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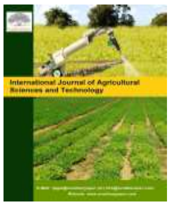

Research Paper

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Genotype by Environment Interaction Analysis and Stability Study of Elephant grass (*Pennisetum purpureum*) Genotypes at Lowlands of East Hararghe zone of Oromia, Ethiopia

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Abstract

Elephant grass could play an important role in providing a considerable amount of quality forage for mixed farming system. Thus, the study was conducted to evaluate and identify stable and high-yielding elephant grass genotypes for herbage dry matter yield, nutritional quality and performance for major agronomic traits. Ten elephant grass genotypes and one elephant grass variety (Zehone-02) as standard checks were used as experimental materials. The genotypes were arranged in a randomized complete block design (RCBD) with three replications. The combined analysis of variance for herbage dry matter yield, plant height, tiller number and leaf to stem ratio over six locations revealed significant ($p<0.001$) variation due to genotypes by environment interaction. The analysis of variance revealed substantial ($p<0.001$) differences between genotypes for herbage dry matter yield, leaf to stem ratio, tiller number and plant height. The concentrations of NDF%, TA% and IVDMD differed significantly ($p<0.001$), while the results for the other quality indicators were not. The genotype ILRI 16803 had the highest herbage dry matter yield (45.24 t/ha) and leaf to stem ratio value (2.86) over other tested materials. The genotype ILRI-16803 had showed 31.17% yield advantage over the standard check (Zehone-02 variety) (31.14 t/ha/year). Genotype by environment interaction analysis also showed that genotype ILRI-16803 was more stable across locations. Therefore, elephant grass genotype ILRI-16803 was the highest yielder and most stable across the study sites, indicating the genotype's potential for cultivation as well as to be released as a variety.

Keywords: *Dry matter, Elephant grass, Genotype, Location, Stability, Variety*

1. Introduction

The major livestock feed resources in Ethiopia are natural pasture, crop residues, improved pastures, forage crops, and agro-industrial by-products (Alemayehu, 2004). The utilization of those feed resources, however, depends up on agro-ecology and crops produced. Natural pastures and crop residues are low in quality and these feed-stuffs are too low to sustain satisfactory levels of animal production (Tessema and Baars, 2006). These natural pastures are declining from

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time to time in both quantity and quality (Ulfina *et al*., 2013). The fast growth of the human population has reduced the natural grazing lands of the country from time to time due to the demand for land for crop production (Yayneshet, 2010). These feed resources cannot support higher animal productivity due to their nutritional limitations that is higher in fiber content and lower in CP content, resulting in low digestibility. Low quality feeds are associated with a low voluntary intake, resulting in insufficient nutrient supply, low productivity, and even weight loss (Hindrichsen *et al*., 2004). This results in low growth rates, poor fertility, and high mortality rates of ruminant animals (Odongo *et al*., 2002).

Elephant grass is a perennial C4 grass species that is native to Sub-Saharan Africa from where it is believed to have been distributed to other tropical and subtropical regions around the world (Kandel *et al*., 2016). 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. Characteristically, Elephant grass is vigorous and highly productive forage, which can withstand long periods of drought (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*., 2009b) and can survive in drought for more than five years. Elephant grass is superior to other tropical grasses in terms of dry season growth and forage quality (Wijitphan *et al*., 2009b) 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 can provide a continual supply of green forage throughout the year and is best fit for intensive small-scale farming systems with appropriate management practices for cut and carry feeding systems in Ethiopia (Tessema and Alemayehu, 2010). Elephant grass has been the most promising high-yielding fodder, giving dry matter yields that surpass most other tropical grasses (Ansah *et al*., 2010). Some authors reported that the dry matter yield of elephant grass is 60 t/ha/year (Rengsirikul *et al*., 2013), 27.5-45.43 t/ha/year (Mekonnen *et al*., 2019) and 20-30 t/ha/year (Farrell *et al*., 2002). Despite the fact that multiple genotypes of elephant grass have existed in Ethiopian's diverse agro-ecologies, they have not been evaluated, and hence nothing is known about their performance and adaptability in the study area. Therefore, the objective of the present study was to evaluate and identify high-yielding and stable genotypes for forage yields, nutritional qualities, and performance for major agronomic traits.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted at Fedis and Babile districts of East Hararghe Zone of Oromia. They are situated at an altitude of 1050 to 2118 m above sea level (Fuad *et al*., 2018). The amount of rainfall varies between 650 and 750 mm, while the average temperature of the districts ranges between 25 and 30°C (Zenna, 2016). Farming system of the districts are characterized by mixed crop-livestock farming. The major crops grown in the districts are maize, sorghum, groundnut, and *khat*. Important livestock species abundantly reared in the districts include cattle, shoat, camels, donkeys and chickens.

