CARIBBEAN FOOD CROPS SOCIETY

PROCEEDINGS

ELEVENTH ANNUAL MEETING

STUDIES OF PANGOLA GRASS *(DIGITARIA DECUMBENS* STENT.) IN BARBADOS

EFFECT OF LEVEL OF NITROGEN FERTILIZATION AND FREQUENCY OF CUTTING ON THE YIELD, CHEMICAL COMPOSITION AND *IN VITRO* CELLULOSE DIGESTIBILITY

by

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SUMMARY

The effect of 0,224, 448 and 896 KgN/ha and 4,6, and 8-week cutting frequencies on yield, chemical composition and *in vitro* cellulose digestibility of Pangola grass was studied in a 32-week experiment. Increasing cutting frequency and N level resulted in decrease in DM and increase in CP contents. Cellulose tended to increase, and ADL to decrease as cutting decreased. Increasing N had little effect on cellulose, ADF, ADL or NDF. Decreasing cutting and increasing N increased DM yield. Yield of DM/unit N and of CP increased while 24-hour IVCD decreased as cutting decreased. Yield of CP and 24-hour IVCD increased with increasing levels of N.

INTRODUCTION

Since its introduction in 1955, Pangola grass *(Digitaria decumbens,* Stent.) has become the major forage crop grown in Barbados. Because of the relative ease with which it is established, its adaptability to a wide range of soils, its vigorous growth and drought tolerance, Pangola has become very popular. It is, however, tolerant of low soil fertility, and a number of workers have reported excellent responses to nitrogen fertilization. (Hosaka and Godell 1954; Engibous *et al.* 1958; Little *et al.* 1959; Adeniyi and Wilson, 1960; Vincente-Chandler *et al.* 1961; Rivera-Brenes *et al.* Crowder *et al.* 1964; Bryan and Sharp, 1965; Kretschmer, 1965; Richards, 1965.) In general results suggest that response to nitrogen fertilization is linear up to 336 kg N/ha. (Oakes *et al.* 1959; Vincente-Chandler *et al.* 1961). Rivera-Brenes *et al.* (1954) reported a linear response up to 896 kg N/ha, and Pangola has been found to continue responding to increasing levels of nitrogen even up to 1,944 kg N/ha. (Rivera-Brenes, 1961; Salette, 1965.) However, as a rule, the efficiency of nitrogen utilization was reported to decrease with increasing rates of this element.

Although Pangola grass has been grown in Barbados for more than 15 years, no work has been done on its nutrient requirements. This paper reports the results of an experiment with this grass lasting 32 weeks at the Pine Animal Nutrition and Grassland Research Station. The experiment was designed to measure the effects of different cutting treatments and levels of nitrogen on the production, chemical composition and *in vitro* cellulose digestibility of Pangola grass.

MATERIALS AND METHODS

The Pine Animal Nutrition and Grassland Research Station which is in the South-Western part of the island, is about 45 metres above sea level, and enjoys "intermediate rainfall", an average annually of 1,186 m.m., with most of the rain falling from June to mid-January. The soil

on the station is a Black Association Soil, (Vernon and Caroll, 1966) pH 7.3, with a high cation exchange capacity, although exchangeable potassium is low.

The experiment was laid down on a four-month old sward of grass which had already been cut back twice. It involved a 3x4 factorial design with each treatment replicated 4 times. The treatments studied were nitrogen in the form of Sulphate of Ammonia, at 0,224,448 and 896 kg. per hectare and cutting frequencies of 4,6 and 8 weeks. The gross plot size was 5.1 x 1.8 metres. Fertilizer was applied in water at the start of the experiment and after every cutting.

At harvest guard rows 0.46 metre were cut from the end of plots and a strip 0.92 metre wide between two guard-rows 0.46 metre wide was cut by motor scythe. The grass was collected and fresh weight was recorded. A sample of approximately 500 gm. was taken and dried in a Unitherm oven 95° C for 24 hours for calculation of dry matter yield on a per hectare basis. Dried samples were milled and kept until completion of the experiment in the field, and then samples from each cutting at each N level were combined. Sub-samples were analysed for crude protein and ash (A.O.A.C., 1965), Neutraldetergent fibre (Van Soest and Wine, 1967), Acid-detergent fibre and Acid-detergent lignin (Van Soest, 1963) and cellulose (Crampton and Maynard 1938 as modified by Donefer *et al.* 1960). The *in vitro* cellulose digestibility of forage samples was determined after 24 hours using the method of Donefer *et al.* (1960).

The experiment was run for a 32-week period covering both a wet and a dry season. Between harvests, the experiment was irrigated, when necessary, to ensure that it had received 76.2 mm of water every 11 days.

