

Establishment and early growth of *Brachiaria* grass cultivars in acidic soils of western Kenya

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KALRO - Kitale

Abstract

Successful establishment determines productivity and long term persistence of pastures. The objective of this study was to evaluate the establishment and early growth of eight *Brachiaria* grass cultivars at three sites in the humid highlands of western Kenya. The grass cultivars were; *Brachiaria brizantha* cvs. Marandu, Xaraes, Piata, and MG4, *B. decumbens*, cv. Basilisk, *B. humidicola* cvs. Humidicola and Llanero and *Brachiaria hybrid* cv. Mulato II. Rhodes grass (*Chloris gayana*) and Napier grass (*Pennisetum purpureum* cv. Kakamega 1) were included as controls. Growth parameters (height, cover and spread) were monitored at 8, 12 and 14 weeks after seedling emergence (WAE). In addition, dry matter yield (DMY) was determined at 14 WAE. Growth parameters and DMY varied significantly ($p < 0.05$) among the cultivars in all the sites. Among the *Brachiaria* cultivars, MG4, Basilisk and Xaraes recorded the highest mean height and plot cover. All *Brachiaria* cultivars gave significantly ($p < 0.05$) lower DMY than Napier grass in Eldoret and Kitale while Basilisk and Xaraes recorded similar DMY with Napier grass at Alupe. In Eldoret, Xaraes recorded the highest DMY (2.54 t ha^{-1}) while in Kitale and Alupe the highest DMY was recorded in MG4 (3.7 t ha^{-1}) and Basilisk (4.72 t ha^{-1}), respectively. Among the *Brachiaria* cultivars, Basilisk, MG4, Xaraes and Piata established successfully and attained the highest spread, cover and were tallest.

Key words: *Brachiaria* cultivars, dry matter yield, plot cover, plant height, tillers, spread

Introduction

Dairy farming is an important enterprise for the livelihoods of many households in Kenya, as a source of income and employment (Thorpe *et al.*, 2000). In western Kenya, cattle also play an important role, as a source draught power and provide manure for crop production. Unfortunately, in many small-scale farms in this region, inadequate and poor quality feeds are among major constraints to dairy production in the zero-grazing system (Orodho, 2007). In most cases particularly during the dry seasons, the cut and carry systems in the integrated crop-livestock systems becomes unsustainable and cattle are left to graze freely. One approach to achieve increased livestock production in western Kenya where the soils have inherent low soil fertility (Okalebo *et al.*, 2006) is through introduction of high quality forages. Such forages must be adapted to biotic and abiotic factors such as soil fertility, climatic conditions and resilience to continuous defoliation. *Brachiaria* grass a perennial grass native to East and Central Africa is widely grown in South America to sustain the dairy and beef industries (Maass *et al.*, 2015). Improved *Brachiaria* grasses are exceptionally tolerant to aluminum toxicity due to acidity and drought (Miles *et al.*, 2004) and could play a role in integrated crop-livestock systems in the humid highlands of western Kenya where soils are acidic.

Previous studies reported by Njarui and Wandera, 2004; Nguku *et al.*, 2016 on adaptability of Brachiaria cultivars in semi-arid regions showed that a number of Brachiaria cultivars produced more dry matter than commonly cultivated Rhodes grass. Elsewhere in Kiboko, Kenya, cv. Mulato-II was found to be superior to native range grasses such as Buffel (*Cenchrus ciliaris*) and horsetail grass (*Chloris roxburghiana*) in both primary dry matter production and subsequent regrowth under irrigation (Machogu, 2013). Additionally the grass had higher nutritive quality but was heavily infested by red spider mites. However, little information is available on their adaptability of this grass in the humid region of western Kenya. The objective of the study was therefore to evaluate the establishment and early growth of selected Brachiaria grass cultivars in the humid highlands of western Kenya.

