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Adaptability Study of Brachiaria Grass Accessions for Forage Yield and Nutritive Value in Lowlands of East Oromia, Ethiopia

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Abstract: Livestock production in the lowlands of Eastern Oromia of Ethiopia depends mainly on natural pastures and crop residues which are of poor quality and the yield is generally low during the dry season. Therefore, there is a need to introduce alternative forages of high quality that are adapted to the region. The objective of this study was to identify and select the best Brachiaria grass accession/s for dry matter (DM) yield and nutritive quality in lowlands of Eastern Oromia. The experiment was conducted in the lowlands of Fedis and Dire-Dawa districts during 2018 to 2020. The experimental materials were brachiaria decumbens accessions 1087, 13205, 14721, 14720 and brachiaria ruziziensis accessions 13332, 14743, 14771, 14774, 14813. These grass accessions were compared with one local check, a locally cultivated brachiaria grass. Plant established successfully at both sites for the last three years. Tiller numbers, plant height, forage dry matter yield and plot covers were recorded at 16 weeks after planting. Significant ($p<0.05$) difference were detected among the tested grass accessions in plot cover, height, tiller number, dry matter yield, OM%, Ash%, CP%, NDF%, ADF% and ADL% contents. The results showed that brachiaria grasses had the potential to provide forage of high quality and adequate quantity for livestock feed. Accession of brachiaria ruziziensis 14813 (24.685 t/ha) and brachiaria decumbens 14721 (20.89t/ha) showed the highest forage dry matter production than the remaining evaluated grass accessions. Although brachiaria grass accession 14720 and 13205 had higher CP content than accessions 14721, high forage dry matter yield is more appealing to farmers it is not recommended for cultivation in the study area. Thus, these two grass accessions brachiaria ruziziensis 14813 and brachiaria decumbens 14721 are the most suitable for providing better quality and quantity of livestock feed in the lowlands of Eastern Oromia, Ethiopia and similar agro-ecologies to the study area.

Keywords: Dry Matter Yield, Plant Height, Plot Cover, Tiller Numbers

1. Introduction

Forages play an important role in agricultural economy of developing countries by providing the cheapest source of feed for the livestock. In Eastern lowlands of Oromia, one of the most important challenges to livestock production is scarcity of feeds during the dry season. Smallholder farmers face the challenge that grazing land is gradually becoming scarcer, and their current cattle productivity is too low for effective commercialization. Farmers depend on natural pasture and crop residue for livestock and more often give low priority to pasture establishment. These available feed resources in the smallholder mixed farms are inadequate in quantity and low in quality.

Past attempts to improve livestock production in this 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 and associated income here. Particularly as beef demand of the area is increasing in the country, this presents cattle-keeping smallholders in east Oromia is with an opportunity to enhance their livelihoods. To address the challenges of feed shortage in the region, there is need to select high quality forages that are adapted to the region.

The genus Brachiaria consists of about 100 species distributed across tropical and sub-tropical region [18]. Brachiaria have advantage over those in other genera including adaptation to drought and low fertility soils, sequesters carbon through its large roots system, enhance nitrogen use efficiency and subsequently minimize eutrophication and greenhouse gas emissions [1, 12, 16]. Brachiaria plays important roles in soil erosion control and ecological restoration. Brachiaria species have been important component of sown pastures in humid low lands and savannas of tropical America with current estimated acreage of 99 million hectare in Brazil alone [9]. Africa is the center of origin of Brachiaria grasses. Brachiaria species are native to eastern and central Africa and are extensively grown as livestock forage in South America and East Asia [2]. Important species include B. ruziziensis, B. decumbens, B. brizantha and B. humidicola.