RESULTS AND DISCUSSION

1. Effects of Treatments on Chemical Composition

(a) Frequency of Cutting

As the frequency of cutting increased, the mean Dry Matter (DM) content decreased (range 28.2% - 21.8%) and the mean crude protein (CP) content increased (range 7.4% - 12.3%) linearly. (Table 1) These trends are in agreement with those reported for Pangolagrass (Chicco, 1962. Butterworth, 1963. Grieve and Osborne, 1965, Vincente-Chandler *et al.* 1961). There was a tendency for the cellulose content to increase as cutting frequency decreased (31.2% to 33.1%). This agreed with the results reported by Gomide *et al.* (1969). Acid-detergent fibre, ADF showed a slight increase (36.9% to 38.0%) as cutting frequency decreased. This represents the ligno-cellulose content and therefore showed trends similar to cellulose. Acid-detergent lignin (ADL) on the other hand decreased (6.1% to 4.8%) as the interval between cuts increased. This decrease in ADL with age is contrary to all other reported work and is not understood. However, Neutral-detergent (NDF), representing the cell constituent was unaffected. Ash content decreased slightly as the cutting interval increased, in agreement with the results obtained by Gomide *et al.* (1966).

(b) Nitrogen Level

As would be expected, mean DM content decreased (25.4% to 23.3%) and mean CP content increased (8.7% to 11.9%) as nitrogen level increased. There was an exception however, at the 6-and-8-week frequencies when CP decreased as nitrogen was increased from 0 to 224 kg/ha. This decrease was probably due to a reduction in the leaf/stem ratio. The grass in the plots receiving 0 kg N was observed to have grown slower and to have less stem than grass in the 224 kg N plots.

Neither cellulose, ADF, ADL nor NDF was affected by increasing nitrogen levels. This result was in agreement with that reported by Gomide *et al.* (1969) and agrees with the report of Blaser (1964) that nitrogen

fertilization does not generally alter the structural carbohydrates of forages. Similarly, the effect on ash content was slight and not consistent. (Table 1)

2. Effect of treatments on Yield

(a) Yield of Dry Matter

Both decreasing cutting frequency and increasing level of nitrogen fertilization had a highly significant ($P < .01$) positive effect on DM yield. (Table 2) This effect was also reported for Pangolagrass by Adeniyi and Wilson (1960) and Caro-Costa *et al.* (1965). Highest yield of 20, 190 kg/ha over the 32 week experimental period was obtained from the 8-week cutting frequency receiving 896 kg N/ha. per year. This is equivalent to 32,812 kg/ha in a 52-week period. The response to nitrogen was almost linear up to 896 kg N/ha when cut at the 4-and 6-week frequencies, while at the 8-week frequency it was linear up to 448 kg N/ha at which point the yield per additional unit of nitrogen decreased.

The yield of DM per unit of applied N increased as the cutting frequency decreased but tended to be highest at the 448 kg N level and lowest at the 896 kg N level. Although the effect of maturity reported here agreed with the results obtained by Vincente Chandler *et al.* (1961) the effect of increasing N differed in that these workers in Puerto Rico found a rapid decline in yield of DM per unit of applied N as the level of N fertilization increased. The mean for all treatments reported here was 150.0 kg/ha of applied N, which was less than that of 23.9 kg (range 1.3 to 69.6) reported by Vincente-Chandler *et al* (1961) and 21.8 kg (range 20-119) reported by Bryan and Sharpe (1965).

(b) Yield of Crude Protein

The mean yield of CP (Table 2) increased as the cutting frequency decreased. The highest yield of 1,828 kg CP was obtained in the 4-week frequency at 896 kg N per ha. On the other hand, the mean increase of protein yield as a function of increasing N fertilization was much more pronounced being 350.7, 597.0, 997.1 and 1,748 kg/ha at the 0,224, 448

and 896 kg N/ha levels respectively (i.e. 596.9, 970.0, 1745.3 and 2841.8 kg/ha per year). Vincente-Chandler *et al* (1961) reported a similar trend, however, the yields obtained in this study are lower than those (865.8, 1878.2, 2688, 3173.0 kg/ha per year) reported by these workers.

The proportion of applied nitrogen recovered in the forage (Table 3) was found to increase with increasing rates of fertilizer nitrogen. These results do not agree with those published by Vincente-Chandler *et al* (1961) or by Bryan and Sharpe (1965), who both reported a decrease in nitrogen recovered as the fertilizer nitrogen increased, but they are in agreement with those reported by Whitney and Green (1969).

The effect of cutting frequency on the proportion of applied nitrogen recovered in the forage was inconsistent. The proportion recovered from the 8-week cutting treatment was highest while that from the 6-week frequency was lowest. Reports by other workers on this effect are conflicting. Bryan and Sharpe (1965) reported that the proportion of applied nitrogen recovered declined as the cutting frequency increased. Vincente-Chandler *et al* (1961) on the other hand found that the nitrogen recovered in the forage was not appreciably affected by the cutting interval.

