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Original Research Article

Evaluation and Herbage Yield Performance of Elephant Grass (Pennisetum Purpureum (L.) Varieties for Animal Feed in the case of: Highland and Midland Agro-Ecology of Guji Zone Southern, Oromia

Teshale Jabessa[1*], Ketema Bekele[1], Getacho Tesfaye[1]

[1]Oromia Agricultural Research Institute Bore Agricultural Research Center, Bore, Ethiopia

***Corresponding author:** Teshale Jabessa
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Abstract: The goal of the study was to find and choose a more adaptable, higher-yielding forage type. A randomized complete block design (RCBD) with three replications was used to arrange the seven elephant grass varieties (16791, 16798, 16840, 16800, 16819, 15743, and local variety). The forage sample's biomass yield and all other agronomic characteristics were calculated, and statistical analysis was used to analysis the data. According to the findings, there was statistically significant (p0.01) difference in dry matter yield amongst elephant grass kinds. Elephant grass cultivars at highland and midland agro ecologies did not differ significantly ($p>0.05$) in terms of tillers per plant or leaf-to-stem ratio. Elephant grass cultivars 16791, 15743, and 16819 produced the maximum herbage dry matter yield. Under the study locations, these kinds are well suited and suitable as animal feeds. Therefore, it was suggested that livestock farmers use these three types of elephant grass as a source of feed to increase animal output in the study areas and other places with comparable agro ecology.
Keywords: Evaluation, Elephant grass, Highland, Midland, Variety.

INTRODUCTION

The biggest impediment to livestock production in the developing world is still a lack of feeds, both in terms of quantity and quality [1], especially during the dry season. Even in years with a favorable rainy season, there is not enough fodder to support animals due to a shortage of grazing acreage and inefficient grazing management. Better feed options that take into account both the quantity and quality of the feed are required to increase cattle productivity in such a situation. This necessitates the development of high-quality forage crops that can withstand both biotic and abiotic environmental stresses and offer an alternative source of high-quality and quantity feeds [2- 3].

One of the most productive and adaptable tropical grass species is Pennisetum purpureum and can be grown in a variety of locations and farming practices, such as smallholder, industrial, dry, or wet climates and the most prolific and promising fodder crops in Africa [4]. Large, robust, and deeply rooted perennial bunch grass Pennisetum purpureum is prized for its high yield and usage as cow feed [5]. Additionally, it is a prime candidate for primary fodder due to its ease of establishment and regeneration, production of appetizing green shoots, efficiency in the use of water, and persistence of repeated cutting [6]. The grass is recommended for smallholder crop-livestock farming systems, especially in dairy and feedlot production systems, according to the aforementioned statement [7].

Due to the growing human and livestock populations and shifting land use patterns, which cause a reduction in grazing pastures, the majority of smallholder livestock producers possess small and fragmented pieces of land [8], and can be the best-fitting alternative to other feed options in such regions because of its capacity to produce high amounts of herbage yields with little inputs. The production of Pennisetum purpureum varies among cultivars, with some producing as much as sixty tons of dry matter per hectare per year [9]. The management decisions, the environment, and the cultivar being utilized, however, can have a greater impact on the yield. Elephant grass forage variants, which have superior biomass production and nutritional quality,

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should be grown in order to increase the availability of animal feed in terms of quantity and quality. Therefore, the objectives of the current study were to select, adaptable and high biomass yielding Elephant grass varieties for the study area and other areas having similar agro-ecologies.

MATERIAL AND METHODS

Description of the Study Area

The experiment was carried out at the Bore Agricultural Research Center's Songo Baricha on station and Adola sub- site in Guji Zone. Bore district is located in South-eastern Oromia, 385 kilometers from Finfinne and 220 kilometers from the capital city of the Guji Zone (Negele), with latitudes ranging from 557'23" to 626'52" N and longitudes ranging from 3825'51" to 3856'21". The yearly rainfall in the district is approximately 1400-1800 mm, while the average temperatures range from 10.1 to 20 ^{O}C. The site's predominant soil type is black soil. Bore Agricultural Research Station is 7 kilometers from the Bore district, which is located at 624'37" N latitude and 3834'76" E longitude.

