 ab	0.92 b	0.98 b	0.96 b	1.82 abc	1.32 bc	15.8 bc
6	2.14 bc	1.82 a	0.81 b	0.94 abc	0.68 ab	0.62 b	1.54 abc	1.71 ab	0.58 b	1.02 b	0.86 b	2.51 a	1.27 cd	15.2 cd
5	2.08 bc	1.54 a	0.97 b	0.37 c	0.86 a	0.80 b	1.20 bc	0.77 b	0.64 b	0.92 b	1.06 b	1.42 c	1.05 cd	12.6 cd
4	1.47 c	1.28 a	0.66 b	0.59 bc	0.53 ab	0.51 b	0.69 c	1.20 ab	0.59 b	1.43 b	0.82 b	1.40 c	0.93 d	11.2 d
Mean	2.63	1.75	1.02	0.94	0.62	0.82	1.47	1.48	0.81	1.28	1.13	1.84	1.32	15.8

[1] Means in the same column followed by the same letter do not differ significantly at the 5% probability level.

TABLE 3.—*Monthly rainfall at Corozal Substation during the course of the experiment, 1981-1983*

Month	1981	1982	1983
		mm	
January	122	39	91
February	82	134	16
March	356	11	153
April	202	89	247
May	369	388	277
June	114	27	49
July	100	114	104
August	203	110	189
September	179	181	185
October	387	121	30
November	181	222	106
December	427	219	80
Total	2,722	1,655	1,527

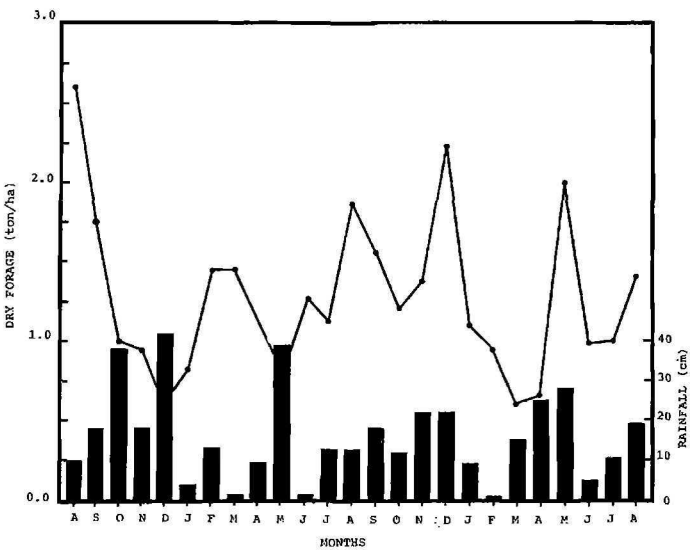

FIG. 1.—Seasonal dry forage on offer, mean for all grasses, grazed in small plots every 5 to 7 weeks at Corozal, Puerto Rico, 1981 to 1983.

TABLE 4.—*Mean dry forage on offer of tropical grasses under grazing in the humid region at Corozal, Puerto Rico, 1982-1983*

Grass number	Grazing dates													
	Sept. 7 1982	Oct. 7 1982	Nov. 9 1982	Dec. 7 1982	Jan. 12 1983	Feb. 15 1983	Mar. 14 1983	Apr. 13 1983	May 17 1983	Jun. 14 1983	Jul. 21 1983	Aug. 24 1983	Mean per grazing	Total per year
	ton/ha													
1	3.20 a[1]	0.87 b	2.49 a	2.54 a	0.73 a	1.06 a	1.07 a	0.60 a	1.93 a	1.26 a	1.69 ab	3.33 a	1.73 a	20.8 a
7	1.99 ab	2.33 a	1.40 ab	2.14 a	1.77 a	0.65 a	0.54 a	0.52 a	2.50 a	1.45 a	1.95 a	2.17 ab	1.62 ab	19.4 ab
2	1.61 b	1.52 ab	1.31 ab	1.69 a	1.17 a	1.12 a	0.88 a	0.80 a	2.14 a	0.80 a	1.23 abc	1.62 ab	1.32 bc	15.8 bc
3	1.29 b	0.95 b	1.56 ab	2.00 a	0.57 a	1.20 a	0.28 a	0.84 a	1.63 a	0.00 b	0.00 d	0.00 c	0.86 d	10.3 d
6	1.16 b	1.41 ab	1.06 b	2.77 a	0.85 a	1.36 a	0.48 a	0.64 a	1.98 a	1.01 a	1.01 bc	0.54 b	1.19 bc	14.3 bc
4	0.94 b	0.68 b	1.21 ab	2.16a	0.78 a	0.61 a	0.38 a	0.55 a	1.66 a	1.20 a	0.57 c	1.19 b	0.99 d	11.9 d
5	0.69 b	0.75 b	0.61 b	2.34 a	2.00 a	0.57 a	0.60 a	0.58 a	2.12 a	1.10 a	0.63 c	0.95 b	1.08 b	13.0 b
Mean	1.55	1.22	1.38	2.23	1.12	0.94	0.60	0.65	2.00	0.98	1.01	1.40	1.25	15.1

[1] Means in the same column followed by the same letter do not differ significantly at the 5% probability level.

were intermediate and *D. pentzii* cv. Slenderstem and *C. nlemfuensis* cv. Star were the least productive grasses (P=0.05). During this second year the mean production of all grasses decreased from February to April, normal for the region (22).

