MONTHLY NUTRIENT VARIATION OF PARAGRASS (*Brachiaria mutica*) AND STARGRASS (*Cynodon plectostachyum*) COLLECTED FROM PASTURES GRAZED BY GOATS

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Summary

A 13-month study was conducted to determine the monthly variation of crude protein (CP), cell contents (CC), fiber fractions and mineral concentrations of paragrass [*Brachiaria mutica* (Forsk.) Stapf.] and stargrass (*Cynodon plectostachyum* Pilger) and to estimate the correlations among the nutrient fractions and climatic factors. The forage samples collected by hand plucking were found to contain CP and mineral concentrations, i.e. calcium (Ca), magnesium (Mg), potassium (K) and zinc (Zn) above the critical levels based on ruminant needs. Monthly differences ($p < 0.05$) were observed in all CP, CC, neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicellulose (HE), cellulose (CE), and acid detergent lignin (ADL) between the two grass species. Monthly differences ($p < 0.05$) were also observed in all concentrations of forage Ca, K, phosphorus (P), copper (Cu) and Zn except in Mg of both grasses and K of stargrass. Species differences ($p < 0.05$) were observed in all nutrient fractions except Mg and K concentrations. Rainfall had positive correlations to CP, P ($p < 0.01$) and CC ($p < 0.05$); it had negative correlations to NDF ($p < 0.05$), ADF, CE, Ca, Cu and Zn ($p < 0.01$). Temperature, humidity and daylength had also some correlations to various nutrient fractions.

(**Key Words** : Paragrass, Stargrass, Nutrient Variation, Nutrient Characteristics, Mineral Content)

Introduction

There are many factors affecting the growth of forage plant, e.g. light, temperature, water, nutrient availability and other environmental conditions. Their influences are dynamic and change significantly with time. Consequently, the stage and rate of growth influence the chemical and physical characteristics of the forage (Gill et al., 1989).

Previous reports from our laboratory (Fujihara et al., 1992a,b) indicated that some forage minerals are limiting during specific months of dry and wet seasons in the philippines. However, data on the monthly variation of various nutrients are lacking. Hence, this study was conducted with the following objectives: 1) to determine the monthly variation in crude protein (CP), cell contents (CC), fiber fractions and mineral concentrations of two dominant forages, paragrass and stargrass, collected from pastures grazed by goats, and 2) to estimate the correlations among the nutrient fractions and climatic factors. This report is a part of our research study in characterizing the nutrient contents of Philippine forages with emphasis on their mineral concentrations, an area where information are limiting. Moreover, part of this report has been presented elsewhere (Serra et al., 1995a).

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Materials and Methods

Study area

The study area was conducted at the small ruminant farm of Department of Animal Science, Central Luzon State University, College of Agriculture, Philippines (15° 43′ N, 120° 54′ E). The monthly total rainfall and average monthly temperature, humidity and daylength are presented in figure 1.

