Productivity and Nutritive Value of *Urochloa* Grass Cultivars in Semi-Arid Tropical Kenya

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Abstract
There is increasing demand for high yielding and nutritious forages to meet the growing dairy farming in semi-arid Kenya. The productivity and nutritive value of seven *Urochloa* grass cultivars (*Urochloa decumbens* cv. Basilisk, *U. brizantha* cvs. Marandu, MG4, Piatá and Xaraes, *U. humidicola* cv. Llanero and *U. hybrid* cv. Mulato II) were evaluated in two diverse semi-arid environments, Katumani and Ithookwe in Kenya. At Katumani, the dry matter (DM) yield (5000 - 7500 kg/ha) was highest during the first harvest during the long rains (LR) 2014 season. Dry matter yield declined progressively with season and in the third season (LR 2015) only Xaraes achieved over 2000 kg/ha. All *Urochloa* cultivars died and no yield was recorded after the third harvesting season (LR 2015) due to prolonged dry season. At Ithookwe, all plants survived during the period of evaluation. Generally the DM yield was highest (4200 – 9200 kg/ha) in the second harvesting season during short rains (SR) 2014 with Llanero having the highest yield and Mulato II the lowest. Significant differences ($P < 0.05$) in forage quality was recorded in calcium, phosphorus, ash, neutral detergent fibres (NDF) and lignin content. However, none of the cultivars consistently contained more than the other cultivars in all the forage quality parameters analysed. The cv. Xaraes had the highest calcium content and Marandu had the lowest while MG-4 contained the highest phosphorus and Basilisk the lowest. Mulato II contained the highest crude protein and lowest NDF. The study revealed that *Urochloa* could increase forage resources in the semi-arid regions of Kenya where annual rainfall exceed 700 mm without prolonged dry season.

Key words: brachiaria, dry matter yield, crude protein, forage quality composition, *in-vitro* dry matter digestibility, plant tillers.

Introduction
The rapid growth in demand of milk and other dairy product has presented an opportunity for expansion of dairy farming in semi-arid areas of Kenya. In the semi-arid eastern midlands of Kenya, Napier grass (*Pennisetum purpureum* Schum.) is the most widely cultivated fodder by the dairy farmers in the hill masses where it is relatively wetter but is not drought tolerant. Due to continuous cultivation for a long time, it has become susceptible to Napier stunting and head smut diseases. Napier stunt causes herbage yield reduction of 40 - 90% (Mulaa et al. 2004) and 35% milk reduction while head smut causes yield loss of 25 - 46% (Mwendia et al. 2006). There is need for other forages that are drought tolerant and persistence to support livestock productivity. *Urochloa* (commonly known as brachiaria) grass offers an alternative potential to bridge the gap to increase feed availability. *Urochloa* grass is adapted to infertile acid soils, is highly productive and nutritious for livestock feed (Ghimire et al. 2015). Moreover, it has potential to mitigation climate change through carbon sequestration and provides other ecosystem benefits (Djikenk et al. 2014). *Urochloa* is widely cultivated in Australia, South America and part of South East Asia supporting a highly vibrant beef industry. Despite the widespread distribution of the genus *Urochloa* in Kenya, with 33 documented species, it has been underutilized for livestock production due to limited research. Nguku et al. (2016) recommended evaluation for several seasons to assess it productivity with the semi-arid region of Kenya. The objective of the study was to evaluate the productivity and nutritive value of seven *Urochloa* grass cultivars in diverse drought prone region of eastern midlands tropics of semi-arid Kenya.

Methods
The study was conducted at Katumani (1º35′S, 37º14′E) and Ithookwe (1º37′S, 38º02′E) in the eastern midlands of Kenya. Katumani is located at higher altitude (1600 m) than Ithookwe (1160 m) but mean

temperature is lower (19.6ºC) than Ithookwe (22.5ºC). Ithookwe receives higher mean annual rainfall (1010 mm) than Katumani (700 mm). The rainfall in both sites is bimodal, with the long rains (LR) occurring from March to May and short rains (SR) from October to December, is generally erratic with frequent droughts. The soil ranges from Chromic luvisols to is red sandy earth.