Materials and methods

Study site description

The experiments were conducted in three sites, Kitale, Alupe and Eldoret in the western region of Kenya. They lie in different agro-ecological zones with different rainfall and temperature regimes (Table 1). Rainfall in Kitale is unimodal and occurs from April to November while in Alupe and Eldoret is bimodal. The dominant soils in Alupe and Eldoret are classified as Rhodic Ferralsols that are well drained, shallow to moderately deep with very low water retention capacity (WRB, 2006). In Kitale the soil are characterized by weak to moderate structure, low fertility and low organic matter content (WRB, 2006). Selected initial physical and chemical soil properties in the study sites are presented in Table 2.

Table 1 Location, elevation, temperatures, rainfall and soils for the three experimental sites, Kitale, Alupe and Eldoret.

Site	Kitale	Alupe	Eldoret
Latitude	1°0'6.6''N	0°28'N	1°0' 6.6''N
Longitude	34°59'E	34°07'E	34°59' 10''E
Agro-ecological zone	UM3	LM3	LH3
Altitude (m asl)	1890	1189	2073
Mean temperature (°C)	10 - 27	22	7 - 29
Annual rainfall (mm)	1000 - 1200	1100 – 1450	1103
Soil type	Acrisols	Rhodic Ferralsols	Rhodic Ferralsols

UM=Upper Highlands; LM=Lower midlands; LH=Lower Highlands

Treatments and experimental design

The treatments consisted of seven Brachiaria grass cultivars; *Brachiaria decumbens* cv. Basilisk, *B. humidicola* cvs. Llanero and Humidicola, *B. brizantha* cvs. Marandu, MG4, Piatã, Xaraes and *B. hybrid* cv. Mulato II., Two commonly cultivated local grasses, Rhodes grass (*Chloris gayana*) and Napier grass (*Pennisetum purpureum* cv. Kakamega 1) were included as control. The treatments were laid out in a randomized complete block design with three replications. Prior to sowing of the seed, triple super phosphate (TSP, 46 % P₂O₅) fertilizer was applied in the furrows at a rate of 40 kg P ha⁻¹. The grasses were sown in June 2014 in plot sizes of 4 m x 5 m. The seeds were

manually drilled in the furrows at an inter row spacing of 0.5 m, at rate of 5 kg ha⁻¹ while 3 root splits of Napier grass were planted in holes 15 cm deep at a spacing of 1 m within and between rows. All the plots were kept weed free throughout the experimental period by hand weeding.

Table 2 Soil physical and chemical properties in Kitale, Eldoret and Alupe sites

	Kitale	Eldoret	Alupe*
Parameters	0-30cm	0-30cm	0-30cm
Soil pH	5.76	5.86	5.7
Total N (%)	0.03	0.03	0.12
Organic C (%)	0.3	0.3	1.12
Available P Mehlick (ppm)	18	15	-
Available P Olsen (ppm)	-	-	2
Potassium (me %)	1.17	2.01	0.16
Calcium (me %)	4.5	6.6	2.11
Magnesium (me %)	1.2	1.22	0.92
Texture	Clay loam	Sandy clay	Sandy clay

*Source: Omondi (2013).

Data collection

In this study, the establishment period was considered to be the 14 weeks after seedling emergence (WAE). Plant parameters (plant height, plot cover and plant spread) were recorded at 8, 12 and 14 WAE. The spread was measured from one edge to the other of the four plants using a meter ruler while the plant height was measured on the primary shoots from the base of the plant top-most leaf. Plot cover was determined using a quadrat of 1 m x 1 m subdivided into 25 squares of 0.2 m x 0.2 m as described by Njarui and Wandera (2004) while Napier grass cover was determined using the dot method as described by Sarrantonio (1991). At the end of establishment period, the grasses were harvested for dry matter yield determination. Harvesting of plant was carried out from 2 m x 2 m net plots at a cutting height of 5 cm above ground. Samples of fresh shoots biomass were recorded, and approximately 500g subsamples were dried at 65°C to constant weight in forced-air drier and weighed.

Statistical analysis

Data on height, plot cover, spread and dry matter yield were subjected to analysis of variance (ANOVA) to determine the effects of grass cultivars at different growth stages using a general linear model (SAS, 2003) separately for each site. The grass cultivars and replications were considered as fixed factors. Mean differences were evaluated by computing least significance difference (LSD). Pearson correlation was performed to determine the relationships between the shoots dry matter yield and growth parameters (tiller numbers, plant height, spread and cover) using statistix 10 package (Statistix, 2003).

