African Journal of Agricultural Research Vol. 7(14), pp. 2174-2182, 12 April, 2012
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR12.376
ISSN 1991-637X ©2012 Academic Journals

Full Length Research Paper

The quality of crop fractions of a degraded *Panicum maximum* pasture under different cutting intervals and nitrogen fertilizer rates

C. C. Onyeonagu*, O. A. Anyadiegwu and T. K. Uwalaka

Department of Crop Science, University of Nigeria, Nsukka, Nigeria.

Accepted 6 February, 2012

The effects of cutting frequency and levels of nitrogen application on quality of crop fractions of a degraded *Panicum maximum* pasture was investigated in 2001 at Nsukka, Nigeria. Cutting intervals consisted of 3, 6, 9 and 12 weeks, while N rates were 0, 150, 300 and 450 kg^{-}N ha^{-1}. The percentage of P in the leaf, Na in all the fractions, Fe in the leaf and stem fractions, ash in the leaf and Zn in the leaf decreased significantly (P < 0.05) with increased interval between cuts. Nitrogen application increased significantly (P < 0.05) the percentage of P in all the fractions, and the percentage of Fe, K and Zn in the leaf compared with the control. Cutting every 3 weeks produced significantly (P < 0.05) higher concentrations of iron in the leaf and stem fractions than the other cutting intervals with application of 300 kg^{-}N ha^{-1}. The percentage of crude fibre in the stem increased significantly (P < 0.05) from 46 to 60% when the interval between cuts was increased from 6 to 9 weeks, while there was a 6% reduction in the crude fibre content of stem when nitrogen fertilizer was increased from 150 to 300 kg ha^{-1}.

Key words: Mineral composition, cutting frequency, crude fibre, ash content, *Panicum maximum*, pasture, nitrogen fertilizer.

INTRODUCTION

Nitrogen-fertilizer application and plant cutting at maturity are among the factors that influence the nutritional values of pasture (Zhang et al., 1999; Bamikole et al., 2004; Onyeonagu, 2010). It is generally recognized that the nutritive value of tropical pasture falls as they mature due to a rise in fiber content with increasing maturity (Adesogan et al., 2009). Maturity through its effects on plant composition is recognized as a major determinant of forage quality (Deetz et al., 1996). Diet quality in terms of chemical composition, influences feed intakes and animal productivity by its effect on rumen function and efficiency in converting plant material to animal tissue (Zimmerman, 1980). The amount of cell wall as expressed by the neutral detergent fibre (NDF) and its degree of lignification are considered the most important factors determining forage quality and digestibility (Van Soest, 1982).

The potentials of pasture species to meet the mineral needs of livestock are of importance as minerals have been referred to as salt of life (Mc Dowell, 1992). The nutrient contents of pasture plant must be adequate to meet the nutrient requirement of grazing cattle. Grazing animals tend to select plants with higher protein and lower fibre contents from the total available forage. However, plants not selected or unpalatable plants do not necessarily have poor nutritive value. Some micro elements which are not essential to plant growth such as sodium and cobalt are critical to animal performance. When the major macro-nutrients, such as phosphorus, potassium, calcium and nitrogen are low, production in cattle is adversely affected (Amina et al., 1989). The nutritional qualities of pasture plants decrease with age

*Corresponding author. E-mail: onyeonagu@yahoo.com.

as a result of differences in plant composition at different levels of maturity. The presence of increased proportion of plant stem fraction, typical of older plants, was reported to restrict access to the leafy parts, forcing animals to consume lower quality herbage (Reiling et al., 2001). Reiling et al. (2001) also noted that increased pasture maturity had a negative effect on the nutritional value of *Panicum maximum* pasture, indicating that this forage would be best utilized at a younger stage of development.

There is paucity of information on the effects of cutting frequency and fertilizer N-application on the quality of crop fractions of run-down pastures found in Nigeria. The objective of this study was to evaluate the effects of cutting management and nitrogen application on the mineral, crude fibre and ash contents of crop fractions in a degraded *P. maximum* pasture.

