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Research Article

Screening and selection of *Brachiaria brizantha* accessions for forage values under irrigation at Wondo Genet, Sidama, Ethiopia

Aman Getiso*, Diribi Mijena and Edao Shanku

Ethiopian Institute of Agricultural Research, Wondo Genet Agricultural Research Center, P.O. Box 198, Shashemene, Ethiopia

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***Corresponding author:** Aman Getiso, Ethiopian Institute of Agricultural Research, Wondo Genet Agricultural Research Center, P.O. Box 198, Shashemene, Ethiopia, E-mail: aman.getiso@yahoo.com

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Abstract

The experiment was conducted to evaluate different Brachiaria brizantha accessions at the Wondo genet agricultural research center to identify species/accessions so as to use the better performing ecotype for wider distribution among livestock producer communities in the country. Seven Brachiaria grass accessions (*B. brizantha*, 13151; *B. brizantha*, 13368; *B. brizantha*, 13653; *B. brizantha*, 16550; B. humidicola, 9222; *B. brizantha*, 13379 and B. mutica,) were used as treatments in randomized complete block design with three replications. The overall dry matter yield for B. humidicola, 9222 (5.95t/ha), and B. mutica, (5.61t/ha) accessions didn't show a significant difference ($p > 0.05$) but significantly ($p < 0.05$) lower than all other accessions. Mean plant heights for the accessions were significantly different ($p < 0.05$) throughout the harvesting cycle period and overall yield with a lower plant height of B. mutica (63.2 cm) while non-significant ($p > 0.05$) overall mean height was recorded among other accessions. *B. brizantha*, 13151; *B. brizantha*, 13368; *B. brizantha*, 13653; *B. brizantha*, 16550 and *B. brizantha*, 13379 accessions outperformed in terms of overall dry matter yield. Further studies on agronomic performances of promising *B. brizantha* accessions under on-farm conditions and nutritional evaluation involving live-animal experiments are recommended.

Introduction

In Ethiopia, the livestock sector has considerable economic and social importance at regional and national levels [1]. The country has the largest livestock population among African countries [2] and has a high potential in livestock genetic resources [3]. However, the productivity of livestock is below the African average due to inadequate supply of feed and poor feeding practices [1]. The major constraint that influences the productivity of livestock is a shortage of feed both in quantity and quality [4]. Nowadays, the most important livestock feed resources in Ethiopia are natural pasture, crop residues, and grass hay [5]. However, they are poor in quality and provide inadequate protein, energy, vitamins, and minerals [6].

The rising interest in livestock development fueled by rising demands for animal products has led to research in identifying drought-tolerant, more productive, and persistent forages to support livestock productivity [7].

Common forage crops adapted in the farming systems in Ethiopia like Napier grass (Pennisetum species) and silver leaf Desmodium species have been affected by the global effects of climate change and Napier grass is also threatened by the emergence of stunt and smut diseases [8], which has also limited its expansion to drier areas. Therefore, finding unconventional feed resources for livestock is an important pace to maintain livestock production in the country. Among the most promising option for farmers in East Africa in improving both feed availability during the dry season and nutritive quality leading to increasing animal production and productivity are Brachiaria cultivars [9].

Grasses in the genus Brachiaria have an advantage over

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those in other genera including adaptation to infertile acid soils and producing high dry matter (DM) yield [10]. They are also resistant to many diseases affecting baseline varieties in Eastern Africa, particularly Napier stunt and smut disease [9,11]. In addition to adapting to drought, diseases, and low fertility soils, Brachiaria grasses produce high biomass, enhance soil fertility and reduce greenhouse gas emissions [12] and contribute to carbon sequestration [13]. Besides mentioned advantages in the genus, the species produce abundant roots which contribute to the collection of water, soil aggregation, and aeration [14].

