DRY MATTER AND CRUDE PROTEIN YIELDS OF *ECHINOCHLOA PYRAMIDALIS* ON COASTAL CLAY SOIL OF GUYANA[1]

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ABSTRACT

In a field trial conducted at Liliendaal, East Coast Demerara, *Echinochloa pyramidalis* (Lam.) Hitche and Chase was evaluated in 16 m^2 plots for its response to three cutting frequencies (three, four and five weeks), two cutting heights (7.6 cm and 12.7 cm) and two fertilizer rates (zero fertilizer and 84 kg N/ha plus 84 kg P_2O_5/ha) in a randomized complete block design over a two-year period. Accumulated dry matter for the first year was 22 699, 27 554 and 27 073 kg/ha (standard error = 921.93) and crude protein percentage was 11.6, 9.9 and 8.6 (standard error = 0.93) at the three-, four- and five-week harvest intervals, respectively. Accumulated dry matter for the second year was 16 361, 21 778 and 24 033 kg/ha (standard error = 1169.3) and crude protein percentage was 13.0, 10.8 and 9.1 (standard error = 0.11) at three-, four- and five week harvest, intervals, respectively. Cutting height had a small effect on DM yield per harvest, which proved to be significant only in the first year, in favor of the 12.7 cm height. Fertilization significantly increased the accumulated DM yield in the first year but not in the second year. The inconsistencies in the results were due, at least in part, to the pattern of rainfall during the two-year trial. Nevertheless, the results indicate that in a cut-and-carry system, consideration should be given to the category of animals to be fed; for calves and lactating cows, which require a high crude protein content in the feed, a three-week cutting regime would be most appropriate.

(Key words: Tropic fluvaquents, fertilizers, meat, milk).

COMPENDIO

En un ensayo conducido en Liliendaal, en la costa este del Demerara (Guyana), se evaluó el pasto *Echinochloa pyramidalis* (Lam.) Hitche y Chase, en parcelas de 16 m^2, en cuanto a su respuesta a tres frecuencias de corte —tres, cuatro y cinco semanas—, dos alturas de corte (7.6 cm y 12.7 cm) y dos niveles de fertilización: cero y 84 kg N/ha más 84 kg P_2O_5/ha, en un diseño de bloques completos al azar, durante dos ados. En el primer año, la producción acumulada de materia seca fue 22 699 kg/ha, 27 554 kg/ha y 27 073 kg/ha (error estándar = 921.93) y el porcentaje de proteína cruda fue de 11.6, 9.9 y 8.6 (error estándar = 0.93) para los intervalos de corte de tres, cuatro y cinco semanas, respectivamente. En el segundo año, la materia seca acumulada fue de 16 361 kg/ha, 21 778 kg/ha y 24 033 kg/ha (error estándar = 1169.3) y la proteína cruda fue 13.0%, 10.8% y 9.1% (error estándar = 0.11) para los intervalos de tres, cuatro y cinco semanas, respectivamente. La altura de corte tuvo un efecto pequeño sobre la producción de materia seca y solo fue significativo en el primer año, favoreciendo al corte a 12.7 cm de altura. La fertilización aumentó significativamente la producción acumulada de materia seca en el primer año pero no así en el segundo año. La inconsistencia en los resultados se debió, por lo menos en parte, al patrón de lluvias que imperó en los dos años de la prueba. Sin embargo, los resultados indican que en un sistema de alimentación con forrajes de corte, se debe tomar en cuenta la categoría de los animales a ser alimentados; por ejemplo, los terneros y las vacas lactantes, los cuales requieren de un alto contenido de proteína en el alimento, un régimen de cortes cada tres semanas sería lo más apropiado.

INTRODUCTION

The coastal ecozone of Guyana extends for approximately 400 km from the Corentyne river in the east to the Waini river in the west, and varies in width from about 1 km to 60 km inland from the Atlantic coast (2, 7). The land is approximately 2 m below sea level at high tides.

