

Research Article

Evaluation of Different Brachiaria Cultivars for Forage Yield and Agronomic Performance in Sub-humid Climate of Ethiopia

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Abstract

A major reason for the inadequate quantity and quality of feed is the shortage of improved, adapted forages. The growing interest in livestock development, fueled by the rising demand for animal products, underscores the necessity for high-quality, productive forages to address the feed shortage. This study was conducted in 2023 and 2024 at the Bako, Boneya Boshe, and Gute sites to identify the most adaptable and high-yielding cultivars of Brachiaria. The treatment consists of four Brachiaria cultivars (Brachiaria brizantha (DZF-13379), Brachiaria humidicola (DZF-9222), Brachiaria mutica (var. DZF-483) and Brachiaria decumbens (DZF-10871) arranged in a randomized complete block design (RCBD) with three replications. This study showed that the Brachiaria cultivars*year*location interaction was significantly varied ($P < .05$) across all the sites for most of the measured parameters. The highest and the lowest plant heights were recorded for Brachiaria mutica (var. DZF-483) and Brachiaria humidicola (DZF-9222), respectively. The highest DMY was obtained from Brachiaria mutica (var. DZF-483), followed by Brachiaria decumbens (DZF-10871), Brachiaria brizantha (DZF-13379), and Brachiaria humidicola (DZF-9222). Even though there were some differences in some of the measured parameters, Brachiaria mutica (var. DZF-483) and Brachiaria decumbens (DZF-10871) are recommended based on their maximum forage DMY production and distinct growth habits. Thus, it is recommended to be demonstrated and familiarized with the farming community to utilize the potential of these cultivars.

Keywords

Adaptability, Brachiaria Cultivars, Dry Matter Yield, *Brachiaria mutica*, Brachiaria Decumbens

1. Introduction

Ethiopia's livestock sector has been a key component of the nation's economy and continues to hold promise for fostering economic growth. At the household level, livestock is a vital source of sustenance and income for smallholder farmers and pastoralists. Approximately 80% of Ethiopian farmers rely on animal power to plough their fields [1]. Consequently, livestock plays a crucial role in ensuring food security, enhancing nutritional status, and driving economic growth within the

country [2]. Nonetheless, livestock productivity lags behind its rapidly increasing population due to various technical and management-related challenges. Notably, feed shortages, both in terms of quantity and quality, represent a significant technical obstacle that warrants urgent attention. Cultivated forages are insufficient to adequately nourish the large livestock population. In smallholder mixed crop-livestock systems, the widely used fodder Napier grass (*Pennisetum purpureum*)

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faces threats from diseases and also competes as a fuel source in certain regions [3]. Meanwhile, Rhodes grass (*Chloris gayana* L.), a cultivated pasture variety, suffers from a limited genetic base and restricted ecological adaptability [4]. Crop residues, which form the bulk of livestock feed during the dry season, are highly lignified [5]. These residues generally possess insufficient crude protein levels—below the 7% minimum necessary for optimal animal production—and lack essential minerals and vitamins [6]. In the country's extensive livestock production systems, livestock primarily manage to survive on natural pastures, which are diminishing due to the expansion of cropland. These pastures are not only limited in area but also low in quality, with their productivity declining rapidly during the dry season.

A significant factor contributing to the insufficient quantity and quality of feed is the lack of improved, adapted forages. The rising interest in livestock development, driven by increased demand for animal products, has highlighted the need for productive, high-quality forages to alleviate the feed deficit [7]. To address the existing feed shortage and enhance livestock productivity, it is essential to introduce and cultivate high-quality forages that exhibit high-yielding capabilities and adaptability to both biotic and abiotic environmental stresses. Interest in *Brachiaria* research was sparked by the remarkable performance of livestock production on *Brachiaria* pastures in South America [8]. Grasses in the *Brachiaria* genus offer several advantages over other genera, including drought tolerance, resilience in low-fertility soils, and the ability to sequester carbon [9]. Additionally, these grasses enhance nitrogen use efficiency through biological nitrification inhibition (BNI) and help mitigate greenhouse gas emissions [10].