MATERIALS AND METHODS

The experiment was carried out in the Department of Animal Science, University of Nigeria, Nsukka rangeland and was laid out in a randomized complete block design with 4 × 4 factorial arrangement and three replications. Nsukka is located at latitude 06°52′ N and longitude 07° 24′ E, and on altitude of 447.2 m above sea level. The area had been subjected to continuous grazing over the years from 1997 till the time of commencement of this experiment in 2001. Treatments comprised four levels of nitrogen fertilizer: 0, 150, 300 and 450 kg ha^{-1} and four harvesting frequencies; 3-, 6-, 9- and 12- weekly intervals resulting in sixteen treatment combinations per block. The experimental portion (the degraded pasture land) was marked out into three blocks of 19.2 × 2.4 m each. Each block was further divided into 16 plots of 2.4 × 1.2 m each. The treatments (combinations) were applied randomly to the *P. maximum* pasture in each of the three blocks. Basal application of 75 kg K ha^{-1} yr^{-1} and 44 kg P ha^{-1} yr^{-1} as muriate of potash and single supper phosphate, respectively were made by broadcasting. The soil of the experimental site was a sandy loan and was acidic in reaction. The soil had low amounts of nitrogen content, potassium, magnesium and base saturation. The soil was moderate to good in cation exchange capacity, and high in available phosphorus (Onyeonagu, 2005).

Cutting was done at uniform height of about 7 cm. The grass samples harvested per plot were separated into leaf, stem and inflorescence using a sub sample weighing about 500 g. These crop fractions were dried in a forced-air oven set at 80°C and weighed after drying.

Chemical analysis

The sodium (Na), potassium (K), phosphorus (P), iron (Fe) and zinc (Zn) contents of the crop fractions were analyzed. The potassium and sodium were determined using flame photometry as described by Collins and Polkinhorne (1952). Determination of phosphorus was by the Vando-Molybdate calorimetric method. A slight modification of the spectrophotometric procedures recommended by AMC (1967) was used to determined zinc contents of the fractions. While the percentage crude fibre and total ash contents were determined according to the procedures outlined by Pearson (1976).

RESULTS

The concentration of phosphorus in the leaf fraction increased significantly ($P < 0.05$) with N application compared to the control, although the 300 and 450 kg N ha^{-1} produced similar effects (Table 1). Fertilizer N application had no effects on the phosphorus contents in the stem and inflorescence fractions. The phosphorus in the leaf decreased significantly ($P < 0.05$) with increasing cutting interval up to the 9- weeks and then increased subsequently, while that in the stem fraction was statistically similar for the 3-, 6- and 9-weeks cutting intervals but higher with the 12-weekly interval of cutting. Infrequent cutting at 12 weeks gave relatively higher phosphorus percent values in the leaf and stem fractions than the other cutting intervals, especially when combined with the N rate of 150 kg N ha^{-1}.

Moreover, nitrogen application increased significantly ($P < 0.05$) the potassium concentration in the leaf compared with the control. The concentrations of potassium in the stem and inflorescence fractions were not adversely affected by nitrogen application (Table 2). The proportions of potassium in the leaf and stem fractions decreased significantly ($P < 0.05$) with cutting interval up to the 6 weeks and increased with longer intervals of cutting. Potassium concentration in the inflorescence fraction was not affected by cutting treatment. Cutting every 9 or 12 weeks produced on average, the highest concentrations of potassium in the leaf and stem fractions when combined with the higher N rates.

Meanwhile, no obvious differences were observed on the proportions of sodium (Na) in the leaf and stem among the nitrogen rates (Table 3). The 450 kg N ha^{-1} produced higher sodium concentration in the inflorescence fraction than the 300 kg N ha^{-1}, which was similar with the control and 150 kg N ha^{-1}. The sodium contents of all the fractions generally decreased with increasing interval of cutting. Frequent cutting at 3 weeks gave relatively, higher values than the other cutting intervals in the stem fraction, especially when combined with the 0 kg N ha^{-1} rate. On the other hand, the proportion of iron (Fe) in the leaf generally increased with increased application of N, but decreased with increasing cutting interval (Table 4). The 3 weeks harvest schedule produced significantly higher iron concentration in the stem than the 6- or 12-week interval of cutting. The 9- and 12-week intervals of cutting produced similar effects. Cutting and fertilizer treatments had no effects on the iron concentrations in the inflorescence fraction. Frequent cutting at 3 weeks gave relatively higher values than the other cutting intervals when combined with 300 kg N ha^{-1}. Furthermore, the control treatment produced significantly ($P < 0.05$) lower concentration of zinc in the leaf compared with the 150 or 300 kg N ha^{-1}. Zinc concentrations in the leaf remained similar at the rates of

Table 1. Effect of cutting frequency and nitrogen application on phosphorus (P) content (mg $100g^{-1}$) of leaf, stem and inflorescence.

