Effects of Harvest Intervals on the Yield and Composition of 10 Forage Grasses[1]

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INTRODUCTION

Studies on tropical grasses in Puerto Rico have indicated that the best time to harvest forages is at 45-day intervals during periods of fast growth and 60-day intervals during periods of slow growth (17).

It has been observed that yield, chemical composition and nutrient digestibility of grasses are affected by harvest frequency. When the cutting interval is increased, the yield also increases. Crude protein (CP) content and digestibility decrease as forages advance in maturity, while total fiber content, or cell-wall constituents and lignocellulose content, or acid-detergent fiber increase (7).

The effect of cutting frequency on the yield and chemical composition of grasses have been studied under both wet (6) and dry (11) conditions in Puerto Rico. The work reported herein was conducted for the purpose of investigating the effect of three harvest intervals on yield (green (GFY) and dry matter (DMY), CP and digestible protein (DP) content, and mineral content (calcium, Ca; phosphorus, P; potassium, K; and magnesium, Mg) of 10 forage grasses in the semi-arid northwest region of Puerto Rico.

MATERIALS AND METHODS

The 10 forage grasses included in this study are identified in table 1. All grasses, except Hexapangola (15), were studied previously in Puerto Rico (14,16). Hexapangolagrass, considered to have 54 chromosomes (12), was introduced into the Agricultural Experiment Station from the University of Florida in 1967. This hexaploid is very similar morphologically to Pangolagrass.

The grasses were planted by cuttings at the Isabela Substation on a Coto clay (Ultisol) and evaluated during a 1-year period in 1968. The design used was a randomized split-plot with four replications, where grasses were the main plots and growth stages of 30, 45 and 60 days the sub-plots. Individual plots were 10 × 30 feet.

A 14-4-10 fertilizer was applied after each cutting at the rate of 2 tons per acre per year divided in 6, 8 and 12 equal applications. During the dura-

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tion of the experiment, rainfall was well distributed and totalled 69.07 inches.

All grasses were harvested and green-weighed at 30-, 45- and 60-day intervals. Samples were collected at each growth stage, dried at 60° C, and ground in a Wiley mill to pass through a 1-mm screen. Dry matter (DM) and CP contents (3) were determined on all samples. DP content was predicted using the equation $Y = 0.819X = 2.05$ (1), where Y equals % DP content and X equals % CP content. Ca and Mg (9) and P and K (10) were also determined in all samples.

TABLE 1.—*Identification of 10 forage grasses evaluated at Isabela, Puerto Rico*

Grass number	Grass species	Common name	Plant introduction number	
			USDA PI[1]	PR PI[2]
1	*Brachiaria mutica* (Forsk) Stapf.	Tanner	299499	6451
2	*Digitaria decumbens* Stent.	Pangola	111110	—
3	*Brachiaria ruziziensis* (Germain C. Evrard)	Congo	247404	5366
4	*Brachiaria brizantha* Stapf.	Signal	—	1525
5	*Cynodon nlemfuensis* var. *nlemfuensis*	Star	—	2341
6	*Cynodon dactylon* var. *coursii*	—	288218	8991
7	*Digitaria decumbens* Stent.	Hexapangola	—	9477
8	*Digitaria smutsii* Stent.	—	299828	6434
9	*Digitaria decumbens* Stent.	Transvala digitgrass	299752	6439
10	*Digitaria eriantha* Steud.	—	—	5277

[1] United States Department of Agriculture plant introduction number.

[2] University of Puerto Rico Agricultural Experiment Station plant introduction number.

Statistical analyses were conducted as indicated by Snedecor and Cochran (13).

RESULTS AND DISCUSSION

The data in table 2 and figure 1 present the yields of the 10 grasses at the three harvest intervals.

The highest GFY at 30- and 45-day intervals were produced by *Digitaria smutsii* (PRPI. 6434), significantly different ($P < .05$) from Tannergrass (*Brachiaria mutica*, PRPI 6451), Signalgrass (*Brachiaria brizantha*, PRPI. 1525), Stargrass (*Cynodon nlemfuensis*, PRPI. 2341), and *Cynodon dactylon* var. *coursii* (PRPI. 8991). Congograss (*Brachiaria ruziziensis*, PRPI. 5366) produced the highest GFY at 60 days, significantly different ($P < .05$) from all other grasses. *Cynodon dactylon* var. *coursii* had the lowest GF at 30-, 45-, and 60-day intervals.