The evaluation of the adaptability and utilization potential of *Brachiaria* grasses is crucial for ensuring a sustainable supply of feed resources in the study area. To date, the available *Brachiaria* cultivars have not been assessed at the Bako Agricultural Research Center (BARC). Consequently, the introduction and evaluation of *Brachiaria* grass cultivars becomes imperative to address the existing feed shortages in the study area. Hence, this study was designed to assess the adaptability and yield potential of different *Brachiaria* cultivars across Bako, Boneya Boshe, and Gute sub-sites.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted at three sites—Bako onstation, Boneya Boshe, and Gute sub-sites—in the Oromia regional state, western Ethiopia (see Figure 1). The specific sites included Bako (9°06' N, 37°09' E; elevation: 1,650 metres above sea level; mean annual rainfall: 2,285 mm), Boneya Boshe (9°54' N, 37°00' E; elevation: 1,645 metres; rainfall: 1,295 mm), and Gute (9°01' N, 36°40' E; elevation: 1,880 metres; rainfall: 1,586 mm). The soil at Bako is classified as Nitosol,

with 2.5% organic carbon, 10 ppm available phosphorus, 0.22% total nitrogen, and a pH (H₂O) of 5.18. In contrast, Boneya Boshe has clay loam soil containing 1.86% organic carbon, 12 ppm available phosphorus, 0.16% total nitrogen, and a pH (H₂O) of 4.6. At Gute, the soil consists of 60% silt, 35% sand, and 5% clay, with 1.98% organic carbon, 6.2 ppm available phosphorus, 0.17% total nitrogen, and a pH (H₂O) of 4.43. The farming systems in the area primarily involve mixed crop-livestock systems, with key crops including maize (*Zea mays*), teff (*Eragrostis tef*), noug (*Guizotia abyssinica*), sorghum (*Sorghum* spp.), hot pepper (*Capsicum annuum*), and sugarcane (*Saccharum officinarum*). The dominant types of livestock are cattle, small ruminants, and poultry [11].

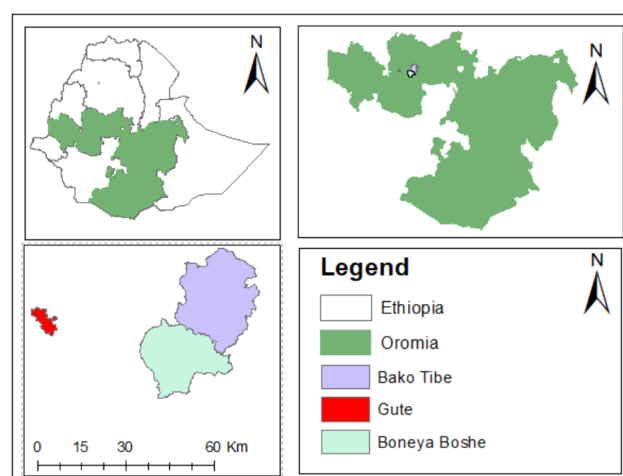


Figure 1. Map of the study area.

2.2. Experimental Materials

Cultivars of *Brachiaria* were collected from the Debre Zeit Agricultural Research Center for this study. The Cultivars were:

- 1) *Brachiaria brizantha* (DZF-13379)
- 2) *Brachiaria humidicola* (DZF-9222)
- 3) *Brachiaria mutica* (var. DZF-483)
- 4) *Brachiaria decumbens* (DZF-10871)

2.3. Treatments and Experimental Design

The experimental design is a randomized complete block design (RCBD) with three replications. The plot size was 2 m x 1.6 m, with a 1 m path between plots and 1.5 m between blocks. The roots of the grasses will be planted at 0.5 m and 0.15 m between rows and plants, respectively, on a well-prepared seedbed. Recommended fertilizer rates of 100 kg/ha DAP and UREA were applied. Recommended management practices (land preparation, hoeing, weeding, etc.) were applied during the experimental periods.