Dry matter yield of up to 19 t/ha has been recorded from Mulato II over 8 months growth period [15]. An annual yield of up to 20 t/ha from Mulato II in Thailand was recorded [16]. Cattle fed with Mulato II produced 11% more milk during the dry season and 23% more during the rainy season compared with those fed on cv. Basilisk and *B. brizantha* cv. Xaraes [17]. In Brazil, livestock fed on *B. brizantha* cv. Piatá showed an average daily weight gain of 0.44 kg/head [18]. Recent studies indicated that the adoption of *B. brizantha* cultivars has the potential to increase baseline milk production of 3-5 L/cow/d on participating farms in Kenya by 15-40% [19] and a farm trial in Rwanda reported a 30% increase in milk production and a 20% increase in meat production [10]. Brachiaria genus increased 15 to 40% milk production in Kenya [9] and is palatable grass to animals [20].

Brachiaria (Trin.) Griseb., consisting of over 100 species, is distributed across the tropics, particularly tropical [Africa [21]. The distribution of *B. brizantha* is high in Africa including Ethiopia [22] and needs more research to exploit maximum in the region. The productivity of the different grass species could be different and is also influenced by the area of origin, including temperature, light intensity, total rainfall, soil type, fertilization level, and stage of maturity [5,23]. Different varieties will perform differently in different agro-ecologies and *B. brizantha* is very variable and several varieties show remarkable differences in habit, morphology, and seed setting capacity [24], but information of this kind is lacking in Ethiopia. Therefore, the study was aimed to evaluate different *B. brizantha* accessions over arrays of environments and identify species/accessions to use the better performing ecotype for wider distribution among livestock producer communities in the country.

Material and methods

Descriptions of the test environments

The study was conducted at Wondo genet Agricultural Research center as National Variety Trial following standard agronomic screening procedures. Wondo genet Agricultural Research center is found in Sidama in the Regional state, Wondo Genet woreda. It is situated about 268km south of Addis Ababa and 14 km southeast of Shashemene. Its geographical location and altitude ranges from 38° 37'13''-380 38'20'' East and 7° 5'23''-7° 5'52'' North and 1760-1920 m. above sea level respectively [25]. The area receives a mean annual rainfall of 1128 mm with minimum and maximum temperatures of 11 and 26°C, respectively [26].

Experimental design and data collection

Five Brachiaria Brizantha accessions, one Brachiaria *humidicola*, and Brachiaria Mutica as standard check root splits were brought from Ethiopian Institute of Agricultural Research, Debrezeit Agricultural Research Center and planted at Wondo genet Agricultural Research Center for performance evaluation for four consecutive years from 2016 to-2019. The Brachiaria Brizantha accessions (treatments) were *B. brizantha, 13151; B. brizantha, 13368; B. brizantha, 13653; B. brizantha, 16550; B. humid cola, 9222; B. brizantha, 13379 and B. mutica*, in Randomized Complete Block Design (RCBD) with three replications. The single plot size was 3m x 4m ($12m^2$) containing 7 rows, each row 0.5m apart and plant spaced 0.25m within rows. The spaces between plots were 1m and the total area of the experiment was 15m*27m ($405m^2$). Therefore, a total of thirty (21) plots each measuring $12m^2$ were used for the planting.

Harvesting was done for herbage when 50% of the plants in each quarter of the plot reach the heading stage of growth. Plant height was recorded by measuring from the ground to the tip of the longest leaf. The weight of the total fresh biomass yield was determined by using a $1m^2$ quadrant and cutting the herbage at 5-10 cm height from the ground from each plot in the field. The sample taken from each plot was weighed to know the total sample fresh weight using sensitive table balance. A 300 g sample was taken from each plot to the laboratory and oven-dried for 24 hours at a temperature of 105°c for herbage DM yield determination.

Statistical analysis

Data on agronomic parameters and yield was analyzed by using analysis of variance (ANOVA) procedures of SAS general linear model (GLM) [27]. The least significant difference (LSD) at a 5% significance level was used for the comparison of means.