Cutting frequency (week)	Nitrogen fertilizer (kg N ha^{-1})				Mean
	0	150	300	450	
Leaf					
3	6.2	6.3	6.2	6.1	6.2
6	6.2	6.3	5.2	5.2	5.8
9	5.0	5.1	4.9	4.7	4.9
12	5.7	8.0	7.6	7.4	7.2
Mean	5.8	6.4	6.0	5.8	6.0
Stem					
3	7.6 (2.9)[1]	4.9 (2.1)	8.0 (2.9)	8.0 (2.9)	7.1 (2.7)
6	2.3 (1.4)	5.4 (2.2)	7.7 (2.9)	7.7 (2.9)	5.8 (2.3)
9	7.0 (2.7)	7.8 (2.9)	7.7 (2.8)	7.9 (2.9)	7.6 (2.8)
12	21.5 (4.5)	34.9 (5.9)	32.6 (4.9)	26.5 (5.1)	28.9 (5.1)
Mean	9.6 (2.9)	13.2 (3.3)	14.0 (3.4)	12.5 (3.5)	12.3 (3.2)
Inflorescence					
3	7.0 (2.0)	7.0 (2.4)	4.7 (1.7)	8.5 (2.2)	6.8 (2.1)
6	0.5 (0.9)	7.8 (2.2)	5.8 (1.9)	4.7 (1.7)	4.7 (1.7)
9	14.2 (3.8)	5.4 (1.8)	4.9 (1.8)	4.4 (2.0)	7.2 (2.4)
Mean	7.2 (2.2)	6.7 (2.2)	5.1 (1.8)	5.9 (2.0)	6.2 (2.0)
			Leaf	**Stem**	**Inflorescence**
S.E. of diff. between 2 cutting means (C)			0.21	0.48	0.74
S.E. of diff. between 2 nitrogen (N)			0.21	0.48	0.85
S.E. of diff. between 2 C × N mean			0.43	0.97	1.48

[1]Values in bracket represent the means transformed by square root method. S.e, Standard error of difference.

Table 2. Effect of cutting frequency and nitrogen application on the potassium (K) contents (mg $100g^{-1}$) of leaf, stem and inflorescence.

Cutting frequency (week)	Nitrogen fertilizer (kg N ha^{-1})				Mean
	0	150	300	450	
Leaf					
3	20.5	18.8	20.8	25.7	21.5
6	16.3	15.2	18.5	16.2	16.8
9	15.5	17.5	20.7	14.5	16.9
12	30.7	61.7	50.6	51.7	48.7
Mean	20.8	28.3	27.5	27.0	25.9
Stem					
3	45.0 (6.5)[1]	35.5 (5.0)	27.8 (5.3)	29.5 (4.8)	34.5 (5.4)
6	8.9 (2.2)	16.6 (3.6)	29.5 (5.4)	53.9 (7.2)	27.2 (4.6)
9	38.9 (6.1)	56.7 (7.3)	80.7 (9.0)	72.7 (8.6)	62.3 (7.7)
12	41.2 (6.4)	51.1 (7.1)	36.1 (5.1)	59.5 (7.7)	47.0 (6.6)
Mean	33.5 (5.3)	40.0 (5.7)	43.5 (6.2)	53.9 (7.1)	42.7 (6.1)
Inflorescence					
3	21.1 (3.1)	25.0 (4.3)	4.7 (1.7)	20.6 (3.1)	17.9 (3.1)

Table 2. Count'd

6	8.3 (2.1)	24.7 (3.5)	21.1 (3.1)	4.7 (1.7)	14.7 (2.6)
9	50.6 (7.1)	17.7 (2.9)	17.2 (2.9)	20.0 (3.9)	26.4 (4.2)
Mean	26.7 (4.1)	22.5 (3.6)	14.4 (2.6)	15.1 (2.9)	19.7 (3.3)
			Leaf	**Stem**	**Inflorescence**
S.E. of diff. between 2 cutting means (C)			4.59	0.92	1.37
S.E. of diff. between 2 nitrogen (N)			4.59	0.92	1.58
S.E. of diff. between 2 C × N mean			9.18	1.84	2.74

[1]Values in bracket represent the means transformed by square root method.

Table 3. Effect of cutting frequency and fertilizer nitrogen application on the sodium (Na) content (mg 100g^{-1}) of Leaf, stem and inflorescence.

