Growth and Yield Evaluation of Urochloa Grass Cultivars in Sub-humid Region of Kenya

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Key words: *Urochloa* cultivars; dry matter yield; nutritive quality, height; plot cover; spread

Abstract

[Maximum 300 words]

Livestock production in sub humid region of Kenya is constrained by inadequate and low quality pasture. A study was conducted to evaluate growth and productivity of eight improved *Urochloa* grass cultivars in lower midlands, upper midlands and lower highlands agro-ecological zones (AEZ) in Eldoret, Kitale and Alupe respectively, western Kenya. The grass cultivars were; *Urochloa brizantha* cvs. Marandu, Xaraes, Piata, and MG-4, *U. decumbens,* cv. Basilisk, *U. humidicola* cvs. Humidicola and Llanero and *Urochloa hybrid* cv. Mulato II. Rhodes grass (*Chloris gayana*) and Napier grass (*Pennisetum purpureum* cv. Kakamega 1) were included as controls. At establishment stage, growth parameters (height, cover and spread) and dry matter yield (DMY) were monitored at 14 weeks after seedling emergence (WAE) and standardization cut conducted to stimulate uniform plant growth. Thereafter (production stage), the plants were repeatedly harvested for DMY determination at 6, 8 and 12 weeks intervals. The growth parameters and DMY varied significantly ($p < 0.05$) among the cultivars in all the AEZ in all the measurement dates. Napier grass recorded the highest mean height (60 to 120 cm) at the end of establishment period while among *Urochloa* cultivars, MG-4, Basilisk and Xaraes recorded the highest mean height and plot cover across all AEZs. All *Urochloa* cultivars gave significantly ($p < 0.05$) lower DMY than Napier grass in Kitale and Alupe while Basilisk and Xaraes recorded similar DMY to Napier grass in Eldoret. In Eldoret, Xaraes recorded the highest DMY (2.54 t ha^{-1}) while in Kitale and Alupe the highest DMY was recorded in MG-4 (3.7 t ha^{-1}) and Basilisk (4.72 t ha^{-1}), respectively. Increasing cutting interval increased DMY but reduced nutritive value of *Urochloa* cultivars in Kitale. Basilisk, MG-4, Xaraes and Piata showed potential to establish and grow well across AEZs and to maximize production and nutritive value cutting at 8 weeks interval is recommended.

Introduction

Dairy farming is an important enterprise for the livelihoods of many households in western Kenya, as a source of income and employment. Unfortunately, many small-scale farms in this region depend on natural pastures, which, are inadequate and of poor quality and this affect dairy production. One approach to achieve increased livestock production is through introduction of high quality forages, which are nutritious with wide ecological adaptation such as *Urochloa* grass (Maass et al., 2015). Improved *Urochloa* grass produce high biomass, enhance soil fertility, reduce greenhouse gas emission (Peters et al. 2012), contribute to carbon sequestration (Djikeng et al. 2014) and are tolerant to most pests and diseases. There has been previous effort to include improved *Urochloa* grass cultivars in eastern region of Kenya (Nguku et al. 2016) but there is little information on adaptability and management of these cultivars in sub-humid region of western Kenya. The objective of this study was therefore to assess adaptability, herbage accumulation and nutritive value of *Urochloa* grass cultivars under different regrowth intervals in humid region of western Kenya.

Methods and Study Site

The study was conducted at Eldoret (0° 29′ 19″ N and 35° 20′ 26′′E), Kitale (1° 0′ 6.6′′N and 34° 59′ 10′′E) and Alupe (1° 28′N) located in lower midlands (LH3), upper midlands (UM3) and lower highlands (LM3) agro-ecological zones (AEZ) of western Kenya, respectively. Soil in Alupe and Eldoret are Rhodic Ferralsols with moderate acidity and low nutrient content while major soils in Kitale are Acrisols/ Luvisols with varying level of compaction due to high clay content (Muya *et al*., 2017). Rainfall in Alupe is bimodal while Kitale and Eldoret have unimodal rainfall pattern. Alupe had higher amount of annual precipitation (1366-1781 mm), followed by Kitale (1275-1341 mm) and Eldoret (752-898 mm) during study period (2014-2015).

