Effects of cutting frequency on forage production and nutritive value of Brachiaria grass cultivars in coastal lowlands of Kenya

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Abstract

Feed shortage during the dry season limits livestock productivity in coastal lowlands of Kenya. A study was conducted to evaluate the effect of cutting frequency on productivity and nutritive value of Brachiaria grass cultivars. Seven (7) Brachiaria grass cultivars: *Brachiaria brizantha* cvs. Marandu, Xaraes, Piata and MG4, *B. decumbens* cv. Basilisk, *Brachiaria hybrid* cv. Mulato II, *B. humidicola* cv. Llanero were evaluated along *Chloris gayana* cv. ex-Tozi as a control at Mtwapa and Msabaha in the coastal lowlands of Kenya. Plant numbers, tiller numbers and dry matter (DM) yield were monitored at 6, 8 and 12 weeks intervals in 2014 and 2015 in both long and short rain seasons. At Mtwapa, generally increasing cutting interval from 6 to 8 weeks resulted to increased DM yield but further increase to 12 weeks, the yield either remained the same or declined. At Msabaha, there was no distinct trend on DM yield by increasing cutting interval. Mulato II, Marandu, MG4 and Xaraes had the highest yield in most of the seasons. The crude protein was generally low (5.3 - 7.7% of DM) and was similar among the Brachiaria grass cultivars and also to Rhodes grass and Napier grass. The CP content at 6 and 8 weeks cutting interval was similar (7.12 and 7.24% of DM) and by increasing cutting interval to 12 weeks it declined to 4% of DM. Similarly increasing cutting interval from 6 to 12 weeks resulted to decline in digestibility. Based on high nutritive quality at 8 week cutting interval and relatively high DM; it can be concluded that harvesting Brachiaria at 8 weeks cutting interval is appropriate in coastal lowlands of Kenya.

Key words: Brachiaria, cutting interval, dry matter yield, forage; nutrient; yield

Introduction

Seasonal feed shortage and inadequate nutrient supply are major constraints to livestock production in coastal Kenya (Mburu, 2015). Ruminant livestock are a predominant component of mixed farming in the region. Dairy production contributes to both improved household nutrition and income (Nicholson *et al*., 2002). Dairy cattle are mainly fed on natural pastures since Napier grass, the recommended fodder is grown by only 10% of the farmers (Njarui *et al*., 2016). Knowledge on the effects of harvesting frequency on foliage yield and quality is essential for development of successful livestock year round feeding strategies. The interval between harvests of grasses affects herbage production, nutritive value and re-growth ability. According to Ball *et al*, (2009), forage quality is influenced by forage species, stage of maturity at harvest, soil fertility and climatic factors. Young re-growth is characterized by high protein, low cellulose and lignin and high digestibility (Wijiphans *et al*., 2009). Various grass harvest intervals and intensity studies revealed that the cutting interval influence growth, yield and persistence of the sward (Probst *et al*., 2011). Slow re-growth of the forages was observed immediately after cutting as the plants had few leaves to intercept light for photosynthesis. To ensure improved and sustainable livestock production under the global influence of climate change, forage management strategies that optimizes the quantity and quality of fodder

supplies is necessary. A study was therefore conducted to assess the seasonal dry matter (DM) production and nutritional value of seven (7) *Brachiaria* grasses under different cutting intervals in coastal lowlands of Kenya.

Materials and methods

Sites

The study was conducted at Mtwapa and Msabaha in the coastal lowlands. The location, detailed climatic condition and soil characteristics of these sites are given by Ondiko *et al*. (2016), in these proceedings.