Results and Discussion

Seasonal condition

Figure 1 below shows the rainfall received in the study sites during the establishment period. The rainfall was 366, 1275 mm and 898 mm for Busia, Kitale and Eldoret, respectively. The wettest months in Eldoret, Kitale and Busia were August, October and September respectively while the month of December received the lowest rainfall in all the sites.

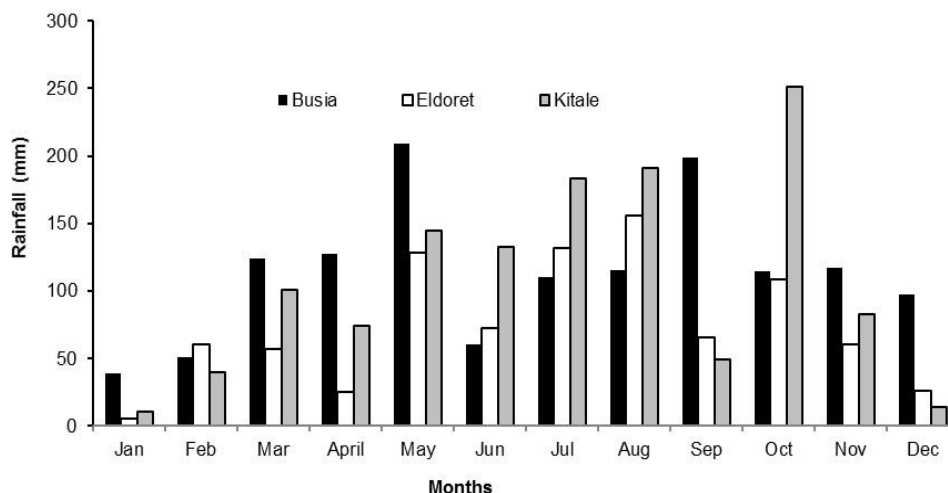


Figure 1 Monthly rainfall during establishment period (year 2014) in Busia, Eldoret and Kitale sites

Growth characteristics

Eldoret

The means of the growth parameters (height, cover and spread) during the establishment period in Eldoret are presented in Table 3. There were significant ($p < 0.05$) differences in spread, cover and height among the grasses. Napier grass recorded significantly higher mean plant heights, spread and cover than all the *Brachiaria* cultivars. Napier grass being a fodder crop and gigantic in nature would naturally show greater advantage in terms of growth characteristic than other grasses when the environment is favorable (Orodho, 2007; Nguku *et al.*, 2016). However, plant height did not differ significantly ($P < 0.05$) among the *Brachiaria* grasses but Basilisk spread more than Xaraes at 12 WAE and had higher cover than MG4 at 12 WAE.

Kitale

The growth parameters (tillers, spread, cover and height) during establishment stage varied significantly ($p < 0.05$) among the grass cultivars in Kitale. Napier grass recorded higher ($P < 0.05$) plant heights and cover than all the *Brachiaria* cultivars (Table 4). At 8 and 12 WAE, *Brachiaria* cultivars gave similar plant heights which were not significantly different from Rhodes grass. However, at the end of establishment period, MG4 and Basilisk recorded significantly higher

plant heights than Rhodes grass and most of the Brachiaria cultivars. The cv. Llanero had the lowest plant height (3.5 cm) and this was attributed to its spreading growth characteristic (Nguku *et al.*, 2016) unlike the other cultivars that are more erect. The highest cover was recorded in cv. MG4 (51.1%) at 12 WAE and Xaraes (58.5%) at 4 WAE which and was significantly ($p < 0.05$) higher than that of all the other Brachiaria cultivars. The cvs. MG4, Basilisk and Xaraes gave significantly higher cover than Rhodes grass while Marandu, Mulato II, Llanero and Humidicola recorded similar cover with Rhodes grass. The erect growth habit of MG4 and decumbent growth characteristic of Basilisk explains why they had greater heights and cover during the establishment.

