Production of grazed tropical grasses in different agroecosystems in Puerto Rico. III. Semiarid[1]

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ABSTRACT

A field experiment was conducted at the Lajas Experiment Substation in the semiarid region of Puerto Rico to evaluate the production and persistence of 8 tropical grasses, *Cynodon nlemfuensis* Star, *C. dactylon* Coastcross-1, *C. plectostachyus* Star, *Panicum maximum* USDA PI 291047, Makueni, Guinea and *P. maximum* USDA PI 259553, and the naturalized pasture *Dichanthium annulatus* pajon. Small plots were grazed at 3- to 5-week intervals for 2 years. *P. maximum* USDA PI 259553 and Makueni were highly productive in the semiarid region, as well as in previous experiments in humid regions in Puerto Rico. They are highly recommended for grazing trials. *P. maximum* Makueni and USDA PI 291047 were the most productive during the first year, although they were not significantly different (P=0.05) from *P. maximum* USDA PI 259553 and Common Guinea, and *Cynodon plectyostachyus* Star. The production of *C. nlemfuensis* Star was similar to that of *Dichanthium annulatus* but higher than that of *C. dactylon* Coastcross-1 (P=0.05). The average production for all grasses declined at the beginning of the year, during the cool short days in February and March, 1983, without any significant difference (P=0.05) among species and cultivars. Production increased at the beginning of the rainy season, but it was low at the peak of the rainy season because of trampling in poorly aerated and compact soils. *C. plectostachyus* Star was the most productive grass during the second year of experiment, although it was not significantly different (P=0.05) from *P. maximum* USDA PI 291017 and 259553 and cultivar Makueni. The production of Common Guinea and that of *D. annulatus* were similar and higher than that of *C. nlemfuensis* Star and *C. dactylon* Coastcross-1 (P=0.05), which did not persist at the end of the experiment. Forage production during the second year was lower than in the first year because of less rainfall in 1983. The mean CP content of all grasses varied from 11.29 to 14.05, except that of *D. annulatus,* which was only 9.73%. CP content was lower during the periods of maximum forage production.

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INTRODUCTION

The grasslands of the southern coastal plains and adjacent foothills are characterized by almost complete absence of trees and the presence of a few scattered shrubs and forbs (2). The soils are fertile and good for agricultural use. However, the region is probably the least developed part of the island because of low rainfall and lack of water for irrigation.

Most of the work on selection of improved forage species has been done in the humid coastal northern plains and mountain regions of Puerto Rico (6, 10). The performance of several grasses under clipping was evaluated in the Lajas Valley, which is representative of the semiarid region of the southern coast (9). *Cenchrus ciliaris* Buffel USDA PI 263509 and *Panicum maximum* Makueni were the most productive grasses during the short cool days from November through March. *P. maximum* USDA PI 291047, Makueni and USDA PI 284765 produced similar dry forage yields, which were higher than those of the other grasses during the rest of the year when temperatures were warmer (9).

Cynodon nlemfuensis Star, *C. dactylon* Coastcross-1 and *C. plectostachyus* Star are highly productive grasses under cutting in the humid mountain and coastal northern regions (6, 10), but they have not been evaluated in the southern region. Under grazing conditions in small plots in the humid regions, *C. plectostachyus* Star (7, 8) has been more persistent than the other grasses. Further evaluation is needed to assess production in drier environments.

Dichanthium annulatus (pajón) is a naturalized grass that has invaded the southern coast, and it is the dominant species in the region. It is drought tolerant and grows well in poorly aerated and compact soils but its nutritive value is poor (2).

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

MATERIALS AND METHODS

The experiment was conducted at the Lajas Agricultural Experiment Substation, lat. 18° 03′ N and long. 67° 03′ W, at an elevation of 27 m, in the semiarid region of Puerto Rico. Mean annual rainfall is 1102 mm, distributed from May through October, and mean daily temperature is 19° C, with seasonal variations of about 3° C.

