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Evaluation of biomass production and nutritive value of nine *Panicum maximum* ecotypes in Central region of Benin

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The grassland resource could be better managed if the effect of different defoliation regimes on the amount of the dry matter and nutritive value was known. Consequently, 9 ecotypes of *Panicum maximum* were evaluated in central region of Benin with an average 1100 mm annual rainfall during 3 years for ley pasture without any fertiliser input. Three cutting regimes (3-10-3, 5-6-5 and 6-4-6-week) were tested for dry matter production (DM), crude protein (CP) content, CP production and mineral (Ca, Mg, P, K, Na, Zn, Mn, Cu and Co) contents. Significant differences were observed between ecotypes ($p < 0.001$), cutting regimes ($p < 0.001$) and years ($p < 0.001$) for DM and CP production. Ecotype and cutting regime influenced significantly CP content ($p < 0.05$) but year had no influence. Forage harvested from 3-10-3-week regime produced significantly ($p < 0.05$) more DM ($4742 \text{ kg DMha}^{-1}$) than 5-6-5-week ($3635 \text{ kg DMha}^{-1}$) or 6-4-6-week cutting regime ($3789 \text{ kg DMha}^{-1}$). But the reverse effect was observed for CP content as 3-10-3-week regime ($5.68 \text{ gkg}^{-1} \text{ DM}$) had significantly ($p < 0.05$) lower CP than those of 5-6-5-week ($8.55 \text{ gkg}^{-1} \text{ DM}$) or 6-4-6-week cutting regimes ($7.15 \text{ gkg}^{-1} \text{ DM}$). Mineral concentrations varied between ecotypes but not by cutting regimes and years. Three ecotypes (n° 1, 4 and 5) consistently outproduced than others and can be harvested through 5-6-5-week cutting regime. P, Na, Zn and Cu deficiencies were the most common detected in the cropped forages.

Key words: Guinea grass, ecotypes, yield, crude protein, mineral contents, Benin.

INTRODUCTION

In savanna region of West Africa, agriculture is facing increasing pressure as a result of continuing increases in both human and livestock populations. In this region, inadequate supply of feeds is a limiting factor to livestock production. Basically, this situation is related to the dependence of livestock raising on naturally available feed resources and little development of forage crops

for feeding to animals. One of the alternatives to improve livestock feeding, and thus productivity, could be the cultivation of productive nutritious forages to be offered during critical periods of the production cycle of animals when other sources of feeds are in short supply. In most of the cases, pasture grasses in the tropics cannot satisfy the minimum requirement of nutrients of animals due to

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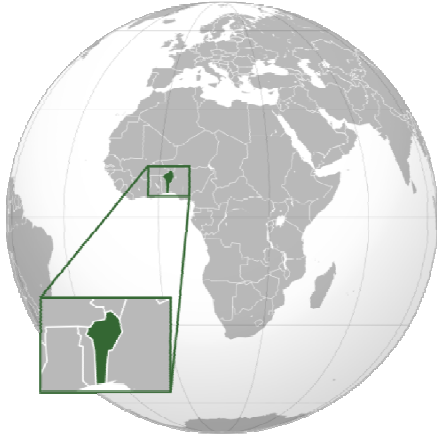


Figure 1. Location of experimental site in West Africa.

harvesting or grazing at advanced stage of maturity. Pastures rapidly decrease in acceptability and digestibility, particularly with crude protein (CP) as low as 2 to 3% in some periods of the year (Teka et al., 2005) and this is far below the minimum CP requirement of 7 to 8% for livestock maintenance (Coleman et al., 2003). There is a need for forage species with high dry matter (DM) production and quality in order to enhance livestock productivity in grazing or cut-and-carry system. In both systems, one of the main issues to be addressed is how often to use forage for better DM production and quality. Several studies have been conducted to test the effect of age of cutting on both yield and quality factors. Haggard (1970), Saleem (1972) and Omaliko (1980) commented that cutting frequency was the major factor that influenced the DM production and nitrogen concentration of *P. maximum*.