Cynodon dactylon var. *coursii* presented the highest DM content at the

TABLE 2.—*Effect of harvest frequency on the yield and crude and digestible protein content of 10 forage grasses*[1]

Species	Green forage yield per acre per year	Dry matter	Dry forage yield per acre per year	Crude protein	Crude protein yield per acre per year	Digestible protein
	Pounds	*Percent*	*Pounds*	*Percent*	*Pounds*	*Percent*
			30-day grasses			
Brachiaria mutica (Forsk) Stapf.	97992^{bc}	20.15^{d}	19797^{cd}	12.35^{bc}	2442^{d}	9.25^{bc}
Digitaria decumbens Stent.—Pangola	114205^{a}	20.53^{d}	23479^{ac}	12.51^{bc}	2936^{ac}	9.40^{bc}
Brachiaria ruziziensis (Germain C. Evrard)	105534^{ab}	20.57^{d}	21790^{bd}	11.53^{c}	2514^{cd}	8.47^{c}
Brachiaria brizantha Stapf.	91154^{c}	20.90^{cd}	19041^{d}	13.13^{ab}	2505^{cd}	9.99^{ab}
Cynodon nlemfuensis var. *nlemfuensis*	85877^{cd}	25.77^{b}	22152^{ad}	13.76^{a}	3065^{a}	10.59^{a}
Cynodon dactylon var. *coursii*	77099^{d}	28.40^{a}	21970^{ad}	11.58^{c}	2533^{bd}	8.51^{c}
Digitaria decumbens Stent.—Hexapangola	109617^{ab}	20.78^{cd}	22757^{ad}	12.44^{bc}	2834^{ad}	9.30^{bc}
Digitaria smutsii Stent.	116991^{a}	20.65^{d}	24162^{ab}	12.41^{bc}	2998^{a}	9.29^{bc}
Digitaria decumbens Stent.—Transvala digitgrass	113277^{a}	22.76^{c}	25859^{a}	11.54^{c}	2982^{ab}	8.48^{c}
Digitaria eriantha Steud.	112830^{a}	20.22^{d}	22824^{ad}	13.38^{ab}	3047^{a}	10.23^{ab}
			45-day grasses			
Brachiaria mutica (Forsk) Stapf.	106364^{cd}	20.18^{d}	21404^{c}	9.07^{c}	1947^{d}	6.12^{c}
Digitaria decumbens Stent.—Pangola	117962^{ac}	18.84^{de}	22147^{bc}	10.91^{ab}	2422^{ac}	7.88^{ab}
Brachiara ruziziensis (Germain C. Evrard)	122036^{ab}	18.62^{de}	22710^{bc}	9.79^{bc}	2220^{bc}	6.81^{bc}
Brachiaria brizantha Stapf.	110325^{bd}	20.50^{d}	22542^{bc}	10.87^{ab}	2449^{ac}	7.84^{ab}
Cynodon nlemfuensis var. *nlemfuensis*	98101^{d}	26.34^{b}	25673^{b}	10.18^{ac}	2639^{ab}	7.18^{ac}
Cynodon dactylon var. *coursii*	78138^{e}	28.47^{a}	22277^{bc}	9.67^{bc}	2156^{cd}	6.70^{bc}
Digitaria decumbens Stent.—Hexapangola	121047^{ab}	20.14^{d}	24399^{bc}	10.79^{ab}	2630^{ab}	7.76^{ab}
Digitaria smutsii Stent.	125700^{a}	20.32^{d}	25419^{b}	11.12^{a}	2833^{a}	8.08^{a}
Digitaria decumbens Stent.—Transvala digitgrass	123731^{ab}	23.90^{c}	29532^{a}	9.12^{c}	2705^{a}	6.17^{c}
Digitaria eriantha Steud.	118960^{ac}	17.68^{e}	20962^{c}	11.32^{a}	2373^{ad}	8.26^{a}
			60-day grasses			
Brachiaria mutica (Forsk) Stapf.	122984^{bd}	25.41^{cd}	31323^{cd}	7.25^{c}	2271^{c}	4.39^{c}
Digitaria decumbens Stent.—Pangola	126215^{bd}	25.30^{cd}	31898^{cd}	7.76^{bc}	2475^{bc}	4.88^{bc}
Brachiaria ruziziensis (Germain C. Evrard)	145509^{a}	24.82^{cd}	36168^{ab}	7.16^{c}	2592^{bc}	4.31^{c}
Brachiaria brizantha Stapf.	128030^{bc}	26.34^{bd}	33717^{bd}	8.55^{ab}	2893^{b}	5.63^{ab}
Cynodon nlemfuensis var. *nlemfuensis*	114944^{cd}	32.68^{a}	37504^{a}	9.09^{a}	3423^{a}	6.14^{a}
Cynodon dactylon var. *coursii*	91966^{e}	32.87^{a}	30269^{d}	8.08^{ac}	2455^{bc}	5.18^{ac}
Digitaria decumbens Stent.—Hexapangola	129482^{bc}	25.58^{cd}	33140^{bd}	8.12^{ac}	2677^{bc}	5.22^{ac}
Digitaria smutsii Stent.	131796^{b}	26.87^{bc}	35211^{ac}	8.16^{ac}	2881^{b}	5.26^{ac}
Digitaria decumbens Stent.—Transvala digitgrass	112566^{d}	28.07^{b}	31470^{cd}	7.90^{ac}	2479^{bc}	5.01^{ac}
Digitaria eriantha Steud.	126977^{bd}	24.39^{d}	30956^{d}	8.94^{ab}	2773^{b}	6.00^{ab}