Forages and forage sample collection

The two forage species that were collected monthly by

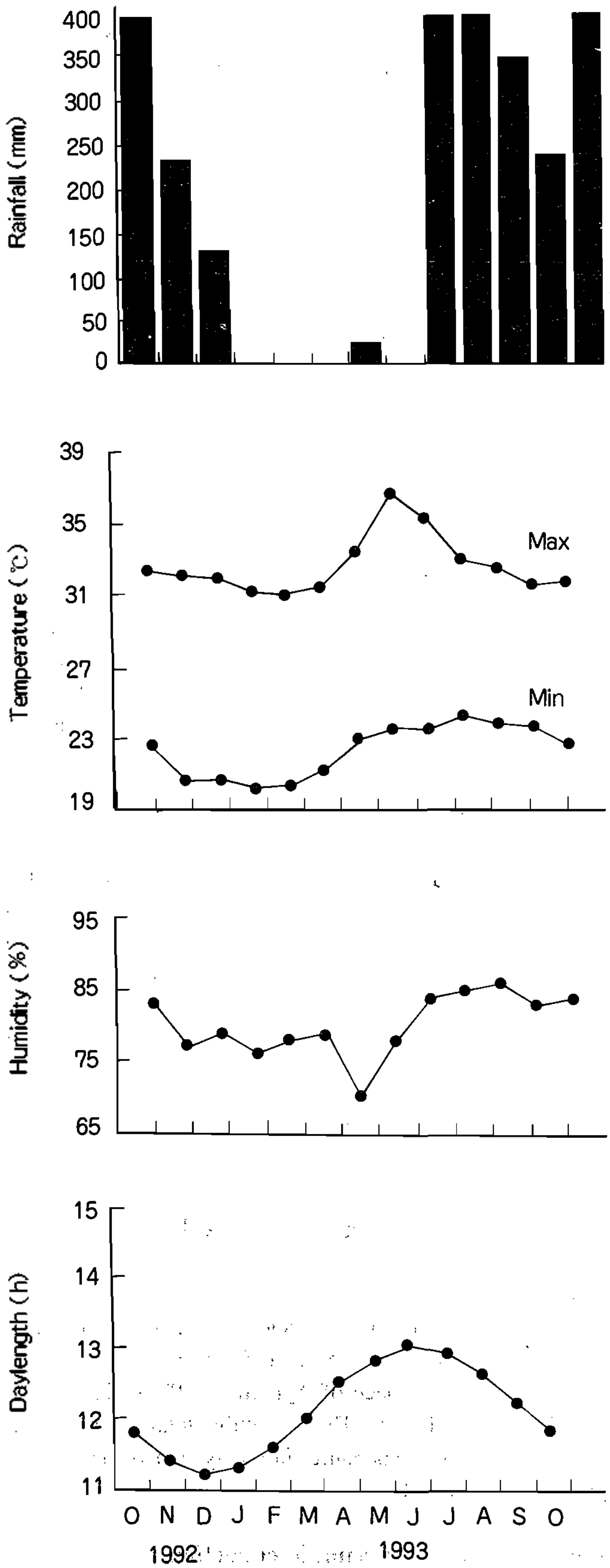

Figure 1. Climatic variations at Central Luzon State University, Nueva Ecija, Philippines.

hand plucking method were: paragrass [*Brachiaria mutica* (Forsk.) Stapf.] and stargrass (*Cynodon plectostachyum* Pilger). Due to its close relationship to fistulated sample, hand plucking method was preferred in sample collection (Serra et al., 1995b). The two grasses under consideration were recommended by Philippine Council for Agriculture and Resources and Development (PCARRD, 1983) for pastures in the country. Paragrass could tolerate fair drought and very good in water logged areas. Stargrass could stand fair in water logged and good in drought-prone areas. The two grasses were dominant species in pastures that were grazed by goats. Stargrass was collected from three pasture sites whereas the paragrass was collected from only one site, in partially wet pasture. Forage sampling was done every first week of the month by three persons. Forage samples collected were dried and ground to pass a 2-mm screen in a Wiley mill. Each samples was stored in plastic container and all of these were brought to Japan for analyses.

Laboratory analyses

The different samples collected were analyzed for dry matter (DM) and CP by standard procedures (AOAC, 1984). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were assessed by the procedures of Goering and Van Soest (1970). Lignin was determined on ADL following ADF analysis. Hemicellulose was calculated as the difference between NDF and ADF. Cellulose was estimated as the difference between ADF and ADL. Neutral detergent soluble or CC was determined as (100%-NDF%).

The different samples were also prepared for mineral analysis by a wet ashing (nitric-perchloric acids) method. The mineral concentrations were measured by Inductively Coupled Plasma Emission Spectrometer (ICPS 2000, Shimadzu Co., Kyoto, Japan). All the glasswares used for analysis were washed with acid before use to remove the contaminating minerals.

Statistical analyses

Data obtained in the present study were statistically analyzed using a completely randomized design, and monthly means were compared using Duncan's multiple range test (Steel and Torrie, 1980). The means of paragrass and stargrass were compared with Student's t-test; correlation coefficients among the various nutrient fractions and climatic parameters were also computed (Steel and Torrie, 1980).