2.4. Biomass Yield Determination

At the 50% flowering stage, the herbage in the two middle rows was harvested, and the fresh biomass weight was taken using a field balance. The harvested herbage mass was manually chopped up into shorter lengths using a sickle, and the subsample weighing 200 g was dried in an oven at 65 °c for 72 hrs. or in the sun to determine herbage dry matter production.

$$DMY \text{ (t / ha)} = 10 * TFW * (DWSs / (HA * FWSs))$$

Where: 10 = constant for conversion of yields in kg/m² to ton/ ha;

- TFW = total fresh weight from harvesting area (kg);
- SSDW = sub-sample dry weight (g);
- HA = harvest area (m²), and
- SSFW = sub-sample fresh weight (g).

2.5. Statistical Analysis

Data were recorded and summarized using Microsoft Excel 2013 and analyzed with the general linear model (GLM) procedure of SAS 9.3. Significant differences among treatment means were separated and compared using the Least Significant Difference (LSD) test at a 5% significance level, or 95% confidence interval.

The model for data analysis was:

$$Y_{ij} = \mu + T_i + B_j + e_{ij}$$

- Where: Y_{ij} = measured response of treatment i in block j ,
 μ = grand mean of the experiment,
 T_i = effect of treatment i ,
 B_j = effect of block j ,
 e_{ij} = random error effect of treatment i in block j .

3. Results and Discussion

3.1. ANOVA Result

The analysis of variance (ANOVA) findings for different *Brachiaria* cultivars tested in Bako, Boneya Boshe, and Gute are presented in Table 1. The findings revealed significant variation ($P<.05$) among the tested cultivars, locations, and years of the study for dry matter yield (DMY), plant height (PH), and leafiness (Leafi). The variations in yield and yield components, other than the plot cover of *Brachiaria* cultivars in this study, were strongly influenced by location. The variability among locations may be attributed to differences in rainfall and temperature, as well as the physicochemical characteristics of the soil [12]. The tested *Brachiaria* cultivars exhibited varying growth traits and dry matter yields. The interaction effects of year, location, and cultivars also showed significant variation. This result aligns with the findings of Wekgari et al. [13].

Table 1. ANOVA result for dry matter yield and growth performance of *Brachiaria* cultivars at Bako in 2023 & 2024.

Source	d.f.	Mean squares			
		DMY	PH	PC	Leafi
Year	1	749.81***	636.06***	1.38ns	2.72*
Rep	2	3.86ns	0.13ns	4.05ns	1.79 ^{ns}
Cltvr	3	428.10***	16665.20***	3.61***	1.79*
Loc	2	48.55***	98.04***	0.51ns	1.54*
Year*Loc*Cltvr	17	3.31***	192.69***	0.98**	1.35**

df=degree of freedom, DMY=dry matter yield, PH=plant height, PC=plot cover, Leafi= leafiness, Rep=replication, Cltvr=cultivar, Loc=location

3.2. Agronomic Performance of Different *Brachiaria* Cultivars at Different Locations

3.2.1. Dry Matter Yield

According to the current study, dry matter yield (DMY) and plant height at harvest of four distinct *Brachiaria* cultivars varied significantly ($P <.01$) (Table 2). *Brachiaria Mutica* produced the

highest DMY among the tested cultivars, followed by *Brachiaria decumbens* in every study location. On the other hand, the lowest DMY was obtained from *Brachiaria humidicola* in each location. With the highest DMY coming from the Gute sub-site, the ranges at Bako, Boneya Boshe, and Gute are 8.83 to 19.90 t ha⁻¹, 8.58 to 18.24 t ha⁻¹, and 10.74 to 20.55 t ha⁻¹, respectively. The highest forage DMY production of this cultivar could be due to the highest plant height of the cultivar. Azeem et al. [14] also concluded that plant height and biomass production are directly

related, with higher plant height resulting in greater biomass yield. The findings of Mekonnen and Mekuriaw [15], Hunegnaw *et al.* [16], and Wekgari *et al.* [13], who found that

the same *Brachiaria* cultivar produced the maximum forage dry matter yield at various locations, are consistent with this conclusion.

