

# Yield, Crude Protein, and Chemical Composition of Five Napier Grass Cultivars on the Northwestern Coastal Plains of Puerto Rico<sup>1</sup>

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## ABSTRACT

Five Napier grass cultivars (*Pennisetum purpureum* Schum.) were evaluated under cutting management on a Bayamón sandy loam soil on the northwestern coastal plains of Puerto Rico for a period of 2.05 years without irrigation. Grasses received a high input of fertilizer (4,484 kg/ha/yr) and were harvested every 50 days. Mean dry forage yield for cultivars PRPI 13079, 7350, Merker, 13078, and 532 were 46755, 45449, 39439, 38816, and 37581 kg/ha/yr, respectively. Cultivars 13079 and 7350 had similar dry forage yields, which were significantly ( $P < .05$ ) higher than those of the remaining cultivars. Cultivar 7350 was the highest crude protein yielder, with 5413 kg/ha/yr. Mean crude protein, P, K, Ca, and Mg contents for the 5 cultivars were 11.44, .37, 2.56, .31, and .34%, respectively. Leaf/stem ratios for all cultivars ranged from a maximum of 60 to a minimum of 52%.

Cultivars 13079 and 7350 are the most outstanding grasses for this region of Puerto Rico. Cultivars 13078 and 532 are recommended as substitutes for the Merker cultivar. However, cultivar 13078 yields can be adversely affected by prolonged droughts.

## INTRODUCTION

The Merker cultivar of Napier grass (*Pennisetum purpureum* Schum.) was introduced to Puerto Rico from Mississippi by the University of Puerto Rico Agricultural Experiment Station in 1934. Since then, it has been used as a soilage crop, especially on the northern and northwestern coastal plains and other regions of the Island. An estimated 500 ha of this grass are grown for soilage in Puerto Rico.<sup>4</sup> Although it has been studied extensively in other aspects (1, 2, 3, 4, 5, 6, 8, 11, 13, 15, 16, 17, 18), little research has been conducted to compare the potential of the Merker cultivar with recent Napier introductions.

Recently, Vélez-Santiago and Arroyo-Aguilú (14) reported that four Napier cultivars (PRPI 7350, 7353, 13078, and 13079) were superior to the Merker cultivar in the humid mountainous region of Puerto Rico when harvested at 45- and 60-day intervals throughout the year. They

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<sup>4</sup> Jiménez, D., 1981. Personal communication.

reported also that Napier cultivars 13078 and 13079 outyielded the Merker cultivar during the season of short, cool days.

In this study, green forage (GF), dry forage (DF), and crude protein (CP) yields and dry matter (DM), P, K, Ca, and Mg contents of the Merker cultivar were compared with those of four selected Napier accessions, both on a year basis and during the cool days of short photoperiod in the northwestern coastal plain of Puerto Rico.

MATERIALS AND METHODS

The experiment was conducted on a private farm in Hatillo, Puerto Rico. The soil is a deep, red, well-drained, acid, sandy loam (Typic Haplorthox) of the Bayamón series, considered to be of medium natural fertility.

The following tabulation identifies the five cultivars:

<u>USDA PI</u> <sup>5</sup>	<u>PR PI</u> <sup>6</sup>	<u>Other</u>	<u>Relative leaf width</u>
285303	13079		Medium
—	7350		Narrow
—	—	Merker	Medium
300086	13078		Broad
—	532 <sup>7</sup>		Medium

The grasses were subjected to a general harvest February 16, 1977, and thereafter GF yields were measured at 50-day harvest intervals for a 2.05-year period. All cultivars, except 532, were previously evaluated at 30-, 45-, and 60-day harvest intervals in the mountainous region of Puerto Rico (14).

Fertilization was at the rate of 4484 kg/ha/yr, divided into 7 equal applications. Lime was applied, according to the method of Riera (10), at planting and after 1 year, at a rate of 2242 kg/ha/yr, to maintain soil pH at approximately 5.5. No irrigation was applied during the course of the study.

The forage from all plots was hand cut every 50 days at approximately 8 cm above ground and immediately weighed. On three occasions, leaf/stem ratio was also determined, on the basis of 30 stems selected at random from each plot. Grass samples per plot were obtained, dried at 55° C in a forced-air oven, and ground in a Wiley mill<sup>8</sup> to pass through a

<sup>5</sup> United States Department of Agriculture plant introduction number.

<sup>6</sup> University of Puerto Rico Agricultural Experiment Station plant introduction number.

<sup>7</sup> Agronomic Center for Research and Teaching, Turrialba, Costa Rica, plant introduction number.