[1] Mean values with one or more common letter(s) do not differ significantly at the 5-percent level.

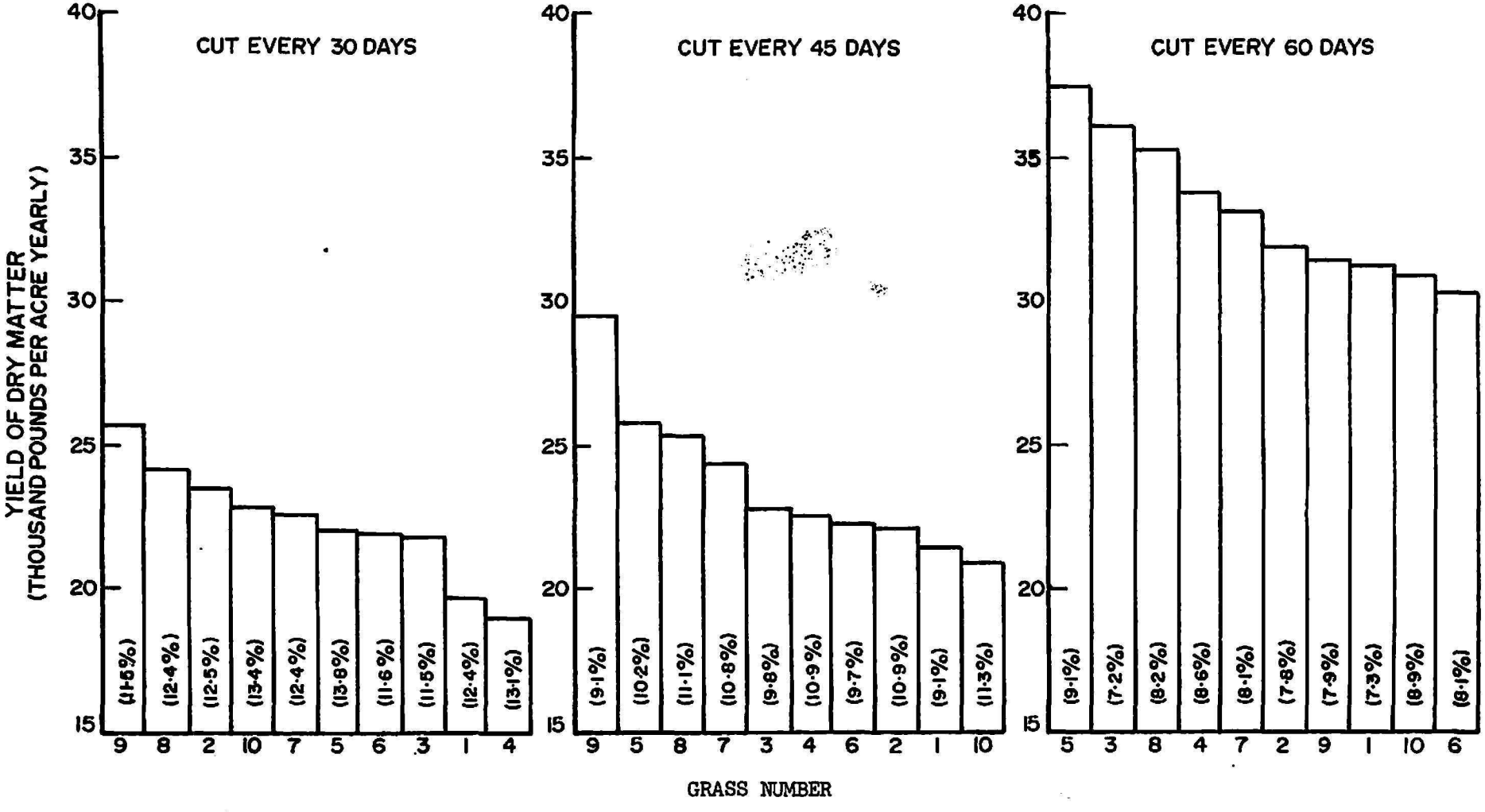

FIG. 1.—Effect of harvest frequency on yield and crude protein content of 10 forage grasses (number in parentheses shows crude protein content of forages on a drymatter basis).

three harvest intervals, being significantly different ($P < .05$) at 30 and 45 days from all other grasses and at 60 days from other grasses except *Digitaria smutsii* PRPI. 6434. Tannergrass exhibited the lowest DM content at 30 days, while *Digitaria eriantha* (PRPI. 5277) was the lowest at 45 and 60 days.

Transvala digitgrass (*Digitaria decumbens*, PRPI. 6439) provided the highest DMY at the 30- and 45-day intervals, being significantly different ($P < .05$) from Congo, Tanner and Signal grasses at 30 days and from all grasses at 45 days. At Ona and Ft. Pierce, Fla., Transvala digitgrass (4) outyielded Pangola (*Digitaria decumbens*). Stargrass produced the highest DMY at the 60-day interval, significantly different ($P < .05$) from other grasses except Congo and *Digitaria smutsii*. The lowest DMY at 30 and 45 days were produced by Signal and *Digitaria eriantha*, respectively. *Cynodon dactylon* var. *coursii* had the lowest DMY at 60 days.

Stargrass had the highest CP and DP contents at the 30- and 60-day intervals, significantly different ($P < .05$) from other grasses except *Digitaria eriantha* and Signalgrass at 30 days and from Pangola, Tanner and Congo grasses at 60 days. Congograss exhibited the lowest CP and DP contents at the 30- and 60-day intervals while Tannergrass had the lowest CP and DP contents at 45 days.

Stargrass produced the highest crude protein yields (CPY) at the 30- and 60-day intervals, significantly different ($P < .05$) from *Cynodon dactylon*, Congo, Signal, and Tannergrasses at 30 days and from all grasses at 60 days. *Digitaria smutsii* had the highest CPY at the 45-day interval, significantly different from Congo, *Cynodon dactylon*, and Tanner grasses. The lowest CPY was produced by Tannergrass at the three intervals.