Table 2. Dry matter yield performances of four *Brachiaria* cultivars across locations in 2023 and 2024.

Cultivars	Location			Combined mean
	Bako	BB	Gute	
<i>B. brizantha</i> (DZF-13379)	8.83 ^c	8.58 ^c	11.60 ^c	9.67 ^c
<i>B. humidicola</i> (DZF-9222)	7.36 ^d	8.67 ^c	10.74 ^c	8.92 ^d
<i>B. mutica</i> (var. DZF-483)	19.90 ^a	18.24 ^a	20.55 ^a	19.56 ^a
<i>B. decumbens</i> (DZF-10871)	10.82 ^b	10.79 ^b	13.54 ^b	11.72 ^b
Mean	11.73	11.57	14.11	12.47
LSD _(0.05)	0.8628	0.846	1.0755	0.5893
P value	<.0001	<.0001	<.0001	<.0001
Cv (%)	8.54	8.49	8.85	7.04

a, b, c, d means with different letters are significantly different. BB = Boneya Boshe, coefficient of variance, LSD = least significant difference.

3.2.2. Plant Height at Harvest

Plant height is one of the traits that are important for forage biomass production. The results of this study showed that there were substantial differences ($P < .05$) in plant height at harvest between four different *Brachiaria* cultivars (Figure 2). In every testing site, *Brachiaria humidicola* and *Brachiaria mutica* had the shortest (60 cm) and tallest plant heights (140 cm) at harvest, respectively. The highest plant height of *Brachiaria mutica* recorded in the current study agrees with the

findings of Hunegnaw *et al.* [16]. In all the study sites, the lowest plant height of *Brachiaria humidicola* was below the mean value of all the cultivars. This is reflected in the lowest dry matter yield of the cultivar among the others in all study locations. This is mainly due to the genetic potential difference among different *Brachiaria* cultivars used in this study. The plant height of *Brachiaria mutica* is lower than the height recorded for the same cultivar at the Haro Sabu Agricultural Research Center by Wekgari *et al.* [13], but higher than the value documented by Dereje *et al.* [17] in the Debre Zeit Agricultural Research Center.

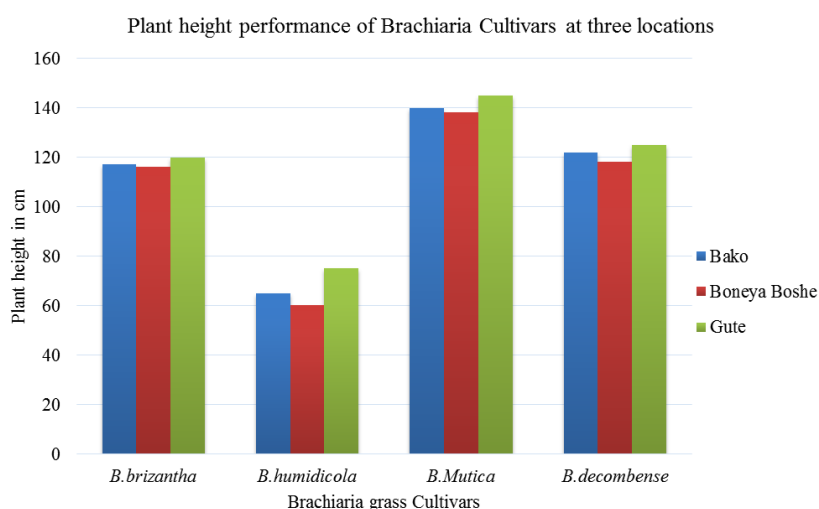


Figure 2. Plant height at the forage harvesting stage of four *Brachiaria* Cultivars across three locations.

3.2.3. Plot Cover

Plot cover in forage crops is a highly desirable characteristic, contributing to both forage biomass production from a specific plot of land and to soil and water conservation. The plot cover among various *Brachiaria* cultivars evaluated in this study demonstrated significant variations (Figure 3). Notably,

B. humidicola, *B. decumbens* and *B. mutica* exhibited comparably higher plot cover than *B. brizantha*. Across all study sites, *B. mutica*, *B. humidicola*, and *B. decumbens* consistently showed the highest plot cover, followed by *B. brizantha*. Findings from this study revealed that plot cover values had a direct positive correlation with forage biomass production. This result is consistent with the finding of Chen *et al.* [18].