<sup>8</sup> Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

1-mm screen. Samples were composited by replications for further chemical analyses. Each cultivar was analyzed for total N with a Technicon auto-analyzer during the following periods: February 17, 1977, to February 2, 1978; and September 2, 1977, to February 2, 1978. Samples from February 17, 1977, to March 8, 1979, were analyzed for total N, P and K (9) and for Ca and Mg (7) contents. CP was calculated as % N  $\times$  6.25.

The data from February 17, 1977, to February 2, 1978 (350 days); September 2, 1977, to February 2, 1978, (152 days); and February 17, 1977, to March 8, 1979 (748 days) for GF, DF, and CP yields and for DM contents were subjected to analyses of variance and Duncan's multiple range test (12).

TABLE 1.—Mean green forage, dry forage, and crude protein yields and dry matter content of 5 *Pennisetum* cultivars during the periods of short, cool days (152 days) and of 350 days

Identification	Green forage yield kg/ha	Dry matter content %	Dry forage yield kg/ha	Crude protein yield kg/ha
<i>Period of short cool days (152 days)</i>				
13079	94,475 a <sup>1</sup>	19.46 a	18,311 a	1,870 ab
7350	91,763 a	19.19 a	18,007 a	2,147 a
Merker	83,493 a	17.92 ab	15,329 b	1,881 ab
13078	91,578 a	16.73 b	15,326 b	1,690 b
532	84,243 a	16.82 b	14,373 b	1,686 b
Mean	89,109	18.02	16,269	1,855
<i>Period of 350 days</i>				
13079	312,023 a	16.79 a	49,630 a	4,945 a
7350	313,275 a	15.73 b	46,189 ab	5,313 a
Merker	296,044 ab	15.30 b	42,393 bc	4,994 a
13078	269,792 b	15.63 b	40,566 c	4,410 a
532	274,722 ab	14.89 b	39,053 c	4,436 a
Mean	293,171	15.67	43,566	4,820

<sup>1</sup> Means in the same column followed by one or more letters in common do not differ significantly at the 5-% probability level.

## RESULTS AND DISCUSSION

The period of short cool days was defined as the 152-day period from September 2, 1977, to February 2, 1978. Table 1 shows yields during this period. No significant differences in GF yields were obtained between cultivars. DM contents for cultivars 13079 and 7350 were significantly ( $P = .05$ ) higher than those of cultivars 13078 and 532. The former also outyielded the other three cultivars in DF. Vélez-Santiago and Arroyo-Aguilú (14) reported similar observations on DF yields for cultivar 13079 during the period of short cool days in the mountainous region of Puerto

TABLE 2.—Mean yields and dry matter, crude protein, and mineral contents of 5 *Pennisetum* cultivars during a 2-year period

Identification	Green forage yield	Dry matter content	Dry forage yield	Crude protein yield	Crude protein	Phosphorus	Potassium	Calcium	Magnesium
	<i>kg/ha/y</i>	%	<i>kg/ha/y</i>	<i>kg/ha/y</i>	%	%	%	%	%
13079	281,342 a	17.57 a	46,755 a	4,759 b	10.19	0.38	2.08	0.22	0.39
7350	294, 744 a	16.36 b	45,449 a	5,413 a	11.94	0.35	2.75	0.38	0.33
Merker	265,394 b	16.15 b	39,439 b	4,744 b	12.00	0.34	2.93	0.31	0.30
13078	247,048 b	16.13 b	38,816 b	4,251 b	11.00	0.36	2.55	0.31	0.30
532	247,762 b	15.81 b	37,581 b	4,502 b	12.06	0.40	2.50	0.32	0.39
Mean	267,258	16.40	41,608	4,734	11.44	0.37	2.56	0.31	0.34

<sup>1</sup> Means in the same column followed by one or more letters in common do not differ significantly at the 5% probability level.

Rico. Only cultivar 7350 was significantly ( $P = .05$ ) superior to cultivars 13078 and 532 in CP yields.

The 350-day data indicated that cultivar 7350 produced highest CP yields, while cultivar 13079 presented highest DM content and DF yield. These two cultivars were practically equal in GF yield. DF yields and DM contents of cultivar 13079, but not those of 7350, were superior ( $P = .05$ ) to those of the Merker cultivar. The latter was not significantly inferior in GF yield. Both cultivars 13078 and 532 were inferior ( $P = .05$ ) to the two leading cultivars in DF yield, but not in CP yield (table 1). The period of short cool days which constituted 41% of this phase of the experiment contributed 30%, 37%, and 38% of the 350-day GF, DF, and CP yields, respectively.

