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Full Length Research Paper

Effects of cutting frequency and nitrogen fertilizer application on yield, proportion of crop fractions and leaf to stem ratio in guinea grass (*Panicum maximum*) pasture

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In a sandy loam soil at Nsukka, the effects of fertilizer-N application and cutting management on the yield and proportions of crop fractions of *Panicum maximum* sown pasture were investigated in 2001 through 2004. The experiment was a 4 × 4 factorial laid out in a randomized complete block design with three replications. Treatments comprised four levels of nitrogen of 0, 150, 300 and 450 kg N ha^{-1} and four harvesting frequencies of 3-, 6-, 9- and 12-weekly intervals, resulting in sixteen treatment combinations per block. Increase in cutting interval and incremental application of N reduced the proportion of leaf to stem in the total grass dry matter yield. The proportion of inflorescence increased significantly (P < 0.05) with increase in interval between cuts in all the years. Nitrogen treatment increased significantly (P < 0.05) the proportion of inflorescence in 2002 and 2004 compared with the control. Leaf blade yield was significantly (P < 0.05) higher where N application at the 300 kg N ha^{-1} was combined with cutting at 6- and 12-weekly intervals in 2003 and 2004, respectively compared with when the 3-weekly interval of cut was combined with 0 kg N ha^{-1}. Inflorescence dry matter was significantly (P < 0.05) higher where 12-weekly cutting interval was combined with 300 kg N ha^{-1} in 2004, compared with the 3-weekly interval of cuts at any N rate. On the whole, herbage dry matter yield was highest with 12-weekly cutting interval and with the higher N rates.

Key words: *Panicum maximum*, fertilizer N, cutting interval, dry matter yield, leaf to stem ratio, inflorescence, crop fractions.

INTRODUCTION

Defoliation frequency and fertilizer-N application have been shown to have pronounced effects, not only on the quantity and quality of herbage produced from a sward, but also upon the yield and proportion of plant parts (Wilman and Asiegbu, 1982; Duru et al., 2000; Onyeonagu and Asiegbu, 2005; Asiegbu and Onyeonagu, 2008). At Nsukka, Nigeria, Asiegbu and Onyeonagu (2008) showed that the dry matter yields of leaf blade, stem and inflorescence fractions of a degraded pasture increased significantly with increase in interval between cuts. These authors also showed that fertilizer-N application reduced significantly the proportion of leaf blade but increased the percentage of the stem fraction.

Some studies have been carried out to test the effects of cutting frequency and initial cutting date on the production of *Panicum maximum* pasture grown and maintained under Nsukka, derived savanna zone of Nigeria conditions (Omaliko, 1980, 1983). In those studies, however, the effects of different nitrogen fertilizer application rates in combination with cutting frequencies were not considered. Information is scanty on the effects of cutting frequency and nitrogen fertilizer application on dry matter yield and proportion of crop fractions of *P. maximum* sown and maintained pastures in Nigeria. The proportions of these crop fractions have important bearing on digestibility (Terry and Tilley, 1964; Duru et al., 2000) and probably also on voluntary intake (Laredo

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and Minson, 1975). The present trial was therefore designed to obtain information on the influence of interval between cuts and fertilizer-N application on the yield and proportion of crop fractions of a sown and maintained pasture typified by *P. maximum*.

MATERIALS AND METHODS

The experiment was carried out in the Department of Crop Science Research and Teaching Farm, University of Nigeria, Nsukka 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. Treatments comprised four levels of nitrogen fertilizer at 0, 150, 300 and 450 kg ha^{-1} and four harvesting frequencies of 3-, 6-, 9- and 12- weekly intervals resulting in sixteen treatment combinations per block. An area of land 21.2 × 11.2 m wide with an area of 226.24 m^2 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 with a sampling area of 0.9 × 1.8 m. Each block was separated by one meter path-way. Basal application of 75 kg K ha^{-1} and 44 kg P ha^{-1} as muriate of potash and single superphosphate, respectively was made by broadcasting. Rooted cuttings of *P. maximum* with height of 15 cm were planted in August 2000 at 20 × 30 cm spacing. The treatment combinations were allocated completely at random in each of the three blocks. Cutting was done at uniform height of about 15 cm with shears. The harvested grass material was separated into leaf, stem and inflorescence fractions. The samples for separation into fractions were of approximately 500 g fresh weight per plot. The fractions were subsequently oven-dried and weighed. These were used to calculate the total dry weights of the crop fractions and the total herbage. The harvest intervals of 3-, 6-, 9- and 12- weeks gave 8-, 4-, 2- and 2- samples, respectively in 2001, 2002, 2003 and 2004 seasons (that is 24 weeks, from May to November). The required quantity of nitrogen as urea (46% N) was divided according to the number of harvests in a year for each harvest interval and evenly applied on the plot after each harvest. The soil of the experimental site was a sandy loam and was acidic in nature. The soil had low amounts of nitrogen content, potassium, magnesium and base saturation. The soil was also low in cation exchange capacity, and high in available phosphorus (Onyeonagu and Asiegbu, 2010).