Seven *Urochloa* grass cultivars; *Urochloa decumbens* cv. Basilisk, *B. humidicola* cvs. Llanero and Humidicola, *B. brizantha* cvs. Marandu, MG-4, Piatã, Xaraes and *B. hybrid* cv. Mulato II were compared with Rhodes grass (*Chloris gayana*) and Napier grass (*Pennisetum purpureum* cv. Kakamega 1). The treatments were arranged in a randomized complete block design with three replications in plot sizes of 4 m x 5 m. At planting, triple super phosphate (TSP, 46 % P_2O_5) fertilizer was applied in the planting furrows at a rate of 40 kg P ha^{-1}. The seeds were manually drilled at an inter row spacing of 0.5 m, at seed rate of 5 kg ha^{-1}. Three (3) root splits of Napier grass were planted in holes 15 cm deep at a spacing of 1 m within and between rows. Data was collected during the establishment and production phase, which lasted for three years (2014-2016). The establishment period was considered to be up to 14 weeks after seedling emergency (WAE) while subsequent period that included (three seasons) two dry and one wet seasons were regarded as production phase. Data collection included growth parameters (height, plot cover, spread) and dry matter yield (DMY) taken at 14 WAE from 4 m^2 net plot. At the start of production phase (14 WAE), a standardization cut was conducted in all plots to stimulate uniform growth and plots were split into three equal portions and allocated three cutting intervals i.e. 6, 8 and 12 weeks at random which were conducted for two dry and one wet seasons. Due to high cost of analysis, plant samples from Kitale site (dry season) were selected for chemical composition analysis. Crude protein, neutral detergent fibre (NDF) and *in-vitro* matter digestibility (IVDMD) were determined using procedure outlined in AOAC (2000), Van Soest et al. (1991), Goering and Van Soest (1970). The generated data was subjected to analysis of variance (ANOVA) using a general linear model (SAS 2001) and means separated by least significance difference (LSD) and standard error of difference (SED).

Results

i) Adaptability and growth characteristics at establishment phase

Table 1 shows growth characteristics and DMY during establishment period. Most grass cultivars established well in all sites except Humidicola, Llanero, Mulato II and Rhodes in Alupe and Kitale. At 14 WAE, Napier grass was the tallest (60 - 120 cm) in all sites while all *Urochloa* cultivars were significantly shorter than Rhodes in Alupe. Among *Urochloa* cultivars, MG-4, Marandu and Basilisk were the tallest in Kitale, Eldoret and Alupe, respectively while Humidicola, Llanero and Mulato II were the shortest across AEZs. In all sites, Napier grass significantly ($P < 0.05$) spread more (23 - 80 cm) than all the *Urochloa* grass cultivars (6.3 - 51.3 cm) while among *Urochloa* cultivars, Basilisk had the highest spread (25 - 51.3 cm). Mulato II and Marandu had the lowest spread and were comparable with Rhodes grass. Napier grass attained the highest plot cover while among *Urochloa* cultivars, Xaraes, MG-4 and Basilisk recorded the highest plot cover. All grass cultivars had higher DMY in Alupe compared to other AEZs and the most productive *Urochloa* cultivars were Xaraes (2.54 t ha^{-1}), MG-4 (3.7 t ha^{-1}) and Basilisk (4.7 t ha^{-1}) in Eldoret, Kitale and Alupe, respectively. Rhodes grass, Humidicola and Mulato II had the lowest DMY.