Experimental design and treatments

Seven (7) *Brachiaria* grass cultivars: *B. brizantha* cvs. Marandu, Xaraes, Piata and MG4, *B. decumbens* cv. Basilisk, *B. hybrid* cv. Mulato II, *B. humidicola* cv. Llanero were evaluated. Rhodes grass (*Chloris gayana*) cv. ex-Tozi was included as a control. The experimental design was completely randomized block in a split plot arrangement with four replications. The main plots were cultivars and the sub plots were the cutting frequencies (6, 8 and 12 weeks). The plot size was 5 x 4 m with a 1 m path between plots and 1.5 m between replicates. The seeds were sown in November 2013 in furrows of about 2 cm deep on well prepared seed bed after ploughing and disc harrowing. The inter row spacing was 0.5 m, giving 10 rows in each plot. Triple super phosphate (TSP, 46% P_2O_5) was applied at the rate of 200 kg/ha prior to sowing of the seeds. The trials were kept free from weeds by hand weeding and slashing within the plots. A standardization cut was carried out in April 2014 at onset of rains which marked the end of the establishment phase. The nitrogenous fertilizer (26% N) was applied at the rate of 100 kg/ha which was done after the standard cut at the onsets of rains.

Data collection

The data recorded were number of plants, tiller number and dry matter at a regrowth period of 6, 8 and 12 weeks after standardization cut. The plot was sub-divided into three plots, and 2 inner rows were sampled leaving a guard row at each side. The number of plants per unit was determined by counting the plants within a 1 x 1 m frame randomly placed over the two rows. Four plants within the central rows were randomly selected for tiller number determination. Immediately after the measurements, fresh biomass production for the re-growth at 6, 8 and 12 weeks were harvested and weighed; sub samples were taken and oven dried at 65^{o}C to constant weight for DM determination.

Herbage chemical analysis

Crude protein (CP) was determined using micro-Kjeldahl according to the method of Association of Official Analytical Chemist (AOAC, 2000). The acid detergent fibre (ADF), neutral detergent fibre (NDF) digestibility and lignin were analysed according to Van Soest and Robertson, 1980.

Ash was determined by heating the samples at 600°C for 2 hours in a muffle furnace. Total P and Ca were determined according to the methods described by Okalebo *et al.* (2002).

Statistical analyses

The forage DM yields were grouped into LR and SR seasons for each cultivar and the three harvesting intervals (6, 8 and 12 weeks). Data on plant population, tiller number and mean DM yield per season were statistically evaluated using analysis of variance (SAS, 2010). The means were separated using Tukey's HSD at 5% level of significance.

Results

Seasonal condition

Rainfall and temperature during the experimental period (2014-2015) at Mtwapa and Msabaha are given in Figure 1. At Mtwapa, the total rainfall was highest in LR 2014 (851 mm) and LR 2015 (855 mm) and lowest in SR 2015 (289 mm). The minimum and maximum temperatures were 23 and 29°C, respectively. Similarly the rainfall at Msabaha was highest in LR 2014 season (592 mm) and LR 2015 (607 mm) and lowest in SR 2015 (136 mm). The minimum and maximum temperatures were similar to that of Mtwapa.