All data collected were statistically analysed using the procedure outlined by Steel and Torrie (1980) for factorial experiment in a randomized complete block design. Separation of treatment means for statistical significance was done using the standard error of the difference between two means (s.e.d.). Square root transformation of the form x + 0.5, where x is the observation, was employed whenever there is zero value.

RESULTS

In 2001, less frequent cutting at 6-weekly interval produced significantly ($P < 0.05$) the highest leaf blade yield when compared with the other cutting intervals (Table 1). Leaf blade yield tended to decrease with increase in cutting interval in 2002. The 9- and 12-weekly cutting intervals did not differ in their effect on leaf blade production in both years. More also, fertilizer-N application did not influence the dry matter yield of leaf blade in 2001 but significantly ($P < 0.05$) increased the dry matter yield of leaf blade compared with where no N was applied in 2002. Nitrogen application at 150, 300 and at 450 kg N ha^{-1} gave similar leaf herbage yield in both years, although yield tended to increase with increase in applied N. Cutting interval and nitrogen fertilizer application did not interact significantly ($P > 0.05$) to produce differential leaf dry matter yield in both years. The 3-weekly interval of cuts had the least stem dry matter yield in both years followed by the 6-weekly interval of cuts. The 12-weekly cuts gave significantly ($P < 0.05$) the highest stem fraction when compared with the other cutting intervals. The 6- and 9-weekly cuts did not differ in their effect on stem dry matter production in both years.

Stem dry matter yield increased with N application compared with where N was not applied in 2001. The highest N rate of 450 kg N ha^{-1} gave the highest stem dry matter which was similar to that from the 300 kg N ha^{-1}. However, fertilizer-N treatment did not affect stem dry matter in 2002, although stem dry matter yield tended to increase with increase in N application. Stem dry matter yield was not significantly ($P > 0.05$) affected by cutting interval × fertilizer application in 2001 and 2002. The dry matter yield of inflorescence tended to increase with increase in cutting interval up to 6 weeks and then decreased significantly ($P < 0.05$) with further increase in cutting interval in 2001. The 3- and 6-weekly schedules gave similar inflorescence dry matter. The dry matter yield of inflorescence was not affected by interval between cuts in 2002. Fertilizer-N treatment did not affect yield of the inflorescence dry matter in both 2001 and 2002. Nitrogen fertilizer × cutting frequency effect was not statistically significant ($P > 0.05$) in 2001. However, the inflorescence dry matter was highest where 12-weekly interval was combined with zero N application in 2002.

In 2003, less frequent cutting at 6-weekly interval produced significantly ($P < 0.05$) the highest leaf blade yield which was similar to the 12-weekly cut (Table 2). The 12-weekly cuts gave significantly the highest leaf blade yield when compared with the other cutting intervals in 2004. The 3- and 9-weekly cuts did not differ in their effect on leaf blade production in both years. Nitrogen fertilizer application did not influence the leaf yield in 2003. In 2004, N treatment significantly ($P < 0.05$) increased leaf blade yield compared to where N was not applied. Nitrogen application at 150 and 300 kg N ha^{-1} gave similar leaf blade yields while N at 300 and 450 kg N ha^{-1} gave similar leaf blade yields in 2004. Leaf blade yield was highest where N application at the 300 kg N ha^{-1} was combined with cutting interval at 6- and 12-weeks interval in 2003 and 2004, respectively. The 12-weekly cut gave significantly the highest stem fraction when compared with the other cutting intervals in 2003 and 2004. Stem dry matter progressively increased significantly with increase in interval between cuts in both years. The 3-weekly cut produced significantly the least stem dry matter yield in both years. In either years, N treatment significantly increased stem yield compared to where N was not applied. The 450 kg N ha^{-1} produced significantly

Table 1. Effect of cutting frequency and fertilizer N-application on dry matter yields of Leaf, stem, inflorescence fractions and total yield of grass in year 2001 and 2002.