To make these lands agriculturally productive, a series of irrigation and drainage canals are operated which provide irrigation water from inland reservoirs and drain excess water into the ocean and rivers. A protective wall along the coast prevents the encroachment of the ocean at high tides.

The mean annual rainfall is greater than 2 000 mm and the land can be flooded for extensive periods interspersed with very dry periods (7). The rainfall pattern is reported to be bi-modal with the major periods of precipitation occurring in the months April to August and November to January (2, 7). The soils are mainly clays belonging to the soil orders Entisols, Inceptisols and Ultisols (2, 12).

Approximately 80 per cent of Guyanaís cattle population exist in this ecozone and could contribute significantly to the national demands for meat and milk. In order to improve production and productivity, improved grasses which are adapted to the stated conditions and give good dry matter production and quality should be used.

Echinochloa pyramidalis (Lam.) Hitche and Chase has been reported to flourish under seasonally flooded conditions (12, 15). It has been recommended and is now being used increasingly as a pasture grass for both soiling and grazing (8).

This study was undertaken to determine the utilization potential of *E. pyramidalis* to provide feed for cattle in one of the cattle-producing areas of the coastal ecozone. The trial was conducted over two years, from

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June 13, 1988 to May 29, 1990, to allow for the effects of annual weather fluctuations

MATERIALS AND METHODS

Soil type

The experiment was conducted at Liliendaal, East Coast Demerara, on a soil in the series Whittaker, classified by Smith (13) as Tropic Fluvaquents.

Experimental design

This was a 3 x 2 x 2 factorial in a randomized complete block design. There were three replicates.

Field layout

An already established *E. pyramidalis* pasture was used for the trial and 16 m^2 plots were measured out and demarcated with pickets. The plots were 0.9 m apart within blocks and a 1.5 m pathway separated the blocks. The entire experimental area was fenced to keep out grazing animals.

Treatments

The 12 treatments were combinations of the following variables: (a) cutting at three-, four- and five-week intervals; (b) fertilizer applied at zero and 84 kg N/ha together with 84 kg P_2O_5/ha; and (c) harvesting at 7.6 cm and 12.7 cm heights.

Harvesting and measurement

Sampling was done using a quadrat of 0.165 m^2. Two samples were randomly taken per plot. All stolons originating within the area of the quadrat were harvested. Markings of 7.6 cm or 12.7 cm on a graduated pole were used to determine the height of sampling and for cutting back the plots.

The weights of the harvested samples were recorded. The samples were then dried in an oven between 50 ∞C and 60 ∞C for approximately 48 hours, or until a constant weight was achieved. The weights of the dried samples were recorded and the dry matter (DM) yield per quadrat determined. The DM yield in kg/ha was calculated by multiplying the DM yield of the quadrat by the constant 60 547. Crude protein (CP) determinations were then made using the micro-Kjeldahl technique.

Daily rainfall data were obtained from the meteorological station situated at the Botanical Gardens, which was approximately 3 km away from the experiment location.

RESULTS

The statistical data for the two periods, June 1988 to May 1989 and June 1989 to May 1990, were analyzed separately.

The results for DM yield, CP content and CP yield for the three cutting frequencies and for the periods from June 1988 to May 1989 and June 1989 to May

Table 1a. Dry matter and crude protein yields and crude protein percentage of *E. pyramidalis* at three-, four- and five- week harvest intervals for June 1988 - May 1989.

Parameter	Harvest intervals			Standard
	3-week	4-week	5-week	error
Accumulated dry matter yield (kg/ha)	22 698.7	27 553.8	27 073.3	921.93
Dry matter per harvest (kg/ha)	1 335.2	21 19.6	27 07.5	78.39
Accumulated crude protein (kg/ha)	2 628.1	2 730.3	2 333.7	108.84
Crude protein per harvest (kg/ha)	154.60	210.03	233.39	8.61
Crude protein (%)	11.56	9.90	8.62	0.93
No. of harvests	17	13	10	—

Error, degrees of freedom = 22

Table 1b. Dry matter and crude protein yields and crude protein percentage of *E. pyramidalis* at three-, four- and five- week harvest intervals for June 1989 - May 1990.