Cutting frequency (week)	Nitrogen fertilizer (kg N ha^{-1})				Mean
	0	150	300	450	
		Leaf			
3	0.5	0.4	0.4	0.5	0.5
6	0.4	0.3	0.2	0.4	0.3
9	0.5	0.3	0.3	0.4	0.4
12	0.4	0.6	0.4	0.3	0.4
Mean	0.5	0.4	0..4	0.4	0.4
		Stem			
3	0.8 (1.1)[1]	0.4 (0.9)	0.6 (1.0)	0.6 (1.0)	0.6 (1.0)
6	0.4 (0.9)	0.5 (1.0)	0.6 (1.0)	0.5 (1.0)	0.5 (1.0)
9	0.5 (0.9)	0.5 (0.9)	0.3 (0.9)	0.2 (0.8)	0.4 (0.9)
12	0.3 (0.9)	0.3 (0.9)	0.2 (0.8)	0.2 (0.8)	0.2 (0.8)
Mean	0.5 (1.0)	0.4 (0.9)	0.4 (0.9)	0.4 (0.9)	0.4 (0.9)
		Inflorescence			
3	0.1 (0.8)	0.2 (0.8)	0.1 (0.7)	0.1 (0.8)	0.1 (0.8)
6	0.1 (0.7)	0.1 (0.8)	0.1 (0.7)	0.1 (0.7)	0.1 (0.7)
9	0.3 (0.9)	0.1 (0.8)	0.1 (0.8)	0.2 (0.8)	0.2 (0.8)
Mean	0.2 (0.8)	0.1 (0.8)	0.1 (0.7)	0.1 (0.8)	0.1 (0.8)
			Leaf	**Stem**	**Inflorescence**
S.E. of diff. between 2 cutting means (C)			0.05	0.05	0.04
S.E. of diff. between 2 nitrogen (N)			0.05	0.05	0.04
S.E. of diff. between 2 C × N mean			0.11	0.11	0.07

[1]Values in bracket represent the means transformed by square root method.

150 and 300 kg N ha^{-1}, but lower at 450 kg N ha^{-1} (Table 5). Increasing interval of cutting significantly ($P < 0.05$) decreased the leaf zinc concentration. The 3-weeekly cutting interval when combined with 300 kg N ha^{-1} produced the highest Zn % in the leaf.

The percentage crude fibre in the stem increased gradually with increasing cutting interval attaining statistical significant ($P < 0.05$) level at 9- compared with 3- weekly cutting interval beyond which there was a reduction (Table 6). Nitrogen fertilizer application depressed the stem crude fibre at 300 kg N ha^{-1} compared with 150 kg N ha^{-1} but not at the control or 450

Table 4. Effect of cutting frequency and nitrogen application on iron (Fe) contents (mg $100g^{-1}$) of leaf, stem and inflorescence.

Cutting frequency (week)	Nitrogen fertilizer (kg N ha^{-1})				Mean
	0	150	300	450	
		Leaf			
3	8.2	5.0	9.8	8.9	8.0
6	5.1	8.3	6.4	5.6	6.4
9	5.7	6.7	6.3	8.7	6.8
12	4.2	3.3	4.8	6.9	4.8
Mean	5.8	5.8	6.8	7.5	6.5
		Stem			
3	7.0 (2.7)[1]	9.0 (1.7)	9.9 (2.3)	5.4 (1.8)	7.8 (2.7)
6	1.4 (1.2)	1.9 (1.5)	3.2 (1.9)	4.5 (2.2)	2.8 (1.7)
9	5.4 (2.4)	5.0 (2.3)	4.2 (2.1)	4.8 (2.3)	4.9 (2.3)
12	2.2 (1.6)	2.4 (1.7)	2.3 (1.5)	5.0 (2.3)	3.0 (1.8)
Mean	4.7 (2.0)	5.9 (2.0)	5.2 (2.1)	4.9 (2.3)	4.6 (2.1)
		Inflorescence			
3	1.0 (1.1)	3.5 (1.8)	0.5 (0.9)	0.9 (1.1)	1.5 (1.2)
6	0.7 (1.0)	1.9 (1.4)	1.2 (1.1)	0.5 (0.9)	1.1 (1.1)
9	3.7 (2.0)	1.5 (1.2)	2.1 (1.3)	3.0 (1.7)	2.6 (1.6)
Mean	1.8 (1.4)	2.3 (1.5)	1.3 (1.1)	1.5 (1.2)	1.7 (1.3)
			Leaf	**Stem**	**Inflorescence**
S.E. of diff. between 2 cutting means (C)			0.81	0.31	0.31
S.E. of diff. between 2 nitrogen (N)			0.81	0.31	0.35
S.E. of diff. between 2 C × N mean			1.63	0.63	0.61

[1]Values in bracket represent the means transformed by square root method.

Table 5. Effects of cutting frequency and fertilizer nitrogen application on the zinc (Zn) content (mg $100g^{-1}$) of the leaf fraction of *Panicum maximum*.