Alupe

During the early growth stages (8WAE), the heights of all Brachiaria cultivars except Basilisk did not differ significantly with the height of Rhodes grass (Table 5). However, at 12 and 14 WAE all Brachiaria cultivars recorded significantly lower heights than Rhodes and Napier grass. The cvs. Llanero, Humidicola, Marandu and Mulato II recorded the lowest heights while Basilisk, MG4, Piata and Xaraes were the tallest. Plant spread differed significantly ($p < 0.05$) among the Brachiaria cultivars. Napier grass recorded the highest spread compared to all the Brachiaria cultivars at 8 and 12 WAE but at 14 WAE, plant spread in all Brachiaria cultivars except Xaraes and Mulato II were similar to that of Napier grass. Basilisk recorded the highest plant spread at 14 WAE while Rhodes grass recorded the lowest plant spread. At 8 and 12 WAE, Napier grass recorded significantly higher plant cover than all Brachiaria cultivars but at 14 WAE, the plant cover for Napier grass was not significantly different from that of Basilisk, Xaraes and Marandu. Piata, MG4, Mulato II, Humidicola and Llanero showed low plot cover during this period and were similar to that of Rhodes grass at the end of establishment period.

Table 3 Mean plant height, spread and cover of grass cultivars during establishment stage in Eldoret site

Brachiaria cultivars	Plant height (cm)			Plant spread (cm)			Plot cover (%)		
	8 WAE	12 WAE	14 WAE	8 WAE	12 WAE	14 WAE	8 WAE	12 WAE	14 WAE
Basilisk	4	8.4	9.5	8.4	32.7	51.3	5.5	51.1	53
MG4	5.7	7.5	8.8	9.7	26.9	36.2	7.3	37.8	50.5
Marandu	4.1	5.7	13.2	9.9	29	26.8	7.3	42	43.5
Piata	3.5	7.1	7.9	9.5	30.6	37.4	6.5	37	41
Xaraes	5.3	8.6	8.8	11.1	24.9	32.6	8	47.8	58.5
Napier grass	9.2	45.2	60.2	21	63.6	79.5	57.3	91.8	94.3
Mean	5.30	13.91	18.1	11.6	34.6	43.9	15.3	51.3	56.8
LSD ($P < 0.05$)	1.85	8.48	13.7	3.65	7.6	20.83	9.23	9.16	15.4

Table 4 Mean plant height, spread and cover of the grass cultivars during establishment stage in Kitale site.

Brachia Cultivars	Plant height (cm)			Plant spread (cm)			Plot cover (%)		
	8	12	14	8	12	14	8	12	14
	WAE	WAE	WAE	WAE	WAE	WAE	WAE	WAE	WAE
Basilisk	6.7	10.6	24.9	25	36.1	48.6	8	24	51
MG4	7.3	11.3	29.2	21.5	30.1	45.6	11.5	42.5	77.5
Marandu	5	7.4	7.8	10.1	20.3	31.8	9.5	16.8	34
Piata	7.2	11.3	15.8	19.7	28.3	41.1	8.5	21.5	45
Xaraes	6.3	8.7	10.6	13.2	21.5	26.1	9.5	24.5	51
Mulato II	3.7	4.3	4.5	6.3	13.3	17.2	4.5	8	11.5
Llanero	3.3	3.3	3.4	23.6	17	18.6	5.6	7.6	17
Napier grass	20.6	67.8	120	31.2	58.2	32.7	62.5	87.2	82.4
Rhodes grass	-	4.2	4.6	-	10.3	15.5	-	8	18.5
Mean	7.52	14.3	24.5	18.8	26.1	30.79	14.8	26.7	43.1
LSD (P<0.05)	4.78	12.64	17.3	13.1	16.65	13.94	10.6	13.9	16.14

Table 5 Mean plant height, spread and cover of the grass cultivars during establishment stage in Alupe site.