Parameter	Harvest intervals			Standard
	3-week	4-week	5-week	error
Accumulated dry matter yield (kg/ha)	16 360.8	21 777.8	24 032.9	1 169.33
Dry matter per harvest (kg/ha)	962.4	1 675.3	2 403.4	101.23
Accumulated crude protein (kg/ha)	2 128.7	2 347.4	2 182.8	134.12
Crude protein per harvest (kg/ha)	125.22	180.58	218.29	10.62
Crude protein (%)	13.00	10.80	9.09	0.107
No. of harvests	17	13	10	—

Error, degrees of freedom = 22

1990 are given in Tables 1a and 1b, respectively. For the two periods June 1988 to May 1989 and June 1989 to May 1990, the cutting intervals had a significant effect ($P<0.05$) on DM yield per harvest and accumulated DM yield. DM yield per harvest was highest at the five-week cutting interval and lowest at the three-week cutting interval; these data directly influenced the accumulated DM yield.

Cutting interval also had a significant effect ($P<0.05$) on the CP content and CP yield per harvest. The CP content was highest at the three-week cutting interval and lowest at the five-week cutting interval. The CP yield per harvest was highest at the five-week cutting interval and lowest at the three-week cutting interval.

Fertilizer had a significant effect ($P<0.05$) on the accumulated DM yields for the period June 1988 to May 1989, but not for the period June 1989 to May 1990. Accumulated DM yield increased overall from 24 783.7 kg/ha without fertilizer to 26 766.9 kg/ha (standard error = 752.72) with fertilizer for the period June 1988 to May 1990. The effects of fertilizer on DM and CP yields at the different cutting intervals for the two periods are shown in Tables 2a and 2b, respectively.

Height at time of harvest had a significant effect ($P<0.05$) on the DM yields per harvest for the period June 1988 to May 1989 but not for the subsequent period June 1989 to May 1990. The DM yield per harvest increased overall from 1969.8 kg/ha at the 7.6 cm harvest height to 2138.4 kg/ha (standard error = 110.86) at the 12.7 cm harvest height for the period June 1988 to May 1989. The effects of harvest height on DM and CP yields at the three cutting intervals for June 1988 to May 1989 and June 1989 to May 1990 are shown in Tables 3a and 3b, respectively.

There were no significant interactions ($P>0.05$) for the two periods. The DM yields for the various harvests at the three-, four- and five-week cutting frequencies are shown in Figs. 1a, 2a and 3a, respectively, for the period June 1988 to May 1989 and in Figs. 1b, 2b and 3b respectively, for the period June 1989 to May 1990. The corresponding recorded rainfall data are shown as well. The pattern of rainfall seemed to influence DM yields per harvest; however a linear regression of DM on rainfall for the three harvest; intervals was significant only at the five-week harvest interval in the second period ($P<0.05$).

Allowing for 3% of live weight as DM intake, with 400 kg live weight equivalent to one animal unit (AU), carrying capacities for the first year would have been 5.2, 6.3 and 6.2 AU at the three-, four- and five-week harvest intervals, respectively. These would have been lower in the second year, the estimates being 3.7, 5.0 and 5.5 AU at the three-, four- and five-week harvest intervals, respectively,

Table 2a. **Dry matter and crude protein yields and crude protein percentage of *E. pyramidalis* for fertilized and unfertilized plots at three- four- and five-week harvest intervals for June 1988 - May, 1989.**

Parameter	Harvest intervals						Standard error
	3-week		4-week		5-week		
	f0	f1	f0	f1	f0	f1	
Accumulated dry matter yield (kg/ha)	22 562 6	22 834 9	25 616 8	29 490 7	26 172 0	27 974 9	1 303 76
Dry matter per harvest (kg/ha)	1 327.0	1343 3	1 970.5	2 268 7	2 617 3	2 797 6	110 86
Accumulated crude protein (kg/ha)	3 630.2	2626 0	2 533 8	2 926.8	2 236.0	2 431 5	153 92
Crude protein per harvest (kg/ha)	154.72	154.48	194 9	255 2	223 6	243 2	12.17
Crude protein (%)	11 63	11 48	9 88	9 91	8 59	8.68	0 13
No. of harvests	17		13		10		—