The Adola sub-site is located in the Midland section of the Bore Agricultural Research Center in the Adola district, 470 kilometers from Addis Abeba and 120 kilometers from the Zonal capital city. It is an area where mixed farming and semi-nomadic economic activities take place, which are the primary source of income for the locals. The District has a total size of 1254.56 km2 and is located at 5o44'10" - 6o12'38" N Latitudes and 38o45'10" - 39o12'37" E Longitudes. The District has three agro-climatic zones: highland (11%), midland (29%), and lowland (60%). The district's main soil types are nit sols (red basaltic soils) and orthic Acrosols [10].

Experimental Treatments and Design

The experiment was executed using six (6) elephant grass varieties like; 16840, 16819, 16800, 16791, 15743, 16798 and Local check were planted at midland and highland with the same procedures for both agro-ecologies at the beginning of the main rainy season in a randomized complete block design (RCBD) with three replications. The plant was established in rows spaced 20 cm between rows and 1 m, 1.5 m between plots and blocks respectively on plot size of 5 m x 2.5 m (12.5 m^2). The root splits were planted in rows with five rows per plot and a total of 25 root splits were planted per plot. Fertilize rate was uniformly applied to all plots in the form of nitrogen phosphate sulfate (NPS) at the rate of 100 kg/ha. After every harvest, the plots were top dressed with 50 kg Urea/ha of which one-third applied at the first shower of rain and the remaining two third applied during the active growth stage of the plant. All other forage crop management practices were applied uniformly to all varieties as recommended.

Methods of Data Collection

All agronomic data like plant survival rate, number of tillers per plant, number of leaf per plant, leaf length per plant, plant height, forage DM yield and leaf to stem fractions were collected. Plant survival rate was calculated as the ratio of the number of live plants per plot to the total number of plants planted per plot and then multiplied by 100. Plant height was based on five plants was randomly selected in each plot, measured using a steel tape from the ground level to the highest leaf. For determination of biomass yield, genotypes were cutting at 5-10 cm from the ground level from two central rows. In order to measure dry matter yield, the harvested fresh sample was measured right in field by sensitive weight balance and 300g subsample per plot was brought to Bore Agricultural Research Center and sampled sample was placed to oven dried for 72 hours at a temperature of 65c^{o}for dry matter determination. Then dry matter yield (t/ha) was calculated by James [11], formula.

The dry matter yield (t/ha) = TFW × (DWss /HA × FWss) ×10
Where TFW = total fresh weight kg/plot
DWss = dry weight of subsample in grams
FWss = fresh weight of subsample in grams
HA = Harvest plot area in square meters and 10 is a constant for conversion of yields in kg/m to t/ha

Leaf to stem ration, the morphological parts were separately weighed to know their sample fresh weight, oven dried for 72 hours at a temperature of 65oC and separately weighed to estimate the proportions of these morphological parts.

Methods of Statistical Analysis

All collected data were analyzed using the general linear model procedure of SAS [12], version 9.1. Mean were separated using least significant difference (LSD) at 5% significant level. The statistical model for the analysis data was: Yijk= μ + Aj + Bi + eijk

Where; Yijk= response of variable under examination, μ = overall mean, Aj = the jth factor effect of treatment/ cultivar, Bi = the ith factor effect of block/ replication, eijk = the random error.