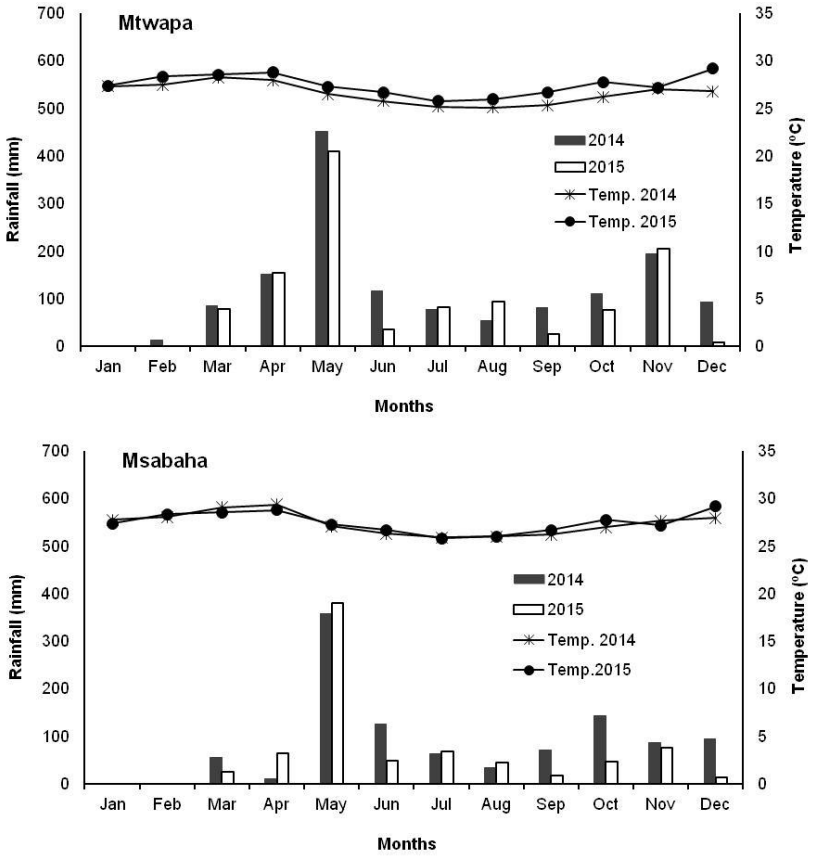

Figure 1 Total monthly rainfall and average temperature during the experimental period 2014- 2015 at Mtwapa and Msabaha

Plant number

There were differences ($P < 0.05$) on plant numbers among the Brachiaria grasses in both sites. Generally, the Brachiaria cultivars had more plant numbers at Mtwapa than at Msabaha. At Mtwapa, Llanero had consistently the highest number of plants in all the seasons but differed ($P < 0.05$) from all the other Brachiaria cultivars only in LR 2014 (Table 1). In LR 2014 it had 40 plants/m^2 and declined to 20.5 plants/m^2 in SR 2014 and further to 13.3 plants/m^2 in SR 2015. Mulato II had the lowest plant numbers in all the seasons. At Msabaha, Llanero had the highest plant numbers in LR 2014 while in the other seasons none of the cultivars had consistently the highest plant numbers (Table 1). Like in Mtwapa plant number declined over time for all Brachiaria cultivars except Mulato II where they remained fairly stable. However, plant number declined with increasing cutting interval from 6 to 12 weeks at both sites (Table 2).

Table 1 Number of surviving plants /m^2 during the long and short rainy seasons at Mtwapa and Msabaha, coastal lowlands**.**

Grass cultivars	Mtwapa				Msabaha			
	LR 2014	SR 2014	LR 2015	SR2 015	LR 2014	SR 2014	LR 2015	SR 2015
Llanero	40.8a	19.5ab	19.2a	13.3a	20.5a	14.7a	11.6a	11.0a
Basilisk	28.4b	19.1abc	16.3a	9.3a	16.0ab	16.1a	10.1a	8.5ab
MG4	21.7bc	18.3abc	14.5b	9.9a	16.5ab	16.8a	11.3a	11.0a
Piata	20.4cd	18.3abc	16.4a	9.3a	12.2ab	16.7a	10.0ab	9.6ab
Xaraes	19.5cd	15.8bc	15.9a	9.2a	8.0ab	12.9ab	9.8ab	8.3ab
Marandu	19.4cd	17.4abc	15.1b	9.3a	10.5ab	12.5ab	10.7a	10.2a
Mulato II	14.3d	13.3c	13.4b	8.7a	7.6ab	14.3a	12.9a	12.3a
Rhodes grass	37.6a	23.1a	17.2a	11.3a	-	-	-	-
Mean	25.3	18.1	16.2	10.0	13.0	14.8	10.9	10.1
CV%	11.6	13.9	12.4	19.7	83.5	47.3	33.4	33.4

Means followed by a different letter within a column are significantly ($P<0.05$) different

Table 2 The effects of cutting frequency on plant numbers/m^2 at Mtwapa and Msabaha, coastal lowlands.