Error, degrees of freedom = 22
f0 = unfertilized f1 = fertilized

Table 2b. Dry matter and crude protein yields and crude protein percentage of *E. pyramidalis* for fertilized and unfertilized plots at three- four- and five-week harvest intervals for June 1989 - May 1990.

Parameter	Harvest intervals 3-week		4-week		5-week		Standard error
	f0	f1	f0	f1	f0	f1	
Accumulated dry matter yield (kg/ha)	16 373.0	16 348.0	20 001.6	23 474.0	22 976.0	25 089.7	1 653.2
Dry matter per harvest (kg/ha)	963.2	961.5	1 544.7	1 805.8	2 297.9	2 509.0	143.16
Accumulated crude protein (kg/ha)	2 139.0	2 118.4	2 193.0	2 501.6	2 060.9	2 304.6	189.67
Crude protein per harvest (kg/ha)	125.8	124.6	168.7	192.4	206.1	230.5	15.00
Crude protein (%)	13.00	12.97	10.93	10.66	9.02	9.15	0.15
No. of harvests	17		13		10		—

Error, degrees of freedom = 22
f0 = unfertilized f1 = fertilized

Table 3a. Dry matter and crude protein yields and crude protein percentage of *E. pyramidalis* at two levels of cutting and harvesting at three- four- and five-week harvest intervals for June 1988 - May 1989.

Parameter	Harvest intervals 3-week		4-week		5-week		Standard error
	H1	H2	H1	H2	H1	H2	
Accumulated dry matter yield (kg/ha)	22 587.8	22 809.7	26 850.0	28 257.4	25 150.0	28 996.4	1 303.76
Dry matter per harvest (kg/ha)	1 328.7	1 341.7	2 065.5	2 173.6	2 515.0	2 899.8	110.86
Accumulated crude protein (kg/ha)	2 652.4	2 603.9	2 698.9	2 761.7	2 224.5	2 443.0	153.92
Crude protein per harvest (kg/ha)	156.00	153.20	207.60	212.40	222.46	244.31	12.17
Crude protein (%)	11.72	11.39	10.04	9.75	8.85	8.42	0.13
No. of harvests	17		13		10		—

Error, degrees of freedom = 22
H1 = 7.62 cm cutting height; H2 = 12.7 cm cutting height

Table 3b. **Dry matter and crude protein yields and crude protein percentage of *E. pyramidalis* at two levels of cutting and harvesting at three-four- and five-week harvest intervals for June 1989 - May, 1990.**

Parameter	Harvest intervals 3-week H1	3-week H2	4-week H1	4-week H2	5-week H1	5-week H2	Standard error
Accumulated dry matter yield (kg/ha)	16 186.7	16 534.8	21 206.7	22 349.0	24 802.0	23 263.7	1 653.15
Dry matter per harvest (kg/ha)	952.2	972.5	1 631.4	1 719.0	2 480.5	2 326.4	143.16
Accumulated crude protein (kg/ha)	2 117.7	2 139.7	2 293.9	2 400.9	2 274.9	2 090.6	189.67
Crude protein per harvest (kg/ha)	124.58	125.85	176.46	184.69	227.52	209.06	15.00
Crude protein (%)	13.11	12.92	10.84	10.75	9.15	9.03	0.15
No. of harvests	17		13		10		—

Error, degrees of freedom = 22
H1 = 7.62 cm cutting height; H2 = 12.7 cm cutting height