RESULT AND DISCUSSION

Agronomic Traits of Elephant Grass Varieties

Number of Plant Survival Rates

The average survival rate of elephant grass varieties tested over years in highland and midland agro ecology is indicated in (Tables 1 and 2). The highest plant survival rate (62.2%) was recorded from variety 16819 followed by varieties 116791 (48.8%) in the highland area. On the other hand, 16840 varieties showed the lowest survival rate (17.8%) in highland areas. There were obtained more numbers of plant survival rates in the midland area when compared with the highland area. The findings of the present investigation were consistent with those of [13-14]. In contrast, the varieties of 16791 in the midland region had the highest plant survival rate (80%), followed by the varieties 15743 (75.5%). This outcome is inferior to the one provided by Mamaru [15], (100%). Napier grass typically has a wide array of adaptations, strong growth, a high biomass yield, and a deep root system to withstand dry conditions [16]. The research regions' different soil types, varying temperatures, and variety of species could all be contributing factors to the decreased survival rate.

Plant Height at Forage Harvest

The mean performance of plant height of elephant grass varieties is presented in (Table 1). The mean values of the current results over the two years showed that plant height was not statistically significantly (p>0.05) different among the tested elephant grass varieties in highland areas. Numerically the highest plant height was recorded from the varieties 16891 and 16798 (180 cm) followed by 15743 at the highland area. The lowest plant height was recorded from the varieties of 16840 (160 cm). On the other hand, plant height was significantly (p<0.05) different in midland areas among the evaluated elephant grass varieties.

Table 1: Elephant grass yield component and over location mean value of agronomic features at highland areas of Guji zone

Varieties	Pc%	Vg%	SR%	NTPP	NLPP(cm)	LLPP(cm)	PH(cm)	LSR	FBM(t/ha)	DMY(t/ha)
16791	89.5a	83.3a	48.8ab	104.6	14	86.6bc	180	0.61	24.1a	10.6a
16819	83.3ab	77.7ab	62.2a	61.6	13.6	79.1c	161.7	0.61	22.3ab	8.7ab
16800	82.7ab	78.4ab	24.4c	50.67	15.5	99.5ab	175	0.6	20.9ab	8.4ab
16798	85.7ab	81.4ab	33.3bc	68.1	16.67	106.6a	180	0.68	20.5ab	6.9bc
15743	87.8ab	83.3a	33.3bc	49.6	16.67	92.8abc	178.3	0.615	18.1b	6.8bc
16840	68.5b	62.9b	17.8c	46.6	15.3	96.6ab	160.7	0.4	17.7b	5.7c
Mean	83	72.9	36.7	63.6	15.33	93.6	172.6	0.6	20.6	7.8
CV	12.1	12.6	29.5	53.1	21.3	8.1	10.7	26.9	14.4	16.3
LSD	*	*	**	Ns	ns	**	ns	ns	*	**

^{a,b,c} Mean in a column within the same category having different superscripts differ significantly (p<0.05) PH (cm)=plant height in centimeter, Pc%=plot cover percentage, LSR=leaf to steam ratio, Vg%=vigor percentage, SR%=survive rate percentage, NTPP=number of tiller per plants, NLPP= number of leaf per plants, LLPP=leaf length per plants in centimeter, FBM t/ha= Fresh biomass tone per hectare, DMY t/ha =dry matter yield tone per hectare, CV=Coefficient of variation, LSD= Least significant difference, **= highly significant, ns= None significant different.

Table 2: At Midland sections of the Guji zone, the overall location mean value of the agronomic and yield component characteristics of Elephant grass

Varieties	SR%	NTPP	NLPP	LLPP (cm)	PH (cm)	LSR	FBM(t/ha)	DMY (t/ha)
16791	80	28.3a	21.2	103.5	282.9a	0.52	39.33	19.07a
15743	75.5	23.3ab	19.7	91.1	210.6b	0.41	39.1	15.ab
16819	74.6	20.9b	16.8	106.5	243.9ab	0.46	29.7	12.8b
Local check	51.1	28.8a	16	109.5	200.8b	0.39	32.05	12.8b
Mean	70.3	25.3	18.46	102.6	234.6	0.44	35.1	15.54
CV	29.6	6.6	15.5	11.3	14.4	20.7	17.5	12.4
LSD	Ns	*	ns	ns	*	ns	ns	**

^{a,b,c} Mean in a column within the same category having different superscripts differ significantly (p<0.05) PH (cm)=plant height in centimeter, LSR=leaf to steam ratio, SR%=survive rate percentage, NTPP=number of tiller per plants, NLPP= number of leaf per plants, LLPP=leaf length per plants in centimeter, FBM t/ha= Fresh biomass tone per hectare, DMY t/ha =drymatter yield tone per hectare, CV=Coefficient of variation, LSD= Least significant difference, **= highly significant, ns= None significant different.