Mean total forage production, 15.8 and 15.1 ton/ha, was similar for both years (tables 2 and 4), with a good distribution throughout the year, except for the dry cool months, in which there was a reduction of about 40 to 50% of the mean production per grazing period. This production under grazing was lower than the potential yields obtainable under cutting management in Puerto Rico (13, 14, 15, 17, 18, 19, 20). Throughout the world, forage yields of grasses under cutting tend to be higher than under grazing (1, 2, 4, 5). Local results indicate that about 40% less forage is produced under grazing than under cutting management, but the higher quality of the forage consumed by grazing animals improves cattle performance (22).

All grases persisted well under intensive grazing management as shown by yields during the final months of the experiment, except *C. nlemfuensis* cv. Star (table 4). This was not the case in another grazing experiment in the same region, in which *C. nlemfuensis* cv. Star persisted, but *C. plectostachyus* did not (7).

Mean CP content of all grasses was 14.91% (table 5). *C. plectostachyus* cv. Star and *C. dactylon* cv. Bermuda showed the highest mean CP content, 16.45 and 16.27%, respectively, and *B. humidicola* the lowest, 12.59%. There was a variation in the mean CP content of all grasses with higher content during the months of slow growth in the dry cool season. Similar results have been reported by other researchers in the region (10, 22, 23).

The final evaluation of forage plants should be to determine animal performance. *B. humidicola* has been one of the most productive grasses in agronomic evaluations in the Colombian Llanos (9); however, animal production in grazing trials has been low compared to that of other grasses in the region because of low crude protein content (16). Both *B. humidicola* and *P. maximum* cv. Makueni should be evaluated in grazing trials in Puerto Rico before they are recommended to the cattle industry.

RESUMEN

Producción de gramíneas tropicales pastadas en diferentes ecosistemas agrícolas de Puerto Rico. I. Montañoso húmedo.

Entre 1981 y 1983 se realizó un experimento en la Substación Experimental de Corozal en la región montañosa húmeda de Puerto Rico para evaluar la producción y persistencia de gramíneas tropicales pastadas en parcelas pequeñas. *Brachiaria humidicola, Cynodon dactylon* cv. Bermuda, *C. nlemfuensis* var. *nlemfuensis* cv. estrella, *Digitaria pentzii* cv. slenderstem, *D. decumbens* cv. transvala, *C. plectostachyus* cv. estrella y

TABLE 5.—*Mean crude protein content of dry forage on offer of tropical grasses under grazing in the humid mountain region at Corozal, Puerto Rico, 1981-1983*[1]

Grass number	Grazing dates											Mean per grazing
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	May	Jun.	Jul.	
						%						
6	19.75	25.63	16.00	25.63	15.25	25.63	15.13	13.13	9.63	11.50	6.63	16.45
2	18.38	24.50	15.38	24.50	17.38	21.00	12.63	14.88	10.50	11.75	8.13	16.27
5	17.75	17.38	13.88	14.63	17.38	18.00	13.50	13.75	9.13	11.38	10.13	14.26
4	17.25	22.50	14.25	22.50	15.50	20.50	11.63	15.13	14.13	13.38	7.38	15.83
3	17.13	21.00	14.63	21.00	15.50	20.50	11.63	12.50	10.00	11.63	8.25	14.89
7	15.88	18.88	13.50	18.88	12.50	23.25	11.63	13.00	10.00	10.75	7.25	14.11
1	12.13	17.00	10.75	17.00	12.38	17.00	11.25	11.75	7.38	11.50	10.38	12.59
mean	16.89	20.98	14.05	20.98	14.73	20.84	12.48	13.45	10.00	11.70	8.31	14.91

[1] Mean of 4 replications for 2 years.

Panicum maxumum cv. makueni se pastaron cada 5 a 7 semanas a una altura de 15 cm. con un grupo de 35 animales adultos por 1 ó 2 días. _P. maximum_ cv. makueni, _B. humidicola_ y _C. dactylon_ cv. Bermuda fueron las gramíneas más productivas el primer año, con una media de 1.71 ton./ha. de materia seca por intervalo de apacentamiento, (P=0.05). Al mismo tiempo, _D. pentzii_ cv. slenderstem fue la menos productiva. La producción de todas las gramíneas disminuyó en diciembre de 1981 y enero de 1982, excepto _P. maximum_ cv. makueni, por ser los días cortos y las temperaturas frescas, factores ambientales limitativos durante esta época en la región montañosa húmeda de Puerto Rico, a pesar de que la lluvia fue excepcionalmente abundante. El segundo año _B. humidicola_ fue la gramínea más productiva, con una media de 1.73 ton./ha., seguida muy de cerca por _P. maximum_ cv. makueni. _D. pentzii_ cv. slenderstem fue de nuevo una de las menos productivas y _C. nlemfuensis_ cv. estrella había casi desaparecido al final del experimento. Este año la producción de todas las gramíneas, sin excepción, disminuyó durante la época de febrero a abril. El rendimiento medio total de forraje por año, 15.8 y 15.1 ton./ha., fue similar en ambos años y muy por debajo de los rendimientos potenciales que se obtienen localmente cuando las gramíneas se cortan. El rendimiento medio de todas las gramíneas disminuyó en los períodos secos. El contenido en proteína bruta, sin embargo, fue mayor.

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