Results and Discussion

In presenting the various nutrient concentrations of this study and citing previous studies, their values in the text are all in DM basis.

Crude protein and cell contents

The monthly variation of crude protein and cell contents in paragrass and stargrass are shown in table 1. Mean monthly CP varied from 8 to 16.7% in paragrass and from 5.8 to 12.3% in stargrass. The CP contents were found to be higher ($p < 0.05$) during the months of May to October (1992-93) in paragrass and during the months of June, August and October (1992-93) and November in stargrass. The existence of specie difference ($p < 0.05$) was observed between the two grass species and tended to be higher in paragrass by 3.6 percentage units. The means on CP content of paragrass and stargrass were close to those data presented by Gerpacio and Castillo (1979). Orden et al. (1990) observed a mean CP value 12.7% in paragrass. The mean CP value of most tropical grasses is 10% and high proportion (21% of the data presented in the literature) contained less than 6%, the minimum quantity required to meet the requirements of rumen bacteria (Minson, 1990). Thus, the CP values obtained in this study would support minimum rumen bacterial functions.

Mean monthly CC varied from 15.6 to 31.7% in paragrass and from 19.3 to 30.8% in stargrass. Higher ($p < 0.05$) CC values were observed in June, July, August in paragrass and December in stargrass. The mean CC of paragrass was higher ($p < 0.05$) than that of stargrass, a difference of two percentage units. Earlier study (Lopez et al., 1976) confirmed that paragrass had higher CC than stargrass when cut at 30 d (44.5 vs. 39.3%). More recently, Orden et al. (1990) observed 42.5% CC in paragrass harvested at 30 to 45 d. On the contrary, workers from Thailand reported 27.3% CC in paragrass when harvested at 30 d (Chairatanayuth and Numsivimonkul, 1987). Their data, however, are within the range of the present study.

Higher CP and CC are observed during the months of rainy season as shown in the present study irrespective of forage species. Rainy season is the period of active plant growth and regrowth, hence, the plants mature with the advancing dry season. As they mature the proportion of cell contents declines in response to a marked incease in cell wall constituents, accompanied by a pronounced decline in the proportion of protein due in part to the increase in stem : leaf ratio. Between species, paragrass tended to contain more CP and CC than the stargrass.

Cell wall contents

Cell wall content (CWC) of a forage is nutritionally important because forage high CWC are of low digestibility and low intake by ruminants (Minson, 1990). The data on the monthly variation of various fiber fractions of paragrass and stargrass are shown in table 1.

Mean monthly NDF fractions varied from 68.3 to 84.4 % in paragrass and from 69.2 to 80.7% in stargrass. Higher ($p < 0.05$) NDF values were observed during the months of February in paragrass and March in stargrass. Stargrass had higher NDF fractions ($p < 0.05$) than paragrass, a difference of two percentage units. Mean monthly ADF fractions varied from 30.6 to 51.4% in paragrass and from 36.8 to 53.8% in stargrass. The ADF fractions were found to be higher ($p < 0.05$) during February in paragrass and March in stargrass. Stargrass had higher ($p < 0.05$) mean ADF value than that of paragrass by 6.5 percentage units. Other workers observed lower values of NDF and ADF compared to the present study in paragrass and stargrass by Lopez et al. (1976) and in paragrass by Orden et al. (1990). Similar findings to the present study in paragrass was seen by Chairatanayuth and Numsivimonkul (1987).

Mean monthly HE fractions varied from 27.8 to 42.5% in paragrass and from 26.9 to 37.7% in stargrass. Higher ($p < 0.05$) HE values were observed during the months of May and August to October (1993) in paragrass and during the months of May, June, September and October (1992-93) in stargrass. The mean HE value of paragrass was higher ($p < 0.05$) than that of stargrass by 4.3 percentage units. Mean monthly CE fractions varied from 24.4 to 45.6% in paragrass and from 32.2 to 47% in stargrass. Higher CE values ($p < 0.05$) were observed during the months of January and February in paragrass and March in stargrass. Stargrass had higher ($p < 0.05$) mean CE value than that of paragrass by 4.3 percentage units. Similar trend of higher HE and lower CE in paragrass than that of stargrass by Lopez et al. (1976). However, their data presented was similar in HE but not in CE of the present study.

