Dry matter yield, mineral contents and proximate composition of *Panicum maximum* (Jacq var. Ntchisi) sown with forage legumes

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Abstract

This study assessed the dry matter yield, mineral and proximate composition of Panicum maximum Jacq var. Ntchisi planted with Lablab purpureus (Lablab), Centrosema pubescens (Centro), Aeschynomene histrix (A. histrix) and Stylosanthes guianensis (Stylo) in a 3 x 5 factorial experiment using Randomized Complete Block Design in early, mid and late rainy season. The dry matter yields (DMY) of panicum sown with Lablab (11.82 t/ha/yr) was significantly higher ($P < 0.05$) than that observed for other mixtures. The least DMY of 9.46 t/ha/yr was observed for panicum in panicum/ A. histrix mixture. The yields recorded for Stylo and Lablab were highest in mid and late rainy seasons than in the early rain. Panicum sown with Lablab had the highest DM (37.71g/100g DM), Crude protein (CP) (11.36g/100g DM), ether extracts (7.20g/100g DM) and ash content (2.52g/100g DM). Among the legumes, Lablab had the highest CP (23.29 g/100g DM), crude fibre (10.61 g/100g DM) and ash content (3.96 g/100g DM). However, Centro was highest in ether extract (9.30g/100g DM). Panicum sown with Lablab had higher concentration of sodium (Na) and iron (Fe) while panicum planted with Stylo had highest concentration of phosphorus (P). The concentration of calcium (Ca) was similar ($P > 0.05$) among the mixtures but differed ($P < 0.05$) in the legumes. Stylo had the highest Ca concentration (0.72%) whereas highest P and Fe values were observed in Lablab. In conclusion, panicum harvested from panicum/lablab mixture had the highest DMY, CP, EE and ash content of grass in early, mid and late rainy season than the other mixtures.

Keywords: Legume, mineral contents, proximate composition, Panicum

Introduction

Shortages of forage often pose constraints to livestock production in Nigeria and where they abound are usually of low nutritive value which manifest in nutritional deficiency among the stock types especially during the dry season (Otuma *et al.*, 2000). Grass which is the cheapest feed for ruminants are unreliable because their nutritional quality declines during the dry season with protein content being as low as 4 g/100g (Topps and Oliver, 1993). This irregularity in forage quantity and quality affects the output of grazing livestock.

The use of forage legumes in ruminant livestock production systems in the tropics has increased and their introduction into farming systems has improved livestock production (Norton and Poppi, 1995). The protein content of legumes may range from 15 – 30 g/100g DM (Topps and Oliver, 1993). They can be grazed in-situ, harvested and fed fresh to animals indoor or stored as hay or silage and fed as conserved forage in the dry season. The rhizomes associated with the root of legumes in a form of symbiotic relationship converts atmospheric nitrogen to forms of nitrogen which plants can take up and recycle within

the soil-plant-animal system.

Panicum maximum cv *Ntchisi* originates from Africa and grows naturally in many parts of the world where tropical and sub-tropical climate is favourable to its growth. It is cherished by all classes of ruminant. The major problem with this grass, like many other grasses, is the rapid decline in crude protein and soluble carbohydrates with advancing age coupled with progressive increases in crude fibre and lignin. There is therefore, the need to improve the nutritive value of the grass with herbaceous legumes. Information on agronomic performance of grasses in grass/legume mixtures in tropical environment is essential for increasing productivity of grazing livestock.

Therefore, the objective of this study was to determine the dry matter yield, proximate composition and mineral contents of *P. maximum* planted with *Centrosema pubescens*, *Lablab purpureus*, *Aeschynomene histrix*, and *Stylosanthes guianensis*.

Materials and Methods

Experimental site

The study was conducted at the Institute of Agricultural Research and Training, Ibadan (Latitude 7° 15'–7° 30' N and Longitude 3° 45'–4° E) between March and October 2004 and 2005. The area has a humid climate, the mean annual rainfall during the experimental period were 805 mm and 1350 mm for 2004 and 2005 respectively.