Brachiaria cultivars	Height (cm)			Plant spread (cm)			Plot cover (%)		
	8	12	14	8	12	14	8	12	14
	WAE	WAE	WAE	WAE	WAE	WAE	WAE	WAE	WAE
Basilisk	22	24.2	33.7	18.2	12.8	25.2	38	66	68.5
MG4	15.7	16.2	24.5	17.7	14.0	22.3	23	46	41
Marandu	11.9	12.1	17.4	15.4	14.0	19.2	27	50.5	50
Piata	13.1	18	25	19.3	12.9	19.0	27	43.5	42
Xaraes	15.9	23.9	26.6	15.9	11.3	14.5	33	77	61.5
Mulato II	7.6	8	8.2	9.8	13.1	12.9	18	34.5	38.5
Humidicola	3.2	1.9	2.9	20.1	15.1	19.6	4.5	15	20.8
Llanero	5.2	3.3	3.4	17.6	12.3	19.9	6.3	31	20
Napier grass	34.4	67.3	95.3	28.6	24.7	23.1	73	94.5	65
Rhodes grass	13.1	75.2	74.9	9.5	7.8	11.6	15.5	22.5	30
Mean	14.2	25	31.2	17.2	13.8	18.7	26.5	48.1	43.7
LSD (P<0.05)	7.54	16.48	14.8	8.6	4.6	7.2	9.54	15.9	18.3

Dry matter yield

The mean DMY for the grasses are presented in Figure 2, 3 and 4. Dry matter yield varied significantly ($p < 0.0001$) among the grass cultivars in all the sites. In Eldoret, Brachiaria cultivars had significant ($p < 0.05$) lower DMY than Napier grass (Figure 2). The cv. Xaraes gave significantly ($p < 0.05$) higher DMY (2.54 t ha^{-1}) than Marandu (1.56 t ha^{-1}) and Piata (1.83 t ha^{-1}). In Kitale, cv. MG4 had the highest DMY (3.7 t ha^{-1}) while Mulato II had the lowest (0.37 t ha^{-1}) but the yield were significantly lower than those of Napier grass (9.9 t ha^{-1}). However, cv. MG4

yielded more than Rhodes grass (Figure 3). In Alupe site, Basilisk and Xaraes were the most productive grasses and yielded 4.7 and 3.9 t ha⁻¹, respectively. However DMY were not significantly different from that of Napier grass (5.2 t ha⁻¹) but were higher than that of Rhodes grass (1.8 t ha⁻¹) (Figure 4). The higher DMY in Alupe was attributed to a warmer (23.8 - 30.7 °C), humid and high rainfall during establishment (97.5 - 198.6 mm) between July - December 2014 during the establishment period (Figure 1). At Alupe and Kitale most Brachiaria cultivars showed upright growth characteristics, whereas in Eldoret the same cultivars showed a spreading growth habit which possibly had a positive effect on DMY production in Alupe and Kitale.

A significant linear relationship ($R^2 = 0.60 - 0.96$; $P < 0.001$) occurred between the plant height and DMY in Kitale and Alupe site while in Eldoret DMY was positively and strongly correlated with plot cover ($R^2 = 0.94$; $P < 0.001$). Mganga, 2009 and Nguku *et al.*, 2016 observed that pasture species which grow fast and tall are more efficient in utilization of resources and therefore, are more competitive and likely to have higher biomass production. Among the Brachiaria cultivars, Basilisk, MG4 and Xaraes were the tallest and had the largest cover (> 50%) at the end of establishment period. Basilisk has extensive roots system (Bulo *et al.*, 1994; Guenni *et al.*, 2002), 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 cv. MG4 spread more and this contributed to higher DMY. The low yield of Humidicola and Mulato II was attributed to the slow establishment. Several authors (Bauer *et al.*, 2010, Mutimura and Everson, 2012; Nguku *et al.*, 2016) have previously reported high DMY production in Mulato II and attributed it to large leaves sizes. However, the range of DMY of 0.4 - 1.6 t ha⁻¹ obtained in this study for Mulato II was far below the DMY (4.1 t ha⁻¹) reported by Nguku *et al.*, (2016) from trials in the semi-arid eastern Kenya. Observations made in all sites showed that Mulato II had higher incidences of spider mites attack as was previously reported in trials in Kiboko by Machogu, (2013). This infestation probably contributed to reduced biomass. Among the Brachiaria cultivars, Basilisk, MG4, Xaraes and Piata established successfully and attained the highest spread, cover and were tallest. The productivity of these grasses after establishment is presented elsewhere in this proceeding.