The *Urochloa* grass cultivars evaluated were *Urochloa decumbens* cv. Basilisk (CIAT 606), *U. brizantha* cvs. Marandu (CIAT 6294), Xaraes (CIAT 26110), Piata (CIAT 16125), MG-4 (CIAT 26646), *U. humidicola* cv. Llanero (CIAT 6133) and *U. hybrid* cv. Mulato II (CIAT 36087). The grasses were planted in plots of 4 x 5 m in a randomized complete block design with 3 replications. The seeds were sown during the SR season in November 2013, following the recommended practice. Triple super phosphate (TSP 46% P_2O_5) fertilizer was applied during planting at a rate of 40 kg/ha P while calcium ammonium nitrate (CAN, 26% N) was top-dressed during the production phase at 100 kg N/ha per year.

To stimulate uniform growth, a standardisation cut was made after the end of the first wet season (SR 2013). Sampling for DM yield began from second wet season during LR 2014 season in which the plants were repeatedly harvested after every 8 weeks from an area of 2 x 2 m. During the same time, the tiller numbers were counted from an area of 1 x 1 m. The materials for DM determination were dried at 105ºC for 48 hours and those for forage quality analysis at 65ºC for approximately 72 hours. Due to relatively high cost of analysis, only samples harvested during the LR 2014 season at Katumani were analysed for nutritive quality using the standard procedures. The DM yields for each season were pooled together before analysis. The data for each site was statistically analysed separately and mean separated using the least significant difference (LSD) test at $P < 0.05$. The DM yield for each season was regressed against respective total number of tillers within an area of 1 x 1 m.

Results

Dry matter production

Katumani

The DM yield for three wet seasons at Katumani is shown in Figure 1. All the cultivars failed to survive beyond the LR 2015 season thus no yields were recorded thereafter. The DM yield was highest during the first harvest (LR 2014) with all the cultivars attaining over 5000 kg/ha. Dry matter declined thereafter and during SR 2015 season, only Xaraes achieved over 2000 kg/ha. Significant difference ($P < 0.05$) on DM yield among the *Urochloa* grass was recorded during the SR 2014 and LR 2015 seasons. The cv. Xaraes produced the highest DM yield in both seasons while cvs. Llanero and Marandu had the lowest yield in SR 2014 and LR 2015 seasons, respectively.

Ithookwe

Unlike at Katumani, all cultivars survived during the period of evaluation and thus DM yield was recorded for four seasons (Figure 2). Significant difference in DM yields among the *Urochloa* grass occurred during the LR 2014 and SR 2014 seasons. However, DM yield was highest during the SR 2014 (4200 – 9200 kg/ha) with Llanero having the highest yield and Mulato II the lowest. In the other seasons, all the cultivars achieved over 3000 kg/ha except Marandu and Mulato II which had less than 3000 kg/ha.

Effect of tillers on dry matter yield

There was significant and positive correlation between DM yield and tiller development at Katumani (r = 0.3766, P <0.001) and Ithookwe (r = 0.2141, $P < 0.001$) which was evidenced by increased DM yield with increased number of tillers (Figure 3). At Katumani, the DM yield increased with increased tiller numbers during the period of the study while at Ithookwe, DM yield increased with increased number of tillers and tended to plateau after 500 tillers m^{-2}.

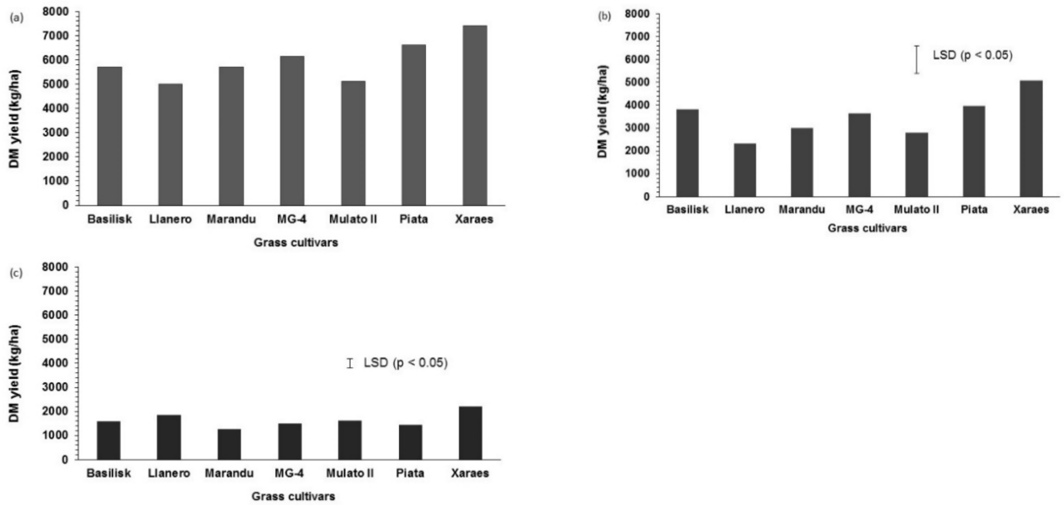

Figure 1. Dry matter (DM) yield of *Urochloa* grass during: (a) long rains 2014, (b) short rains 2014 and (c) long rains 2015 at Katumani, eastern midlands, Kenya