Cutting frequency (week)	Nitrogen fertilizer (kg N ha^{-1})				Mean
	0	150	300	450	
		Leaf			
3	6.0 (2.1)	5.0 (1.8)[1]	13.1 (3.6)	3.8 (1.7)	7.0 (2.3)
6	4.8 (2.0)	4.5 (2.2)	3.6 (1.8)	0.0 (0.7)	3.2 (1.7)
9	2.6 (1.7)	12.1 (3.5)	4.8 (2.1)	3.6 (2.0)	5.8 (2.3)
12	4.8 (1.7)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	1.2 (1.0)
Mean	4.5 (1.9)	5.4 (2.1)	5.4 (2.1)	1.8 (1.3)	4.3 (1.8)
			Leaf		
S.E. of diff. between 2 cutting means (C)			0.44		
S.E. of diff. between 2 nitrogen (N)			0.44		
S.E. of diff. between 2 C × N mean			0.87		

[1]Values in bracket represent the means transformed by square root method.

kg N ha^{-1}. The crude fibre content of stem fraction was greater at 9 weeks interval of cutting when no nitrogen was applied. There was no significant effect of N or cutting interval on the crude fibre content of the inflorescence fraction.

The ash content of leaf was also significantly ($P < 0.05$)

Table 6. Effect of cutting frequency and nitrogen fertilizer application on the crude fibre contents (%) of stem and inflorescence fractions.

Cutting frequency (weeks)	Nitrogen fertilizer (kg N ha^{-1})				Mean
	0	150	300	450	
Stem					
3	37.6	53.6	40.0	54.5	46.4
6	36.4	49.3	50.8	46.8	45.8
9	66.8	58.4	54.1	56.2	59.6
12	58.1	56.8	44.8	44.6	51.1
Mean	49.7	54.5	48.2	50.5	50.7
Inflorescence					
3	51.6	29.7	52.0	48.6	45.5
6	65.6	29.4	32.2	74.0	50.3
9	37.1	74.7	47.2	46.0	51.2
Mean	51.4	44.6	43.8	56.2	49.0

	Stem	Inflorescence
S.E. of diff. between 2 cutting means (C)	2.58	13.65
S.E. of diff. between 2 nitrogen means (N)	2.58	15.77
S.E. of diff. between 2 C × N means	5.17	27.31

*Data on the leaf fibre content were not complete for presentation.

higher at 3- weeks compared with the other cutting intervals but was similar at 9- and 12- weeks cutting intervals (Table 7). Nitrogen fertilizer application reduced the leaf ash at 450 kg N ha^{-1} compared with the control, but not at 150 or 300 kg N ha^{-1}. Ash content of leaf was always greater with increasing cutting frequency, especially when no or little nitrogen was applied. The ash contents of stem and inflorescence fractions were not significantly affected by cutting treatment. Increased N application up to 450 kg N ha^{-1} gave significantly the highest ash in the inflorescence compared with the other rates.

DISCUSSION

Plant age at cutting is a major factor that determines feeding value and the amount of crude fiber of grass (Abate et al., 1981; Harper, 1983). Other factors include proportion of plant parts, proportion of live and dead materials, and range improvement practices (Muhammad et al., 2002). The present investigation aimed at assessing the effects of cutting frequency and N fertilizer application on the mineral, crude fibre and ash contents of crop fractions of a degraded pasture.

According to our results, the iron content of stem, phosphorus content of leaf, sodium contents of all the fractions and zinc content of leaf declined with age of regrowth. Keftasa (1985) also observed that potassium, phosphorus, magnesium and sodium contents of forage grasses declined with age. With temperate grasses, Whitehead (1966) observed that P content and that of most trace elements in herbage declined with age. In addition, potassium content which decline with the age of growth has been reported in tropical forages (Perdomo et al., 1977; Gomide, 1978). Gomide (1978) noted that the decline might be due to the effect of dilution of the element in a great quantity of dry matter that is produced and accumulated with advancing age. The higher potassium content of stem than leaf and the higher phosphorus content of stem than the other fractions observed in this study agree with the findings of Haggar (1971) on *Andropogon gayanus*.