Total monthly rainfall for Ibadan in 2004 and 2005

Fig.1 Total monthly rainfall for Ibadan in 2004 and 2005

The mean monthly temperature was 31 °C for each year.

Pasture Establishment

The total land area measuring 1800m² was cleared, ploughed and harrowed in March 2004 after which the land was divided into fifteen plots, each plot measured 15 m x 6 m. *Panicum maximum* (Ntchisi) was planted in all the plots at a spacing of 1 m x 1 m using crown splits. The legume seeds were scarified to break dormancy and to enhance germination. Seeds of *A. histrix*, lablab and centro were immersed in hot water at 80° C for 5 minutes while seeds of stylo were rubbed on sandpaper until seed coats were broken. Seeds scarified with hot water were air-dried before planting. The seeds of lablab and centro were planted at 2 seeds per hole while seeds of *A. histrix* and stylo were drilled at about 1 cm soil depth between rows of *P. maximum* after two months of establishment.

Experimental Design

The effect of seasons; early rain (March/April), mid rain (June/July) and late rain (September/October) on dry matter yield and nutrient composition of panicum planted as sole crop and panicum planted with four forage legumes were investigated using 3 x 5 factorial arrangement in a randomized complete block design.

Pasture Harvesting and Processing

Panicum was harvested manually from the sole grassland and grass/legume plots at four weeks interval for six months (May – October, 2004) using three 1 m² quadrats thrown at random. The panicum and legumes were cut with knife at 5 cm above ground level, oven dried at 105° C and sub samples pooled together and milled using 1 mm sieve of Thompson hammer mill for chemical analysis.

Chemical Analysis

Dried samples of forages were analyzed for crude protein (CP) using the Kjeldahl

procedure (AOAC 1990). Dry matter, crude fiber, ether extract and ash were determined according to the Official Methods of Analysis (AOAC, 1990).

Statistical Analysis

Data obtained were subjected to analysis of variance (ANOVA) procedure of SAS (1998). Treatment means were compared using Duncan Multiple range test (Duncan, 1955).

Results

The proximate composition of panicum planted with the legumes differed ($P < 0.01$) significantly (Table 1). The dry matter (DM) content varied from 28.29 g/100g DM in sole panicum to 37.71 g/100g DM for panicum/lablab mixture. Higher concentration of crude protein (CP) was obtained for the panicum harvested from panicum/lablab mixture (11.36 g/100g DM) which was also higher than the quantity obtained in panicum/stylo mixture (8.85 g/100g DM), panicum/histrix mixture (8.50 g/100g DM) while the lowest was in panicum/centro mixture (8.18 g/100g DM). The sole panicum which was the control had CP of 7.63 g/100g DM. The crude fibre (CF) content of panicum was highest in panicum/stylo mixture (17.64 g/100g DM), followed by that from panicum/lablab mixture while the least value of 12.42 g/100g DM was recorded for panicum harvested from panicum/centro mixture. The ash content of panicum was highest for panicum/lablab mixture (2.52 g/100g DM) and was followed by panicum in panicum/centro mixture (2.35 g/100g DM). The lowest value was obtained in sole panicum (1.84 g/100g DM). The ether extract (EE) recorded was between 4.71 g/100g DM for the sole panicum and 7.20 g/100g DM for panicum in panicum/lablab mixture. The effect of time of harvest was significant on the DM and CP. The

Table 1: Proximate composition (g/100g) of *Panicum maximum* planted with four forage legumes