Table 1: Growth characteristics and dry matter yield of grass cultivars in Alupe Eldoret and Kitale, at the end of establishment period (14WAE)

	Alupe			Eldoret			Kitale		
Grass cultivars	Height (cm)	Spread (cm)	DMY (t/ha)	Height (cm)	Spread (cm)	DMY (t/ha)	Height (cm)	Spread (cm)	DMY (t/ha)
Basilisk	33.7	25.2	4.7	9.5	51.3	2	24.9	48.6	2.5
MG4	24.5	22.3	2.8	8.8	36.2	2.2	29.2	45.6	3.7
Marandu	17.4	19.2	2.6	13.2	26.8	1.6	7.8	31.8	1.7
Piata	25	19.0	2.9	7.9	37.4	1.8	15.8	41.1	2.2
Xaraes	26.6	14.5	3.9	8.8	32.6	2.5	10.6	26.1	2.1
Mulato II	8.2	12.9	1.6	-	-	-	4.5	17.2	0.4
Humidicola	2.9	19.6	0.5	-	-	-	-	-	-
Llanero	3.4	19.9	0.6	-	-	-	3.4	18.6	0.5
Napier	95.3	23.1	5.2	60.2	79.5	3.9	120.0	32.7	9.9
Rhodes	74.9	11.6	1.8	-	-	-	4.6	15.5	0.4
Mean	**31.2**	**18.7**	**2.7**	**18.1**	**43.9**	**2.3**	**24.5**	**30.8**	**2.6**
LSD (P <0.05)	**14.8**	7.2	**1.6**	**13.69**	**20.83**	**0.6**	**17.3**	**13.9**	**2.3**

ii) **Seasonal dry matter yield at production phase**

During production stage, dry matter yield was assessed for three seasons that included two dry (dry 1 and 2) and one wet seasons (wet 1). Seasonal effects showed that all the *Urochloa* grass cultivars persisted during the dry season while Rhodes grass succumbed to drought in Alupe. *Urochloa* cultivars were more productive in Kitale than in the other sites. During the wet season, the most productive cultivars were Basilisk, Llanero and Xaraes in Eldoret, Kitale and Alupe, respectively. At the end of production phase (dry 2), the most productive cultivars were MG-4 , Mulato II and Xaraes in Eldoret, Kitale and Alupe, respectively.

Table 2: Seasonal dry matter yield (t/ha) in Kitale, Eldoret and Kitale sites

	Kitale			Eldoret			Alupe		
Cultivars	**Dry 1**	**Wet 1**	**Dry 2**	**Dry 1**	**Wet 1**	**Dry2**	**Dry 1**	**Wet 1**	**Dry2**
Basilisk	2.85	11.67	10.53	4.13	14.30	8.19	2.46	3.84	2.63
MG4	2.31	12.28	8.01	3.67	12.68	10.13	2.31	2.84	2.22
Marandu	2.64	11.86	6.98	2.74	10.34	6.09	2.27	3.16	1.73
Piata	2.15	13.16	7.10	2.82	12.46	6.58	2.55	3.35	2.38
Xaraes	1.73	12.65	8.45	3.66	11.45	6.82	3.16	5.21	3.90
Mulato II	1.58	11.90	11.00	1.83	8.81	5.26	2.02	2.64	1.24
Llanero	-	14.25	6.30	-	-	-	3.85	2.66	3.73
Humidicola	-	2.36	8.88	-	-	-	-	-	1.54
Rhodes grass	-	10.70	5.54	-	7.60	5.36	1.06	0.68	-
Mean	2.21	11.20	8.09	3.14	11.09	6.92	2.46	3.05	2.42
LSD (P < 0.05)	2.21	1.82	3.68	0.68	2.43	1.05	0.81	1.12	0.76

iii) Effect of cutting intervals on dry matter yield and nutritive quality at production phase

Effect of cutting intervals on DMY showed that during the dry season, *Urochloa* cultivars were more productive when cut at shorter intervals (6 or 8 weeks) while prolonging the cutting interval to 12 weeks gave higher DMY during wet season across AEZs. The level of most of the nutritive parameters decreased significantly (P < 0.05) with increasing cutting intervals and cutting at either 6 or 8 weeks interval resulted to higher crude protein and *in-vitro* dry matter digestibility (Table 3). All the *Urochloa* cultivars had lower fibres than Rhodes grass and consequently were more digestible.