The soil is a Cartagena clay (Udic Chromusterts) with pH 6.3 and 2 p/m available P (Bray 1) and 132 p/m exchangeable K in the top 15 cm.

A randomized block design with four replications and 8 grass cultivars (table 1) in 8x8 m plots was established August 1981. These grasses were

TABLE 1.—*Identification of grass cultivars*

Grass number	Species	USDA PI[1]	PR PI[2]
1	*Cynodon nlemfuensis* var. *nlemfuensis* cv. Star	——	2341
1	*C. dactylon* cv. Coastcross-1	255455	11504
3	*C. plectostachyus* cv. Star	341818	11487
4	*Panicum maximum*	291047	13093
5	*P. maximum* cv. Makueni	349676	12917
6	*P. maximum* cv. Common Guinea	——	——
7	*P. maximum*	259553	3622
8	*Dichanthium annulatus*	——	——

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

fertilized with a 15-5-10 fertilizer at a rate of 1,600 kg/ha/year divided in 4 equal applications throughout the year. The plots were irrigated as needed.

All plots were cut at a height of 15 cm December 1981, and grazing started 1 month later and continued at 3- to 5-week intervals to a height of 15 cm 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, following the pair quadrats method described by Rivera and Rodríguez (3). Green forage was weighed in the field and samples were taken and dried at 55° C in a forced air oven for 48 h 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 through a 1-mm screen and analyzed for N content with a Technicon Autoanalyzer. Crude protein (CP) was calculated as N x 6.25. The procedure was repeated over 2 consecutive years; information was for 13 grazing dates for each year.

RESULTS AND DISCUSSION

The most productive grasses during the first year of experiment from January 1982 to January 1983 were *P. maximum* Makueni and USDA PI 291047, although they were not significantly different (P=0.05) from *P. maximum* USDA PI 259553 and Common Guinea, and *Cynodon plectyostachyus* Star (table 2). The production of *C. nlemfuensis* Star was similar to that of *Dichanthium annulatus* but higher than that of *C. dactylon* Coastcross-1 (P=0.05). The average production for all grasses declined at the beginning of the year during the cool short days in February and March 1983, without any significant difference (P=0.05) among

TABLE 2.—*Mean dry forage on offer of tropical grasses grazed in the semiarid region at Lajas, Puerto Rico, 1982-1982*

Grass number	Grazing dates														
	Jan. 20 1982	Feb. 24 1982	Apr. 1 1982	May 3 1982	May 26 1982	Jun. 24 1982	Jul. 21 1982	Aug. 19 1982	Sep. 29 1982	Oct. 28 1982	Nov. 29 1982	Jan. 4 1983	Jan. 31 1983	Mean per grazing	Total per year
	metric ton/ha														
7	2.68 a[1]	2.37 a	0.89 a	1.27 ab	1.61 abc	1.37 a	2.08 ab	1.17 ab	1.09 bcd	0.90 b	1.36 b	1.30 b	1.41 a	1.50 ab	19.48 ab
4	2.65 a	1.52 ab	0.62 a	0.66 b	1.70 ab	1.11 a	2.17 a	1.73 ab	2.65 a	0.83 bc	2.66 a	2.21 a	2.17 a	1.75 a	22.68 a
3	2.32 a	1.95 ab	0.99 a	1.46 ab	1.22 bc	1.41 a	2.21 a	1.84 ab	0.38 d	0.42 cd	1.06 b	1.76 a	1.54 a	1.43 ab	18.59 ab
6	2.02 ab	1.21 b	0.63 a	0.81 b	1.18 bc	1.09 a	2.28 a	2.15 a	2.42 a	0.72 bcd	2.73 a	1.70 a	1.55 a	1.58 ab	20.48 ab
5	1.90 ab	1.62 ab	0.38 a	0.65 b	2.11 a	1.21 a	2.19 a	1.80 ab	2.67 a	1.40 a	2.73 a	3.23 a	1.47 a	1.80 a	23.36 ab
2	1.88 ab	1.74 ab	0.86 a	1.70 a	0.81 c	1.02 a	1.37 bc	0.85 b	0.52 cd	0.52 bcd	1.03 b	1.52 a	1.38 a	1.17 c	15.22 c
1	1.65 ab	1.43 ab	0.99 a	1.33 ab	0.82 c	1.00 a	1.12 c	0.95 a	1.18 bc	0.34 d	1.23 b	3.36 a	1.65 a	1.31 b	17.04 b
8	1.01 b	1.21 b	0.46 a	1.09 ab	1.26 bc	1.00 a	1.82 abc	1.74 ab	1.31 b	0.50 bcd	1.44 b	2.77 a	1.36 a	1.31 b	16.98 b
Mean	2.02	1.63	0.73	1.12	1.34	1.15	1.90	1.53	1.31	0.71	1.78	2.23	1.57	1.48	19.23