Generally, studies conducted on the effect of cutting frequency on plant DM production showed that the more infrequent cutting, the higher the DM yields but the crude protein concentration and the proportion of digestible forage dropped correspondingly (Leite et al., 1996; Bamikole et al., 2004; Aganga and Tshwenyane, 2004; Onyeonagu and Asiegbu, 2012). Even if most of these studies have reported positive increasing effect of cutting interval on DM production and the adverse effect on harvested forage quality, some authors have pointed out some variation between species and even between ecotypes in the same species. For example, in Venezuela, Morillo et al. (1997) had tested three cutting frequencies (28, 42 and 56 days) and reported that *P. maximum* forage yield was not influenced by cutting interval but CP concentration and mineral nutrients of the plant were affected. Studying the influence of cutting frequency on three *P. virgatum* cultivars in Canada, Madakadze et al. (1999) reported significant cultivar*cutting interval interaction, suggesting that, in the same species, different clipping schedules should be

recommended for cultivars.

In Nigeria, work of Omaliko (1980) reported that, *P. maximum* forage crude protein content increased simultaneously with DM production from the beginning of the rainy season up to about 4 weeks and after decreased sharply up to about 8 weeks following the onset of the rainy season. These results showed that the effects of cutting intervals on *Panicum spp.* forage DM production and quality vary and need a case-by-case study for each variety or ecotype and region.

In West Africa, pasture species evaluation with the objective of identifying the most productive and adapted species has been of interest for some years (Michiels et al., 2000; Buldgen et al., 2001; Babatoundé, 2005). Most of these species concerned exotic plants such as *Pennisetum purpureum*, *Brachiaria ruziziensis*, *Centrosema pubescens*, *Stylosanthes hamata* and *Aeschynomene histrix*. Very few studies were conducted on autochthonous species such as *P. maximum* ecotypes which could have a potential for animal production (Adjolohoun et al., 2012). The aim of this study was to identify *P. maximum* ecotypes and cutting regimes which could both maximize forage production and nutritive values on low fertility soils in order to provide recommendations on ecotypes and cuttings management to smallholder farmers.

MATERIALS AND METHODS

Site description

The experiment was conducted near Samiondji Farm, located in Agonli region (7°60'N, 2°54'E), in Benin (West Africa) during 3 rainy seasons (2009 to 2011) (Figure 1). The region has a sub-humid climate with a long term annual rainfall of 1100 mm and a bimodal distribution lasting from March –October with peaks in June and September. Annual rainfall in the region during the period of the experiment is 1200, 1105 and 1058. Minimum and maximum temperatures are observed in December (dry and cold season) and March (dry and hot season) with 19 to 20°C and 30 to 33°C, respectively. Soil at the experimental site was sandy (89% sand) with a pH of 6.0, organic carbon 0.8%, nitrogen 0.08% and P (extractable) = 8 ppm. Other mineral element concentrations were 0.9 cmol/kg for potassium and sodium, 1.6 cmol/kg for magnesium and 3.5 cmol/kg for calcium, giving an effective cation exchange capacity (ECEC) of 6.5 cmol/kg.

Culture establishment, DM and CP production evaluation

The selection of *Panicum maximum* ecotypes for this experiment was based on previous work described by Adjolohoun et al. (2012). Table 1 summarizes some morphologic, agronomic and physiological traits of these ecotypes. The site was ploughed and harrowed before planting in 7 × 7 m (49 m²) plots separated from each other by a 2-m band. The nine *P. maximum* ecotypes were established at the beginning of raining season in 2009 at 40 cm spacing (optimal density) using crown splits (4 to 5 tillers/hole). During the 3 experimental years, weeding was done manually with hand hoes. The following three cutting regimes were tested: 3-10-3, 5-6-5 and 6-4-6-week giving a constant period evaluation of 16 weeks for each cutting regime during each three years. These treatments were chosen as a combination of four commonly cutting

Table 1. Some morphologic, agronomic and physiologic traits of tested *P. maximum* ecotypes.