The inconsistencies in changes in trace element contents observed in this study agreed with the statement of Conrad (1978) that trace minerals in plants may increase, decrease or show no consistent change with the stage of growth, plant species, soil or seasonal conditions. The sodium contents of the fractions showed no consistent trend with maturity. This agreed with the findings of Hunt (1973) and Whitehead (1966). Hunt (1973) showed that the lack of consistency of sodium content with maturity could arise from comparisons of different intervals on either side of peak Na content. He also noted that interpretation of Na content was complicated by the relationship between Na and K; where K is deficient, uptake of Na increases. The increases in the concentrations of P, especially for the more mature

Table 7. Effects of cutting frequency and Nitrogen fertilizer application on the ash contents (%) of the leaf, stem and inflorescence fractions.

Cutting frequency (week)	Nitrogen fertilizer (kg N ha^{-1})				Mean
	0	150	300	450	
Leaf					
3	11.0	7.7	9.0	7.3	8.8
6	8.3	7.0	6.7	7.0	7.2
9	6.3	6.7	4.7	6.0	5.9
12	5.7	7.0	6.3	5.0	6.0
Mean	7.8	7.1	6.7	6.3	7.0
Stem					
3	7.0	4.3	9.3	6.3	6.7
6	8.5	6.0	9.0	6.3	7.5
9	7.3	10.3	8.8	6.3	8.2
12	8.0	7.3	7.3	6.7	7.3
Mean	7.7	7.0	8.6	6.4	7.4
Inflorescence					
3	5.7	2.7	4.5	4.7	4.4
6	0.7	2.2	3.7	9.2	3.9
9	5.7	2.7	4.2	2.2	3.7
Mean	4.0	2.5	4.1	5.3	4.0

	Leaf	Stem	Inflorescence
S.E. of diff. between 2 cutting means (C)	0.66	1.06	0.24
S.E. of diff. between 2 nitrogen means (N)	0.68	1.06	0.27
S.E. of diff. between 2 C × N means	1.36	2.12	0.47

herbage observed in the present work agreed with the findings of Hunt (1973) while working with perennial ryegrass.

In this study, the iron content of leaf, phosphorus content of the leaf fraction, potassium content of leaf, and sodium content of inflorescence were remarkably affected by nitrogen fertilizer application. Hunt (1973) reported that with perennial ryegrass, raising the levels of nitrogen from 59 to 111 kg ha^{-1} significantly increased the percentages of K, P, Ca, Mg, and Na in the dry matter. Phosphorus concentration in perennial ryegrass was reported (Hunt 1973) to increase with N application and this was attributed to adequate P supply in the soil. Hunt (1973) showed that with perennial ryegrass, increased N application resulted in high uptake of both N and K. He noted that K content was close to percentage N since K is the most frequent cation accompanying anionic N from soil to root. With Guinea grass-Verano mixture, Bamikole (2003) observed that nitrogen fertilization of grass significantly enhanced the intake of sodium in goats better than in unfertilized Guinea grass.

According to NRC (1981, 1985), mineral requirement recommendation for cattle, sheep and goat, the crop fractions in the present study were deficient in all the elements measured with the exception of zinc. A study on mineral content of the main forage species in the sub-region of Huri, Zaire (Kiatoko et al., 1987) revealed that on the basis of nutritional requirements, phosphorus (P), sodium (Na) and zinc (Zn) deficiencies in forage were found to be severe in most pasture, while on the other hand, iron (Fe) and potassium (K) were very high. Low levels of sodium and phosphorus in tropical forages have earlier been reported (Oyenuga and Hill, 1966; Bamikole, 2003). With Guinea grass-verano mixture, Bamikole (2003) observed that nitrogen fertilization of grass significantly enhanced the intake of sodium in goats better than in unfertilized Guinea grass; however, there was a generally low intake of sodium due to insufficient level of this mineral in the forage irrespective of the treatment imposed. This is an indication of the necessity to supplement this mineral in animals grazing such forages.

The increase in crude fibre contents of crop fractions with cutting intervals as observed in the present investigation was expected (FAO, 2003). Crude fibre has been considered as an indicator of low digestibility, and increases approximately from 8 to 13% as the growing season progressed and plants accumulated structural contents (Cowan et al., 1975). Abate et al. (1981) showed that digestibility declined after forage plant has headed. They noted that increase in structural constituents (crude fiber, cellulose and lignin) and a decrease in the non-structural constituent, mainly the soluble carbohydrate contributed to the decrease in grass digestibility with increasing season. The common explanation for the decline was due to the fall in leaf: stem ratio, and rise in cell wall component coupled with increased lignification (Abate et al., 1981; Onyeonagu and Asiegbu, 2005). Reiling et al. (2001) showed that increased pasture maturity had a negative effect on the nutritional value of *P. maximum* pasture, indicating that this forage would be best utilized at younger stages of development. The presence of an increased proportion of plant stems, typical of older plants was reported to restrict access to leafy parts and forced animals to consume lower quality herbage (Reiling et al., 2001). In the present investigation, high levels of nitrogen fertilizer application reduced the percentage crude fibre in the stem fractions. Cherney et al*.* (1995) also showed that alfalfa fertilized with 336 kg N ha^{-1} had slightly lower neutral detergent fibre than alfalfa fertilized with 0 kg N ha^{-1}, the later cutting of alfalfa was also higher in neutral detergent fibre than the early season cuts. Nitrogen application has been shown to reduce pasture crude fiber and ash-contents (Gilmour et al., 1997).