Cutting interval (weeks)	Mtwapa				Msabaha			
	LR 2014	SR 2014	LR 2015	SR 2015	LR 2014	SR 2014	LR 2015	SR 2015
6	29.8 a	28.3a	21.2a	9.7b	18.9a	15.6b	15.6a	13.9a
8	26.5b	18.3b	13.7b	8.6b	11.0b	19.9a	10.7b	14.0a
12	19.4c	7.72c	13.4b	10.8a	8.1b	6.9c	5.0c	6.6b

Means followed by a different letter within a column are significantly ($P<0.05$) different

Tiller number

There was variation in the numbers of tillers among the Brachiaria grass cultivars in all seasons. Overall, the Brachiaria cultivars had more tillers during the LR seasons than in the SR seasons at both sites. At Mtwapa, Mulato II maintained the highest number of tillers in all the seasons (Table 3). Rhodes grass recorded lowest number of tillers compared with all the other Brachiaria grasses except in SR 2015. At Msabaha, Mulato II had consistently the highest number of tillers in LR 2014, SR 2014 and LR 2015 and was among the Brachiaria with the highest number of tillers in SR 2015 (Table 3). Piata and Llanero tended to have the lowest number of tillers in most of the seasons. There was no definite trend on number of tillers by increasing cutting interval from 6 to 12 weeks; the number either increased on declined in different season (Table 4).

Table 3 Average seasonal cumulative tiller numbers per plant during the production phase (2014-2015) at Mtwapa and Msabaha.

Grass cultivars	Mtwapa				Msabaha			
	LR 2014	SR 2014	LR 2015	SR 2015	LR 2014	SR 2014	LR 2015	SR 2015
Mulato II	78.6a	43.3a	83.0a	57.1a	75.8^{a}	34.3^{ab}	48.3^{a}	32.6^{ab}
MG4	48.9b	29.6b	53.7bc	42.0ab	48.4^{ab}	28.1^{ab}	36.8^{ab}	35.0^{a}
Marandu	43.8b	29.5b	45.9b	37.0b	53.8^{ab}	31.8^{ab}	35.6^{ab}	27.9^{ab}
Basilisk	39.3b	28.6b	39.6bc	41.0ab	48.3^{ab}	28.8^{ab}	32.8^{ab}	21.4^{ab}
Xaraes	36.7b	24.9b	40.0bc	29.5b	44.7^{b}	28.3^{ab}	31.3^{ab}	26.6^{ab}
Piata	36.5b	24.5b	38.8bc	35.1b	37.3^{bc}	24.0^{b}	27.8.^{b}	22.0^{ab}
Llanero	35.7b	26.4b	28.1c	29.6b	36.8^{bc}	33.6^{ab}	28.6^{b}	16.5^{bc}
Ex-Tozi	33.4b	23.1b	26.1c	37.7ab	-	-	-	-
Mean	44.1	28.7	44.4	38.6	49.3	29.8	33.6	26.8
CV%	10.6	19.7	20.7	18.9	72.2	41.8	47.7	38.8

Means followed by different letter within same column are significantly (P<0.05) different

Table 4 The effects of cutting frequency on tiller numbers/m^2 at Mtwapa and Msabaha.

Cutting interval (weeks)	Mtwapa				Msabaha			
	LR 2014	SR 2014	LR 2015	SR 2015	LR 2014	SR 2014	LR 2015	SR 2015
6	45.5a	31.2a	46.6b	33.9b	49.8ab	23.8b	30.1b	35.5a
8	44.7a	28.6ab	45.8b	33.6b	41.3b	32.6a	30.3b	12.8c
12	42.1a	26.26b	51.3a	40.8a	52.9a	34.8a	41.2a	28.3b

Means followed by different letter within same column are significantly (P<0.05) different