Trait	Ecotype								
	1	2	3	4	5	6	7	8	9
Morphologic									
Plant height (cm)	123	178	271	166	258	328	430	359	233
Leave length (cm)	47	59	66	51	76	87	107	93	55
Leave wide (mm)	25	32	37	26	34	37	42	38	37
Tiller per stuff (unity)	33	49	43	57	48	52	44	64	77
Tiller diameter (mm)	7	6	5	5	6	5	6	4	4
Stuff diameter at 75 cm above soil level (cm)	40	40	53	57	53	58	52	59	69
Panicle length (cm)	38	41	39	46	60	74	114	95	39
Agronomic									
Leaf/stem (ratio)	1.35	1.18	1.0	1.02	0.99	0.91	1.05	0.99	0.75
Leave number/tiller (unity)	7.6	7.5	7.4	12.0	8.6	9.4	8.0	9.5	8.0
Physiologic									
Panicle emergence (weeks after sowing)	6.4	7.0	8.0	9.5	10.7	11.2	9.0	10.8	12.6
Drought resistance (% of plant greenness)	65	44	39	53	40	38	10	35	31

Adjolohoun et al. (in press).

intervals to simulate grazing system (3 to 6-week interval) or a possible interval (10-week) in hay production systems. Treatment was a combination of each ecotype with cutting regime and was replicated 4 times, giving a total of $9 \times 3 \times 4 = 108$ plots arranged in a complete randomised block design. Three weeks after planting, all the plots were cut back to a suitable height of 15 cm (standardization cut to promote a uniform stand) without recording biomass production data. Three quadrats of 1×1 m were randomly chosen in each plot and harvested at 15 cm (Middleton, 1982; Thakshala and Pathirana, 2000) above soil level using a sickle and immediately weighed. After each harvest, the residual biomass of the plots was cut to the same height and removed. Afterwards, forage from the 3 quadrats of each plot was bulked and 2 samples (approximately 200 g) were taken from each plot and oven-dried for 48 to 72 h at 60°C and weighed for dry matter content and yield determination. These 2 samples were bulked per plot and ground through a 1-mm screen prior and analysed for CP (Kjeldahl-method, $N \times 6.25$) (AOAC, 1990). The DM production data over 16 weeks for each year was obtained by combining yields of the 3 harvest intervals of each cutting regime (3-10-3, 5-6-5 and 6-4-6-week) in each year. Forage CP content and CP production per ha were calculated for each year and treatment on the basis of the contribution of each cutting to total DM of the year. Standardization cuts were done each year at the beginning of raining season and harvested material was discarded.

Macro- and micro-nutrients determination

All samples harvested for each ecotype were pooled within years for each regime cutting on the basis of their contribution to total dry matter recorded in the year. Pooled samples were used to measure mineral concentrations. Ca, Mg, K, Na, Zn, Mn, Cu and Co concentrations were determined by atomic absorption spectrophotometry using a Perkin Elmer AAS-800 (Wellesley, MA). P was determined by the colorimetric method using Molybdovanadate reagent (Stewart et al., 1974).

Statistical analysis

Means and standard error of means on DM production per ha, CP content and CP production per ha data were calculated for $n = 4$ for each treatment and year. The means were classified by the Differences of Least Square Means method using the MIXED procedure of the SAS 8.02 software (SAS Inc, Cary, NC, USA) with the following model:

$$A = \mu + E_i + C_j + Y_k + (E^*C)_{ij} + (E^*Y)_{ik} + (C^*Y)_{jk} + (E^*C^*Y)_{ijk} + e_{ijkl}$$

Where A is the result of the measurement, μ = overall mean, E_i = ecotype effect ($i = 1, 2, \dots, 9$), C_j = cutting regime effect ($i = 1, 2, 3$), Y_k = year effect ($k = 1, 2, 3$), and their above two or three way interactions. The term e_{ijkl} = experimental error. When significant interaction occurred, the data were reanalysed separately by two- or one-way analysis of variance. Mineral content data were analysed through the following model: $B = \varepsilon + M_i + N_j + (M^*N)_{ij} + e_{ijk}$. Where B is the result of the measurement, ε = overall mean, M_i = ecotype effect ($i = 1, 2, \dots, 9$), N_j = cutting regime effect ($i = 1, 2, 3$) and $(M^*N)_{ij}$ their interaction. A $p < 0.05$ level of significance was used to separate means.

