Growth Performance and Yield of Three Brachiaria Cultivars Subjected to Different Eco-Climatic Zones of Tanzania

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Abstract
Replacement of high quality (perennial forage) with low quality (annual forage) due to the effects of climate change has resulted into low milk production in Tanzania to 4.5L which is below the genetic potential of producing at least 15L of milk per cow per day. Though high yield fodder grasses such as Brachiaria have been recommended as climate smart fodder grass, little information has been documented in Tanzania particularly with respect to the growth performance of these grasses across different eco-climatic zones. The current study determine the performance and yield of three cultivars of Brachiaria (*Brachiaria brizantha* cv. Piata, *Brachiaria brizantha* cv. Xaraes and *Brachiaria decumbens* cv. Basilisk) in three different eco-climatic zones, namely Humid, Sub-humid and Semi-arid zones. The study used the Split-plots Design whereas eco-climatic zones were considered as the main factor and Brachiaria cultivars were treated as the minor factor. Data on growth attributes and biomass yield were subjected to two ways ANOVA using SAS (2014). Also, the Post Hoc tests were performed using the Least Square Difference (LSD) at 5% to separate mean values. The study revealed that the Sub-humid climate had significantly higher number of emerged seedlings and number of tiller per plants. Similarly, all three cultivars had significantly higher above ground biomass in sub-humid climate compared to both humid and semi-arid zone. Interestingly, *B. decumbens* cv. Basilisk was relatively shorter grass but scored the highest values for plant number and biomass. However, for valid recommendation on the best Brachiaria cultivars further studies on nutritive values and feeding trials are imperative.

Introduction
About 99% of livestock in Tanzania belongs to traditional pastoralists and agro pastoralists who derive their livelihoods from rangelands which cover about 74% of the total land area of Tanzania (Mwilawa et al 2008). Unfortunately, degradation of rangeland resources due to the effects of climate change and variability has become a serious challenge due to its negative impact on the pastoral livelihoods. These rangelands are characterized by poor natural pasture especially during the dry season and hence livestock remain under-nourished for long dry periods. During the dry period, pastoralists and agro pastoralists, in addition to natural pasture, depend on available crop residues such as cereal crops with low Crude Protein (CP) levels ranging from 3 to 4% (Mtengeti et al. 2008). Scarcity of forage resources has resulted in low milk production dropping from 15L per cow per day (Mtengeti et al. 2008) to 4 or 5L.
In many areas of Tanzania where land is not a limiting factor, there are opportunities for improvement of livestock production through establishment of improved pasture. Brachiaria is recommended among the improved pastures with adequate biomass and nutritional value compared to the available poor natural pasture. However, there have been limited efforts towards increasing quality and availability of forage through introduction of improved pasture in Tanzania. In this regard, to improve forage availability and quality the InnovAfrica Project introduced Brachiaria to different eco-climatic regions of Tanzania. More specifically, under InnovAfrica project, three Brachiaria cultivars (*Brachiaria brizantha* cv. Piata, *Brachiaria brizantha* cv. Xaraes and *Brachiaria decumbens* cv. Basilisk) were tested at three different eco-climatic zones (humid, sub-huimd and arid zones) to determine their growth performance and yield.

Methods and Study Site
The study was conducted in three different eco-climatic regions namely; Southern Highland (Humid climate), Eastern Zone (sub-humid) and Northern Zone (Semi-arid). In the Southern Highland the study was carried out in Rungwe district (lies between 9^{0}00'S, and 9^{0}30'S; and 33^{0}30'E and 34^{0}00'E) in Mbeya region, Southern Highland of Tanzania (Mwakisunga and Majule 2012; Mweya et al. 2007). Rungwe District is located between 770 metres and 2865 metres above the sea level and average rainfall ranges from approximately 900 mm in the lowland to 3300 mm in the highland zone (Nyunza and Mwakaje 2012). In the Eastern Zone, the study was carried at Sokoine University of Agriculture (Morogoro; situated at 37º 39E and 06º 5'S) and Kibaha Education Centre (Coastal region; located at 6º32' and 6º43'S). The rainfall in the

humid zone is bi-modal, ranging from 600-1000mm per annum (Kindo et al. 2010; Kizima et al., 2014). In the semi-arid Northern zone, the study was conducted in Monduli district which is located in the North-East of the country between latitude 3º.29" South and longitude 36º.45" East with average annual rainfall below 600 mm (Kimaro et al. 2018).

Experimental design and sampling procedure

The study used the Split-Plot Design where Eco-climatic zones were considered as the major factor and Brachiara cultivars as the minor factor. Each cultivar was sown in four sub-plots of 4 x 5 m. The distance between sub-plots was 1 m apart. The seedbeds were prepared by using hand hoe and the pasture seeds were sown at the depth of 0.5 to 1 cm deep. The sowing rate was approximately 5 kg seeds/ha at specific rows maintained at 50 cm intervals between rows. The sowing in all experimental plots was done at the on-set of the rainy season. The Triple Super Phosphate (250 kg/ha) was applied during sowing and Urea (150kg/ha) was used as top dressing fertilizer after 8 weeks of establishment. All sub-plots received similar agronomic management such as weeding and thus the only sources of variations were eco-climatic zones (variation in rainfall) and Brachiaria cultivars.