Hexapangola (*Digitaria decumbens*) did not differ significantly from Pangola in any of the parameters studied.

Mean GFY, DM and DMY of the 10 grasses increased while mean CP and DP decreased as the grasses matured (table 3). Caro-Costas et al. (5) obtained a significant increase in DMY but a significant decrease in CP, as the length of the harvest interval increased from 30 to 90 days in Stargrass. Similar results were obtained by Vicente-Chandler et al. (18) in Congograss and by Arroyo-Aguilú et al. (2) with CP and DP in Pangola, Congo and Star grasses.

Significant differences were obtained between harvest intervals in GFY and DMY (table 3). In DM, significant differences were obtained between 30- and 60- and between 30- and 45-day intervals, respectively. Crude protein and DP exhibited also significant differences between intervals. However, CPY at 30 and 60 days were significantly higher than those obtained at 45 days.

The mean Ca, P, K, and Mg contents of the 10 grasses are shown in table 3. Mean Ca content increased from 30 to 45 days, with no change

at the 60-day interval. Caro-Costas et al. (5) determined that the Ca content of Stargrass was not affected significantly by the length of the harvest interval, although there was a tendency to increase as the length of the harvest interval increased from 30 to 90 days. The mean P and K contents decreased as the harvest interval increased. Similar results for P and K contents were obtained with Stargrass in Puerto Rico by Caro-Costas et al. (5) and in tropical grasses in Brazil by Gomide et al. (8). Mean Mg contents were similar at the three harvest intervals with a slight increase at

TABLE 3.—*Mean green forage, dry matter and crude protein yields, and dry matter, crude protein, digestible protein, calcium, phosphorus, potassium, and magnesium contents in 10 forage grasses at 3 harvest intervals*[1]