RESULTS

Dry matter, crude protein content and crude protein production

DM production data of tested ecotypes are presented in Table 2. There was significant difference between ecotypes ($p < 0.001$), cutting regimes ($p < 0.001$) and years ($p < 0.001$) (Table 3). DM production averaged per ecotype, cutting regime and year was $4055 \text{ kg ha}^{-1} \text{ year}^{-1}$ (not showed in Table 2). Averaged over ecotypes,

Table 2. Dry mater yield (kgha⁻¹) of 9 *Panicum maximum* local ecotypes under 3 cutting regimes during three years.

Ecotype	Year								
	2009			2010			2011		
	3-10-3	5-6-5	6-4-6	3-10-3	5-6-5	6-4-6	3-10-3	5-6-5	6-4-6
1	5403 ^{Acd(1)}	4104 ^{Ac}	4218 ^{Ac}	4341 ^{Bc}	3322 ^{Bc}	3434 ^{Bc}	3377 ^{Cc}	2602 ^{Cb}	2808 ^{Cb}
2	5531 ^{Ac}	4786 ^{Ac}	4987 ^{Ac}	3965 ^{Bcd}	3105 ^{Bc}	3260 ^{Bc}	2144 ^{Cd}	1599 ^{Cbc}	1571 ^{Ccd}
3	4177 ^{Ae}	3845 ^{Ad}	4065 ^{Ac}	3014 ^{Bd}	2594 ^{Bcd}	2468 ^{Bd}	1451 ^{Ce}	1065 ^{Ccd}	1076 ^{Cd}
4	11106 ^{Aa}	9689 ^{Aa}	9887 ^{Aa}	9567 ^{Ba}	7109 ^{Ba}	8210 ^{Ba}	6045 ^{Ca}	4539 ^{Ca}	4687 ^{Ca}
5	9400 ^{Ab}	7999 ^{Ab}	8056 ^{Ab}	6509 ^{Bb}	4472 ^{Bb}	4656 ^{Bb}	4443 ^{Cb}	2305 ^{Cb}	2800 ^{Cb}
6	4277 ^{Ae}	3590 ^{Ad}	3806 ^{Ac}	3200 ^{Bd}	2506 ^{Be}	2697 ^{Bde}	2199 ^{Cd}	1475 ^{Cc}	1500 ^{Ccd}
7	3136 ^{Ae}	2139 ^{Ae}	2560 ^{Ad}	2056 ^{Bd}	985 ^{Be}	1290 ^{Be}	910 ^{Ce}	405 ^{Cd}	820 ^{Cd}
8	6560 ^{Ac}	5256 ^{Ac}	4945 ^{Ac}	3502 ^{Bcd}	2076 ^{Bd}	2301 ^{Bd}	2015 ^{Cd}	910 ^{Cd}	1243 ^{Cd}
9	10023 ^{Aab}	8643 ^{Aab}	7780 ^{Ab}	6134 ^{Bb}	4967 ^{Bb}	5060 ^{Bb}	3541 ^{Cc}	2051 ^{Cbc}	2080 ^{Cc}
Mean	6624	5561	5593	4699	3460	3708	2903	1883	2065
SEM	557	521	485	439	346	414	346	224	242

⁽¹⁾ Values within a column followed by the same lower case letter do not differ significantly ($p < 0.05$). For the same cutting regime and for the same ecotype, values followed by the same upper case letter do not differ significantly ($p < 0.05$).

Table 3. Results of a 3-way ANOVA (GLM) showing the significance of ecotypes (9 ecotypes), cutting regimes (3-10-3-week, 6-5-6-week, 5-6-5-week), year (2009, 2010, 2011) and their interactions on dry matter production, crude protein content and crude protein production.