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

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

Month	1981	1982	1983
		mm	
January	10	13	15
February	35	30	18
March	50	7	121
April	98	42	105
May	129	155	243
June	90	43	16
July	52	128	31
August	103	190	133
September	164	211	24
October	168	135	152
November	71	137	160
December	175	55	76
Total	1,145	1,146	1,093

species and cultivars; then production increased at the beginning of the rainy season in May (table 3), but it was low at the peak of the rainy season in October (fig. 1), probably because of trampling in poorly aerated and compact soils.

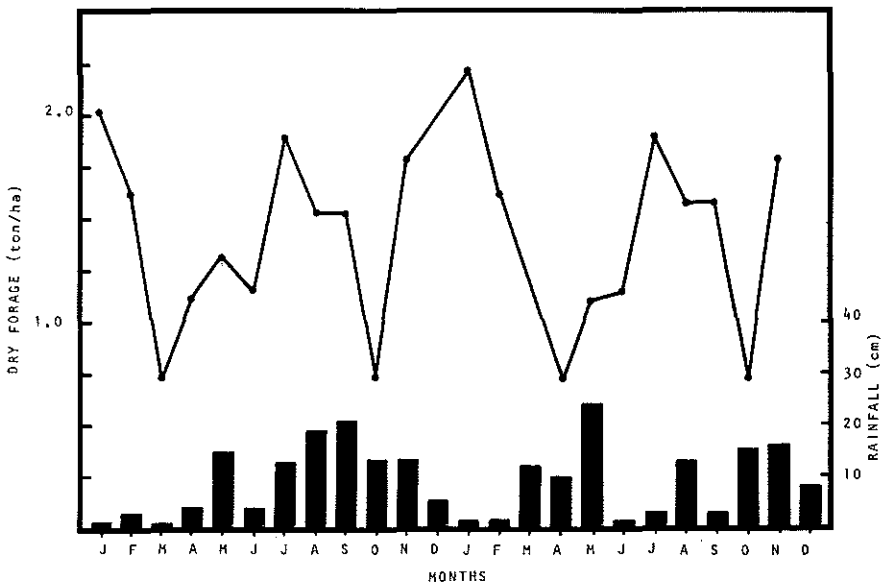

FIG. 1.—Seasonal dry forage on offer, mean for all grasses, grazed in small plots every 3 to 5 weeks at Lajas, Puerto Rico, 1982 to 1984.

TABLE 4.—*Mean dry forage on offer of tropical grasses grazed in the semiarid region at Lajas, Puerto Rico, 1983-1984*