Cutting frequency (week)	Nitrogen fertilizer (kg N ha^{-1})				Mean
	0	150	300	450	
	Year 2001				
Leaf dry matter					
3	5644.6	7967.1	7692.8	7326.6	7157.8
6	7983.0	9228.4	11043.9	9859.4	9528.7
9	6965.4	6793.2	6113.5	7365.7	6809.4
12	5975.7	6582.0	7860.5	8575.3	7248.4
Mean	6642.2	7642.7	8177.7	8281.7	7686.1
Stem dry matter					
3	418.1	419.9	397.7	687.0	480.7
6	1474.1	1957.4	2615.7	2592.7	2160.0
9	2310.7	1720.7	2161.5	2449.6	2160.6
12	3106.1	2209.5	3827.0	5691.7	3708.6
Mean	1827.3	1576.9	2250.5	2855.3	2127.5
Inflorescence dry matter					
3	151.0 (12.2)	156.2 (12.5)	129.1 (11.2)	205.3 (13.4)	160.4 (12.3)
6	208.5 (14.2)	296.5 (15.2)	232.3 (14.4)	330.1 (16.4)	266.8 (15.0)
9	0.0 (0.7)	17.1 (2.9)	68.7 (5.3)	121.0 (6.8)	51.7 (3.9)
12	17.1 (2.9)	21.5 (3.8)	61.8 (5.0)	43.4 (4.3)	35.9 (4.0)
Mean	94.2 (7.5)	122.8 (8.6)	123.0 (9.0)	174.9 (10.2)	128.7 (8.8)
Total grass yield (leaf + stem + inflorescence)					
3	6213.8	8543.3	8219.5	8218.9	7798.9
6	9665.6	11482.3	13891.9	12782.2	11955.5
9	9276.0	8531.0	8343.7	9936.3	9021.7
12	9099.0	8812.9	11749.4	14310.4	10992.9
Mean	8563.6	9342.4	10551.1	11311.9	9942.3
Year 2002					
Leaf dry matter					
3	4281.8	6304.8	7463.4	7369.9	6355.**0**
6	4434.5	6806.1	6941.8	7214.6	6349.2
9	4075.1	4578.3	4499.4	4312.0	4366.2
12	4792.1	5236.6	5167.4	4192.0	4847.0
Mean	4395.9	5731.4	6018.0	5772.1	5479.4
Stem dry matter					
3	130.4	208.0	174.8	177.9	172.8
6	422.1	961.0	1009.2	1097.1	872.4
9	1060.1	1063.4	1151.1	1440.1	1178.7
12	2145.9	1891.0	1793.7	1193.5	1756.0
Mean	939.6	1030.8	1032.2	977.2	995.0
Inflorescence dry matter					
3	51.8	86.0	69.0	75.7	70.6
6	58.7	149.7	181.0	130.2	129.**9**
9	108.8	105.1	78.6	164.0	114.1
12	211.9	127.5	78.2	73.0	122.7

Table 1. Count'd.

Mean	107.8	117.1	101.7	110.7	109.3
Total grass yield (leaf + stem + inflorescence)					
3	4464.0	6598.8	7707.2	7623.6	6598.4
6	4915.2	7916.8	8132.1	8441.9	7351.5
9	5244.0	5746.7	5729.1	5916.1	5658.9
12	7149.9	7255.1	7039.3	5458.4	6725.7
Mean	5443.3	6879.3	7151.9	6860.0	6583.6
Year 2001					
		Leaf	**Stem**	**Inflorescence**	**Grass Total**
S.E.D. between 2 cutting frequency means (C)		645.72	430.00	2.40	936.77
S.E.D. between 2 Nitrogen means (N)		645.72	430.00	2.40	936.77
S.E.D. between 2 C × N means		1291.44	860.00	4.80	1873.54
Year 2002					
		Leaf	**Stem**	**Inflorescence**	**Grass Total**
S.E.D. between 2 cutting frequency means (C)		400.96	213.92	24.47	587.96
S.E.D. between 2 Nitrogen means (N)		400.96	213.92	24.47	587.96
S.E.D. between 2 C × N means		801.93	427.85	48.93	1175.93

The comparison is based on transformed means in parenthesis because of zero values in some instances.