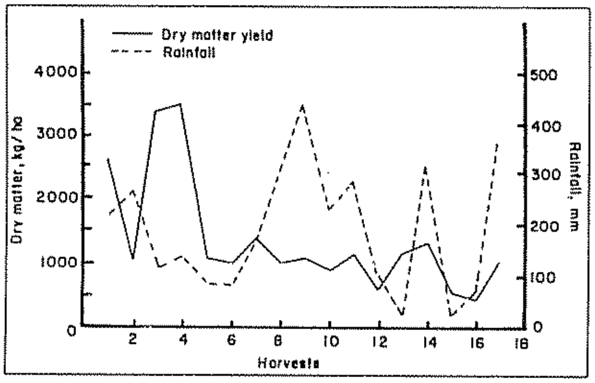

Fig. 1 a. Dry matter yields of *E. pyramidalis* harvested every 3 weeks and rainfall from June 1988 to May 1989.

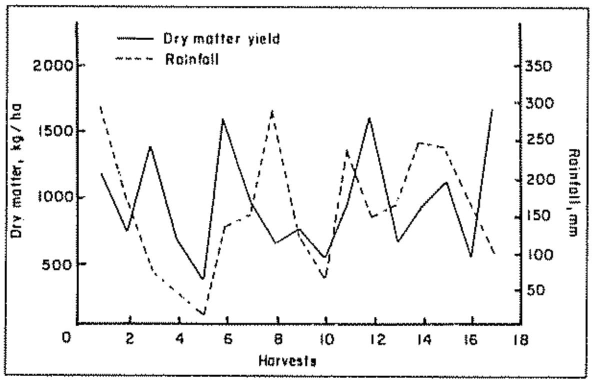

Fig. 1b. Dry matter yields of *E. pyramidalis* harvested every 3 weeks and rainfall from June 1989 to May 1990.

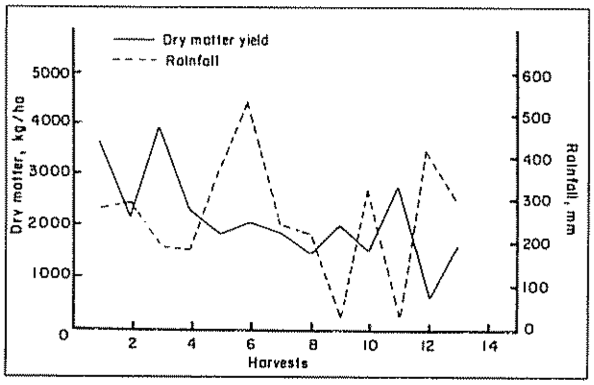

Fig. 2 b. Dry matter yields of *E. pyramidalis* harvested every 4 weeks and rainfall from June 1988 to May 1989.

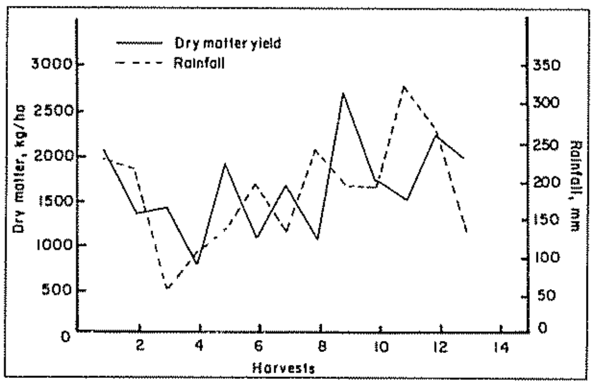

Fig. 2 b. Dry matter yields of *E. pyramidalis* harvested every 4 weeks and rainfall from June 1989 to May 1990.

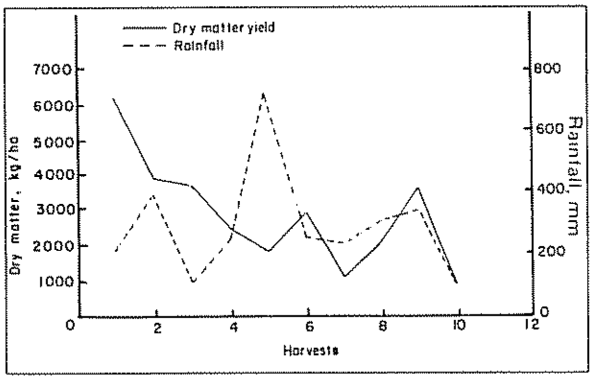

Fig. 3 a. Dry matter yields of *E. pyramidalis* harvested every 5 weeks and rainfall from June 1988 to May 1989.