3. Effect of treatments on *in vitro* cellulose digestibility.

The *in vitro* cellulose digestibility carried out in the Animal Science Department of Macdonald College was found to decrease as the frequency of cutting decreased. (Table 3). The results obtained here are in agreement with results published for temperate forages by Lloyd *et al* (1961) and Donefer and Mosi (1970) and for tropical forages, including Pangola, by Gomide *et al* (1969). These latter workers suggested that this decrease was probably due to the early lignification of tropical grasses as reported by French (1956). However, the effect of age on lignin content reported here does not agree with this suggestion: but it was noticeable that, as was the case with work

done elsewhere, the early decline in IVCD occurred simultaneously with early increase in cellulose content of the grass. Increasing levels of nitrogen fertilization tended to increase the IVCD of the forage. However, when the grass was cut on an 8-week frequency there was a tendency for the IVCD to decrease with increments in N fertilization over 224 kg/ha. This trend agreed with the report, by Gomide *et al* (1969), that with more matured Pangolagrass, the IVCD decreased with increasing nitrogen fertilization. These workers did not study growth stages between 4 to 12 weeks, so the point at which fertilizer nitrogen began to have a depressing effect on IVCD was not known.

Table 1

The effect of nitrogen fertilization and frequency of cutting on the chemical composition (dry matter basis) of Pangola grass

Cutting Frequency	Level of N kgN/ha/yr.	DM	CP	Cellulose	ADF	ADL	NDF	ASH
		%	%	%	%	%	%	%
4 weeks	0	21.8	10.1	31.7	38.8	6.4	69.4	10.5
	224	23.1	10.8	30.6	37.1	5.5	67.7	10.7
	448	22.7	12.2	30.9	35.7	6.3	68.7	10.4
	896	19.6	16.1	31.4	35.8	6.0	69.9	10.5
	Mean	21.8	12.3	31.2	36.9	6.1	68.9	10.5
6 weeks	0	24.5	9.2	32.6	37.7	5.9	69.6	10.10
	224	25.5	8.5	32.3	36.0	5.4	68.1	9.4
	448	26.4	8.9	33.5	37.2	5.6	68.9	9.7
	896	23.3	11.5	33.6	37.5	5.1	68.3	9.5
	Mean	24.9	9.5	33.0	37.1	5.5	68.7	9.7
8 weeks	0	30.7	7.4	32.4	37.4	4.7	67.2	10.6
	224	30.7	6.9	32.8	37.6	4.9	68.4	9.9
	448	27.5	7.0	33.2	38.4	4.7	67.9	9.1
	896	24.0	8.1	33.9	38.7	4.8	69.0	9.1
	Mean	28.2	7.4	33.1	38.0	4.8	68.1	9.7

Table 2

The effect of nitrogen fertilization and frequency of cutting on the yield of dry matter and crude protein and efficiency of utilization of applied nitrogen over a 32-week period

Cutting Frequency	Level of N kgN/ha/hr	Yield of dry matter per hectare	Yield of crude protein per hectare	Recovery of N in forage	Dry matter produced per kg of each increment of N.
		kg	kg	%	kg
4 weeks	0	2,813 e	282.7	–	–
	224	5,098 de	551.0	31.1	10.2
	448	7,640 cd	935.1	37.9	10.8
	896	11,370 c	1,828.2	44.9	9.6
6 weeks	9	4,483 de	414.2	–	–
	224	6,799 d	508.6	11.0	10.3
	448	10,252 c	915.5	29.1	12.9
	896	15,526 ab	1,780.8	40.0	12.3
8 weeks	0	4,815 de	355.3	–	
	224	10,616 c	731.4	43.7	25.9
	448	16,367 ab	1,140.7	45.6	25.8
	896	20,190 a	1,637.4	37.2	17.2

a,b,c,.. Figures bearing the same superscript are not significantly different (P = 0.05) (Duncan's Multiple Range Test.)

Table 3

24–hr *in vitro* cellulose digestibility of Pangolagrass cut at three frequencies at different levels of nitrogen fertilization

Fertilizer level kg N/ha	24-hr. IVCD 4 weeks	6 weeks	8 weeks	Mean
0	49.1	47.0	48.9	48.3
224	53.1	52.0	51.2	52.1
448	56.3	52.8	51.0	53.4
896	60.4	55.6	50.4	55.5
Means	54.7	51.9	50.4	

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ACKNOWLEDGEMENTS

The authors would like to thank Mr. F. Harper and Miss P. Russell of the Pine Animal Nutrition Grassland Research Station for assistance given in the management and laboratory analysis. This research was made possible through funds made available by the Canadian International Development Agency and the Barbados Ministry of Agriculture.