Table 2. Effect of cutting frequency and fertilizer N-application on dry matter yields of leaf, stem, inflorescence fractions and total yield of grass in year 2003 and 2004.

Cutting frequency (week)	Nitrogen fertilizer (kg N ha^{-1})				Mean
	0	**150**	**300**	**450**	
Year 2003					
Leaf dry matter					
3	2556.3	3794.9	4423.6	4276.9	3762.9
6	3510.8	4756.8	4876.8	4514.1	4414.6
9	4571.8	3226.8	3615.9	2923.5	3584.5
12	4659.3	4024.2	4806.3	4015.8	4376.4
Mean	3824.6	3950.7	4430.7	3932.6	4034.6
Stem dry matter					
3	68.4	83.7	143.6	225.9	130.4
6	92.7	607.9	929.6	1167.0	699.3
9	903.3	904.5	1040.4	1205.9	1013.5
12	1549.8	1310.6	2040.0	2178.8	1769.8
Mean	653.5	726.7	1038.4	1194.4	903.3
Inflorescence dry matter					
3	21.2(4.5)	2.1(5.2)	55.7(7.5)	85.6(9.1)	47.4(6.6)
6	14.5(3.3)	64.7(8.1)	69.6(8.3)	112.1(10.4)	65.2(7.5)
9	51.4(7.2)	30.6(5.6)	36.4(5.8)	60.1(7.8)	44.6(6.6)
12	106.8(10.2)	84.0(9.0)	162.9(12.6)	139.5(11.7)	123.3(10.9)
Mean	48.5(6.3)	51.6(6.9)	81.1(8.6)	99.3(9.7)	70.1(7.9)
Total grass yield (leaf + stem + inflorescence)					
3	2645.9	3905.7	4622.9	4588.4	3940.7
6	3618.1	5429.3	5876.0	5793.2	5179.1

Table 2. Count'd.

9	5526.5	4162.0	4692.7	4189.6	4642.7
12	6315.8	5418.7	7009.2	6334.0	6269.4
Mean	4526.6	4728.9	5550.2	5226.3	5008.0
Year 2004					
Leaf dry matter					
3	3433.2	5148.9	6270.2	6840.7	5423.3
6	5492.8	7885.2	8781.1	7330.5	7372.4
9	4601.8	5880.5	5334.7	5931.2	5437.0
12	6620.6	9226.9	10624.0	7590.1	8515.4
Mean	5037.1	7035.4	7752.5	6923.1	6687.0
Stem dry matter					
3	94.3	77.1	271.5	503.4	236.6
6	725.4	1576.2	2322.2	1922.7	1636.7
9	1584.3	2584.4	2992.1	3968.8	2782.4
12	4215.5	5516.9	6209.7	5740.5	5420.6
Mean	1654.9	2438.6	2948.9	3033.8	2519.1
Inflorescence dry matter					
3	27.4	25.7	69.7	95.7	54.6
6	88.1	246.0	297.8	288.6	230.1
9	139.0	319.1	331.3	595.6	346.3
12	235.1	255.1	383.0	262.3	283.9
Mean	122.4	211.5	270.4	310.5	228.7
Total grass yield (leaf + stem + inflorescence)					
3	3555.0	5251.7	6611.4	7439.8	5714.5
6	6306.4	9707.4	11401.1	9541.8	9239.2
9	6325.0	8784.0	8658.1	10495.6	8565.7
12	11071.2	14998.9	17216.7	13592.9	14219.9
Mean	6814.4	9685.5	10971.8	10267.5	9434.8

Year 2003	**Leaf**	**Stem**	**Inflorescence**	**Grass total**
S.E.D. between 2 cutting frequency means (C)	238.63	128.22	0.72	337.38
S.E.D. between 2 Nitrogen means (N)	238.63	128.22	0.72	337.38
S.E.D. between 2 C x N means	477.26	256.44	1.43	674.75
Year 2004	**Leaf**	**Stem**	**Inflorescence**	**Grass total**
S.E.D. between 2 cutting frequency means (C)	401.62	412.85	62.91	725.68
S.E.D. between 2 Nitrogen means (N)	401.62	412.85	62.91	725.68
S.E.D. between 2 C x N means	803.24	825.69	125.82	1451.37