The decrease in the ash content of the crop fractions with increasing interval between cuts and with increase in nitrogen fertilizer application agreed with the findings of Wan Hassan et al. (1987), who showed that ash content of tropical pastures decreased with an increase in cutting intervals. A study undertaken by Eckard (1990) to determine the effect of different levels of nitrogen applications (0, 25, 50 and 75 kg ha^{-1}) during late autumn, early and late winter on ash content of perennial grass showed that ash content increased throughout autumn due to dry condition, while during early winter, levels for 50 and 25 kg N ha^{-1} were significantly lower than zero N-application. However, at late winter, ash content decreased for all treatments. The result indicates that fertilizer-N reduced the ash contents of perennial grass species.

Conclusion

A study of the effect of cutting frequency and nitrogen fertilizer application on the mineral profile of crop fractions of a degraded *P. maximum* pasture indicated significant effects of the main factors and their interactions on almost all the mineral elements. The 3-weekly interval of cutting when combined with 300 to 450 kg N ha^{-1} had relatively low crude fibre contents and high ash values in the fractions and therefore appeared to be a better management option when cutting for conservation (hay) as well as when grazing or where very high quality of herbage is sought from grass. Frequent cutting at 3-weekly interval with 300 kg N ha^{-1} proved to be a better management option for high quality of leaf, stem and inflorescence fractions taken together.

REFERENCES

Abate A, Kayongo-male H, Karue CN (1981). Dry matter, protein energy and fiber intake by daring- heifers grazing a Rhode grass pasture. Anim. Feed Sci. Technol., 6: 15-26.

Adesogan AT, Sollenberger LE, Newman YC, Vendramini JMB (2009). Factors affecting forage quality. University of Florida IFAS Extension Forage Handbook SS-AGR-93 http://edis.ifas.ufl.edu.

AMC (1967). Analyst, 92(320): 324-403.

Amina A, Wan Mohammed WO, Zulkifli S (1989). Seasonal dry matter. production and nitrogen fixation of Leucaena (*Leucaena leucocephala)* and stylo (*Stylosanthes guianensis)* in pure swards and Association with signal Grass (*Brachiara decumbens).* Masters. Agricultural Science Thesis UPM, Sardang. Selangor.

Bamikole MA (2003). Macro-minerals bioavailability study in goats fed forages fertilized Guinea grass and Guinea grass-Verano stylo mixture. Livest. Res. Rural. Dev. 15(12): 1 – 4.

Bamikole MA, Akinsoyinu AO, Ezenwa I, Babayemi OJ, Akinlade J, Adewumi K (2004). Effect of six-weekly harvests on the yield, chemical composition and dry matter degradability of Panicum maximum and Stylosanthes hamata in Nigeria. Grass. Forage. Sci. 59(4): 357 – 363.

Cherney DJR, Cherney JH, Siciliano-Jones J (1995). Alfalfa composition and in sacco fiber and protein disappearance as influenced by nitrogen application. J. Appl. Res., 8: 105–120.

Collins GC, Polkinhorne H (1952). Analyst, 77, 430.

Conrad JH (1978). Soil, plant and animal tissues as predictors of the mineral status of ruminants. In: JH Conrad and LR McDowell (eds), Latin American Symposium on Mineral Nutrition Research with Grazing Ruminants. University of Florida, Gainesville, Florida. pp. 143 – 148.

Cowan RJ, Byford IJR, Stobbs TH (1975). Effect of stocking rate and energy supplementation on milk production from tropical grass legume pastures. Austr. J. Exp. Agric. Anim. Husband., 15: 740-746.

Deetz DA, Jung HG, Buxton DR (1996). Water-deficit effects on cell-wall composition and *in vitro* degradability of structural polysaccharides from alfalfa stems. Crop Sci., 36: 383–388.

Eckard RJ (1990). Grazing management. J. Grassland Soc.-South Africa, 7: 174-178.