Effect	Dry matter yield	Crude protein content	Crude protein yield
Ecotype	< 0.001	0.037	0.013
Cutting regime	< 0.001	0.007	0.005
Year	< 0.001	0.601	0.003
Ecotype×cutting regime	0.663	0.097	0.232
Ecotype×Year	0.003	0.261	0.006
Cutting regime×year	0.720	0.321	0.231
Ecotype×cutting regime×year	0.874	0.881	0.695

Ecotype 4 was the most productive (7871 kg ha⁻¹ year⁻¹, not showed in Table 2). DM production of Ecotype 5 (5630 kg ha⁻¹ year⁻¹) and Ecotype 1 (5587 kg ha⁻¹ year⁻¹) were significantly lower than that of Ecotype 4. DM production of Ecotype 9 (3734 kg ha⁻¹ year⁻¹), Ecotype 2 (3439 kg ha⁻¹ year⁻¹),

Ecotype 8 (3201 kg ha⁻¹ year⁻¹), ecotype 6 (2806 kg ha⁻¹ year⁻¹) and Ecotype 3 (2639 kg ha⁻¹ year⁻¹) were not significantly different ($p > 0.05$) (not showed in Table 2). Ecotype 7 produced the lowest DM (1589 kg ha⁻¹ year⁻¹). Over cutting regimes, 3-10-3-week cutting regime had

produced (4742 kg ha⁻¹ year⁻¹) significantly ($p < 0.01$) more than the two others (4-6-4- and 5-6-5-week with 3789 and 3635 kg ha⁻¹ year⁻¹, respectively). There is no significant difference between DM productions of 4-6-4- and 5-6-5-week cutting regimes. The two or three-way

Table 4. Crude protein concentrations of 9 *P. maximum* local ecotypes under 3 cutting regimes.

Cutting regime	Ecotype									Mean
	1	2	3	4	5	6	7	8	9	
3-10-3	5.41 ^{ABc}	5.80 ^{ABc}	5.24 ^{ABc}	5.76 ^{ABc}	5.23 ^{ABc}	5.02 ^{Bc}	5.95 ^{ABc}	6.01 ^{Ac}	6.00 ^{ABc}	5.68
5-6-5	8.66 ^{Ba}	8.76 ^{ABa}	9.00 ^{ABa}	8.99 ^{ABa}	8.55 ^{BCa}	7.34 ^{Ca}	8.89 ^{ABa}	9.64 ^{Aa}	8.07 ^{Ba}	8.55
6-4-6	7.01 ^{Bb}	6.98 ^{Bb}	7.55 ^{Bb}	8.03 ^{ABb}	7.85 ^{ABb}	6.89 ^{Bb}	7.44 ^{Bb}	8.32 ^{Ab}	7.00 ^{Bb}	7.15
Mean	7.03	7.18	7.26	7.59	7.21	6.42	7.43	7.99	7.02	7.12
SEM	0.22	0.21	0.26	0.23	0.24	0.17	0.20	0.25	0.14	0.13

Values within a column followed by the same lower case letter do not differ significantly ($p < 0.05$). In the same line, values followed by the same upper case letter do not differ significantly ($p < 0.05$).

interactions were not significant except for ecotype*year ($P = 0.003$) (Table 3). Through ecotypes and cutting regimes, year 1 (4742 kg ha⁻¹year⁻¹) produced significantly ($p < 0.05$) more DM than year 2 (3789 kg ha⁻¹year⁻¹) and year 3 (3635 kg ha⁻¹year⁻¹). A decrease in DM production was observed for all ecotypes during the three year experiments but the extent of decrease varied largely according to ecotypes. Ecotype 1 was less affected by DM decreasing. In year 3, this ecotype produced 64% of the forage yield in year 1 but other ecotypes produced only between 25 and 50% of their DM yielded in year 1.

Crude protein concentrations of tested ecotypes were presented in Table 4. There was significant difference between ecotypes ($p < 0.05$) and cutting regimes ($p < 0.01$) for CP content but year effect was not significant ($p > 0.05$) (Table 3). Cutting regime influenced more significantly forage crude protein content than ecotype. CP per ha is presented in Table 5. It was significantly influenced by ecotype, cutting regime and year (Table 3).

Mineral concentrations

Among tested plants, Ecotype 7 appeared to be more concentrated for macronutrients content (Table 6). Its forage ash content was the highest and represented 1.5 to 2.6 times those of others ecotypes. Its P content was 1.8 to 2.9 times as compared to others. Its Mg and K contents were the highest of all. Ecotypes 1, 4 and 8 showed the lowest Ca concentrations. All ecotypes had similar Na concentrations. For micro-nutrients, significant differences were observed between ecotypes for Zn, Mn and Cu. However, ecotypes did not differ significantly in Co content (Table 6).