Seed viability was determined in the field by comparing germination rate of tested cultivars. Growth characteristics were determined by observation of growth attributes (number of tillers, number of plants and height of plant). Numbers of individual plants were counted randomly using 0.5 x 0.5 m quadrat. Within the quadrat, four individual plants were selected randomly for height measurement and counting number of tillers per plant. Yield in terms of above ground biomass of each cultivar was estimated in the laboratory through dry matter determination using standard procedure.

Data analysis

Data were subjected to Two Way Analysis of variance (ANOVA) Using Split Plots Model. The adopted Model was; Responses (Growth attributes and yield) = Fixed Effect of Eco-climatic zones + Fix Effect of Brachiaria Cultivars + Fix Interaction Effects of Eco-climatic zone and Brachiaria cultivars + Split-plots error. In cases where significances were determined, the Least Square Difference (LSD) was applied (at 5%) to discriminate the differences among more than two means. Analyses were performed following the Split-plots using the SAS software of 2014.

Results

The results from the present study indicate that Eco-climatic zones have significant influence on growth performance and yield of Brachiairia cultivars. The main effect of eco-climatic zones indicated that, the highest number of plants, number of tillers per plant and plant heights were recorded at sub-humid eco-climatic zones (Table 1). Similarly, the Brachiaria cultivars showed marked variations, whereas the *Brachiaria decumbens cv Basilisk* had significant higher mean values of plant numbers and number of tillers per plant (Table 1). On the contrary, the *B. decumbens cv Basilisk* was the shortest cultivars

Table 1: Influence of eco-climatic zones of growth attributes of Brachiaria cultivars

Eco-climatic zone	**Plant number/m2**	**Tillers/plants**	**Plant Height (cm)**
Humid	94.38 ± 5.44b	2.90 ± 0.52b	65.68 ± 3.30b
Sub-Humid	112.42 ± 5.52a	8.58 ± 0.53a	84.29 ± 2.49a
Semi-arid	17.17 ± 4.11c	1.97 ± 0.39b	16.26 ± 3.35c
Brachiaria cultivars			
B. decumbens cv Basilisk	120.01 ± 5.34a	6.20 ± 0.52a	56.54 ± 3.62b
B. brizantha cv Xaraes	55.01 ± 5.31c	4.06 ± 0.52b	62.02 ± 3.60ab
B. brizantha cv piata	73.85 ± 5.34b	5.74 ± 0.52a	66.01 ± 3.62a

The mean values with different superscripts within column differ significantly at 5%

The results in Table 2 indicated that the interaction effects of eco-climatic zones and Brachiaria cultivars had significant effects ($P \leq 0.05$) in all growth attributes. For example, *B. brizantha* cv Xaraes exhibited lowest numbers of tillers in sub-humid zone but comparatively, it had slightly higher number of tiller per plant within semi-arid and humid zones.

Table 2: Growth attributes of Brachiaria cultivars at different eco-climatic zones for three months.

Eco-climatic zone	**BrachiariaCutlivar**	No. of plants/0.25m2	No. of tiller/plant	Plant height (cm)
Humid	B. decumbens cv Basilisk	134.16 ± 8.24b	3.22 ± 0.89c	63.47 ± 5.71b
	B. brizantha cv Xaraes	71.66 ± 8.24c	2.58 ± 0.89c	63.82 ± 5.71b
	B. brizantha cv Piata	77.33 ± 8.24c	2.89 ± 0.89c	69.73 ± 5.71b
sub-humid	B. decumbens cv Basilisk	167.69 ± 6.23a	10.22 ± 0.68a	75.61 ± 4.31a
	B. brizantha cv Xaraes	66.40 ± 6.23c	5.98 ± 0.68b	85.78 ± 4.31a
	B. brizantha cv Piata	103.16 ± 6.23b	9.54 ± 0.68a	91.50 ± 4.31a
Semi-arid	B. decumbens cv Basilisk	18.19 ± 8.24d	1.97 ± 0.91cd	14.50 ± 5.83c
	B. brizantha cv Xaraes	18.41 ± 8.24d	2.16 ± 0.89c	18.66 ± 5.71c
	B. brizantha cv Piata	16.69 ± 8.24d	1.76 ± 0.91d	15.53 ± 5.83c

NB: The different superscript within the column show significant different at 5%

The results on above ground biomass yield had significant variation on both eco-climatic zones and Brachiaria cultivars. The highest yield was noted in sub-humid zone (7269.09kg/ha) while the lowest yield was found in semi-arid zone (4638.10kg/ha). On the other hand, *B. decumbens* cv Basilisk had significantly higher biomass (6608.54kg/ha) while *B. brizantha* cv Piata (5480.29kg/ha) and *B. brizantha* cv Xaraes (5663.19kg/ha) didn't differ significantly. Nevertheless, the interaction between eco-climatic zones and Brachiaria cultivars showed significant variations (Figure 1). For example, B. *brizantha* cv Piata exhibited the highest value in sub-humid zone which was contrary to the semi-arid condition.