Results and discussion

The dry matter yield for different harvesting cycles and overall yield were presented in Table 1. The overall dry matter yield for Brachiaria humidicola, 9222 (5.95t/ha), and B. mutica, (5.61t/ha) accessions didn't show a significant difference ($p > 0.05$) but significantly ($p < 0.05$) lower than all other accessions. Differences in dry matter yield across the accessions can be ascribed to differences in growth rate and growth habit, which are arbitrated through the genotypic and phenotypic differences which is also a common phenomenon of grasses [28,29].

Mean plant heights for the accessions were significantly different ($p < 0.05$) throughout the harvesting cycle period and overall yield as shown in Tables 2,3. Among the *Brachiaria* accessions Bracharia Mutica, (63.22 cm) recorded lower plant overall mean height but a non-significant difference ($p > 0.05$) of overall mean height was recorded among other accessions Figure 1.

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Table 1: Mean forage DM yield (t/ha) of B. brizantha, B. humidicola, and B. mutica genotypes/accessions were tested at the forage harvesting stage across eight harvesting cycles.

Accessions	Harvesting cycle								Overall mean
	1	2	3	4	5	6	7	8	
B. brizantha (13151)	19.1	16.44	7.45^{ab}	6.97	8.75^{a}	4.65	6.95^{a}	2.79^{ab}	9.14^{a}
B. brizantha (13368	20.8	13.81	7.96^{a}	8.54	5.47^{b}	4.16	6.98^{a}	2.26^{ab}	8.74^{a}
B. brizantha (13653)	19.7	12.98	8.71^{a}	7.89	5.73^{b}	4.87	7.42^{a}	3.38^{a}	8.83^{a}
B. brizantha (16550)	18.2	11.39	8.53^{a}	8.80	7.29^{ab}	3.88	6.37^{a}	1.94^{ab}	8.30^{a}
B. humidicola (9222)	14.8	13.95	3.30^{b}	5.67	3.07^{c}	2.47	3.20^{a}	1.08^{b}	5.95^{b}
B. brizantha (13379)	20.1	12.00	6.72^{ab}	8.97	6.56^{b}	4.30	5.28^{ab}	1.92^{b}	8.20^{a}
B. mutica	13.4	10.78	3.49^{b}	6.17	2.23^{c}	2.17	5.20^{ab}	1.45^{b}	5.61^{b}
SEM	2.23	3.51	1.32	1.66	0.69	0.81	0.84	0.54	0.61
Sign.	NS	NS	*	NS	***	NS	*	*	**

SEM = Standard error of the mean; NS = Non-Significant; Means followed by a common superscript letter within a column are not significantly different from each other at $P < 0.05$.

Table 2: Mean forage fresh biomass yield (t/ha) of B. brizantha, B. humidicola, and B. mutica genotypes/accessions were tested at the forage harvesting stage across eight harvesting cycles.

Accessions	Harvesting cycle								Overall mean
	1	2	3	4	5	6	7	8	
B. brizantha (13151)	74.33^{a}	64	28.67^{ab}	26.00	30.00^{a}	15.33	22.33^{ab}	7.68^{b}	33.54^{a}
B. brizantha (13368	76.67^{a}	49	30.00^{a}	27.33	20.00^{b}	12.33	24.33^{ab}	8.30^{b}	31.00^{a}
B. brizantha (13653)	72.67^{a}	47.67	33.33^{a}	27.33	18.67^{bc}	13.67	26.67^{a}	13.15^{a}	31.64^{a}
B. brizantha (16550)	75.67^{a}	45.67	32.00^{a}	32.00	25.33^{ab}	14.00	22.67^{ab}	6.35^{b}	31.71^{a}
B. humidicola (9222)	62.67^{ab}	59.67	12.00^{c}	21.33	12.67^{cd}	8.00	14.00^{c}	4.03^{b}	24.30^{b}
B. brizantha (13379)	75.67^{a}	50.33	27.00^{abc}	28.00	25.33^{ab}	14.67	19.67^{bc}	5.91^{b}	30.82^{a}
B. mutica	53.00^{b}	53.33	14.00^{bc}	25.33	9.67^{d}	6.00	21.33^{ab}	4.32^{b}	23.37^{b}
SEM	5.52	13.17	4.88	5.36	2.12	2.81	2.05	1.35	2.07
Sign.	*	NS	**	NS	***	NS	*	**	**

SEM = Standard error of the mean; NS = Non-Significant; Means followed by a common superscript letter within a column are not significantly different from each other at $P < 0.05$.