Item and unit of measurement	Harvest interval (days)			Mean
	30	45	60	
Green forage yield per acre per year, pounds	102,458[c]	112,236[b]	123,047[a]	112,580
Dry matter, percent	22.07[b]	21.50[b]	27.23[a]	23.60
Dry matter yield per acre per year, pounds	22,383[c]	23,707[b]	33,166[a]	26,418
Crude protein, percent	12.46[a]	10.29[b]	8.10[c]	10.28
Crude protein yield per acre per year, pounds	2,786[a]	2,437[b]	2,692[a]	2,639
Digestible protein, percent	9.35[a]	7.28[b]	5.20[c]	7.28
Calcium, percent	.28	.44	.44	.39
Phosphorus, percent	.27	.23	.17	.22
Potassium, percent	2.21	2.11	1.55	1.96
Magnesium, percent	.26	.28	.25	.26

[1] Mean values with one or more common letter(s) do not differ significantly at the 5-percent level.

the 45-day interval. Caro-Costas et al. (5) indicated that the Mg content of Stargrass was not affected by the length of the harvest interval.

SUMMARY

The effect of three harvest intervals (30, 45 and 60 days) on the yield, crude protein (CP), digestible protein (DP), and mineral (calcium, Ca; phosphorus, P; potassium, K; and magnesium, Mg) composition of 10 forage grasses was determined during a 1-year period at the Isabela Substation. The species studied included three *Brachiarias*, five *Digitarias* and two *Cynodons*.

As the 30-day harvest interval, the dry matter yield (DMY) ranged from 25,859 to 19,041 pounds per acre per year. The highest DMY was obtained by Transvala digitgrass (*Digitaria decumbens*, PRPI. 6439).

Stargrass (*Cynodon nlemfuensis* PRPI. 2341) had the highest CP and DP contents.

The highest DMY at the 45-day interval was obtained by Transvala digitgrass, being significantly different ($P < .05$) from other grasses. The DMY ranged from 29,532 to 20,962 pounds per acre per year. *Digitaria eriantha* had the highest CP and DP contents.

Stargrass had the highest DMY and CP at the 60-day harvest interval. The DMY ranged from 37,504 to 30,269 pounds per acre per year.

Mean Ca and Mg contents in the grasses increased at the 45-day interval with no Ca increase but a Mg decrease at 60 days. Mean P and K contents decreased as the harvest intervals increased.

The yielding ability of the grasses was encouraging, especially in the Transvala digitgrass and Stargrass species. The CP and DP contents tended to vary as plants matured, suggesting that studies of mineral absorption and/or utilization of forage grasses by ruminants should be undertaken.

RESUMEN

Se determinó el efecto de tres intervalos de corte (30, 45 y 60 días) en el rendimiento y contenido en proteína cruda (PC), proteína digestible (PD) y minerales (calcio, Ca; fósforo, P; potasio, K y magnesio, Mg) de 10 yerbas forrajeras durante 1 año, en la Subestación de Isabela, que está localizada en la región noroeste de Puerto Rico. Las especies evaluadas incluyeron tres *Brachiarias*, cinco *Digitarias* y dos *Cynodons*.

A los 30 días de edad, la producción de materia seca (PMS) fluctuó entre 25,859 y 19,041 libras por cuerda por año. La yerba "Transvala digitgrass" (*Digitaria decumbens*, PRPI 6439) obtuvo la PMS mayor y la Estrella (*Cynodon nlemfuensis*, PRPI 2341) presentó los contenidos más alto en PC y PD.

La mayor PMS a los 45 días de edad la obtuvo la "Transvala digitgrass," la cual fue significativamente diferente ($P < .05$) a las nueve yerbas restantes. La PMS varió de 29,532 a 20,962 libras por acre por año. La yerba *Digitaria eriantha* obtuvo el contenido más alto en PC y PD.

La yerba Estrella obtuvo la PMS y reveló el contenido en PC más altos a los 60 días de edad. La PMS varió de 37,504 a 30,269 libras por cuerda por año.

Los contenidos promedio en Ca y Mg aumentaron a los 45 días, permaneciendo igual el de Ca a los 60 días, mientras que el de Mg disminuyó. Los contenidos promedio en P y K disminuyeron según aumentó el intervalo de corte.

La habilidad de las yerbas para aumentar su producción fue alentadora, especialmente en la "Transvala digitgrass" y la Estrella. El contenido en PC y en PD fue mayor a edades tempranas, resultando en rendimientos mayores en PC. El contenido en Ca, P, K y Mg varió de acuerdo al intervalo de corte, sugiriendo la conveniencia de hacer posibles estudios de absorción y/o utilización de minerales con rumiantes.

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