Number of Tillers per Plant

The combined analysis indicated that non-significant (p>0.05) variation was observed among the varieties in the highland area. The mean tiller performance of the tested elephant grass varieties is indicated in (Table 1). In highland environments, variety 16791 produced the most tillers over the years (104.6), followed by variety 16798 (68.1), while variety 16840 produced the least (46.6). The variation in the number of tillers produced per plant among the genotypes of Pennisetum purpureum grass may be due to genetic differences among genotypes and their interactions with the environment [17]. Due to the perennial nature of elephant grass, it produces numerous tillers and dense vegetative growth as the pasture consolidates [18]. Elephant grass had more tillers per plant as the plant grew taller at the time of cutting [19]. Elephant grass variety genetic differences and interactions with the environment may be the reason for the variation in tillers produced per plant among each of the varieties. The combined study revealed that the varieties in the midland region showed considerable significant (p<0.05) variation among the varieties in the midland area.

Number of tillers is more adaptive at midland area due to favorable growth environmental factors. Tiller performance also varies with production years due to environmental factors.

Dry Matter Yield

Forage dry matter (DM) yield of Napier grass varieties showed significant ($p<0.05$) variation in the combined analysis (Table 1). The DM yield of analysis ranged from 10.6 - 5.7 t/ha with a mean of 7.8 t/ha in the highland area. On the other hand, the dry matter (DM) yield of Napier grass varieties showed significant ($p<0.05$) variation in the midland area. Generally, the varieties of 16791 gave (19.07 t/ha) the highest mean DM yield followed by 16819 (8.7 t/ha). This result was lower than the result reported by Deribe *et al*., [20], (12.6). On the other hand, the lowest DM yield was obtained from the varieties of 16840 (5.7 t/ha). According to Tessema [21], and Ishii [22], the longest varieties showed higher DM yields than the shorter varieties. This might be due to, variances in the tested varieties, testing years, and varieties by years interaction effects resulting in discrepancies in dry matter yield [6]. The variances in planting techniques, soil properties, and varietal variants may be to blame for the disparities in plant survival rate, tiller performance, and plant height.

Fresh Biomass Yield

The mean average biomass yield were shown significant ($p<0.05$) different between the varieties at the highland area. The highest mean value of biomass yield was obtained from 16791 (24.1 t/ha) followed by 16819 varieties (22.3 t/ha).

Leaf to Steam Ratio

Between the two agro ecologies, there was no statistically significant variation in the variance of the leaf to stem ratio ($p>0.05$). The highland regions were where the higher leaf-to-stem ratio was found. This is because changes in the ambient temperature in the midland region cause the leaf to shutter. The leaf to stem ratio range that was noted was 0.4-0.68. The present conclusion from the leaf-to-stem ratio range was also supported by studies by Deribe *et al*., [20], who reported a range of 0.31 to 1.01, and Elkana *et al*., [6], who found a range of 1.7 to 3.1.

CONCLUSION AND RECOMMENDATIONS

The current study's findings suggest that the 16791 and 16819 varieties for highland areas and the 15743 and 16791 varieties for midland areas are well adapted and productive regarding major forage parameters like dry matter yield, survival rate, and plant heights that are intended to fill the gap of the community's low quantity ruminant feed supply. Future studies should concentrate on the impact of forage dry matter yield, chemical compositions, and the feeding effect of superior candidates on livestock production in relation to planting space, cutting interval, and forage composition.

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