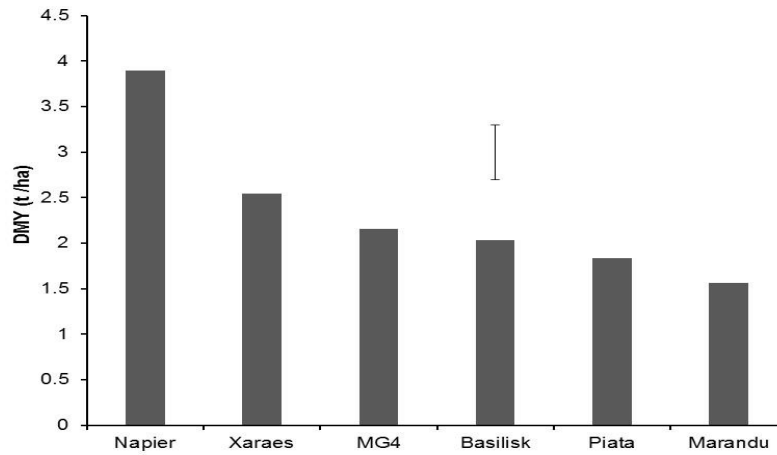


Figure 2 Dry matter yields of grass cultivars during establishment stage in Eldoret (Bar represents the $LSD_{P<0.05}$)

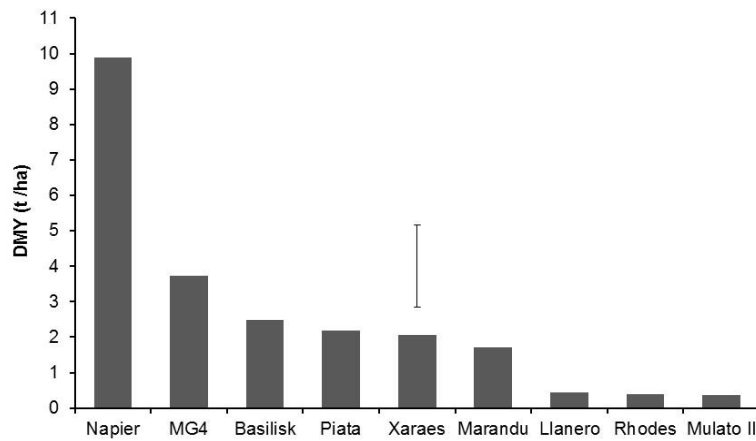


Figure 3 Dry matter yields of grass cultivars during establishment stage in Kitale (Bar represents the $LSD_{P<0.05}$)

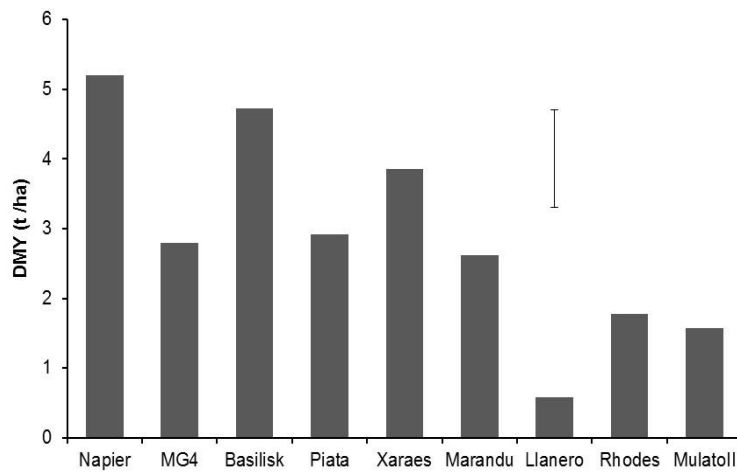


Figure 4 Dry matter yields of grass cultivars during establishment stage in Alupe (Bar represents the $LSD_{P<0.05}$)

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