Recently, the mounting demand for livestock products in Africa has renewed interest of farmers, researchers, and development and government agencies on forages particularly to climate resilient forages like Brachiaria grass. Therefore, there have been multiple repatriations of Brachiaria grass to Africa as hybrids and improved landraces [10, 5]. These materials have shown positive performance in terms of improved forage availability and livestock productivity. These results have revealed Brachiaria as an ideal forage option for the livestock farmers in East Africa. Despite the immense benefits demonstrated of these grasses in other countries, the potential of improved Brachiaria grass in East Oromia 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 East region. Therefore, there is a need for identifying Brachiaria grass accessions that are more productive and adaptable to the lowland production systems of Eastern Oromia, since accessions within a species differ in yield potential and quality of forage produced.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted under rain-fed conditions during 2018 and 2019 growing season in Fedis Agricultural Research Center, in Fedis District on Boko station, which is 550 km to the East of Addis Ababa and 24 km southeast of Harari city. The Fedis district is situated at an altitude of 1200 to 1600 m and 1500 m of boko station above sea level, [4]. The amount of rainfall varies between 650 and 750 mm, while the average temperature of the district ranges between 25 and 30 °C [22]. In the vicinity of the site; Vertisols and *Afilsols* soil type are common to the area. Soil is loam [3].

2.2. Experimental Design and Treatments

The experiment was conducted from 2018 to 2020 at two locations for the last three years. The grass accessions were brachiaria decumbens accessions 1087, 13205, 14721, 14720 and brachiaria ruziziensis accessions 13332, 14743, 14771, 14774, 14813 and one local check. All the experimental materials were obtained from Holeta Agricultural Research Center of Ethiopia Except the local check. The treatments were laid out in a randomized complete block design with three replications. The plot sizes were 4 m x 3 m with a 1 m path between plots and 1.5 m between blocks respectively. The grass roots were planted at about 0.5 m and 0.25 m between rows and plants respectively on a well prepared seed bed.

2.3. Data Collection

Plant height, plot cover and tiller number at 16 weeks after planting in both sites. At the end of 16 weeks after planting, the plants were harvested for dry matter (DM) yield determination. Plant height was determined by measuring the primary shoots from the base of the plant to the topmost flag leaf of four tagged plants as described by Rayburn and Lozier [17]. The percentage plot cover was determined from a 1 m x 1 m quadrat sub-divided into 25 squares as described by Njarui and Wandera [14]. Tillers were counted for tagged plants. During the DM yield determination, the plants were cut to a stubble height of 5 cm in an area of 4 m^2. Fresh herbage was harvested, weighed and a sub-sample taken, oven dried at of 65°C to a constant weight and dry weights recorded. The nutrient analysis of Organic matter (DM%), Ash%, Crude protein (CP%), Neutral Detergent Fiber (NDF%), Acid Detergent Fiber (ADF%) and Acid Detergent Lignin (ADL%) were conducted at Haramaya University.

2.4. Data Analysis

The values on growth 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 the least significant difference (LSD) test at $p < 0.05$ [6].

3. Result and Discussions

3.1. Brachiaria Grass Accessions Plant Height, Plot Cover, Tiller Number and Dry Matter Yield

The composite means of the growth parameters (height, plot cover, tiller numbers and dry matter yield) during the establishment period are presented in Table 1. There were significant ($p < 0.05$) differences in plot cover, plant height, tiller numbers and dry matter yield among the grass

accessions. The plot cover and plant height of the tested brachiaria accessions ranges from around 20% to 100% and 66.05cm to 155cm respectively. The grass accessions 14813 (100% and 143 cm) and 14721 (100%and 155 cm) consistently recorded the highest plot cover and plant height in all the observations although it was not higher (P > 0.05) than most of the grass accessions (Table 1). Accession 1087 had significantly the lowest plot cover (20%) and maintained the lowest plant height (66.05 cm) although it was not lower (P >0.05) than 13205 grass accessions in plant height (Table 1). The difference in plot cover among the grass accessions might be attributed to differences in growth rate among the grasses accessions. The delay or slow to establish from the planted root may took time build reasonable plot cover and height. The plant tiller number ranges from 36.05 to 90.13 tillers/plant where accession 1087 had significantly the lowest except accession 13332 (Table 1).