DISCUSSION

Dry matter production, crude protein content and crude protein production

Despite that all ecotypes belong to the same species, high significant difference ($p < 0.001$) for DM production appeared between them across cutting regimes and

years, showing that they react differently toward these parameters. Therefore, there are great possibilities for choosing some of them for increasing animal feeds in West Africa region. Ecotype 4 was consistently the highest and Ecotype 7 the lowest yielder. The superior yield of Ecotype 4 at all harvest regimes may be a function of its better soil nutrients or water use (Pieterse et al., 1997). On the other hand, Ecotype 4 was reported by Adjolohoun et al. (2012) to have more leaves than others. This intrinsic trait of this ecotype can allow it to have more surface area and therefore more photosynthesis activity due to more solar irradiance quantity which could be intercepted. This particular characteristic can contribute to its higher DM production (Alejandra et al., 1997). A decrease in dry matter production was observed through the years for all tested ecotypes. *P. maximum* grows on a large range of soils, but produces poor stands on infertile types (Cook et al., 2005). The declining yields recorded for ecotypes may be due to the poor tolerance of this species of low fertility once the initial N mineralised by cultivation was depleted. A similar pattern of yield decrease was observed for *P. maximum* by Omokanye et al. (2000). Robbins et al. (1989) and Lloyd et al. (1991) also reported productivity declines with age in sown tropical pastures.

Out of these nine ecotypes, Ecotype 9 had a lesser DM decreasing, showing its better adaptation to environment conditions prevailing in the testing area. This ecotype was reported by Adjolohoun et al. (2012) as drought-tolerant and therefore could be less affected by decreasing rainfall in the area and this could account for its low decrease in dry matter production. This ecotype may also be less demanding in fertility, which may explain the lower decrease in production over time.

There were no significant ecotype*cutting regime interaction ($p = 0.663$) for DM production. This result shows that cutting regime influence through ecotypes for DM was similar for all nine tested ecotypes. This result is interesting and of practical implication as it allows for suggesting to small farmers the same cutting regime independently to ecotypes or harvesting year. Cutting regime of 3-10-3-week had produced constantly the highest dry matter. Nevertheless, all of forages harvested according to this regime had between 5 and 6 g CPkg⁻¹

Table 5. Crude protein production per ha of 9 *Panicum maximum* ecotypes under 3 cutting regimes (3-10-3-week, 6-5-6-week, 5-6-5-week-week) during 2008, 2009 and 2010.

Ecotype	Year								
	2008			2009			2010		
	3-10-3	5-6-5	6-5-6	3-10-3	5-6-5	6-5-6	3-10-3	5-6-5	6-5-6
1	292 ^{Ad}	355 ^{Ae}	296 ^{Af}	235 ^{Bc}	287 ^{Bc}	241 ^{Bc}	182 ^{Cbc}	225 ^{Cb}	197 ^{Cb}
2	321 ^{Ad}	419 ^{Ad}	348 ^{Ae}	230 ^{Bc}	272 ^{Bc}	227 ^{Bcd}	125 ^{Cc}	140 ^{Ccd}	110 ^{Cc}
3	219 ^{Ae}	346 ^{Ae}	307 ^{Aef}	158 ^{Bd}	234 ^{Bcd}	186 ^{Bde}	76 ^{Cde}	96 ^{Cde}	82 ^{Cd}
4	640 ^{Aa}	871 ^{Aa}	791 ^{Aa}	551 ^{Ba}	639 ^{Ba}	657 ^{Ba}	348 ^{Ca}	408 ^{Ca}	375 ^{Ca}
5	492 ^{Ab}	684 ^{Ab}	635 ^{Ab}	340 ^{Bb}	383 ^{Bb}	366 ^{Bb}	232 ^{Cb}	197 ^{Cbc}	220 ^{Cb}
6	215 ^{Ae}	264 ^{Af}	262 ^{Af}	161 ^{Bd}	184 ^{Bde}	187 ^{Be}	111 ^{Ccd}	108 ^{Ce}	103 ^{Cc}
7	187 ^{Ae}	190 ^{Af}	190 ^{Ag}	122 ^{Bd}	88 ^{Be}	96 ^{Bf}	54 ^{Ce}	45 ^{Cf}	61 ^{Cd}
8	394 ^{Ac}	507 ^{Ac}	411 ^{Ad}	211 ^{Bc}	200 ^{Bd}	192 ^{Bd}	121 ^{Cc}	88 ^{Cde}	104 ^{Cc}
9	601 ^{Aa}	698 ^{Ab}	544 ^{Ac}	368 ^{Bb}	401 ^{Bb}	354 ^{Bb}	213 ^{Cb}	165 ^{Ccd}	146 ^{Cc}
Mean	373	482	421	264	299	278	163	165	155
SEM	33	45	38	25	30	33	20	21	19