Table 3: Effect of cutting frequencies on herbage nutritive value in Kitale during second dry season

	Crude protein (%)				In-vitro dry matter digestibility ((%)				Neutral Detergent Fibre (%)			
Cultivars	6	8	12	Mean	6	8	12	Mean	6	8	12	Mean
Basilisk	15.9	15.7	10.4	**14.0**	67.1	68.8	61.5	**65.8**	57.6	60.0	64.6	**60.7**
MG4	14.8	12.6	8.9	**12.1**	66.4	67.7	58.3	**64.1**	56.7	60.1	66.6	**61.1**
Marandu	14.9	15.1	11.0	**13.7**	64.7	67.9	64.7	**65.8**	55.0	60.6	54.5	**56.7**
Mulato II	14.6	17.5	16.7	**16.2**	59.4	56.8	64.1	**60.1**	55.7	56.3	48.1	**53.4**
Piata	14.0	15.5	10.9	**13.5**	70.0	68.6	66.4	**68.3**	61.3	61.3	63.8	**62.1**
Xaraes	14.3	14.0	10.4	**12.9**	63.9	64.1	62.5	**63.5**	58.4	63.5	63.6	**61.8**
Rhodes grass	11.0	14.3	5.6	**10.3**	61.9	60.6	52.8	**58.4**	61.9	67.6	71.2	**66.9**
Mean	14.21	14.97	10.56		64.8	64.9	61.5		58.09	61.35	61.77	
$SED_{variety}$	1.582				1.782				3.953			
$SED_{cut\ interval}$	0.902				1.178				2.188			
$SED_{variety*cut\ interval}$	3.571				3.060				7.606			

SED-standard error of difference,

Discussion and conclusion

All grass cultivars established well in Alupe and Kitale compared to Eldoret possibly due to differences in time of establishment and rainfall amount. While planting of the grass in Kitale and Alupe was conducted during rainy season, in Eldoret it was conducted a few days to cessation of rains. In Alupe and Kitale most *Urochloa* cultivars showed upright growth characteristics whereas in Eldoret the same cultivars showed a spreading growth habit. Pasture species, which grow fast and tall are more competitive, efficient in utilization of resources, and likely to have higher biomass production (Mganga 2009, Nguku et al. 2016). Among the *Urochloa* cultivars, Basilisk, MG-4 and Xaraes were the tallest and had the largest cover (> 50%) and DMY at the end of establishment and production phases across sites. This is an indication that they can be a good alternative to Rhodes grass and Napier. Basilisk has extensive roots system, aggressive growth habit, dense cover and utilizes nitrogen efficiently (Loch 1997). Xaraes is reported to have greater leaf and stem elongation rates and higher leaf blade, which results to higher biomass production since the stem, is the structural component with higher weight than leaves (Rodrigues et al. 2014). The low yield of Humidicola, Llanero and Mulato II was attributed to the slow establishment and attack of Mulato II by red spider mites, which are the most prevalent pests in *Urochloa* cultivars (Mutisya et al. 2018). The difference in yield due to cutting intervals and seasons was attributed to rainfall distribution and moisture availability. For many grasses, longer regrowth intervals result in greater herbage accumulation when moisture is sufficient and therefore results of this study support conclusion of other authors (Hare et al. 2013). Overall, the CP for all *Urochloa* cultivars was well above 7% and higher than levels recorded in Rhodes, which is considered critical for livestock production. Although DMY increased and decreased with increasing cutting intervals during wet and dry seasons respectively, cutting at 8 weeks resulted to high nutritive quality and beyond this stage, quality was compromised. Among the *Urochloa* cultivars, Basilisk, MG-4, Xaraes and Piata gave higher DMY and nutritive qualities and are a good alternative to Rhodes grass and Napier in the study area

Acknowledgements

The study was undertaken in collaboration between Kenya Agricultural and Livestock Research Organization (KALRO) and Biosciences eastern and central African - International Livestock Research Institute (BecA-ILRI) Hub, Nairobi and was funded by the Swedish International Development Cooperation Agency (Sida). We are grateful to KALRO -Kitale and University of Eldoret staff for their technical support.

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