Mean monthly ADL fractions varied from 2.3 to 7.8% in paragrass and from 4.1 to 11.2% in stargrass. Higher ($p < 0.05$) ADL values were observed during the months of November, December and February in paragrass, and during the months of December and February in stargrass. The mean ADL value of stargrass was higher ($p < 0.05$) than that of paragrass (6.5% vs. 4.5%). The values obtained by Lopez et al. (1976) were 6.6 and 5.1% ADL of paragrass and stargrass, respectively. Whereas, Orden et al. (1990) got 5.3% ADL in paragrass. Lignin has long been recognized as a feature of less digestible fiber fraction, thus the lower the value the better for the ruminants.

TABLE 1. MONTHLY VARIATION IN CRUDE PROTEIN, CELL CONTENT AND FIBER FRACTIONS (% DM) OF PARAGRASS AND STARGRASS

Item	OCT.	NOV. 1992	DEC.	JAN.	FEB.	MAR.	APR.	MAY 1993	JUN.	JUL.	AUG.	SEP.	OCT.	MEAN	SE
CP															
Paragrass	14.4^{ab}	10.9^{c}	10.2^{cd}	8.1^{d}	8.0^{d}	10.4^{c}	12.3^{bc}	16.7^{a}	15.4^{a}	16.1^{a}	16.1^{a}	16.5^{a}	15.1^{a}	13.1^{j}	0.56
Stargrass	11.3^{ab}	10.6^{ab}	10.4^{b}	6.1^{c}	5.8^{c}	7.2^{c}	7.3^{c}	7.2^{c}	12.2^{a}	10.3^{b}	12.3^{a}	11.1^{ab}	12.2^{a}	9.5^{k}	0.34
CC[1]															
Paragrass	24.8^{fg}	27.2^{bc}	26.6^{cde}	21.4^{h}	15.6^{i}	24.1^{g}	27.1^{bcd}	25.2^{efg}	31.4^{a}	30.5^{a}	31.7^{a}	28.4^{b}	25.6^{def}	26.1^{j}	0.45
Stargrass	23.1^{ef}	26.3^{b}	30.8^{a}	23.0^{ef}	22.3^{f}	19.3^{g}	22.0^{f}	24.2^{cde}	24.2^{cde}	24.1^{cde}	23.3^{def}	24.6^{cd}	25.5^{bc}	24.1^{k}	0.41
NDF															
Paragrass	75.2^{cd}	72.8^{ef}	73.4^{de}	78.6^{b}	84.4^{a}	75.9^{c}	72.9^{ef}	74.8^{cde}	68.6^{h}	69.5^{gh}	68.3^{h}	71.6^{fg}	74.4^{cde}	73.9^{j}	0.45
Stargrass	76.9^{bcd}	73.7^{f}	69.2^{g}	77.0^{bcd}	77.7^{bc}	80.7^{a}	78.0^{b}	75.8^{cde}	75.8^{cde}	75.9^{bcde}	76.7^{bcde}	75.4^{def}	74.5^{ef}	75.9^{k}	0.41
ADF															
Paragrass	37.4^{d}	43.0^{c}	42.9^{c}	50.8^{b}	51.4^{a}	36.0^{de}	35.8^{de}	32.3^{fg}	30.6^{g}	30.8^{g}	27.9^{h}	31.7^{g}	34.3^{ef}	37.3^{j}	0.37
Stargrass	40.4^{f}	42.3^{cde}	43.4^{cd}	48.8^{b}	50.2^{b}	53.8^{a}	43.7^{c}	43.1^{cde}	41.6^{ef}	42.0^{de}	42.6^{cde}	40.3^{f}	36.8^{g}	43.8^{k}	0.31
HE[2]															
Paragrass	37.8^{cd}	29.8^{fg}	30.4^{ef}	27.8^{g}	33.0^{e}	39.9^{bc}	37.1^{d}	42.5^{a}	38.0^{bcd}	38.7^{bcd}	40.4^{ab}	39.9^{abc}	40.1^{abc}	36.6^{j}	0.51
Stargrass	36.4^{ab}	31.4^{cd}	25.7^{e}	28.2^{de}	27.6^{e}	26.9^{e}	34.2^{bc}	34.7^{abc}	34.3^{abc}	33.9^{bc}	34.2^{bc}	35.1^{ab}	37.7^{a}	32.3^{k}	0.68
CE[3]															
Paragrass	33.4^{cd}	36.2^{b}	35.1^{bc}	45.6^{a}	45.0^{ab}	32.0^{de}	32.0^{de}	29.1^{f}	28.0^{f}	28.4^{f}	24.4^{g}	28.4^{f}	30.6^{ef}	32.9^{j}	0.53
Stargrass	36.0^{ef}	33.6^{g}	32.2^{g}	41.7^{b}	40.1^{c}	47.0^{a}	37.8^{d}	37.2^{de}	36.5^{def}	36.4^{def}	37.7^{d}	35.5^{f}	32.6^{g}	37.2^{k}	0.34
ADL															
Paragrass	4.0^{def}	6.7^{ab}	7.8^{a}	5.3^{bcd}	6.5^{abc}	4.0^{def}	3.8^{def}	3.2^{ef}	2.6^{f}	2.3^{f}	3.5^{def}	4.9^{cde}	3.7^{def}	4.5^{j}	0.37
Stargrass	4.5^{hi}	8.7^{b}	11.2^{a}	7.0^{c}	10.1^{a}	6.8^{cd}	5.9^{de}	5.8^{ef}	5.1^{efgh}	5.6^{efg}	4.9^{ghi}	4.8^{ghi}	4.1^{i}	6.5^{k}	0.19