The comparison is based on transformed means in parenthesis because of zero values in some instances.

higher stem yield than the other N levels in 2003 but was similar with the 300 kg N ha^{-1} in 2004. There were no cutting intervals x fertilizer application effects on stem dry matter yield in both years. The 12- and 9-weeks intervals of cut produced significantly the highest dry matter yield of inflorescence in 2003 and 2004, respectively. The 6- and 9-weekly cuts did not differ in their effects on inflorescence dry matter production in 2004. Fertilizer N application significantly increased the dry matter yield of inflorescence compared with where N was not applied in

2003 and 2004. The highest N rate of 450 kg N ha^{-1} gave the highest inflorescence dry matter which though was similar to that from the 300 kg N ha^{-1} in 2003. The dry matter yield of inflorescence was similar for the 150, 300 and 450 kg N ha^{-1} in 2004. On the other hand, it was highest where cutting interval at 12 weeks was combined with 300 kg N ha^{-1} in 2003. There were no cutting intervals × fertilizer application effects on inflorescence dry matter in 2004.

Furthermore, leafiness in terms of leaf blade dry matter yield as percentage of the total herbage dry matter was significantly highest with 3- and followed by 6-weekly interval of cuts and decreased with lax cutting of 9 or 12 weeks of cut in 2001 and 2002 (Table 3). The percentage of leaf dry matter was not affected by fertilizer application in both years. The percentage of leaf dry matter was not significantly influenced by cutting interval × fertilizer application in both years. The percentage stem fraction followed the opposite trends compared with the percentage of leaf blade dry matter with respect to cutting frequency or N application. The inflorescence as a percentage of the total herbage dry matter was on average low, although it appeared highest with 6- or 9-weekly intervals of cuts in 2001 and 2002, respectively compared with others. Fertilizer N application did not affect the percentage of inflorescence dry matter in both 2001 and 2002. The percentage of leaf dry matter was significantly highest with 3- and followed by 6-weekly interval of cuts and decreased with lax cutting of 9 or 12 weeks of cut in both 2003 and 2004 (Table 4). Leafiness decreased with incremental application of fertilizer in 2003 and 2004. The percentage stem fraction followed the opposite trends compared with the percentage of leaf blade dry matter with respect to cutting frequency or N application in both 2003 and 2004. The inflorescence as a percentage of the total herbage dry matter was significantly highest with 12– or 9- weekly interval of cuts in 2003 and 2004, respectively, compared with others. On the average, the percentage of inflorescence dry matter increased with incremental application of fertilizer in 2003.

In 2001, the proportion of leaf to stem at 3-weekly cuts was 14.9:1; this ratio fell to 4.4:1 at 6 weeks, 3.1:1 at 9 weeks and 2.0:1 at the 12–weekly cutting interval (Table 5). The proportion of leaf to stem when N was not applied was 3.6:1; this ratio, however, fell to 2.9:1 at the highest N-rate of 450 kg N ha^{-1}. The proportions of leaf to stem in 2002, 2003 and 2004 seasons followed the same trends observed in 2001 with respect to cutting frequency or N application except in 2002, where the proportion of leaf to stem appeared to increase with fertilizer N application.

DISCUSSION

The observed decrease in the proportion of leaf blade yield and increase in the yield and proportion of stem with increase in interval between cuts and with nitrogen application were earlier reported by Asiegbu and Onyeonagu (2008). They showed that when 0, 150, 300 and 450 kg N ha^{-1} were applied to a degraded *P. maximum* pasture found in Nsukka, Nigeria, the proportion of leaf blade to the total herbage was highest with 3- followed by 6-weekly cutting interval and decreased with lax cutting of 9 or 12 weeks interval. They also showed that leafiness decreased with the addition of more N fertilizer. The percentage stem fraction followed the opposite trends compared with the percentage of leaf blade. The proportion of inflorescence was below 2%. The leaf blade dry matter yield increased from 1796 to 3676 kg ha^{-1} when N application increased from zero to 450 kg N ha^{-1}. Similarly, in the present investigation, the leaf blade dry matter yield increased from 6642 to 8282 kg ha^{-1} when N application increased from zero to 450 kg N ha^{-1}. The stem dry matter yield increased from 5037 to 7753 kg ha^{-1} when N application increased from zero to 450 kg N ha^{-1}. The proportion of inflorescence was on average above 2%. It would, however, be noted that while Asiegbu and Onyeonagu (2008) worked on degraded pasture, the present study was on sown and maintained pasture, and this could account for the differences in yields obtained.