Forage	Season	Composition					
		Dry Matter	Crude Protein	Crude fibre	Ash	Ether extract	NFE
P. max./ Stylo mixture	1	30.12	8.41	16.47	2.23	5.66	32.18
	2	29.44	8.25	17.29	2.05	5.38	31.67
	3	41.00	9.89	19.16	2.26	6.30	32.24
	Mean	33.52 ^b	8.85 ^b	17.64 ^a	2.18 ^c	5.78 ^c	32.03 ^b
P. max./A. histrix mixture	1	40.31	8.38	11.88	1.77	6.60	34.28
	2	32.60	8.42	13.94	1.89	6.74	36.99
	3	30.80	8.70	12.67	1.80	6.43	35.80
	Mean	34.57 ^b	8.50 ^{bc}	12.83 ^c	1.82 ^d	6.59 ^b	35.69 ^b
P. max./ Centro mixture	1	42.30	8.06	12.60	2.17	6.05	32.48
	2	31.44	7.98	12.36	2.30	6.84	35.60
	3	32.07	8.50	12.30	2.58	6.25	35.00
	Mean	35.27 ^b	8.18 ^c	12.42 ^d	2.35 ^b	6.38 ^b	34.36 ^b
P. max./ Lablab mixture	1	43.20	10.60	16.21	2.58	7.40	26.44
	2	35.48	11.28	15.00	2.60	7.63	28.02
	3	34.45	12.20	13.94	2.38	6.57	35.80
	Mean	37.71 ^a	11.36 ^a	15.05 ^b	2.52 ^a	7.20 ^a	35.69 ^b
sole P. max.	1	33.45	7.26	14.70	1.76	4.88	45.68
	2	27.54	7.85	15.11	1.80	4.23	40.72
	3	23.88	7.78	14.56	1.96	5.02	38.61
	Mean	28.29 ^c	7.63 ^d	14.79 ^{bc}	1.84 ^d	4.71 ^d	41.67 ^a
SEM		2.23	0.48	0.37	0.14	0.58	5.62
Significance							
P. max.		***	***	***	***	***	***
Season		***	***	NS	NS	NS	NS
P. max. x Season		***	NS	***	NS	***	***

^{a,b,c,d} Means in a column with similar superscript are not significantly different ($P > 0.01$)

** $P < 0.01$; *** $P < 0.001$; NS, not significant. ¹ 1= Early rain; 2= Mid rain; 3= Late rain.

NFE=Nitrogen free extract, SEM= Standard error of the mean

proximate composition of the legumes differed significantly ($P < 0.01$) as shown in Table 2. The concentrations of CP and CF were in the order of lablab > *A. histrix* > stylo > centro and values ranged from 16.71g/100g DM and 7.52 g/100g DM for centro to 23.29 g/100g DM and 10.61 g/100g DM for lablab respectively. The ash content ranged from 1.52 g/100g DM for *A. histrix* to 3.96 g/100g DM for lablab while the ash content of centro and stylo were not significantly ($P > 0.01$) different. The EE concentration was between 9.30 g/100g DM for centro and 7.68 g/100g DM for *A. histrix*. The effects of time of harvest was only significant ($P < 0.01$) on the DM and

NFE contents of the legumes.

The mineral composition of panicum planted with legumes is presented in Table 3. The values obtained for phosphorus (P), calcium (Ca), sodium (Na) and iron (Fe) differed ($P < 0.01$) among the treatments. The P content was higher for panicum in panicum/stylo mixture (0.76 %) while the lowest P content among the mixtures was observed for panicum harvested from panicum/histrix mixture (0.40 %) which was not significantly ($P > 0.01$) different from 0.44 % recorded for panicum in panicum/lablab mixture. The calcium content obtained ranged from 0.15 % to 0.25 % for panicum in panicum/stylo and

Table 2: Proximate composition (g/100g) of four forage legumes sown with *Panicum maximum*