The brachiaria grass accessions 14813 (24.685 t/ha) and 14721 (20.89t/ha) recorded significantly (p < 0.05) higher mean dry matter yield than all the Brachiaria accessions while 1087 (5.92 t/ha) had the lowest (Table 1). The result was high compared with that obtained by Hare *et al*. [7] (16.3 t/ha DM yield). However, the result is almost similar to those of Hare *et al.* [8] and FAO [2] who reported that DM yield of brachiaria grass up to 20 t/ha. The higher dry matter yield might be due to their high tiller number, plot cover and plant height. Because the tiller numbers increased the chances of survival for most grasses and that large number of tillers produced allowed grasses to attain relatively high dry matter. The results are in agreement with Mganga [11], reporting that tillering ability increases dry matter yield.

In general, the height, plot cover and tiller number of brachiaria grass accessions 14813 and 14721 were almost similar with the tested local check, but perform significantly higher than local check (14.08 t/ha) in forage dry matter yield. The brachiaria grass accessions 14813 and 14721 had 75.36% and 48.37% forage dry matter yield advantage over the local check, respectively.

Table 1. *Composite mean of plot cover, plant height, tiller number and dry matter yield of the brachiaria grass accessions tested over years and locations.*

Treatments	Plot cover%	Plant height (cm)	Tiller number	DMY (t/ha)
1087	20.00d	66.05c	36.05c	5.92d
13205	58.33c	98.67bc	90.13a	9.31cd
13332	69.17bc	135.28ab	57.67bc	12.29bcd
14720	98.33a	131.67ab	73.94ab	11.13cd
14721	100.00a	155.00a	81.10ab	20.89ab
14743	81.67abc	127.17ab	78.48ab	12.66bcd
14771	90.83ab	148.50a	79.06ab	15.30bc
14774	69.17bc	119.17ab	71.55ab	8.30cd
14813	100.00a	143.00ab	82.19ab	24.69a
Local check	98.33a	131.83ab	79.28ab	14.08bc
CV (%)	30.62	33.24	36.7	36.42
p –value	**	**	*	**
LSD (0.05)	13.89	24.11	15.457	4.5007

LSD: least significant difference, DMY: dry matter yield, CV: coefficient of variation

3.2. Brachiaria Grass Accessions Nutritive Value

The composite mean of herbage chemical composition (OM%, Ash%, CP%, NDF%, ADF% and ADL%) of Brachiaria accessions during the study time are presented in Table 2. Significant (p<0.05) difference were observed among the tested grass accessions in OM%, Ash%, CP%, NDF%, ADF% and ADL% contents (Table 2). Brachiaria grass accession 13205 (10.87%) had significantly (P< 0.05) the highest CP% content compared with the other accessions except accessions 14720 (10.34%) and 14813 (10.03%). The results were similar to values obtained by Villela *et al.* [20], who found that the brachiaria decumbens had CP content of 9.43% in autumn and Hare *et al.* [7], who recorded average CP ranging from 9.8 to 11.8% for brachiaria grass. However, the results were lower than the values of CP ranging from 13-16% recorded by Vendramini *et al.* [19] for brachiaria grass. Generally, the CP content in all the Brachiaria grasses accessions ranges 8.08 – 10.87% (Table 2). This result was almost similar to the CP content ranging from 7-10% reported by Nguku *et al.* [13].

