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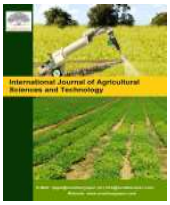

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Elephant Grass Herbage Dry Matter Yield Potential in Harari Region, Ethiopia

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Abstract

Livestock production in Harari region of Ethiopia depends mainly on natural pastures and crop residues which are poor in quality and quantity particularly during dry season. Therefore, it need introduction of alternative improved forages of high quality and quantity which are adapted to the areas. Thus, the activity was conducted at three sites of Harari Region to identify and select the best elephant grass cultivar for dry matter yield (DMY). Four elephant grass cultivars and one local check was evaluated. The treatments were laid out in a randomized complete block design with three replications. Survival rate, tiller numbers, plant height, forage dry matter yield, leaf to stem ratio, number of nods and internod length were recorded at their respective recommended stages. The elephant grass cultivars had significant ($p<0.05$) effect on survival rate, plant height, tiller number, dry matter yield and leaf to stem ratio. Based on the current result, higher herbage DMY (15.12 t/ha) was recorded from cultivar # 15743 followed cultivar # 16788 (14.51 t/ha) and cultivar #16836 (14.50 t/ha), respectively while lower herbage dry matter yield (10.39 t/ha) was received from local check. The ANOVA results indicated that leaf to stem ratio (LSR) of cultivar # 15743 (1.94) was higher ($p<0.05$) than cultivars # 16836 (1.74), 16788 (1.55), 16798 (1.36) and local check (1.26). ANOVA results indicated that higher tiller number recorded from cultivar # 16836 (9.78), # 15743 (8.83) and # 16788 (8.58) while lower tiller number recorded from local check (5.56). Generally, elephant grass cultivar # 15743, # 16788 and # 16836 were well adapted and productive in regarding to herbage dry matter yield. Therefore, these grass cultivars were very important to fill the gap of low quantity and quality of animal feed supply of the study area. Thus, these three elephant grass cultivars were recommended for Harari region with similar agro-ecologies.

Keywords: *Dry matter yield, Leaf to stem ratio, Plant height, Tiller numbers*

1. Introduction

Livestock in Ethiopia is mainly of smallholder farming system with an animal having multi- purpose use and contributes about 16.5% of the national Gross Domestic Product (GDP) and 35.6% of the agricultural GDP (Sintayehu, 2017). It also contributes 15% of export earnings and 30% of agricultural employment (Behnke, 2010, Sintayehu, 2017). Ethiopia has

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large livestock population and diverse agro ecological zones suitable for livestock production. However, livestock production has mostly been subsistence oriented and characterized by low reproductive and production performance. This is mainly shortage of feed resources in quality and quantity (Malede, 2013). The main feed resources for livestock in Ethiopia are natural pasture, crop residues and aftermath grazing which are low in quantity and quality for sustainable animal production (Adugna, 2008). This problem results in low growth rates, poor fertility and high mortality rates of ruminant animals (Odongo *et al*., 2002). These feed resources cannot support higher animal productivity due to their nutritional limitations. The major constraint to such low productivity is shortage of livestock feeds in terms of quantity and quality, especially during the dry season (Ahmed *et al*., 2010).

Different strategies were used to correct the nutritional limitations of these feed resources. One of such strategies that has been receiving recognition and considered as the best option is the use of improved forage species. Forages play an important role in agricultural economy of developing countries by providing the cheapest source of feed for the livestock. The integration of improved forage crops in agricultural systems has many advantages including soil conservation, weeds, pests and diseases control besides to their primary use as high quality animal feeds (Getnet and Gezahagn, 2012). Forages are essential in animal production systems hence the most important feed as a substitute for concentrates normally used for feeding livestock. In fact, forages were certainly known as a cost effective feed rather than commercial concentrate. The substitution of forage to concentrate from 30 to 70% in dairy cattle diet could reduce up to 30% cost of production (Sanh *et al*., 2002).