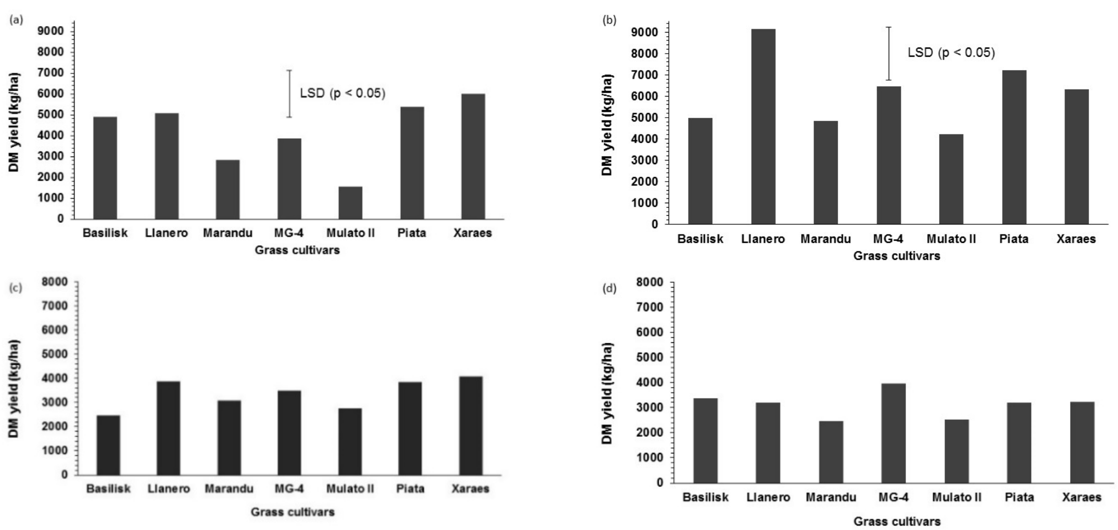

Figure 2. Dry matter (DM) yield of *Urochloa* grass during: (a) long rains 2014, (b) short rains 2014, (c) long rains 2015 and (d) short rains 2015 seasons at Ithookwe, eastern midlands, Kenya

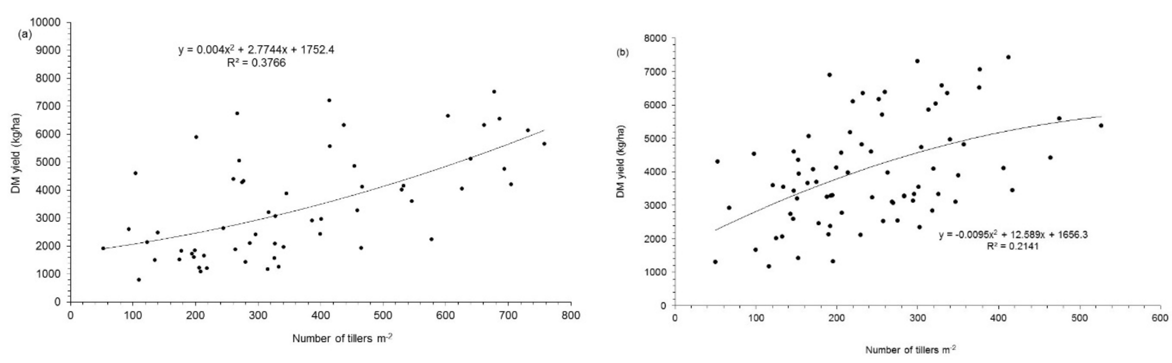

Figure 3. The effect of number of tillers on dry matter yield of *Urochloa* grass at (a) Katumani and (b) Ithookwe.