Dry matter yield

Mtwapa

There was a significant interaction between Brachiaria cultivar and cutting interval on DM yield at Mtwapa. The DM yield increased for all the Brachiaria cultivars with increased cutting interval from 6 to 8 weeks during LR 2014 season except for Xaraes and Rhodes grass where yield declined. At 12 weeks the yield remained relatively the same or declined marginally for some cultivars (Figure 2). In SR 2014 season, DM yield were highest at 6 and 8 week cutting interval and declined at 12 weeks cutting interval. In both LR 2015 and SR 2015, yield increased with increasing cutting interval from 6 to 8 weeks but at 12 weeks the yield either remained relatively the same or declined significantly for some of the Brachiaria grasses. None of the Brachiaria out yielded the others in LR 2015 but in SR 2015 Llanero had highest yield at 12 weeks cutting interval. Mulato II, Piata, MG4, and Marandu tended to have the attained the highest yield in most of the season.

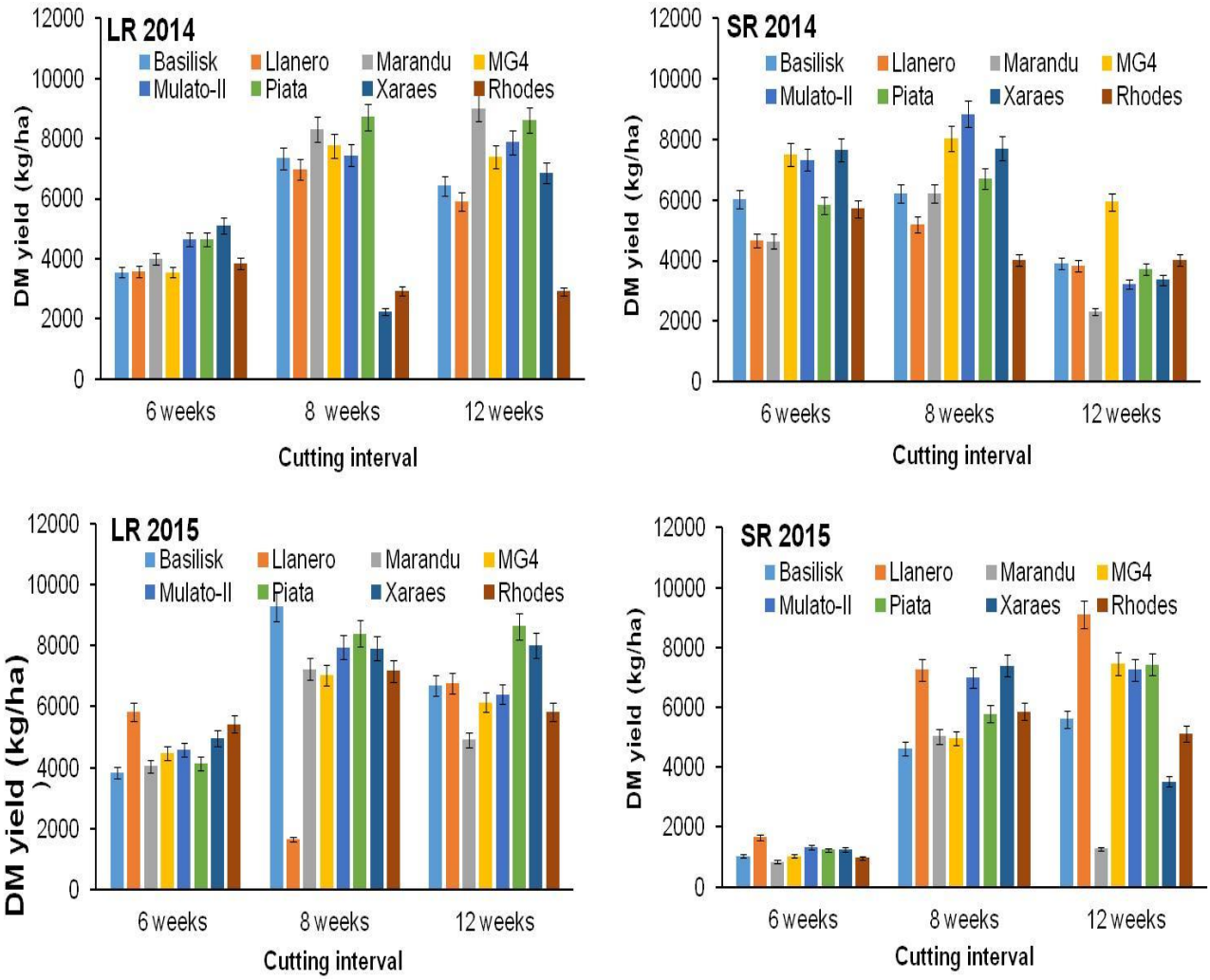

Figure 2 Seasonal DM yield (kg ha^{-1}) of grasses at Mtwapa in coastal lowlands of Kenya.

Msabaha

Like in Mtwapa, there was also a significant interaction between Brachiaria cultivars and cutting interval on DM yield at Msabaha. However there was no distinct trend on DM yield by increasing cutting interval across seasons. In LR 2014, there were large variation in yield among the Brachiaria grasses at 6 and 8 weeks cutting interval but at 12 weeks yield were almost similar (Figure 3). In SR 2014 yield tended to higher at 6 and 8 weeks cutting interval and declined at 12 weeks for all the Brachiaria grasses. In LR 2015, increasing cutting interval from 6 to 8 week resulted in increased DM yield for all the Brachiaria but at 12 weeks cutting interval, yield declined considerably. In SR 2015 yield were relatively low (<2000 kg/ha) for all the Brachiaria in all cutting interval.