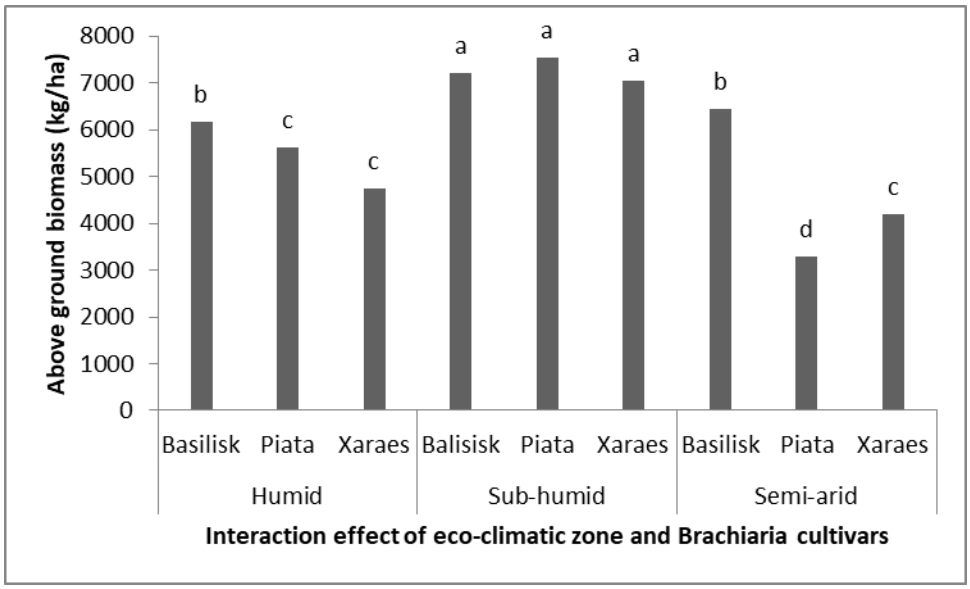

Figure 1: Above ground biomass of Brachiaria cultivars across different eco-climatic zones

Discussion

The growth performance and morphological characteristics of Brachiaria cultivars are highly influenced by weather conditions including humidity, temperature and rainfall. Differences in weather condition enable individual cultivars to respond to such variations through adjustment of their morphological structure and physiology for survival. The worthy performance of Brachiaria recorded in sub-humid zones in terms of plants number per unit area, number of tillers per plant and biomass yield could be associated with favourable weather condition. The rainfall in Morogoro and coastal region is moderate which favour maximum growth rate of Brachiaria as reported by Wassie et al. (2018) in a study done in the mid-attitude of Ethiopia with moderate rainfall ranging from 600 to 1000 mm per annum. Although, Brachiaria is one of the drought tolerance grasses recommended in tropics, Skerman and Rivers (1990), pointed out that, it grows well in rainfall exceeding 500 mm per annum. Nevertheless, the relatively reduced growth rate recorded in

the humid eco-climate zones of the Southern Highlands with the highest amount of rainfall (up to 3000 mm) compared to those from sub-humid zones could be associated with its poor flooding tolerance (Skerman and Rivers 1990). Flooding normally alter the morphological structure of plants particularly the erect-stem grasses such as *B. brizantha* and *B. decumbens* (Skerman and River 1990), with little effect of stoloniferous grasses such as *Brachiaria mutica* (Baruch and Merida 1995).

In addition to significance higher growth performance noted across different eco-climatic zones, the *B. decumbens* cv Basilisk consistently scored higher values of above ground biomass in all eco-climatic region compared to other cultivars. Low (2015) pointed out that; *B. decumbens* is one of the recommended preferable pasture for ruminant grazing due to its ability to produce abundant biomass and aggressive growth habit. Its ability to grow over the wide range of eco-climatic zones makes it an important pasture that is recommended for sustainable livestock production. Interestingly, this cultivar also outperformed in semi-arid zone characterized by persistent drought which implies that, *B. decumbens* is drought tolerant and can be grown in a wide range of soil types and climates ranging from tropical to sub-tropical (Low 2015).

Conclusion and Recommendations

The study determined the growth habits and yield of three Brachiaria cultivars subjected to different eco-climatic zones of Tanzania. The results revealed that, sub-humid climate had highest influence on growth attributes and biomass yield against the semi-arid zone characterized by poor growth performance and low yield. Although, *B. decumbens* cv. Basilisk was relatively shorter grass but scored the highest values for plant number and biomass yield and hence recommended for different climatic conditions. The study recommends further studies on nutritive values and palatability for these Brachiaria cultivars.

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