Table 2 shows the GF, DF, and CP yields and DM, CP, P, K, Ca, and Mg contents of the grasses throughout the 2-year period. The highest GF

TABLE 3.—*Proportion of leaf blades (percent of dry-weight basis) for 5 Pennisetum cultivars harvested every 50 days*

Harvest date	Day	Leaf/stem ratio <sup>1, 2</sup>					Mean	Rainfall per period
		13079	7350	Merker	13078	532		
								<i>mm</i>
12-13-77-2-2-78	52	57	53	61	56	56	57	100
5-11-78-6-29-78	50	59	63	57	60	60	60	323
6-30-78-8-21-78	53	50	49	48	57	57	52	151
Mean	51	55	55	55	58	58	56	

<sup>1</sup> Mean values of 4 replicates per grass.

<sup>2</sup> Stem includes the sheath.

and DF yields were obtained with cultivars 13079 and 7350, respectively, being significantly ( $P = .05$ ) different from the other three cultivars. Cultivar 7350 produced the highest CP yield, significantly ( $P = .05$ ) different from all other cultivars. The other cultivars were rather similar in CP yields.

Cultivar 13079 had the highest DM content, significantly ( $P = .05$ ) different from all the others, but the lowest CP content. This same negative relationship has been observed in other studies (14). Cultivar 13079 also contained the lowest K and Ca contents, while the other cultivars differed little in CP, P, K, Ca, and Mg contents. Similar mineral contents were reported by Vicente-Chandler et al. (17) for the Merker cultivar when harvested every 40 days.

The leaf/stem ratio between cultivars was very similar and varied from a maximum of 60 to a minimum of 52% during different months of the year (table 3).

The yields of these Napier cultivars harvested every 50 days, with 4484 kg of 15-5-10 fertilizer/ha/yr remained high throughout most of the year except during the period of short cool days when growth was slower. It is recommended that the harvest interval be lengthened in order to increase yields during this part of the year (18). Except during the period of slow

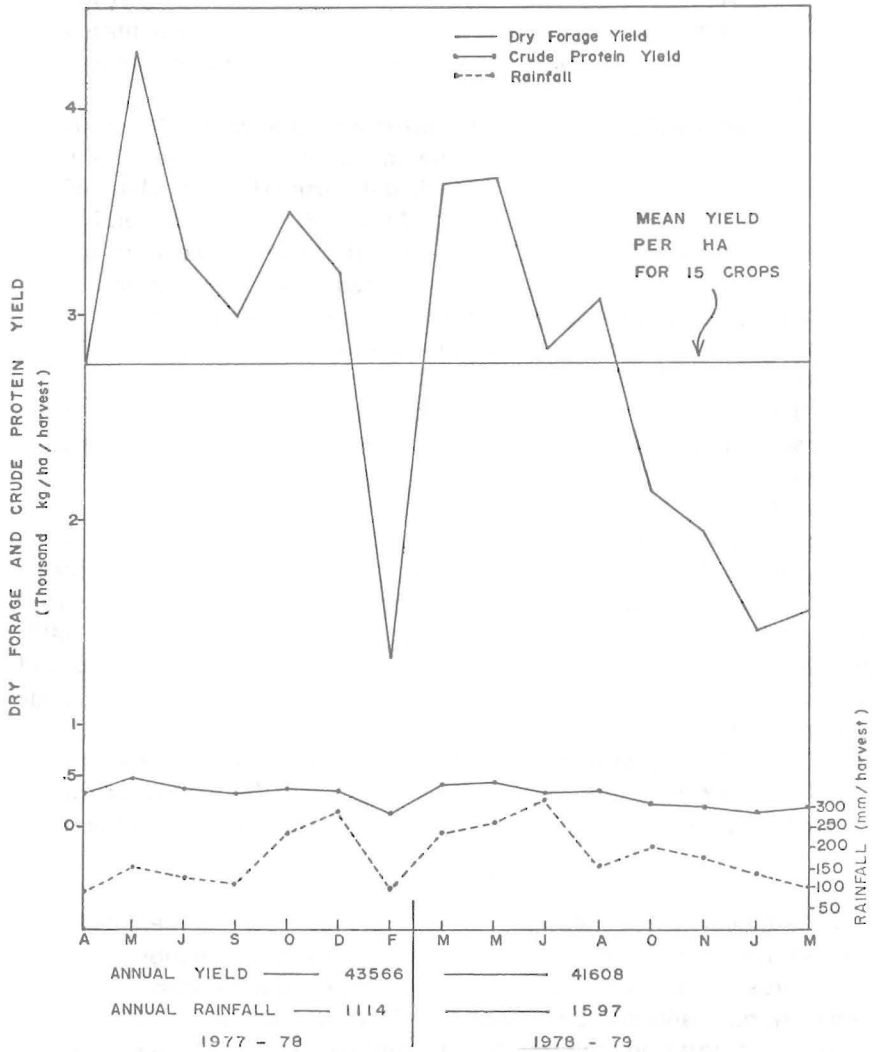


FIG. 1.—Mean dry forage and crude protein yields, and rainfall distribution—5 Napier cultivars harvested every 50 days from April 6, 1977 to March 8, 1979 at Hatillo, Puerto Rico.