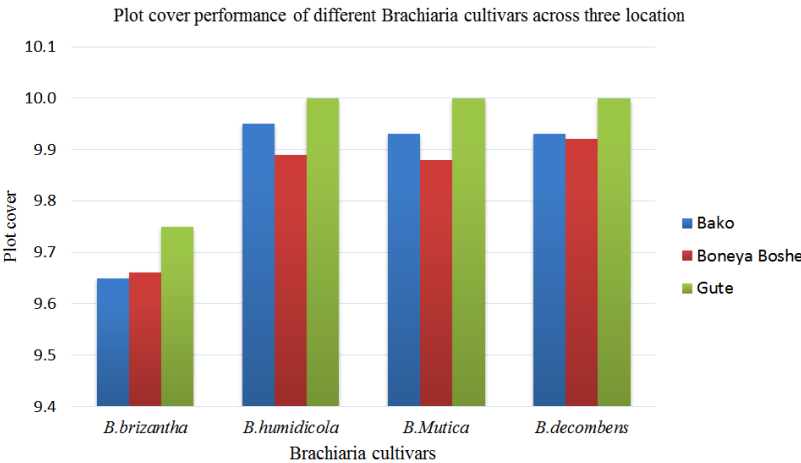


Figure 3. Plot cover of four *Brachiaria* Cultivars across three locations.

3.2.4. Vigour and Leafiness

The vigour and leafiness characteristics of four *Brachiaria* cultivars are presented in Table 3. At the Bako site, although

numerical differences were observed among the cultivars, no significant variation in vigour and leafiness was recorded. This result is against the findings of Mekonnen and Mekuriaw [15].

Table 3. Agronomic performance of four *Brachiaria* cultivars across locations in 2023 & 2024.

Cultivar	Vigor			Leafiness		
	Bako	BB	Gute	Bako	BB	Gute
B. brizantha (DZF-13379)	8.33	8.50 ^b	8.33 ^b	8.50	9.00	8.33 ^b
B. humidicola (DZF-9222)	9.17	8.17 ^b	8.83 ^b	9.33	9.33	9.00 ^{ab}
B. mutica (var. DZF-483)	9.00	9.83 ^a	9.67 ^a	9.00	9.17	9.67 ^a
B. decumbens (DZF-10871)	9.16	9.83 ^a	9.83 ^a	8.33	9.50	9.83 ^a
Mean	8.92	9.08	9.17	8.79	9.25	9.21
LSD _(0.05)	0.946	0.505	0.744	1.000	1.013	0.838
P value	0.234	0.0001	0.002	0.172	0.754	0.005
Cv (%)	8.7	4.6	6.7	9.3	9.0	7.5

^{a, b},=means with different letters are significantly different. BB=Boneya Boshe

In contrast, both *Brachiaria mutica* and *Brachiaria decumbens* exhibited noticeably higher vigour, followed by

Brachiaria brizantha and *Brachiaria humidicola*. At the Boneya Boshe sub-site, leafiness among all cultivars was

statistically similar. However, at the Gute sub-site, differences in leafiness were statistically significant, with *Bra-*

chiaria mutica, *Brachiaria decumbens*, and *Brachiaria hu-*
midicola exhibiting comparable levels of leafiness.