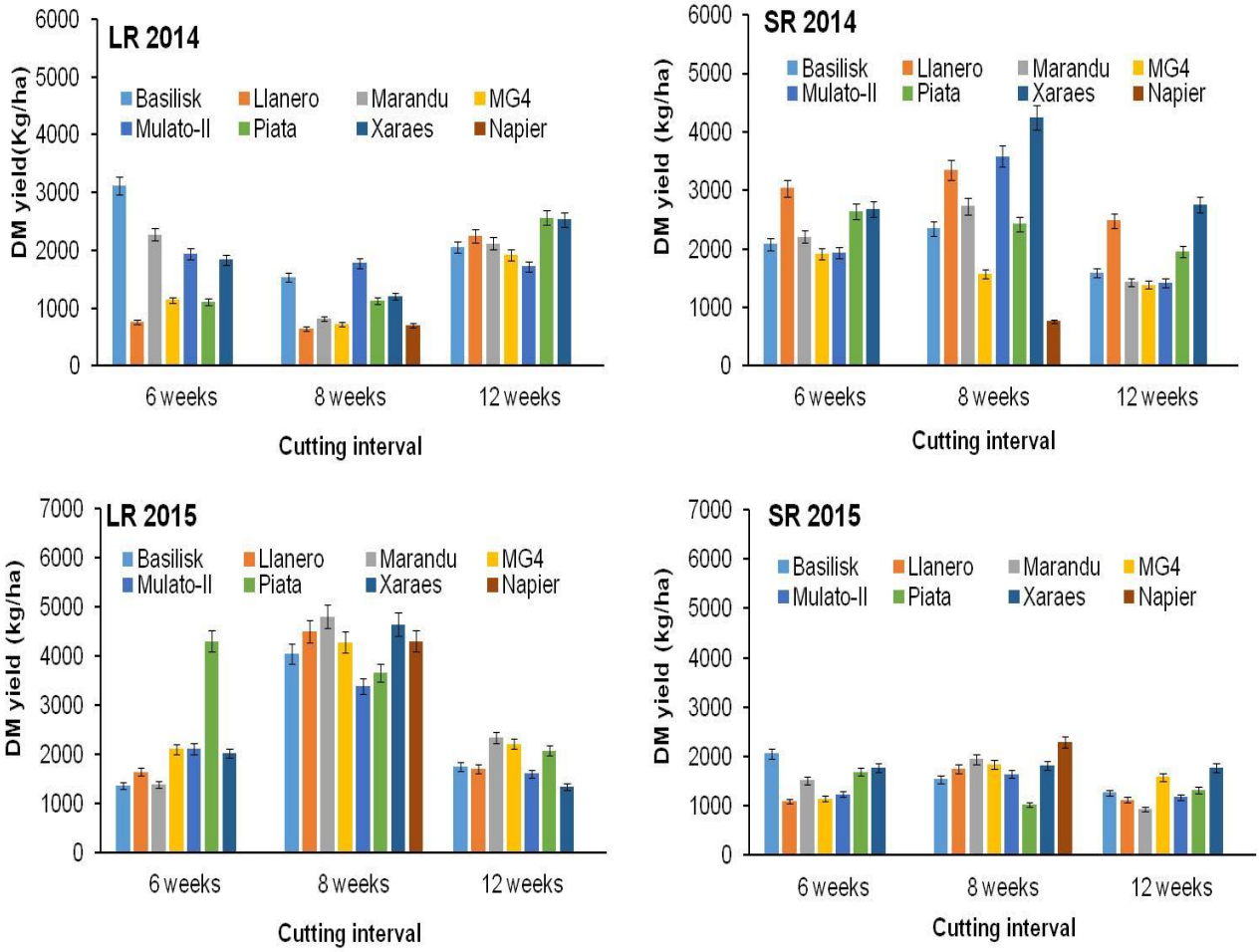

Figure 3 Seasonal DM yield (kg ha^{-1}) of grasses at Msabaha in coastal lowlands of Kenya.

Chemical composition

The crude protein was generally low (5.3 - 7.7% of DM) and was similar among the Brachiaria grass cultivars and also to Rhodes grass and Napier grass. There were differences ($P < 0.05$) in ADF, NDF, digestibility, ash and Ca content. Rhodes grass had the highest ADF and NDF

compared with the other the Brachiaria grasses but was only significantly (P<0.05) different from Mulato II (Table 5). Napier grass had the highest DMD (57.6%) but was only higher (P < 0.05) than Basilisk, Xaraes and Rhodes grass. Rhodes grass had higher Ca than Piata, MG4, Basilisk and Llanero. Increasing cutting interval from 6 to 12 weeks resulted in decreasing CP content and DMD but the fibres increased (Table 6).

Table 5 Chemical composition (% of DM) for Brachiaria cultivars and controls in coastal Kenya