Values within a column followed by the same lower case letter do not differ significantly ($p < 0.05$). For the same cutting regime and for the same line, values followed by the same upper case letter do not differ significantly ($p < 0.05$).

Table 6. Macro- and micro-mineral concentrations of 9 *Panicum maximum* ecotypes compared with ruminant needs ($n = 3$)*.

Ecotype	Ash (% DM)	Macro-minerals					Micro-minerals			
		Ca	P	Mg	K	Na	Zn	Cu	Mn	Co
		(g/kg DM)					(mg/kg DM)			
1	5.77e ⁽¹⁾	6.66 ^a	0.62 ^e	1.9 ^b	10.59 ^b	0.1 ^a	14 ^b	3 ^b	81 ^{ab}	0.1 ^a
2	9.05 ^b	6.61 ^a	0.59 ^e	1.8 ^b	8.46 ^c	0.2 ^a	12 ^b	6 ^a	75 ^{bc}	0.1 ^a
3	7.43 ^{cd}	5.55 ^b	0.92 ^{bc}	1.40 ^c	7.98 ^c	0.1 ^a	16 ^{ab}	5 ^{ab}	66 ^c	0.1 ^a
4	5.90 ^e	5.95 ^b	0.87 ^c	1.05 ^c	9.04 ^c	0.1 ^a	15 ^{ab}	4 ^b	88 ^{ab}	0.1 ^a
5	10.01 ^b	7.21 ^a	0.65 ^{de}	1.93 ^b	10.88 ^b	0.2 ^a	16 ^{ab}	7 ^a	80 ^{ab}	0.2 ^a
6	6.66 ^{de}	6.01 ^{ab}	1.01 ^b	1.07 ^c	12.02 ^b	0.1 ^a	15 ^{ab}	4 ^b	91 ^a	0.1 ^a
7	15.09 ^a	5.98 ^b	1.81 ^a	2.65 ^a	21.6 ^a	0.1 ^a	20 ^a	5 ^{ab}	77 ^b	0.1 ^a
8	5.78 ^e	2.08 ^d	0.77 ^{cd}	1.91 ^b	8.21 ^c	0.1 ^a	17 ^{ab}	4 ^b	69 ^c	0.1 ^a
9	8.55 ^{bc}	3.76 ^c	0.79 ^c	1.36 ^c	10.55 ^c	0.1 ^a	18 ^a	3 ^b	65 ^c	0.1 ^a
Mean	8.25	5.87	0.86	1.69	11.04	0.1	16	5	77	0.1
SEM	3.2	1.01	0.3	0.8	9	0.0	4	0.5	14	0.0
Ruminant needs ⁽²⁾	-	2.4	1.2	1.2	6-8	0.7	50	10	50	0.1

⁽¹⁾ Values within a column followed by the same case letter do not differ significantly ($p < 0.05$). Cutting regime had no significant effect on ecotype mineral concentrations and therefore, only means through ecotype are presented. ⁽²⁾ Requirements for cattle (200 kg LWt) with average liveweight gain of 100 g/d (Rivière, 1991) for Ca, P and S; NRC (2000) for K, Na and Underwood and Suttle (1999) for Mg.