growth, plant height at harvest generally ranged from 1.53 to 1.82 m. Weeds were not a problem, in contrast to the situation which prevailed when the grasses were harvested every 30-days in the mountainous region of Puerto Rico (14). Thus, the grasses maintained solid stands throughout the 2 years of the experiment.

The annual excess of GF yield of cultivar 13079 over that of the Merker cultivar (15948 kg/ha/yr) would be enough to supply the theoretical feed requirement for 0.45 animal-year/ha (227 kg liveweight), assuming a daily intake equivalent to 15.67% of liveweight and 20% of wasted forage in a feeding operation (18).

Figure 1 shows that forage yields varied widely during different mo of the year. DF yields were below the mean of the 15 harvests from December 13, 1977 to February 2, 1978, and during the final phase of the experiment from October 9, 1978, to March 8, 1979. Apparently, the shorter and cooler days during the latter part of the first year and during the first 3 mo of the second year contributed to a reduced growth rate, although yields of cultivars 13079 and 7350 were affected less than those of other cultivars (table 1). A similar seasonal pattern of DF yields was reported by Vicente-Chandler et al. (17) for the Merker cultivar.

At the end of the trial, the soil had a pH of 4.6, in spite of the lime application at planting and again at the beginning of the second year of the experiment. This is in agreement with the statement of Vicente-Chandler et al. (18), that quantities of N as high as 840 kg/ha/yr have a strong effect in lowering soil pH. Thus, the need to apply at least 2242 kg/ha/yr of calcium carbonate to maintain optimum soil pH was evident. Rainfall was adequate for rapid grass growth, except during the period from December 14, 1977, to February 2, 1978, when cultivar 13078 presented symptoms of water stress. This cultivar has broad leaves and thick stems. Therefore, its water requirements may be higher than those of other cultivars.

Cultivars 13079 and 7350 excel over the remaining cultivars. Cultivars 13078 and 532 were comparable to the Merker cultivar, except during prolonged drought, when cultivar 13078 yields were adversely affected.

#### RESUMEN

Se evaluaron cinco cultivares de la gramínea de corte elefante (*Penisetum purpureum* Schum.) durante 748 días en los llanos húmedos costaneros del noroeste de Puerto Rico. Estas se abonaron a razón de 4484 kg/ha y año con un análisis 15-5-10, distribuido en siete partes iguales y se cortaron cada 50 días. El suelo es del tipo Bayamón lómico arenoso, considerado de mediana fertilidad. Se determinaron los rendimientos de forraje verde y seco y de proteína bruta y los contenidos de materia seca, proteína bruta, fósforo, potasio, calcio y magnesio.

Los rendimientos de las cultivares 13079 y 7350 fueron mayores que los de la cultivar Merker, generalmente utilizada por los ganaderos de la región, tanto por su rendimiento en los meses fríos como durante el año entero. Los rendimientos de forraje seco de las cultivares 13079, 7350, Merker, 13078 y 532, respectivamente fueron de 46755, 45449, 39439, 38816 y 37581 kg/ha y año. Las cultivares 13079 y 7350 produjeron rendimientos similares de forraje seco y sobrepasaron significativamente ( $P = .05$ ) las restantes cultivares. La cultivar 7350 produjo el rendimiento mayor de proteína bruta, que fue de 5413 kg/ha y año. Los contenidos medios de proteína bruta, fósforo, potasio, calcio y magnesio fueron 11.44, .37, 2.56, .31 y .34%, respectivamente. La razón de hoja a caña fue bastante similar en las cinco cultivares y varió de un máximo de 60 a un mínimo de 52%.

Se concluye que, cosechar las gramíneas Napier cada 50 días fue apropiado para la mayor parte del año, excepto en los meses fríos en que las yerbas no crecieron lo suficiente para producir buenos rendimientos. Se sugiere cortarlas a un intervalo más largo durante esta época del año con el fin de conseguir mejores rendimientos.

Se recomiendan las cultivares 13079 y 7350 para corte en vez de la cultivar Merker para esta zona de Puerto Rico. Las cultivares 13078 y 532 son recomendables también como posibles substitutas de la cultivar Merker. Sin embargo, la cultivar 13078 sufre más los efectos de sequías prolongadas.

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