In lowlands of Harari region, one of the most important challenges to livestock production is scarcity of feeds during the dry season. The available feed resources in the smallholder mixed farms are inadequate in quantity and low in quality. Past attempts to sustain livestock production in the study area focused mainly on crop residues and farmers usually harvest fodder from thinned crop plants, weeds and defoliated leaves. Despite these efforts, cultivated forages account very low contribution mainly due to lack of suitable grasses adapted to environmental conditions of the area. In addition, land sub-division has also contributed to feed shortage through limited available land for pasture establishment. Planting nutritious forages on small parcels of land and cut and-carry these to feed their penned cattle can considerably increase animal production, productivity and associated income here. Particularly as beef demand (Harar sanga) of the area is increasing in the country, this presents cattle-keeping smallholders in Harari region is with an opportunity to enhance their livelihoods. To address the challenges of feed shortage in the study area, there is need to select high quantity and quality forages that are adapted to the region.

Elephant grass originates from sub-Saharan tropical Africa (Clayton *et al*., 2013) and has been introduced in most tropical and subtropical regions worldwide as forage. Elephant grass also called Napier grass, Uganda grass and by several other names in different parts of the world. Characteristically, Napier grass is vigorous and highly productive forage, which can withstand long periods of drought (Lowe *et al*., 2003; Tessema, 2005). Although little or no growth takes place during the dry periods, it rapidly recovers with the onset of rains (Mwendia *et al*., 2006; Wijitphan *et al*., 2009) and can survive in drought for more than five years (Woodard *et al*., 1991). It is an erect and tall perennial grass up to 5 m heights with prolific tillering ability after cutting or grazing and adaptive to well-drained fertile soil. Napier grass is superior to other tropical grasses in terms of dry season growth and forage quality (Wijitphan *et al*., 2009) and can support large tropical livestock units per hectare (Muia *et al*., 2001).

Elephant grass performs well in low, mid and highland areas of Ethiopia (Tessema, 2008). It has become by far the most important species due to its wide ecological range of adaptation (from sea level to over 2,000 meters), high yield and easy of propagation and management (ILRI, 2010a). It can provide a continual supply of green forage throughout the year and best fits for intensive small scale farming systems with appropriate management practices for cut and carry feeding system in Ethiopia (Tessema and Alemayehu, 2010). Napier grass has been the most promising high-yielding fodder, giving dry matter yields that surpass most other tropical grasses (Ansah *et al*., 2010). Despite the immense benefits demonstrated of these grasses in other regions of Ethiopia, the potential of improved elephant grass in Harari regional state to address the challenge of livestock feed scarcity remain unexploited and there is no information on the production and uses of these grasses in the region. Therefore, there is a need for identifying elephant grass cultivars that are more productive and adaptable to the region. The objective of this work was to select the high biomass yield and most adaptable elephant grass cultivars to the study areas.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted during 2018 and 2019 of main cropping season in Harari regional state, Ethiopia. The specific area of the study was in Harawe at two sites and Qile PAs of Harari regional state, Ethiopia. Harawe PA is located at 534.7

km from Addis Ababa and 9.7 km South East of Harar city. Harawe PA is located at 9° 15' 50" N latitude and 42° 8' 53" E longitude. Altitude of Harawe PA is 1808 meters above sea level. The annual rainfall amount ranges from 823-900 mm and the temperature ranges between 16-35°C. Qile PA is bordering Babile district in the South East, Harawe PA in the West, Fedis district in the North and Erer dodota in the South. Qile PA is located at 541.3 km East of Addis Ababa and 16.3 km to the South East of Harar city which is the capital city of Harari region and East Hararghe zone. Qile PA is located at 9° 05' 00" N latitude and 41° 51' 00" E longitude. The altitude of Qile PA is 1749 meters above sea level. The annual rainfall ranges from 623 to 768 mm and the mean annual temperature of the area ranges between 19-35°C.

2.2. Experimental Design and Treatments

Elephant grass cultivars used for the experiment were ILRI# 15743, ILRI# 16836, ILRI# 16788, ILRI# 16798 and one local check as control. All the experimental materials were obtained from Fedis Agricultural Research Center of Oromia Agricultural Research Institute except the local check that is taken from the study areas. The cultivars were arranged in a randomized complete block design with three replications. The plot sizes were 2.5 m x 3 m with a 1 m path between plots and 1.5 m between blocks. The elephant grass stem cuttings were planted at about 0.5 m and 0.5 m between rows and between plants, respectively on a well prepared land and pits.