Forage	Season	Composition					
		Dry Matter	Crude Protein	Crude fibre	Ash	Ether extract	NFE
<i>Stylosanthes guianensis</i>	1	32.80	17.27	8.64	2.74	7.82	26.14
	2	31.66	18.65	8.83	2.80	6.88	28.03
	3	38.02	18.23	9.95	3.07	9.00	29.47
	Mean	34.16 ^d	18.05 ^c	9.14 ^b	2.87 ^b	7.90 ^c	27.88 ^a
<i>Aeschynomene histrix</i>	1	40.63	22.38	9.83	1.56	7.72	17.29
	2	41.28	20.94	10.27	1.47	7.84	18.44
	3	44.15	20.88	11.34	1.53	7.48	14.97
	Mean	42.02 ^a	21.40 ^b	10.48 ^{ab}	1.52 ^c	7.68 ^d	16.90 ^c
<i>Centrosema pubescens</i>	1	37.45	17.28	7.68	3.16	8.36	22.59
	2	36.28	16.45	7.07	3.22	9.51	26.11
	3	42.49	16.40	7.81	3.82	10.03	24.29
	Mean	38.74 ^b	16.71 ^d	7.52 ^c	3.40 ^{ab}	9.30 ^a	24.33 ^b
<i>Lablab purpureus</i>	1	35.80	23.30	10.48	3.87	8.66	18.16
	2	39.21	22.06	10.12	3.64	8.43	17.58
	3	34.22	24.51	11.23	4.37	8.44	15.92
	Mean	36.41 ^b	23.29 ^a	10.61 ^a	3.96 ^a	8.51 ^b	17.22 ^c
SEM	2.08	1.22	1.30	1.28	0.19	3.52	
Significance							
Legume		***	***	***	***	***	***
Season		***	NS	***	NS	NS	***
Legume x Season		***	NS	NS	NS	***	***

^{a,b,c,d} Means in a column with similar superscript are not significantly different ($P > 0.01$)

** $P < 0.01$; *** $P < 0.001$; NS, not significant. ¹ 1= Early rain; 2= Mid rain; 3= Late rain.

NFE=Nitrogen free extract, SEM= Standard error of the mean

panicum/*A. histrix* mixtures. The concentration of sodium differed ($P < 0.01$) significantly and ranged from 0.09 % for panicum from panicum/*A. histrix* mixture to 0.21 % for panicum from panicum/centro mixture. The least (0.07 %) sodium concentration was recorded for sole panicum. The iron concentration ranged from 154.85 ppm for panicum harvested from panicum/*A. histrix* mixture to 171.45 ppm for panicum from panicum/lablab mixture and was followed by 164.35 ppm recorded for panicum from panicum/stylo mixture. The effect of time of harvest was significant ($P < 0.01$) in P contents of the panicum but not significant in Ca, Na and Fe contents. The forage legumes differed ($P < 0.01$) significantly in the concentration

of P, Ca and Fe except in the concentration of Na (Table 4). The mean P content ranged from 0.58 % in centro to 0.79 % in lablab and was followed by 0.73 % observed for stylo. The Ca content in legumes ranged from 0.46 % in histrix to 0.72 % in stylo. The concentration of Fe ranged from 158.55 ppm in centro to 176.40 ppm in lablab. The effects of time of harvest was not significant ($P > 0.01$) on the mineral contents.

There was an increase in dry matter yield (DMY) from early to late rainy season and varied significantly ($P < 0.01$) among the treatments at four weeks cutting interval (Table 5). Throughout the season, the yield of panicum in panicum/lablab mixture was

Table 3: Mineral composition (%) of *Panicum maximum* sown with four forage legumes

Forage	Season	Phosphorus	Calcium	Sodium	Iron (ppm)
<i>P. max.</i> / Stylo mixture	1	0.44	0.28	0.08	166.22
	2	0.88	0.22	0.09	156.70
	3	0.96	0.25	0.13	170.13
	Mean	0.76 ^a	0.25 ^a	0.10 ^b	164.35 ^b
<i>P. max.</i> / histrix mixture	1	0.38	0.24	0.07	158.25
	2	0.36	0.28	0.09	160.41
	3	0.46	0.23	0.11	145.89
	Mean	0.40 ^c	0.25 ^a	0.09 ^b	154.85 ^c
<i>P. max.</i> / Centro mixture	1	0.51	0.22	0.18	159.77
	2	0.62	0.23	0.24	163.18
	3	0.64	0.27	0.21	162.30
	Mean	0.59 ^b	0.24 ^a	0.21 ^a	161.75 ^b
<i>P. max.</i> / Lablab mixture	1	0.48	0.22	0.18	168.28
	2	0.50	0.26	0.20	172.49
	3	0.34	0.24	0.22	173.58
	Mean	0.44 ^c	0.24 ^a	0.20 ^a	171.45 ^a
Sole <i>P. max.</i>	1	0.10	0.16	0.08	138.68
	2	0.08	0.13	0.06	139.27
	3	0.15	0.16	0.07	137.25
	Mean	0.11 ^d	0.15 ^b	0.07 ^d	138.40 ^d
SEM		0.05	0.01	0.01	2.71
Significance					
<i>P. max.</i>		***	***	***	***
Season		***	NS	NS	NS
<i>P. max.</i> x Season		***	NS	NS	***