For all brachiaria accessions, the NDF% content ranges from 57.94-64.65. The result was lower than 66.4% - 74.3% for mulato grass that reported by Pariz et al. [15]. Comparing the contents of NDF among brachiaria accessions the highest NDF% was significantly (P< 0.05) obtained by accessions 1087 (64.65%), 13332 (64.09%), 14743 (63.93%), 14774 (64.10%) and the local check (63.78%) while accessions 14720 (57.94%) and 13205 (58.12%) recorded the lowest NDF% value (Table 2). The highest NDF value obtained was almost similar with above 60% of NDF contents of brachiaria ruziziensis that reported by Pariz et al. [15]. The Brachiaria accessions 14721 (61.94%) and 14813 (61.29%) recorded significant lower NDF than the local check (63.78%) and consequently were more digestible than the local check. The content of ADL% was similar between all accessions of Brachiaria grass, only accessions 1087 (5.39%) and 14743 (5.29%) had significantly (P< 0.05) higher than the local check (4.56%) (Table 2).

Table 2. *Composite mean of Herbage chemical composition (OM%, Ash%, CP%, NDF%, ADF% and ADL%) of Brachiaria grass accessions.*

Treatments	OM	Ash	CP	NDF	ADF	ADL
1087	92.127a	9.63a	9.17bc	64.65a	45.38a	5.39a
13205	90.84abc	9.09abc	10.87a	58.12c	42.76bc	4.83ab
13332	91.38ab	8.37c	8.08c	64.09a	41.53cd	4.91ab
Local check	88.92c	8.86abc	9.06bc	63.78a	42.03cd	4.56b
14720	89.81bc	9.42ab	10.34ab	57.94c	41.79cd	4.09ab
14721	90.68abc	9.24ab	9.13bc	61.94b	41.12cd	4.83ab
14743	91.76ab	8.86abc	8.36c	63.93a	44.93ab	5.29a
14771	90.42abc	9.35ab	9.19bc	61.02b	43.12abc	4.99ab
14774	89.30c	9.23ab	8.09c	64.10a	41.19cd	4.83ab
14813	90.06abc	8.58bc	10.03ab	61.29b	40.23d	5.03ab
CV (%)	1.31	6.1	10.05	1.53	3.47	12.59
LSD	0.97	0.45	0.76	0.78	1.2	0.31

OM: Organic matter, CP: Crude protein, NDF: Neutral Detergent Fiber, ADF: Acid Detergent Fiber, ADL: Acid Detergent Lignin, LSD: least significant difference, CV: coefficient of variation

Photos taken during the study time

Figure 1. *Brachiaria grass accessions at experimental site.*

Figure 2. *Farmers training on planting or establishment, management and using of brachiaria grass at experimental site.*

Figure 3. *Farmers' field day or demonstration of brachiaria grass accessions at experimental site.*

Figure 4. *Women participation in brachiaria grass harvesting and uses.*

4. Conclusions and Recommendations

The study showed that Brachiaria grass favors the production of high quantity and quality forage in the lowlands of East Oromia, Ethiopia. The Brachiaria accessions evaluated showed high adaptation and forage dry matter yield with accessions 14813 and 14721 having the highest yield in all years and locations. These two Brachiaria grass accessions performed well in terms of plot cover, plant tiller number, plant height and had appreciable dry matter yield. They had the potential to tolerate the drought areas implying that they are likely to survive in areas that receives between 650 and 750 mm annual rainfall. These top performing accessions yielded much greater than the controls; local check grass and the remaining tested accessions, thus they could be considered as suitable grasses for inclusion in the local farming system. Generally, the highest in forage dry matter yield and nutritive value of brachiaria grass accessions 14813 and 14721 over locations and years revealed that these accessions are better adapted and performed well as compared to the tested brachiaria accessions. Thus, they are recommended for cultivation and production in Eastern Oromia, Ethiopia and similar agro ecologies to the study area.

Abbreviations

ADF	Acid Detergent Fiber
ADL	Acid Detergent Lignin
CP	Crude Protein
DMY	Dry Matter Yield
FARC	Fedis Agricultural Research Center
NDF	Neutral Detergent Fiber
OARI	Oromia Agricultural Research Institute
OM	Organic Matter

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