[a,b,c,d,e,f,g,h,i] For each nutrient fraction, means within row having different superscripts differ ($p < 0.05$).

[j,k] For each nutrient fraction, means between species with different superscript differ ($p < 0.05$).

[1] Cell content; [2] Hemicellulose; [3] Cellulose.

Generally, lower fiber fraction values during the months of rainy season for both forage species. It is evident in the tropics that during the rainy season active plant growth or regrowth occur, thus lower in structural carbohydrates including the lignin in this period. Paragrass tended to have lower fiber fractions that of stargrass possibly due to wider stem-leaf ratio of the latter. As stems often contain more structural carbohydrates than leaves.

Macro- and microminerals

The monthly variation in macro- and microminerals concentrations of paragrass and stargrass are shown in table 2. Mean monthly Ca concentrations varied from 3.3 to 4.6 g/kg DM in paragrass and from 3.9 to 5 g/kg DM in stargrass. The Ca concentrations were higher ($p < 0.05$) during the months of November to May, August and September in paragrass and during the months of April in stargrass. The mean value of stargrass was higher ($p < 0.05$) than that of paragrass by 0.4 unit. All mean Ca concentrations were above the critical level of 3 g/kg DM (McDowell, 1985). The observed values for Ca concentrations of stargrass were within the range 3.4 to 7.5 g/kg DM reported by Fujihara et al. (1992a) where their samples collected from experimental farms in the three regions of Philippines. Minson (1990) reported a mean of 3.8 and a range of 0.9 to 8.2 g Ca/Kg DM of tropical forages.

Mean monthly P concentrations varied from 1 to 2.2 g/kg DM in paragrass and from 2.1 to 3.1 g/kg DM in stargrass. Higher ($p < 0.05$) P concentrations were observed during the months of October to December and April to October in paragrass and almost all except the months of December and April in stargrass. There was a difference ($p < 0.05$) between the mean P values of paragrass and stargrass (1.9 g/kg DM vs. 2.7 g/kg DM). The mean P concentration of stargrass in this study was below from the range 3.3 to 4.6 g P/kg DM as reported by Fujihara et al. (1992a). Other workers reported a range 0.3 to 2.6 g P/kg DM in leaf samples of various grasses in tropical regions (Minson, 1990). The mean P concentrations of paragrass across months were below the critical level 2.5 g/kg DM (McDowell, 1985). Whereas, only the means of two months (December and April) appeared to be lower than the critical value in stargrass.