Food Agricultural Organization (2003). *Panicum maximum,* guinea grass, colonial grass Tanganyika grass. Available at http://www.fao.org/ag/agap/frg/AFRIS/ DATA/118.HTM.

Gilmour AR, Thompson R, Cullis BR, Welham SJ (1997). Grazing management ASREML. NSW Agriculture pp. 16-26.

Gomide JA (1978). Mineral Composition of grasses and tropical leguminous forages. In: Latin American symposium on Mineral Nutrition Research with Grazing Ruminants. University of Florida, Gainesville, Florida, pp. 32 - 40.

Haggar RJ (1971). Seasonal production of *Andropogon gayanus* 1. Seasonal changes in yield components and chemical composition. Samaru Research Bulletin, p. 137.

Harper F (1983). Principle of Arable crop production. Blackwall Science Limited London pp. 270-274.

Hunt IV (1973). Studies of response to fertilizer nitrogen. Part 4. Effects of fertilizer nitrogen on the chemical composition of primary growth of perennial ryegrass. J. Grassland Soc., 28: 171-180.

Keftasa D (1985). Rhodes grass seed production. Forage network in Ethiopia Newsletter Not KCA. Addis Ababa, Ethiopia pp. 19-21.
Kiatoko M. Mandiki S, Mbifo GS (1987). Mineral Composition of forages and mineral supplementation in the cattle rearing sub-region Huri (Zaire). Portugar V: 14(1-2): 61-66.
McDowell LR (1992). Minerals in animal and human nutrition 1st edition. Academic Press New York, pp. 6 - 12.
Muhammad IR, Hena SW, Agishi EC, Olorunju SAS (2002). Effect of date of cutting on fodder yield and in vitro dry matter digestibility of lablab(*Lablab purpureus)* J. Anim. Prod. Res., 18(1&2): 19 – 30.
National Research Council (1981). Nutrient requirements of goats: Angora, dairy and meat goats in temperate and tropical countries. Nutrient requirements of domestic animals No. 15. National Academy of Sciences, Washington, D.C.
National Research Council (1985). Nutrient requirements of domestic animals. Sixth edition. National Academy of Sciences, Washington, D.C.
Onyeonagu CC, Asiegbu JE (2005). Herbage leaf to stem ratio and yield distribution over time as influenced by cutting frequency and N-fertilizer application in an old run-down *Panicum maximum* pasture. J. Agric. Food Environ. Extens., 4(1): 74–77.
Onyeonagu CC (2005). Reclamation of a run-down pasture through improved management. An MSc Dissertation submitted to the Faculty of Agriculture, University of Nigeria, Nsukka, p. 65.
Onyeonagu CC (2010). Studies on fertilizer nitrogen and cutting management of sown grass and legume pastures in a pure mixed swards. A Ph.D Thesis submitted to the Faculty of Agriculture, University of Nigeria, Nsukka, p. 202.
Oyenuga VA, Hill DH (1966). Influence of fertilizer application on the yield, efficiency and ash constituents of meadow hay. Niger. Agric. J., 3: 6 – 14.
Pearson D (1976). The chemical analysis of foods. Churchill Livingstone Edinburgh London and New York, pp. 240–241.
Perdomo JT, Shirley RL, Chicco CE (1977). Availability of nutrient minerals in four tropical forages fed freshly chopped to sheep. J. Anim. Sci., 45: 1114 – 1119.
Reiling EA, Coertze RT, Niekerk WA, Rethman (2001). An evaluation of Panicum maximum C.V.Gatton: the influence of stage of maturity on diet selection intake and rumen fermentation in sheep. South Afr. J. Animal Sci., 31: 85–91.
Van Soest PJ (1982). Nutritional Ecology of the ruminant. O and B books Inc. Oregon, USA.
Wan Hassan WE, Abubakar C, Tan KL (1987). The performance of Imported Jersey cattle in Malaysia. Proceedings of the 5th Annual Conference of Malaysia Society of Animal Production pp. 192-201.
Whitehead DC (1966). Nutrient minerals in grassland herbage. Commonwealth Bureau of Pastures and Field Crops, Commonwealth Agricultural Bureau, London p. 86.
Zhang HL, Redmon L, Fuhrman JK, Springer T (1999). Quick nitrate test for hybrid sudangrass and pearlmillet hays. Communications in Soil Science. Plant Anal., 30: 1573–1582.
Zimmerman I (1980). Factors influencing the feed intake and live weight change of beef cattle on beef cattle on a mixed tree savannah in the Transvaal. J. Range Manage., p. 33.