2.3. Land Preparation and Planting

A total area of 10.5 m x 19 m (199.5 m^2) was ploughed and harrowed with Oxen. The field was divided in to fifteen (15) plots with each plot measuring 7.5 m^2. The elephant grass cultivars were prepared by cutting stems with three nods per cutting for planting. The cuttings were planted one and half nods in the soil at an angle of about 45°C. Plant population per plot were 42 and plant population per cultivar was 126 (42 plants*3reps).

2.4. Dry Matter Yield Determination

An area of 1.5 m^2 (1 mx1.5 m) was randomly selected and harvested with a sickle at a height of 10 cm above the ground. The total harvest per plot of fresh forage was weighed and about 500g of sub samples taken from each plot and chopped in short lengths (2-4 cm) for dry matter determination using AOAC (1990) procedure. This involves drying in an oven at 105°C overnight. The dry matter yield of each cultivar at each plot was calculated on dry matter basis by multiplying the percentage dry weight of the sub-samples from the whole fraction to the fresh weight of the respective cultivar at each plot per 1.5 m^2 and multiplied by constant number (ten) then converted to ton per hectares.

2.5. Height and Leaf to Stem Ratio (LSR) Determination

The height of plant at each plot was measured by measuring five plants from the samples harvested for dry matter yield determination and the average height of five plants was taken as a height of plant at each plot. LSR of elephant grass cultivar at each plot was measured by the fraction of dry leaf weight of plants sampled to stem dry weight of plants sampled or on dry matter basis.

2.6. Data Collected

Plant height, tiller number and biomass yield were recorded at 90 days after planting in all three sites. At 90 days after planting, the plants were harvested from middle rows for dry matter (DM) yield determination. Plant height was determined by measuring from the base of the plant to the topmost flag leaf. Tiller numbers were counted from five plants. During the DM yield determination, the plants were cut to a stubble height of 10 cm from middle rows of the plots. Fresh herbage was harvested, weighed and a sub-sample taken, oven dried at 105°C for 24 hours to a constant weight.

2.7. Data Analysis

The values on agronomic parameters and dry matter yields were statistically evaluated by analysis of variance (ANOVA) using general linear model (GLM) procedure of Statistical Analysis Software to perform ANOVA (SAS 9.1). Means were separated using least significant differences at $p < 0.05$.

3. Results and Discussion

3.1. Morphological Characteristics and Dry Matter Yield of Elephant Grass cultivars

The result of combined analysis of variance showed that survival rate, plant height, tiller number, leaf to stem ratio and dry matter yield at harvesting was significantly difference ($p < 0.05$) among the evaluated elephant grass cultivars (Table