3.2.5. Effect of Year on Dry Matter Performance of Different Brachiaria Cultivars

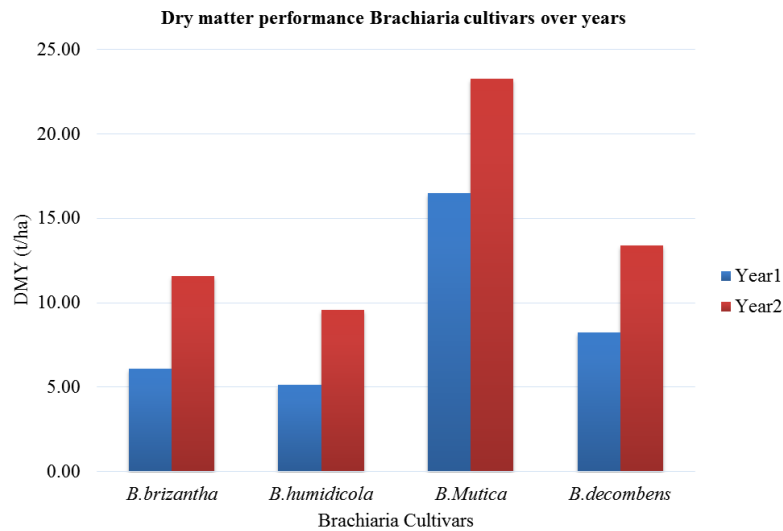


Figure 4. Forage Dry matter Performance of different Brachiaria Cultivars in year 1 and year 2.

In this study, a significant variation was noted between the first and second years of establishment of Brachiaria cultivars across all testing sites (Figure 4). The most substantial difference in dry matter yield (DMY) was observed in *Brachiaria mutica* (var. DZF-483), which exhibited a variation of 6.77 t ha⁻¹, whereas *Brachiaria humidicola* (DZF-9222) demonstrated the smallest variation at 4.42 t ha⁻¹.

Generally, the forage dry matter yield for all Brachiaria cultivars increased over the years and is comparable with the previous work of Garay *et al.* [19]. This increase can likely be attributed to enhanced root development in these perennial grass cultivars, allowing them to more effectively utilize essential growth nutrients from the soil.

3.3. Morphological Characteristics of the Four Brachiaria Cultivars

The four Brachiria cultivars in the current study were found to have distinct patterns of growth (Table 4). Farmers and growers can take care of the agronomic practices that a crop requires by being aware of and identifying the growth characteristics of any crop. For example, *Brachiaria mutica* spreads quickly along the ground surface and requires enough land area to reach its maximum growth potential for forage production. However, the other cultivars spread less along the ground surface and grow erect upward. In addition to forage biomass production potential as a criterion, farmers may find this observation result useful in selecting cultivars based on their available plot of land.

Table 4. Growth habit of four Brachiaria cultivars used for the study.

Cultivars	Growth Habit
Brachiaria brizantha (DZF-13379)	Erect/prostrate with high seed-bearing potential
Brachiaria humidicola (DZF-9222)	Erect/prostrate with dense spongy ground cover with no seed-bearing potential
Brachiaria mutica (var.DZF-483)	Spreading/creeping by rhizomes along the ground with moderate seed-bearing potential
Brachiaria decumbens (DZF-10871)	Erect/prostrate with high seed-bearing potential

4. Conclusion

This study evaluated the growth and herbage dry matter yield of four *Brachiaria* cultivars across three sub-humid agro-ecological zones in western Oromia, Ethiopia. The combined analysis highlights the significance of taking into account locations and cultivar attributes when choosing forage grasses. Notably, *Brachiaria mutica* (var. DZF-483) is the leading cultivar, demonstrating superior dry matter yield and agronomic traits across all the testing sites and years, followed by *Brachiaria decumbens* (DZF-10871). Consequently, demonstrating *Brachiaria mutica* (var. DZF-483) and *Brachiaria decumbens* (DZF-10871) on farmers' fields in the study areas due to their promising biomass production and adaptability is recommended. Furthermore, it is suggested to conduct additional research to analyze the nutritional value of the cultivars and the performance of animals when these grass cultivars are used as a basal diet supplemented with concentrates.

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Abbreviations

ANOVA	Analysis of Variance
BARC	Bako Agricultural Research Center
BNI	Biological Nitrification Inhibition
DMY	Dry Matter Yield
GLM	The General Linear Model
LSD	Least Significant Difference
RCBD	Randomized Complete Block Design
SAS	Statistical Analysis Software

Author Contributions

Wakgari Keba: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Conflicts of Interest

The author declares no conflicts of interest.

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