Grass number	Grazing dates													Mean per grazing	Total per year
	Feb. 28 1983	Mar. 25 1983	Apr. 22 1983	May 17 1983	Jun. 6 1983	Aug. 5 1983	Sep. 1 1983	Sep. 23 1983	Oct. 21 1983	Nov. 14 1983	Dec. 7 1983	Jan. 12 1983	Feb. 17 1984		
	metric tons/ ha														
3	0.87 a[1]	1.88 a	1.65 a	1.16 ab	0.99 ab	2.02 a	0.40 cd	1.62 a	1.80 abc	1.66 a	1.20 a	1.66 a	1.30 a	1.40 a	18.21 a
8	0.82 a	1.26 ab	0.89 a	1.12 ab	0.59 b	1.69 ab	0.51 cd	1.88 a	1.08 bc	0.61 b	0.82 ab	0.66 bc	0.55 bc	0.96 c	12.50 c
2	0.80 a	1.29 ab	1.15 a	0.65 b	0.82 ab	0.72 c	0.48 cd	1.01 a	1.23 abc	0.43 b	0.00 c	0.00 e	0.00 d	0.66 d	8.58 d
4	0.73 a	0.97 b	1.53 a	1.27 ab	1.26 a	1.04 bc	1.06 bc	0.93 a	2.07 a	2.32 a	1.12 a	0.65 bc	1.80 ab	1.29 ab	16.75 ab
7	0.72 a	1.15 ab	1.15 a	1.54 ab	0.09 ab	1.28 abc	1.82 a	2.02 a	1.11 bc	2.11 a	1.59 a	1.05 b	1.21 abc	1.36 ab	17.63 ab
6	0.53 a	1.09 ab	1.30 a	1.02 ab	1.13 ab	0.54 c	1.05 bc	0.74 a	1.93 ab	2.17 a	0.74 ab	0.51 bcd	2.32 a	1.16 bc	15.05 bc
1	0.50 a	1.34 ab	1.35 a	1.02 ab	0.60 b	0.80 bc	0.05 d	0.59 a	0.88 c	0.70 b	0.59 ab	0.33 cd	0.34 c	0.70 d	9.09 d
5	0.46 a	0.94 b	1.90 a	1.78 a	1.04 ab	0.82 bc	1.41 ab	1.29 a	1.93 ab	1.97 a	0.91 ab	0.64 bc	1.97 a	1.32 ab	17.15 ab
Mean	0.68	1.24	1.37	1.20	0.92	1.11	0.85	1.26	1.51	1.50	0.87	0.69	1.19	1.11	14.37

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

C. plectostachyus Star was the most productive grass during the second year of experiment from February 1983 to February 1984, (table 4), although it was not significantly different (P=0.05) from *P. maximum* USDA PI 291047 and 259553 and cultivar Makueni. The production of Common Guinea and *D. annulatus* was similar and higher than that of *C. nlemfuensis* Star and *C. dactylon* Coastcross-1 (P= 0.05), which did not persist at the end of the experiment.

Production during the second year was lower than that of the first year (tables 2 and 4), probably because of less rainfall in 1983, especially in June, July, and September, which are normally rainy (table 2). Apparently, irrigation was not sufficient to overcome the moisture deficit in the soil during dry spells.

Mean CP content of all grasses, except *D. annulatus* (pajón), varied from 11.19 to 14.05% (table 5). The CP content of *D. annulatus* (pajón) was only 9.73%, indicating a lower nutritive value compared to that of improved species. The distribution of the CP content also varied according to the seasonal production of dry forage and it was lower during the periods of slow growth (fig. 1). Similar results have been found in the more humid northern coastal plains and humid mountains (4, 7, 8, 9) which have been explained by the dilution effect of yields in the presence of a uniform amount of N (11).

P. maximum USDA PI 259553 was highly productive in this experiment, as has been reported in more humid environments in Puerto Rico (1, 5, 8). The same is applicable to cultivar Makueni (7, 8). These grasses are highly recommended for grazing trials to evaluate animal performance in all the different agricultural agroecosystems in Puerto Rico to compare results with those reported in the humid mountain region at Corozal (1).

RESUMEN

Producción de gramíneas tropicales pastadas en diferentes escosistemas agrícolas de Puerto Rico. III. Semiárido.