Mean monthly Mg concentrations varied from 2 to 2.7 g/kg DM in paragrass and from 2.3 to 2.8 g/kg DM in stargrass. No month and species differences were observed for Mg concentration of paragrass and stargrass. All of the mean values observed were above the critical value in forage, 2 g/kg DM (McDowell, 1985). The range of Mg concentration of stargrass as reported by Fujihara et al. (1992a) was 1.8 to 3.3 g/kg DM. The mean Mg concentration of tropical grasses was 3.6 g/kg DM and only 14% of these grasses contained less than 2 mg/kg DM (Minson, 1990).

Mean monthly K concentrations varied from 9.1 to 12.7 g/kg DM in paragrass and from 9.7 to 10.6 g/kg DM in stargrass. Higher ($p < 0.05$) K concentration was observed during the month of April in paragrass but no monthly differences were observed in stargrass. All the monthly mean K concentrations were above the critical value of 0.6 to 0.8 g/kg DM (McDowell, 1985). McDowell (1985) stated that only few confirmed reports of K deficiency on ruminants grazing exclusively forages in the tropics.

Mean monthly Cu concentrations varied from 8.3 to 12 mg/kg DM in paragrass and from 8.2 to 12.7 mg/kg DM in stargrass. Higher ($p < 0.05$) Cu concentrations during the months of October (1992) to May in paragrass and November to April in stargrass. Paragrass was lower ($p < 0.05$) in Cu mean concentration than that of stargrass by one unit. A 70 and 30% of the values presented in paragrass and stargrass were below to the critical level of 10 mg Cu/kg DM (McDowell, 1985), respectively. Higher value on Cu concentration of stargrass obtained by Fujihara et al. (1992b), a mean 16.5 mg/kg DM with a range 11.7 to 24.3 mg/kg DM. Tropical grasses had a wider distribution of Cu levels, a range from 2 to 14 mg/kg DM (Minson, 1990).

Mean monthly Zn concentrations varied from 42.7 to 73.4 mg/kg DM in paragrass and from 33.9 to 44.9 mg/kg DM in stargrass. Higher ($p < 0.05$) Zn concentrations were obtained during the months of January to April in paragrass and November, January to April and June in stargrass. Paragrass had higher ($p < 0.05$) mean Zn concentration than that of stargrass by 19.8 units. The values obtained for the concentration of Zn in stargrass in this study were higher than the values obtained by Fujihara et al. (1992b), a mean 25.9 mg Zn/kg DM and a range 16.8 to 36.7 mg Zn/kg DM. All the Zn concentrations of the two grass species were above the critical level of 30 mg/kg DM (McDowell, 1985). The data obtained for mean Zn concentration of grasses in the tropics was 36 mg/kg DM with 6% of samples ($n = 145$) containing < 20 mg/kg DM (Minson, 1990).

Changes in mineral composition occur as plant growth and season advances and the magnitude of such changes varies between forage species. The two tropical seasons influence soil properties and conditions which in turn affect the uptake and utilization of minerals by plant (Reid and Horvath, 1980). Also, plant species show marked

TABLE 2. MONTHLY VARIATION IN MACROMINERALS (Ca, P, Mg AND K in g/kg DM) AND MICROMINERALS (Cu AND Zn in mg/kg DM) OF PARAGRASS AND STARGRASS