Forage quality composition

Table 1 shows the results of forage quality analysis. There were marked differences ($P < 0.05$) in the level of calcium, phosphorus, ash, neutral detergent fibres and lignin among the *Urochloa* cultivars. However, none of the cultivars consistently contained more of all the forage quality parameters than the other cultivars. For mineral levels, Xaraes had the highest calcium content and Marandu had the lowest while MG-4 contained the highest phosphorus and Basilisk the lowest. Mulato II contained the highest crude protein and lowest neutral detergent fibres. Llanero was more ($P < 0.05$) lignified than the other *Urochloa* cultivars.

Table 1. Herbage chemical composition (% of DM) and digestibility of *Urochloa* cultivars at 8 weeks cutting interval at Katumani, eastern midlands of Kenya

Urochloa cultivars	Ca	P	Ash	†CP	‡NDF	±ADF	+ADL	TTIVDMD
Xaraes	0.27^{A}	0.11^{B}	12.6^{BC}	9.6^{AB}	65.2^{AB}	35.4^{A}	2.3^{C}	56.14^{A}
Piata	0.24^{AB}	0.10^{BC}	11.4^{C}	8.9^{BC}	67.0^{AB}	40.8^{A}	2.9^{BC}	56.09^{A}
MG4	0.22^{AB}	0.14^{A}	12.5^{BC}	8.0^{C}	64.7^{B}	38.6^{A}	3.3^{B}	56.89^{A}
Llanero	0.17^{BC}	0.10^{BC}	11.4^{C}	9.5^{AB}	66.6^{AB}	40.9^{A}	4.4^{A}	55.37^{A}
Mulato II	0.13^{CD}	0.08^{C}	15.0^{A}	10.7^{A}	60.6^{C}	38.8^{A}	2.6^{BC}	58.62^{A}
Basilisk	0.11^{CD}	0.05^{D}	12.1^{BC}	8.0^{C}	68.1^{A}	42.2^{A}	3.4^{B}	54.32^{A}
Marandu	0.09^{D}	0.08^{C}	13.9^{AB}	9.2^{BC}	65.6^{AB}	38.8^{A}	2.3^{C}	48.19^{A}
LSD ($P < 0.05$)	0.08	0.03	1.84	1.4	3.2	N.S.*	0.9	N.S.

†CP=Crude protein; ‡NDF=Neutral detergent fibre, ±ADF=Acid detergent fibre; +ADL=Acid detergent lignin; TIVDMD=*in-vitro* dry matter digestibility.
Means with different superscript in the same column differ significantly at $P < 0.05$
*N.S. not significant

Discussion

The *Urochloa* grass cultuvars differed in producivity between the sites with DM yield being higher at Ithookwe than at Katumani in all the seasons. This was attributed to the relatively higher rainfall at the Ithookwe site. However, the DM yields were low compared with those recorded by Pizarro et al. (2013) in Asia but were similar to those recorded by Wassie et al. (2018) in Ethiopia. The cvs. Llanero, Xaraes, Piata, MG-4 and Basilisk were the most productive in both sites. Mulato II and Marandu had the lowest yield in most of the harvests and this was mainly due to red spider mites attack. Tiller number had influence on the yield as shown by the positive correlation. Katumani site favoured development of more tillers compared with Ithookwe. High tiller number enhances resource use from the soil and recovery after defoliation. Nevertheless, high number of tillers can be detrimental under low rainfall as it lead to high evapo-transpiration and moisture loss. Unfortunately, the low rainfall was not sufficient to sustain excessive tillering ability at Katumani and this contributed to death of plants due to limited moisture availability after the LR 2015 season. The CP contents were low compared with those reported by Nyambati et al. (2016) in the cooler and wetter highlands of central Kenya, Wassie et al. (2018) in Ehtiopia and Pizzarro et al. (2013) in Asia. Nevertheless, all the *Urochloa* cultivars had CP content within the range of 9-12% that is regarded as highly palatable.

Despite the *Urochloa* cultivars showing poor survival under extreme climatic condition, when the dry season exceeded over 5 months with high temperatures, they can boost the forage resource base in the semi-arid regions of Kenya due to their high yield and nutritive quality. The cultivars Llanero, Xaraes, Piatá, Basilisk and MG4 were the most suitable for integration in the local farming system due to their consistently high yield in both sites. Although Mulato II had higher CP than the other cultivars, it is not recommended for cultivation in the region due to being susceptible to red spider mites pest. It should be noted that the *Urochloa* is unlikely to survive in areas that receives less than 700 mm annual rainfall with dry seasons exceeding five months. Further research is needed to quantify the feeding value of *Urochloa* cultivars on animal production performance.

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