1). Since the interaction among the treatment and location is non-significant, combined analysis was used. The survival rate and plant height of the grass ranges from 56.89% to 88.21% and 71.36 cm to 116.27 cm, respectively. The highest (88.21%) mean survival rate was recorded from elephant grass cultivar ILRI # 16788, while the lowest (56.89%) mean survival rate was obtained from local check. The elephant grass cultivar ILRI # 16788 was significantly ($p < 0.05$) higher in survival rate than ILRI #15743 and local check cultivar. However, no significant differences observed in survival rate between ILRI # 16788, ILRI #16836 and ILRI #16798 cultivars. Statistically significant variation ($p < 0.05$) was observed in numbers of tillers among the elephant grass cultivars evaluated. The higher (9.78) tiller number was recorded from ILRI # 16836 while local check had the lower tiller number. Elephant grass cultivar ILRI # 16836 was significantly ($p < 0.05$) higher in tiller number than ILRI #16798 and local check cultivars. However, no significant differences observed in tiller number between ILRI # 16836, ILRI #15743 and ILRI #16788 cultivars. There were also significant ($p<0.05$) differences among the elephant grass cultivar on dry matter yields (DMY) in t/ha. The mean value of herbage dry matter yield (DMY) was ranged between 10.39 – 15.12 t/ha. The highest dry matter yield was recorded from elephant grass cultivars, ILRI #15743 (15.12 t/ha), ILRI # 16788 (14.51) and ILRI # 16836 (14.50 t/ha), that was statistically non-significant. Numerically, the highest mean value was obtained from ILRI # 15743 (15.12 t/ha) followed by ILRI # 16788 (14.51 t/ha) and ILRI # 16836 (14.50 t/ha). The dry matter yield of the current study was comparable with that of Tamrat *et al*. (2019), who reported 16.6 t/ha annual DM yield for elephant grass cultivar in Ethiopia. The mean DMY of the present result 13.53 t/ha was higher than the previous finding of 12.77 t/ha at 2 months age as reported by Deribe *et al*. (2017) and lower than the other findings which was 41.05 t/ha at 4 months age as reported by Ansah *et al*. (2010) which might be due to the proportional increment of dry matter yield with advance in age of harvesting. Muyekho (2015) reported that yields depend on agro-ecological zone and management but on average elephant grass can give 12 to 25 t/ha of dry matter yield. There was statistically significant difference ($p<0.05$) observed in leaf to stem ratio (LSR) among the elephant grass cultivars evaluated. This result was supported by Tamrat *et al*. (2019), who reported that there is significant variation in LSR. The higher (1.94) leaf to stem ratio was recorded from ILRI # 15743 while local check (1.26) had the lower in leaf to stem ratio. The current result of LSR of elephant grass cultivars was higher than the result reported by Tamrat *et al*. (2019), who reported that LSR of elephant grass cultivars ranged from 0.86 to 1.00. The leaf to stem ratio (LSR) is one of the criteria in evaluating the quality of the pasture because the higher proportion of leaves compared to stem indicate a better nutritive value (Zailan *et al*., 2018). In the present study, the LSR which ranged from 1.26 to 1.94 were different from the range of ratio reported by Tessema and Alemayehu (2010a) that is 0.41 to 1.13. This variation might be due to varietal difference of elephant grass. ANOVA result revealed that there was significant variation ($p < 0.05$) in number of nods and nod length among elephant grass cultivars.

Table 1: Combined meLan Agronomic Parameters and Biomass Yield of Elephant Grass Cultivars in Harari Region

Treatments	SR (%)	PHt (cm)	BMY (t/ha)	NT	NN	NL	LSR
15743	77.32^{b}	71.36^{b}	15.12^{a}	8.83^{ab}	2.37^{d}	10.25^{b}	1.94^{a}
16788	88.21^{a}	116.27^{a}	14.51^{a}	8.58^{ab}	5.31^{a}	14.09^{a}	1.55^{c}
16836	85.37^{a}	74.76^{b}	14.5^{a}	9.78^{a}	2.81^{c}	11.21^{b}	1.74^{b}
16798	85.71^{a}	97.33^{ab}	13.11^{b}	7.39^{b}	4.07^{abc}	13.75^{a}	1.36^{d}
Local	56.89^{c}	89.22^{ab}	10.39^{c}	5.56^{c}	4.89^{ab}	14.56^{a}	1.26^{d}
Mean	78.7	89.79	13.53	8.03	4.09	12.77	1.57
CV (%)	5.9	32.8	6.2	17.1	28.8	15.7	9.4
LSD (0.05)	5.83	36.72	1.04	1.71	1.396	2.499	0.18
Significance	*	*	**	*	**	*	**

Note: SR = Survival rate, PHt = Plant height, TN = tiller number; DMY = Dry matter yield; NN = nod number, NL nod length, LSR = leaf to stem ratio, CV = Coefficient of variation; $^{a, b, c, d}$ Means in a columns, values followed by different letters differ significantly ($p < 0.05$), * = significant, ** = highly significant.

4. Conclusion and Recommendations

The study result revealed that elephant grass had high survival rate, leaf to stem ratio and dry matter yield at recommended harvesting stage (3 months) in Harari regional state, Ethiopia. Elephant grass cultivar ILRI # 15743, ILRI # 16788 and ILRI # 16836 were recorded higher herbage dry matter yield. They were the most productive grasses yielded 15.12, 14.51 and 14.50 t/ha, respectively. In conclusion, the three elephant grass cultivars were produced optimum herbage dry matter yield and recommended as the promising forage biomass producers in the study areas. Therefore, these three cultivars, ILRI # 15743, ILRI # 16788 and ILRI # 16836 were recommended for demonstration on farmers land for wider production.

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Conflicts of Interest

The authors declared that there is no conflict of interest.

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