Grass cultivars	CP	ADF	NDF	ADL	DMD-	Ash	Ca	P
Piata	5.4a	48.9abc	66.6ab	2.5a	50.2ab	8.3ab	0.3b	0.3a
Marandu	6/0a	49.0abc	65.7ab	3.2a	51.2ab	8.4ab	0.4ab	0.3a
Mulato-II	5.8a	46.2c	61.7b	2.1a	52.2ab	9.4ab	0.4ab	0.3a
MG4	6.2a	49.5abc	65.7ab	3.3a	48.3abc	8.9ab	0.3b	0.3a
Basilisk	7.7a	49.7abc	65.1ab	4.0a	46.0bc	7.8b	0.3b	0.3a
Llanero	6.5a	48.5abc	67.4ab	3.0a	52.1ab	8.7ab	0.3b	0.3a
Xaraes	4.9a	50.6ab	63.7ab	2.8a	43.8bc	8.1ab	0.4ab	0.3a
Rhodes grass	5.3a	52.4a	69.4a	3.4a	40.4c	6.9b	0.5a	0.3a
Napier grass	6.9a	48.2bc	61.1b	2.9a	57.6a	11.0a	0.4ab	0.3a
Mean	6.1	49.2	65.1	3.0	49.1	8.6	0.4	0.31
CV (%)	26.0	2.9	3.9	38.4	6.7	12.1	14.2	12.3
SE	1.6	1.4	2.6	1.2	3.3	1.0	0.1	0.04

CP= Crude protein, ADF- Acid detergent fibre, NDF-Neutral detergent fibre, ADL-acid detergent lignin, , DMD%-, Ca- calcium, P- phosphorus, CV%- coefficient variation, se- standard error

Table 6 Effects of cutting interval; 6, 8 and 12 weeks on nutritive quality (% of DM) of Brachiaria grass at Mtwapa.