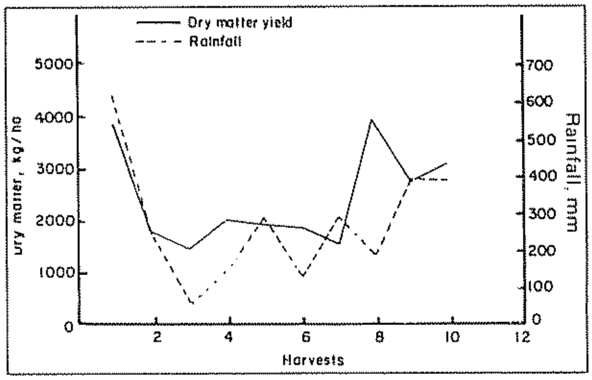

Fig 3 b. Dry matter yields of *E pyramidalis* harvested every 5 weeks and rainfall from June 1989 to May 1990.

DISCUSSION AND RECOMMENDATIONS

The higher DM yields obtained at the longer cutting frequencies would be expected as the plants would have more time to produce and accumulate metabolites. Also at extended cutting intervals, tiller and leaf formation, leaf elongation and stem development would be higher. Cutting too frequently would deplete carbohydrate reserves and cause a decline in root development, resulting in reduced forage yield (3).

The higher CP content at the shorter harvest intervals is also to be expected because CP content declines with age (11), particularly in tropical pastures.

The lower yield obtained at the shorter cutting height in the first year may be the result of less reserves in the residual herbage to promote regrowth. Also, continuous cutting of forage nearer ground level would result in the plant becoming weakened, and would reduce regrowth potential (3). It was also shown by Funes *et al.* (4) that DM yields were higher at longer cutting intervals and at higher heights of harvesting.

The major effect of fertilizer was on DM yields. Nitrogen fertilizer is known to increase the DM production of grasses (5). It has also been demonstrated by Azevedo *et al.* (1) that phosphorus can increase the yields of *E. pyramidalis*. In this study, however, fertilizer did not seem to affect the CP content, probably because of the levels of fertilizer used. The major benefit of applying N and P together, at the levels used in this trial, would be to increase DM yields. There is also the possibility that the flooded conditions during the experimental period would have caused movement across plots and confounded the effects of fertilizer.

The variation in DM at the various periods may have been a result of the rainfall pattern. Rainfall is known to affect the pattern of forage production (6, 14)While rainfall was not an experimental treatment, its effect cannot be ignored and Figs. 1a, 1b, 2a, 2b, 3a and 3b, indicated some influence of rainfall on DM yield. The lack of significance in the regression analyses might have been due to the rainfall distribution for the regrowth periods. All the rainfall for a period may not have contributed to regrowth, especially when this rainfall occurred near the time of harvesting.

In a cutting regime for animal feeding, consideration should be given to the category of animals to be fed and to the balance between quality and quantity of forage available. For animals that require a high crude protein content, such as calves and lactating cows, a three-week cutting regime may be most appropriate; however, due to the lower dry matter yield, lower stocking rates would have to be employed.

A five-week harvest interval may be used for dry cows and replacement heifers and higher stocking rates could be accommodated. The four-week cutting frequency would give a good balance between crude protein yield and dry matter production and may be recommended as the optimum harvest interval. This cutting interval has also been recommended by Muñoz *et al.* (8, 9, 10). It may also be more beneficial for DM production to harvest at 12.7 cm rather than at 7.6 cm.

The fluctuating pattern of production implies that forage conservation would have to be a regular practice to ensure a regular supply of forage throughout the year, especially when stocking levels are close to carrying capacities.

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