Table 3: Mean plant height (cm) of B. brizantha, B. humidicola, and B. mutica genotypes/accessions were tested at the forage harvesting stage across eight harvesting cycles.

Accessions	Harvesting cycle								Overall mean
	1	2	3	4	5	6	7	8	
B. brizantha (13151)	211.47^{a}	136.20^{ab}	100.47^{a}	108.3^{a}	117.93^{a}	64.87^{ab}	117.6^{a}	78.6	116.93^{a}
B. brizantha (13368	186.00^{ab}	121.60^{b}	100.13^{a}	98.27^{ab}	118.27^{a}	75.13^{a}	117.1^{a}	71.2	110.96^{a}
B. brizantha (13653)	174.33^{b}	147.13^{a}	109.27^{a}	109.00^{a}	106.53^{a}	77.33^{a}	118.53^{a}	75.8	114.74^{a}
B. brizantha (16550)	192.60^{ab}	126.73^{ab}	95.93^{a}	116.67^{a}	113.00^{a}	52.93^{abc}	113.53^{a}	70.2	110.2^{a}
B. humidicola (9222)	204.80^{ab}	140.27^{ab}	75.4^{b}	135.67^{a}	131.40^{a}	47.27^{bc}	118.73^{a}	68.27	115.23^{a}
B. brizantha (13379)	190.47^{ab}	144.53^{ab}	108.2^{a}	98.47^{ab}	123.60^{a}	36.73^{c}	117.20^{a}	76.33	111.94^{a}
B. mutica	174.40^{b}	87.40^{c}	30.73^{c}	65.33^{b}	32.20^{b}	31.07^{c}	51.8^{b}	32.8	63.22^{b}
SEM	9.40	7.26	5.54	12.14	9.21	7.98	6.38	3.23	2.84
Sign.	*	**	***	*	***	**	***	***	***

SEM = Standard error of the mean; NS = Non-Significant; Means followed by a common superscript letter within a column are not significantly different from each other at P < 0.05.

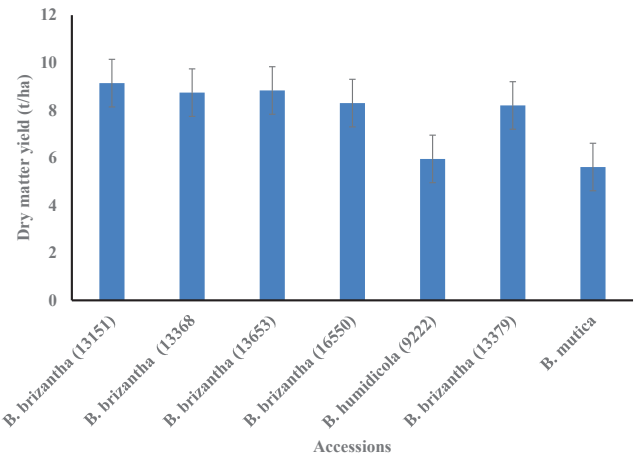

Figure 1: Over all mean DM yield (t/ha) of Brachiaria genotypes/accessions tested at forage harvesting stage across eight harvesting cycle.

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Conclusions and recommendations

The Brachiaria accessions: *B. brizantha*, (13151); *B. brizantha*, (13368); *B. brizantha*, (13653); *B. brizantha*, (16550) and *B. brizantha*, (13379) outperformed in terms of overall dry matter yield. Further studies on agronomic performances of promising *B. brizantha* accessions under on-farm conditions and nutritional evaluation involving live-animal experiments are recommended.

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