Wilman et al. (1976a) reported that when 28, 84, 140 and 196 kg N ha^{-1} were applied to Italian ryegrass, the level of applied N had little effects on the proportion of crop fractions except during the period immediately before and after the beginning of ear emergence when the higher rates of N increased the proportion of stem, and reduced that of green leaves. The leaf blade dry matter yield increased from 660 to 1,230 kg ha^{-1} when N application was increased from 28 to 196 kg N ha^{-1}. The stem dry matter yield increased from 410 to 580 kg ha^{-1}, respectively. Pinto et al. (1994) also reported that increased application of fertilizer N led to increase in leaf blade weight and stem weight in *P. maximum*. In addition, Wilman and Asiegbu (1982) reported that in perennial ryegrass-white clover swards, application of N increased the proportion of leaflet with the 3- and 4-week intervals compared with lax cutting. The proportion of petiole was also increased by N application and by increasing the interval between harvests from 4 to 8-12 weeks. The proportion of inflorescence was highest with the 8- 12- and 4-week intervals and lowest with the 3-week interval. These aforementioned results were also confirmed by the results of the present investigation.

Leafiness is a quality attribute in forage, indicating that the leafier the herbage the better the quality for a particular species (Omaliko, 1980; Onyeonagu and Asiegbu, 2005). Wilman et al. (1976a) working with perennial ryegrass also showed that the proportion of green leaf was highest after 2 to 3 weeks of regrowth, and subsequently declined very considerably. The proportion of stem was lowest after 2 to 3 weeks, increased quickly from 3 to 6 weeks and more slowly to 9 weeks. They also showed that the crop responded to applied N by lengthening the stem to better display the

Table 3. Effect of cutting frequency and fertilizer N-application on leaf, stem, and inflorescence fractions as percentage of the total grass herbage dry matter in year 2001 and 2002.

Cutting frequency (week)	Nitrogen fertilizer (kg N ha^{-1})					Mean
	0	150	300	450		
Year 2001						
Leaf fraction						
3	90.92	93.26	93.71	90.15		92.01
6	82.89	81.00	80.00	78.38		80.57
9	75.90	79.41	73.79	73.99		75.77
12	65.94	75.20	68.84	59.87		67.46
Mean	78.91	82.21	79.08	75.60		78.95
Stem fraction						
3	6.69	4.91	4.75	7.62		5..99
6	15.03	16.65	18.44	19.47		17.40
9	24.10	20.43	25.66	24.85		23.76
12	33.90	24.58	30.47	39.87		32.21
Mean	19.93	16.65	19.83	22.95		19.84
Inflorescence fraction						
3	2.39 (1.69)	1.83 (1.52)	1.54 (1.42)	2.22 (1.61)		1.99 (1.56)
6	2.08 (1.60)	2.35 (1.59)	1.56 (1.40)	2.15 (1.57)		2.03 (1.54)
9	0.00 (0.71)	0.16 (0.80)	0.55 (0.96)	1.16 (1.14)		0.47 (0.90)
12	0.16 (0.80)	0.22 (0.84)	0.69 (1.01)	0.26 (0.85)		0.33 (0.87)
Mean	1.16 (1.20)	1.14 (1.19)	1.09 (1.20)	1.45 (1.29)		1.21 (1.22)
Year 2002						
Leaf fraction						
3	95.99	95.59	96.83	96.68		96.27
6	90.46	86.31	85.05	85.63		86.86
9	78.20	79.00	78.74	73.07		77.25
12	68.61	74.76	74.15	76.90		73.61
Mean	83.31	83.91	83.69	83.07		83.50
Stem fraction						
3	2.86	3.13	2.26	2.32		2.64
6	8.32	11.79	12.63	12.90		11.41
9	19.78	18.91	19.96	24.25		20.73
12	28.57	23.68	24.73	21.78		24.69
Mean	14.88	14.38	14.90	15.31		14.87
Inflorescence fraction						
3	1.14	1.28	0.90	0.99		1.08
6	1.22	1.90	2.31	1.47		1.71
9	2.02	2.09	1.30	2.68		2.02
12	2.82	1.56	1.12	1.32		1.70
Mean	1.80	1.71	1.41	1.62		1.63
	2001 Leaf	**2001 Stem**	**2001 Inflorescence**	**2002 Leaf**	**2002 Stem**	**2002 Inflorescence**
S.E.D. between 2 cutting frequency means (C)	2.748	2.656	0.150	2.001	1.830	0.316
S.E.D. between 2 Nitrogen means (N)	2.748	2.656	0.150	2.001	1.830	0.316
S.E.D. between 2 C × N means	5.496	5.312	0.299	4.002	3.659	0.632

The comparison is based on transformed means in parenthesis because of zero values in some instances.