DM and therefore, less than 7 and 8 g CPkg⁻¹ DM required by Minson (1990) and Coleman et al. (2003) for adequate ruminant nutrition. Such forages with low CP content will limit micro-organism activities in the rumen and therefore induce slow rate of digestion. This would result in decreased DM intake and reduced animal performance. So, cutting regime of 3-10-3-week, even if it allows the highest dry matter production couldn't be recommended to farmers.

Some tested Ecotypes (1, 4 and 5) produced between 388 and 586 kg CPha⁻¹year⁻¹ higher than that reported by Adjolohoun et al. (2008) for exotic *P. maximum* C1 (377 kg CPha⁻¹year⁻¹). This variety of *Panicum* was intensively vulgarized through West Africa by agricultural extension services. Our results show that there are some indigenous *Panicum* which can produce more than this exotic *Panicum*. Such result is important as it suggests that, many of tropical developing countries would have a

range of potential forage which would be fully evaluated before beginning programs relying solely on introduced cultivars.

Minerals concentration of forages

Ecotype 5 forage concentrations in Ca are more than three times that of Ecotype 8. All of forage concentrations in Ca are above the requirements levels of 2.4 g/kg (Rivière, 1991) except for Ecotype 8 (2.08 g/kg). Hbage Ca is used very efficiently by cattle when necessary and an average forage Ca absorbability of 0.68 can be exceeded (AFRC, 1991) for tested ecotypes. The highest level of 7.21 g/kg obtained with Ecotype 5 can suggest a possible toxicity for sheep, but Ca is not generally regarded as a toxic element, because homeostatic mechanisms ensure that excess dietary Ca is extensively excreted in faeces (Underwood and Suttle, 1999). P forage concentrations (0.62 to 1.81 g/kg DM) recorded in this trial were lower than that reported for *P. maximum* cv Mulate (2.5 g/kg DM) (Pieterse et al., 1997) but, forage P of Ecotype 7 (1.81 g/kg DM) compared well with those noted for *P. maximum* cv Petrie, Gatton and Vencedor (1.7 to 1.8 g/kg DM) reported by Pieterse et al. (1997). Deficiency for P is the most common nutritional mineral problem for the tested ecotypes in the area (Adjolohoun et al., 2008), probably due to the low P levels in soils. P supplementation would be necessary for animal feeding in the area. Under the same environmental and growing conditions, concentration in P forage of Ecotype 7 was more than 3-fold that of Ecotype 2 showing the possibility of choosing *P. maximum* ecotype that could have an important contribution for herbivorous P diet for this region. On the other hand, the lowest P content of Ecotype 2 for animal production could have an important consequence for livestock nutrition by the fact that this ecotype is one of the most available in the area (Coastal region of West Africa) (Adjolohoun et al., 2012) and may be the only one available species sometimes. K concentrations of tested forages were largely above the critical values for deficiency suggested for grazing ruminants and summarized by (NRC, 2000). Except for Ecotype 7, forage Mg contents observed in this study were in the range 1.05 to 1.97 g/kg DM. They were lower than the range of 2.4 to 3.9 g/kg DM reported for *P. maximum* cv. Gatton by Davison et al. (1987). Except for Ecotypes 4 and 6, forage Mg content differences were lower to meet animal requirements, specially for pregnant and lactating cattle which need 1.4 and 2.1 g kg⁻¹ DM (Sultte, 1983). The low concentrations of forage in Na, Zn and Cu need a provision of mineral supplements when the forages are solely used in animal feeding.

This trial conducted on *P. maximum* ecotypes aimed to identify some best ecotypes for both biomass production and nutritive values. It had produced valuable findings as it demonstrated an useful great variability in potentials between tested ecotypes for dry matter and nutritious

forage production never reported among indigenous ecotypes of this species. Under the conditions of this experiment, it can be concluded that Ecotypes 1, 4 and 5 are the most interested for both dry matter and crude protein production. Among the 3 cutting regimes tested, 5-6-5-week regime could be recommended for maximizing both quantity and quality forage production. Such results had also never been reported on the species. In general, forage of tested ecotypes had adequate Ca, K, Mg and Co contents for satisfying livestock dietary maintenance requirement. However, forages need to be complemented for P, Zn and Cu for good animal production. Due to variation in the area conditions and their effects on plant production, we suggest that the study should be continued in others environments.

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