En un experimento que se realizó entre 1981 y 1984 en la Subestación Experimental de Lajas en la región semiárida de Puerto Rico se estudió la producción y persistencia de 8 gramíneas tropicales pastadas en parcelas pequeñas. *Cynodon nlemfuensis* estrella, *C. dactylon* coastcross-1, *C. plectostachyus* estrella, *Panicum maximum* USDAPI 291047, makueni y guinea común *P. maximum* USDA PI 259553 y el pasto natural *Dichanthium annulatus* pajón se pastaron a intervalos de 3 a 5 semanas a una altura de 15 cm. por un grupo de 35 animales adultos por un período de 1 a 2 días. Las gramíneas más productivas durante el primer año del experimento fueron *P. maximum* makueni y USDA PI 291047, aunque no fueron diferentes (P=0.05) de *P. maximum* USDA PI 259553, guinea común y *C. plectostachyus* estrella. La producción de *C. nlemfuensis* estrella fue similar a la de *D. annulatus* pajón, pero más alta que la de *C. dactylon* coastcross-1

TABLE 5.—*Mean crude protein content[1] of dry forage on offer of tropical grasses under grazing in the semiarid region at Lajas, Puerto Rico, 1981-1984*

Grass number	Grazing dates												Mean per grazing
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
	%												
7	19.38	13.88	12.56	10.50	12.12	10.88	18.38	10.13	12.12	8.75	17.50	10.12	13.02
2	16.25	15.38	10.50	14.25	14.12	8.12	17.38	10.63	11.13	6.75	17.25	9.25	12.58
6	16.13	13.63	11.50	12.12	11.75	9.75	17.38	12.00	11.13	10.00	16.13	9.25	12.81
3	16.13	17.25	13.75	11.63	13.38	9.88	21.63	11.88	16.38	9.88	19.13	7.75	14.05
4	16.00	14.25	11.63	10.50	11.25	9.50	17.38	13.25	9.63	8.88	13.38	10.87	12.21
1	15.63	17.00	15.13	12.50	12.50	11.25	21.63	12.38	10.38	9.38	15.25	8.12	13.43
5	13.38	13.25	9.63	12.12	11.50	7.75	16.75	10.25	10.58	7.75	12.88	9.62	11.29
8	13.38	11.25	8.25	6.88	10.50	6.63	15.63	8.99	6.50	5.38	15.00	8.37	9.73
Mean	15.78	14.49	11.62	11.31	12.14	9.22	18.27	11.19	10.98	8.35	15.81	9.17	

[1]Mean of 4 replications for 2 years.

(P=.05). La producción media de todas las gramíneas disminuyó al comienzo del año durante los días cortos y frescos de febrero y marzo, 1983, sin que hubieran diferencias significativas (P=0.05) entre especies y cultivares. Luego aumentaron hasta el comienzo de la estación lluviosa en mayo, pero fueron bajas hacia la época de lluvias máximas en octubre, debido probablemente a la pobre aireación y pisoteo en los suelos mal drenados y compactos. *C. plectostachyus* estrella fue la gramínea más productiva el segundo año del experimento en 1984, aunque no fue diferente (P=0.05) de *P. maximum* USDA PI 291047 y 259553 y la cultivar makueni. La producción de guinea común y *D. annulatus* pajón fue similar y más alta que las de *C. nlemfuensis* estrella y *C. dactylon* coastcross-1 (P=0.05), la cual no persistió al final del experimento. La producción durante el segundo año fue menor que durante el primero debido probablemente a una menor incidencia de las lluvias en 1983, especialmente durante los meses de junio, julio y septiembre, los cualos son normalmente lluviosos. La media del contenido en proteína bruta fue mayor en las hierbas mejoradas que en la naturalizada *D. annulatus* pajón, y menor en todas las especies durante los períodos de máximo crecimiento. *P. maximum* USDA PI 259553 fue muy productiva en la región semiárida tal como se ha informado de otros ambientes más húmedos en Puerto Rico; lo mismo sucedió con la cultivar makueni.

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