Table 4. Effect of cutting frequency and fertilizer N-application on leaf, stem, and inflorescence fractions as percentage of the total grass herbage dry matter in year 2003 and 2004.

Cutting frequency (week)	Nitrogen fertilizer (kg N ha^{-1})				Mean
	0	150	300	450	
	Year 2003				
Leaf fraction					
3	96.79	97.11	95.68	93.24	95.71
6	97.07	87.60	83.20	78.41	86.57
9	82.78	77.62	76.57	69.84	76.70
12	73.64	74.74	68.80	63.56	70.19
Mean	87.57	84.27	81.07	76.26	82.29
Stem fraction					
3	2.44	2.17	3.11	4.91	3.16
6	2.54	11.20	15.61	19.72	12.27
9	16.30	21.64	22.56	28.74	22.31
12	24.66	23.76	28.89	34.24	27.89
Mean	11.48	14.69	17.54	21.90	16.41
Inflorescence fraction					
3	0.76 (1.12)	0.72 (1.09)	1.20 (1.31)	1.85 (1.52)	1.13 (1.26)
6	0.39 (0.93)	1.20 (1.30)	1.18 (1.29)	1.87 (1.53)	1.16 (1.26)
9	0.93 (1.19)	0.74 (1.11)	0.87 (1.14)	1.42 (1.39)	0.99 (1.21)
12	1.70 (1.47)	1.50 (1.41)	2.30 (1.67)	2.20 (1.64)	1.93 (1.55)
Mean	0.95 (1.18)	1.04 (1.23)	1.39 (1.35)	1.84 (1.52)	1.30 (1.32)
Year 2004					
Leaf fraction					
3	96.46	98.06	94.86	92.07	95.36
6	87.83	80.94	77.11	76.97	80.71
9	72.96	67.62	62.02	57.39	65.00
12	60.41	62.51	61.86	56.32	60.27
Mean	79.41	77.28	73.96	70.69	75.34
Stem fraction					
3	2.74	1.46	4.11	6.70	3.75
6	10.86	16.47	20.30	20.05	16.92
9	24.83	28.91	34.39	37.34	31.37
12	37.55	35.88	35.89	41.76	37.77
Mean	19.00	20.68	23.67	26.46	22.45
Inflorescence fraction					
3	0.80	0.49	1.04	1.24	0.89
6	1.32	2.58	2.59	2.98	2.37
9	2.21	3.48	3.60	5.26	3.64
12	2.04	1.62	2.25	1.92	1.96
Mean	1.59	2.04	2.37	2.85	2.21

	2003 Leaf	2003 Stem	2003 Inflorescence	2004 Leaf	2004 Stem	2004 Inflorescence
S.E.D. between 2 cutting frequency means (C)	1.452	1.322	0.072	2.365	2.010	0.505
S.E.D. between 2 Nitrogen means (N)	1.452	1.322	0.072	2.365	2.010	0.505
S.E.D. between 2 C × N means	2.904	2.644	0.145	4.730	4.020	1.009

The comparison is based on transformed means in parenthesis because of zero values in some instances.

Table 5. Whole grass, leaf and stem dry matter, leaf and stem proportions and ratio of leaf to stem as influenced by cutting interval and fertilizer-N levels.