Cutting interval	CP	ADF	NDF	ADL	DMD-	Ash	Ca	P
6	7.12^{a}	46.36^{b}	62.28^{b}	3.08^{ab}	55.63^{a}	10.39^{a}	0.39^{a}	0.36^{a}
8	7.24^{a}	49.89^{a}	63.34^{b}	2.02^{b}	47.82^{b}	9.346^{b}	0.35^{ab}	0.20^{b}
12	3.99^{b}	51.41^{a}	69.84^{a}	3.92^{a}	48.80^{c}	6.11^{c}	0.33^{b}	0.25^{c}

CP= Crude protein, ADF- Acid detergent fibre, NDF-Neutral detergent fibre, ADL-acid detergent lignin, , DMD%-, Ca- calcium, P- phosphorus, Means followed by a similar letter with the same row are not different (P>0.05) within a column

Discussion

The study demonstrated variation in tiller development and productivity among the Brachiaria grasses. Basilisk and Llanero produced high plant number among the cultivars in all the cutting intervals. The number of tiller increased with frequent cutting interval as observed by Onyeonagu *et al*. (2005a). The effect of rainfall on forage yields in the coastal lowlands was demonstrated with higher yield recorded during the LR season when the rainfall was high. The DM yields at Msabaha were 46% lower than those obtained at Mtwapa and this was attributed

to the lower rainfall at that site. Msabaha is located in CL4 which receives less rainfall than CL3 where Mtwapa is located. The total rainfall at Mtwapa during the LR 2014 was 851 mm compared to 592 mm at Msabaha while in SR 2015 rainfall at Mtwapa (289 mm) was twice that of Msabaha (136 mm).

Among the tested grasses Mulato II, Piata, Marandu and Xaraes showed outstanding potential as a forage plant in coastal lowlands since it has shown that it can grow under low rainfall maintaining high yields. More tillers were reported for Mulato II at Mtwapa and in Msabaha. The grasses at the 8 week interval have had developed stems and leaf photosynthetic area, resulting into higher dry matter production (Vinther, 2006). The current results are in agreement with Vinther (2006) who found that harvest interval affects productivity, partly through changes in their morphological development. DM production is thus related to harvest frequency.

Nutritional composition

The CP content was general low in all the Brachiaria grasses (5.3 - 7.7%) compared with mean of 7-10% reported by Nguku *et al.* (2015) in the semi-arid region of eastern Kenya. However, the CP of 7.7% content from Basilisk was relatively higher compared with that reported by Evitayani *et al*. (2004a). The high temperatures at Mtwapa could have contributed to plants having lower CP than expected as temperatures have been reporded to have effect of quality of grasses (Njarui *et al*., 2015). The ADF content of Rhodes grass was higher was less digestible than Brachiaria indicating that Brachiaria grasses are superior to Rhodes grass. As ADF increased, the DMD declined and this is consistent with work of Albayrak *et al*. (2011) who reported that as the ADF increases the digestibility of the forage usually decrease causing consumption of the forage by animal to decrease. However, the stage at which the grass is harvested may have positive or negative impact on quality. As reported by Bruinenberg *et al*. (2002), at a given harvest date, the differences in digestibility of DM of grasses may occur because of differences in the phenological stage.

Conclusions

Based on this research, it can be concluded that the cutting intervals can affect the forage DM yield and nutritive values of Brachiaria grasses. Cutting 8 weeks interval could be the optimal level for harvesting Brachiaria grass since the quality forage is high and yield are not compromised. The forages should be fed to ruminant livestock to determine animal responses in terms of production of milk, meat and animal health.

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