Item	OCT.	NOV. 1992	DEC.	JAN.	FEB.	MAR.	APR.	MAY 1993	JUN.	JUL.	AUG.	SEP.	OCT.	MEAN	SE
Ca															
Paragrass	3.3^{a}	4.0^{ab}	4.1^{ab}	4.2^{ab}	4.1^{ab}	4.1^{ab}	4.6^{a}	4.4^{ab}	3.4^{c}	3.4^{c}	4.4^{ab}	4.0^{ab}	3.8^{bc}	3.9^{f}	0.16
Stargrass	4.2^{cd}	4.2^{cd}	4.6^{bc}	4.2^{cd}	4.6^{bc}	4.8^{b}	5.0^{a}	4.1^{cd}	4.0^{d}	4.0^{d}	3.9^{d}	4.0^{d}	4.0^{d}	4.3^{g}	0.16
P															
Paragrass	1.8^{abc}	2.2^{a}	2.2^{a}	1.0^{d}	1.0^{d}	1.2^{bcd}	2.1^{a}	2.0^{a}	2.2^{a}	2.2^{a}	2.2^{a}	2.0^{a}	1.9^{ab}	1.9^{f}	0.23
Stargrass	2.7^{ab}	2.5^{ab}	2.3^{b}	2.7^{ab}	3.1^{a}	2.7^{ab}	2.1^{b}	2.5^{ab}	3.1^{a}	3.1^{a}	3.1^{a}	3.0^{a}	2.7^{ab}	2.7^{g}	0.20
Mg															
Paragrass	2.4	2.4	2.5	2.6	2.7	2.6	2.7	2.0	2.3	2.2	2.3	2.5	2.4	2.4	0.58
Stargrass	2.6	2.8	2.8	2.5	2.6	2.7	2.4	2.3	2.3	2.3	2.5	2.3	2.3	2.5	0.17
K															
Paragrass	9.1^{d}	9.4^{cd}	9.1^{d}	10.7^{bcd}	11.4^{bc}	11.9^{b}	12.7^{a}	10.6^{bcd}	10.0^{bcd}	10.9^{bcd}	11.2^{bcd}	11.0^{bcd}	11.1^{bcd}	10.7	0.63
Stargrass	10.3	10.6	11.2	10.4	10.3	10.4	9.7	9.8	10.0	9.9	10.1	10.2	10.3	10.2	0.68
Cu															
Paragrass	10.3^{ab}	9.9^{abcd}	9.8^{abcd}	10.2^{ab}	9.9^{abcd}	11.0^{a}	12.0^{a}	9.8^{abcd}	8.3^{e}	8.3^{e}	9.7^{bcd}	9.0^{cde}	8.8^{de}	9.8^{f}	0.36
Stargrass	10.0^{cd}	12.0^{a}	12.1^{a}	12.7^{a}	12.7^{a}	12.6^{a}	11.6^{ab}	10.7^{bc}	10.0^{cd}	9.0^{de}	8.2^{e}	9.3^{de}	9.0^{de}	10.8^{g}	0.32
Zn															
Paragrass	42.7^{e}	48.2^{de}	47.8^{de}	72.0^{a}	73.3^{a}	70.7^{a}	73.4^{a}	60.4^{b}	52.1^{cd}	47.8^{de}	57.3^{bc}	58.1^{bc}	53.9^{bcd}	58.3^{f}	2.29
Stargrass	36.9^{bc}	38.8^{abc}	36.7^{bc}	41.6^{ab}	44.5^{a}	44.9^{a}	40.5^{abc}	37.3^{bc}	39.6^{abc}	36.7^{bc}	33.9^{c}	34.3^{c}	35.8^{bc}	38.6^{g}	2.06

[a,b,c,d,e] For each mineral element, means within row having different superscripts differ ($p < 0.05$).

[f,g] For each mineral element, means between species with different superscript differ ($p < 0.05$).

differences in mineral uptake even they grow on the same soil and under the same environmental conditions (Allaway, 1968).

Correlation coefficients

The correlation coefficients among the different nutrient fractions and climatic parameters are presented in table 3. As mentioned earlier, there are many factors affecting the nutritive value of tropical forages, one of which is the influence of climatic factors.