^{a,b,c,d} Means in a column with similar superscript are not significantly different ($P > 0.01$)

** $P < 0.01$; *** $P < 0.001$; NS, not significant. ¹ 1= Early rain; 2= Mid rain; 3= Late rain.

SEM= Standard error of the mean

the highest for the three times of harvest followed by the DMY of panicum in stylo while the least yields were recorded for sole panicum. The DMY obtained for the legumes varied significantly ($P < 0.01$) in the early rainy season (Table 6). There was no significant differences ($P > 0.01$) in the DMY of the legumes in both mid and late rains. However, the highest yield was recorded in *L. purpureus* (11.45 t/ha/yr), the least yield was obtained in *C. pubescens* (9.41 t/ha/yr) in late rain.

Discussion

The DM content of panicum in mixtures with legumes in this study was lower than 71.29 g/100g reported by Nworgu and Ajayi (2005) and Babayemi *et al.*, (2006). This could be because of the period of establishment of the grass and legumes in this study which was during the rainy season (June – September) whereas the pastures in the cited works were planted during the early dry season (October – January) a time of the year when moisture limitation could impair rapid growth and DM yield. The CP content of panicum in

Table 4: Mineral composition (%) of four forage legumes sown with *Panicum maximum*

Forage	¹ Season	Phosphorus	Calcium	Sodium	Iron (ppm)
<i>Stylosanthes guianensis</i>	1	0.68	0.71	0.22	162.55
	2	0.72	0.69	0.25	164.20
	3	0.79	0.76	0.22	164.35
	Mean	0.73 ^b	0.72 ^a	0.23 ^a	163.70 ^c
<i>Aeschynomene histrix</i>	1	0.75	0.42	0.26	170.29
	2	0.77	0.47	0.26	171.27
	3	0.64	0.49	0.20	167.09
	Mean	0.72 ^b	0.46 ^d	0.24 ^a	169.55 ^b
<i>Centrosema pubescens</i>	1	0.60	0.63	0.26	157.38
	2	0.58	0.61	0.24	160.44
	3	0.56	0.59	0.19	157.83
	Mean	0.58 ^c	0.61 ^b	0.23 ^a	158.55 ^d
<i>Lablab purpureus</i>	1	0.77	0.55	0.26	177.20
	2	0.81	0.48	0.23	168.92
	3	0.79	0.47	0.20	183.08
	Mean	0.79 ^a	0.50 ^c	0.23 ^a	176.40 ^a
SEM		0.02	0.05	0.01	1.88
Significance					
Legume		***	***	NS	***
Season		NS	NS	NS	NS
Legume x Season		***	NS	NS	NS

^{a,b,c,d} Means in a column with similar superscript are not significantly different ($P > 0.01$)

** $P < 0.01$; *** $P < 0.001$; NS, not significant. ¹ 1= Early rain; 2= Mid rain; 3= Late rain.

SEM= Standard error of the mean

panicum/legume mixture was higher than 7.02 g/100g DM (Bamikole *et al.*, 2004) and 7.20 g/100g DM (Babayemi *et al.*, 2006). Similarly, the CP concentration of

panicum in panicum/ Lablab mixture (11.36 g/100g DM) was higher than 9.70 g/100g DM reported for nitrogen fertilized guinea grass (Bamikole *et al.*, 2004). The

Table 5: Dry matter yield of *Panicum maximum* sown with four forage legumes

Forage	Harvesting period		
	Early rain t/ha/yr	Mid rain t/ha/yr	Late rain t/ha/yr
<i>P. max.</i> / Stylo mixture	9.82 ^b	11.30 ^b	11.82 ^b
<i>P. max.</i> / <i>A. histrix</i> mixture	6.69 ^d	8.39 ^c	9.46 ^c
<i>P. max.</i> / Centro mixture	7.09 ^c	8.58 ^c	9.70 ^c
<i>P. max.</i> / Lablab mixture	11.39 ^a	12.49 ^a	14.07 ^a
Sole <i>P. max.</i>	3.44 ^e	5.23 ^d	5.64 ^d
SEM	0.42	0.23	0.28