Cutting Interval (week)	Weight of Whole grass (kg ha^{-1})	Weight of Leaf (kg ha^{-1})	Weight of Stem (kg ha^{-1})	Proportion of leaf (%)	Proportion of stem (%)	Leaf to stem ratio
			Year 2001			
3	7638.5	7157.8	480.7	93.7	6.3	14.9:1
6	11688.7	9528.7	2160.0	81.5	18.5	4.4:1
9	8970.0	6809.4	2160.6	75.9	24.1	3.1:1
12	10957.0	7248.4	3708.6	66.2	33.8	2.0:1
Nitrogen level (kg N ha^{-1})						
0	8469.5	6642.2	1827.3	78.4	21.6	3.6:1
150	9219.6	7642.7	1576.9	82.9	17.1	4.8:1
300	10428.2	8177.7	2250.5	78.4	21.6	3.6:1
450	11137.0	8281.7	2855.3	74.4	25.6	2.9:1
Cutting interval (weeks)			**Year 2002**			
3	6527.8	6355.0	172.8	97.4	2.6	37.5:1
6	7221.6	6349.2	872.4	87.9	12.1	7.3:1
9	5544.9	4366.2	1178.7	78.7	21.3	3.7:1
12	6603.0	4847.0	1756.0	73.4	26.6	2.8:1
Nitrogen level (kg N ha^{-1})						
0	5335.5	4395.9	939.6	82.4	17.6	4.7:1
150	6762.2	5731.4	1030.8	84.8	15.2	5.6:1
300	7050.2	6018.0	1032.2	85.4	14.6	5.8:1
450	6749.3	5772.1	977.2	85.5	14.5	5.9:1
Cutting interval (weeks)			**Year 2003**			
3	3893.3	3762.9	130.4	96.7	3.3	29.3:1
6	5113.9	4414.6	699.3	86.3	13.7	6.3:1
9	4598.0	3584.5	1013.5	78.0	22.0	3.5:1
12	6146.2	4376.4	1769.8	71.2	28.8	2.5:1
Nitrogen level (kg N ha^{-1})						
0	4478.1	3824.6	653.5	85.4	14.6	5.8:1
150	4677.4	3950.7	726.7	84.5	15.5	5.5:1
300	5469.1	4430.7	1038.4	81.0	19.0	4.3:1
450	5127.0	3932.6	1194.4	76.7	23.3	3.3:1

Table 5. Contd.

Cutting interval (weeks)			Year 2004			
3	5659.9	5423.3	236.6	95.8	4.2	22.8:1
6	9009.1	7372.4	1636.7	81.8	18.2	4.5:1
9	8219.4	5437.0	2782.4	66.1	33.9	1.9:1
12	13946.0	8515.4	5420.6	61.1	38.9	1.6:1
Nitrogen level (kg N ha^{-1})						
0	6692.0	5037.1	1654.9	75.3	24.7	3.0:1
150	9474.0	7035.4	2438.6	74.3	25.7	2.9:1
300	10701.4	7752.5	2948.9	72.4	27.6	2.6:1
450	9956.9	6923.1	3033.8	69.5	30.5	2.3:1

leaves to receive light, resulting in an increase in the proportion of stem by weight and a reduction in the proportion of leaf. The fact that the stem constitute increasingly greater proportion of the total grass herbage yield (Omaliko, 1980; Lazo et al., 1996; Onyeonagu and Asiegbu, 2005) to the disadvantage of the leaf after the sward had been growing for periods longer than 3 weeks, would partly account for the rapid deterioration in quality characteristic of the tropical pasture species (Saleem, 1972; Omaliko, 1980).

The proportion of inflorescence was on average low, although it appeared highest with 9-weekly interval of cuts compared with others in 2004. Hay and Newton (1996) reported similar result in White clover (*Trifolium repens* L.) and showed that severe defoliation resulted in frequent removal of inflorescence primordial, while infrequent defoliation allowed time for the inflorescence to develop. Applied N did not affect the proportion of inflorescence in 2001 and 2002 but the highest N rate of 450 kg N ha^{-1} increased the proportion of inflorescence over the control in 2003. It appeared therefore that cutting masked the effect of N levels on the proportion of inflorescence in 2001 and 2002 years. In addition, the effect of cutting interval would have been confounded by the periodicities of the timing of cuts when some periods coincided with the time of initiation of inflorescences without allowing them develop much (Wilman et al., 1976b; Asiegbu and Onyeonagu, 2008). The lengths of seasons also limited the number of cuts, especially at the lower frequencies (Asiegbu and Onyeonagu, 2008).

Finally, the significant cutting interval × nitrogen interactions on dry matter yields of crop fractions observed in the present study had also been reported by other workers (Wilman and Asiegbu, 1982; Asiegbu and Onyeonagu, 2008) and had been partly attributed to the ability of fertilizer-N to accentuate the beneficial effects of longer and infrequent cutting interval, especially when the growth conditions permitted better N availability, uptake and utilization (Chheda and Akinola, 1971).

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