The CP of grasses of the present study was positively correlated to rainfall, temperature, humidity ($p < 0.01$) and daylength ($p < 0.05$). The CC was positively correlated to rainfall ($p < 0.05$). All fiber fractions except HE were negatively correlated to rainfall, i.e. NDF ($p < 0.05$), ADF and CE ($p < 0.01$). Temperature had also a negative correlation to ADF, CE and ADL ($p < 0.01$) and positive correlation to HE ($p < 0.01$). Moreover, daylength had a negative correlation to ADF ($p < 0.05$) and ADL ($p < 0.01$) and positive correlation to HE ($p < 0.01$). The increase in CP, CC and HE due to rainfall accompanied by rise of environmental temperature and longer daylength is associated to the new growth of forage plants. Whereas the rise of fiber fractions, i.e. NDF, ADF, CE and ADL, is parallel to the advancing plant growth on advancing season. Advancing plant growth is associated to increase structural cell wall components caused by increased metabolic activity (due to high temperature) including greater activity of enzymes associated with lignin biosynthesis, and more rapid conversion of photosynthetic products into structural components such as lignin (Van Soest, 1988). Furthermore, the pool size of the soluble carbohydrate is more reduced by respiration during long dark period.

TABLE 3. CORRELATION COEFFICIENTS AMONG THE DIFFERENT NUTRIENT FRACTIONS AND CLIMATIC PARAMETERS

Concept	Rainfall	Temperature	Humidity	Daylength
CP	0.83**	0.69**	0.73*	0.58*
CC[1]	0.62*	0.47	0.41	0.31
NDF	−0.52*	−0.47	−0.41	−0.31
ADF	−0.71**	−0.78**	−0.54	−0.67*
HE[2]	0.51	0.77**	0.47	0.74**
CE[3]	−0.70**	−0.69**	−0.52	−0.54
ADL	−0.49	−0.71**	−0.44	−0.75**
Ca	−0.82**	−0.29	−0.23	−0.23
P	0.79**	0.45	0.37	0.52
Mg	−0.35	0.85**	−0.42	−0.75**
K	−0.47	−0.19	−0.36	0.08
Cu	−0.84**	−0.56**	−0.87**	−0.53
Zn	−0.81**	−0.32	−0.64**	−0.15

[1] Cell content; [2] Hemicellulose; [3] Cellulose.
* ($p < 0.05$); ** ($p < 0.01$).

Forage Ca concentration was negatively correlated ($p < 0.01$) to rainfall. During rainy season there is an active plant growth and the general trend, forage Ca is generally low during periods of active plant growth and high when lack of moisture slow growth (Minson, 1990). On the contrary, the forage P concentration was positively correlated ($p < 0.01$) to rainfall when there is an active plant growth. It declines parallel to advancing plant maturity associated to advancing season.

Forage Mg concentration was positively correlated ($p < 0.01$) to temperature and negatively correlated to daylength ($p < 0.01$). It is a fact that Mg concentration is positively related to the temperature at which the forage is grown (Fleming, 1973; Minson, 1990). Minson (1990) stated based on previous papers that the positive relation between Mg concentration and temperature probably accounts for the low incidence of hypomagnesemic tetany in cattle grazing temperate pastures in summer and all tropical pastures. For the influence of daylength the forage Mg concentration, it is possibly associated to their action in photosynthesis. Magnesium is present in chlorophyll (Butler and Jones, 1973), therefore, it assumed that it is being translocated more during long dry period.

Forage Cu concentration was negatively correlated ($p < 0.01$) to rainfall, humidity and temperature. With the active plant growth during the months of rainy season, the fall in Cu concentration in the plant probably due to dilution effect, which means DM production outstrips mineral uptake resulting in a decline of mineral concentration (Fleming, 1973). The influences of humidity and temperature on Cu concentration probably due to translocation process during environmental changes just like the other mineral elements.

Forage Zn concentration was negatively correlated ($p < 0.01$) to rainfall and humidity. During rainy season, there is an active plant growth. Thus, decline in forage Zn concentration is probably due to the natural dilution process. As photosynthetic areas increase, DM production surpass mineral uptake, resulting in a decline in mineral concentration (Fleming, 1973).

Conclusion

This study concludes that month and species differences exist among the nutrient fractions of paragrass and stargrass. Irrespective of forage species, CP, and CC are higher during rainy season whereas cell fiber fractions and most minerals are higher during the dry season. The implication of monthly mineral compositional changes is of considerable interest in relation to animal health, the grazing animals might suffer disorders attributable to mineral deficiencies or imbalances with particular times of the year.

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