^{a,b,c,d,e} Means in a column with similar superscript are not significantly different ($P > 0.01$),

SEM= Standard error of the mean

Table 6: Dry matter yield of four forage legumes intercropped with *Panicum maximum*

Forage	Harvesting period		
	Early rain t/ha/yr	Mid rain t/ha/yr	Late rain t/ha/yr
<i>Stylosanthes guianensis</i>	6.34 ^c	9.39 ^a	11.25 ^a
<i>Aeschynomene histrix</i>	6.10 ^d	8.61 ^b	9.46 ^b
<i>Centrosema pubescens</i>	6.53 ^b	8.53 ^b	9.41 ^b
<i>Lablab purpureus</i>	7.63 ^a	9.30 ^a	11.45 ^a
SEM	0.06	0.67	1.05

^{a,b,c,d,e} Means in a column with similar superscript are not significantly different ($P > 0.01$),

SEM= Standard error of the mean

ash and EE contents of panicum in panicum/legume mixture for all treatments in the late rainy season were higher than values cited by Arigbede *et al.*, (2005). This showed that mineral and crude fat contents in forages would likely be higher at the end of the rainy season than in the early or mid rainy season. The CP contents of Centro and *A. histrix* was similar to values by Nworgu and Ajayi (2005) whereas higher CP content was recorded for Lablab compared to value reported (Babayemi *et al.*, 2006). Higher CP was observed in Stylo compared to 12.1 g/100g DM reported (Bamikole *et al.*, 2004).

The Calcium content of panicum in panicum/legume mixtures was higher than that of the sole panicum. At similar cutting interval, the Ca content obtained in this study was higher than the value reported by Babayemi *et al.*, (2006) for panicum. However, the values obtained for Ca were within the recommended requirement for ruminant livestock (SCARS, 1990). Phosphorus content of panicum planted with legume was higher than that of the sole panicum. The values of P obtained for the panicum in panicum/legume mixtures were within the recommended requirement for ruminant livestock (ARC, 1984; SCARS, 1990), whereas the P content of the sole panicum was below the requirement. Higher Na and Fe contents were observed

in all panicum planted with legumes than that of sole panicum in late rain. The contents of Na and Fe for panicum planted with legume were adequate for ruminant livestock. The Ca, P, Na and Fe contents obtained for the herbaceous legumes exceeds the recommended requirement for ruminant livestock (ARC, 1984).

The dry matter yield (DMY) of panicum planted with the legumes was twice that of the sole panicum. The dry matter yield obtained in the early rain for Centro and *A. histrix* were higher than 6.63 t/ha/yr and 7.25 t/ha/yr earlier reported (Nworgu and Ajayi, 2005). This could be because higher rainfall was recorded in this study (Fig.1) than reported by the authors. The DMY of Stylo was four times higher than that reported by Bamikole *et al.*, (2004). The yield of Lablab cv Rongai brown in this study in the early rain was higher than 13.14 t/ha/yr (Amodu *et al.*, 2004) for Lablab cv Rongai white and brown. The higher DMY obtained for Lablab was likely due to its aggressive and vigorous growth habit.

Conclusion

The dry matter yield, proximate composition and mineral contents of panicum could be enhanced for ruminant nutrition when the panicum is planted with *A. histrix*, Lablab, Centro and Stylo. The highest dry matter yield and nutritive

composition were observed for panicum in panicum/Lablab mixture. The variations observed in dry matter yield, proximate composition and mineral contents of the pastures in this study compared to previous work could be as a result of age of cutting, season and geographical location. It is evident that planting panicum with any of these legumes in mixtures increased the nutrient composition which were observed to be within the recommended requirement for ruminant livestock. The best period of the rainy season to expect high mineral profile in grass is during the late rain to early dry season.

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