2.1.1. Experimental Materials and Management

Eleven (11) elephant grass genotypes including standard check (Zehone-02) were evaluated across locations. All genotypes (ILRI-16803, ILRI- 16840, ILRI-15743, ILRI-16793, ILRI-16795, ILRI-16784, ILRI-16786, ILRI-16836, ILRI-16798, and ILRI-16805) were collected from ILRI (International livestock research institute) and evaluated with the standard

Table 1: Descriptions of Elephant Grass Genotypes Used for the Experiment

No.	Genotypes	Source
1	ILRI-16803	ILRI
2	ILRI-16840	ILRI
3	ILRI-15743	ILRI
4	ILRI-16793	ILRI
5	ILRI-16795	ILRI
6	ILRI-16784	ILRI
7	ILRI-16786	ILRI

Table 1 (Cont.)		
No.	**Genotypes**	**Source**
8	ILRI-16836	ILRI
9	ILRI-16798	ILRI
10	ILRI-16805	ILRI
11	Zehone-02	HARC
Note: ILRI = International Livestock Research Institute, HARC= Holeta Agricultural Research Center.		

check (Zehone-02 variety) that was taken from Holeta Agricultural Research center, across two environments (Fedis and Babile) districts in 2019/20, 2020/21 and 2021/22 main cropping seasons. Elephant grass genotypes were evaluated for herbage yield, leaf to stem ratio and other agronomic parameters and their stability across environment.

2.1.2. Experimental Design and Treatments

The genotypes were arranged in a randomized complete block design (RCBD) with 3 replications on a plot area of 2 m * 1.8 m. The space between plots and replications was 1 m and 1.5 m, respectively. The space between rows and plants was 100 cm and 50 cm, respectively. All agronomic practices were applied equally to all plots as per the recommendation.

2.1.3. Experimental Procedures and Field Management

Elephant grass under the experiment was harvested two times per year. The first harvesting was at 90 days after planting, while the second harvesting was 60 days after the first harvesting. The forage was harvested at 90 days after planting from the two middle rows and a sample of 500 g of fresh biomass was taken both from leaf and stem and dried in an oven at 65 ^{0}C for 72 hours to a constant weight. Leaf to stem ratio (LSR) was calculated from dry matter yield of leaf and stem or LSR equal to leaf dry matter yield divided by stem dry matter yield. Partially dried feed samples were ground to pass through a 1 mm sieve screen using Wiley mill and stored in plastic bags for chemical analysis. The partially dried and ground feed samples were filled in plastic bags and submitted to Holeta Agricultural Research Center and nutritional qualities (DM%, TA%, CP%, NDF%, ADF%, ADL %, and IVDMD) were analyzed.

The dry biomass yield (DM t/ha) was calculated using the following formula:

DM yield (t/ha) = TFW x (DWss /HA x FWss) x 10 (Tarawali *et al*., 1995)

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^2 to t/ha, t/ha = ton per hectare.

2.2. Data Collected

The data collected were survival rate (%), plant height (cm), fresh biomass yield (t/ha), dry matter yield (t/ha), tiller number, nod per plant, nod length, leaf to stem ratio and diseases incidence.

2.3. Data Analysis

Data on agronomic performance, dry matter yield, Leaf to stem ratio and chemical composition were analyzed using SAS software version 9.3. Means were separated using Tukey test at 5% level of significance.

3. Results and Discussion

3.1. Analysis of Variance

Combined analysis of variance (ANOVA) showed significant ($p < 0.01$) variations for genotype and environment for herbage DM yield, plant height, tiller number and, leaf to stem ratio (Table 2). The results of the genotype by environment (G x E) interaction were significantly ($p < 0.01$) affected dry matter yield, plant height, tiller number and, leaf to stem ratio while genotype by year showed no significant on dry matter yield and other major agronomic parameters. These results illustrated the evidence for genetic variability among elephant grass genotypes and the diversity of locations.

Table 2: Combined ANOVA Results of Elephant Grass Genotypes Over Years and Locations

Source of Variation	Df	Mean Square						
		DMY	TN1	TN2	PHt1	PHt2	LSR	LSR2
Rep	2	107.93^{ns}	24.55^{ns}	55.24^{ns}	627.4^{ns}	281.7	0.0387^{ns}	0.0468^{ns}
Genotype(G)	10	476.98**	85.15**	191.60**	6006.9**	2696.5**	3.0794**	3.7261**
Environment (E)	5	140.71**	452.22**	1017.49**	25573.6**	11480.0**	5.3247**	6.4429**
Year (Y)	2	65.26^{ns}	1023.41**	2302.66**	59060.2**	26512.1**	7.7024**	9.3199**
G x E	50	28.87**	17.42*	39.19**	704.8**	316.4**	0.4490**	0.5433**
G x Y	20	39.17^{ns}	10.22^{ns}	22.99^{ns}	483.0^{ns}	216.8^{ns}	0.2013^{ns}	0.2436^{ns}
Residual	130	26.65	16.92	23.09	360.7	161.9	0.1519	0.1837

Note: Df = degree of freedom, DMY = dry matter yield, TN1 = tiller number of 1st harvest, TN2 = tiller number of 2nd harvest, PHt1 = Plant height of 1st harvest, PHt2 = Plant height of 2nd harvest LSR1 = leaf to stem ratio of 1st harvest, LSR2 = leaf to stem ratio of 2nd harvest, ** = highly significant,* = Significant, ns = non-significant

3.2. Herbage Dry Matter Yield Performance

ANOVA result revealed that there was a significant ($p < 0.001$) different in mean herbage dry matter yield among the elephant grass genotypes (Table 3). The dry matter yield of the current study (30.52-45.24 t/ha/year) is in agreement with

Table 3: The Combined Mean Total Herbage Dry Matter Yield (t/Ha/Year), 1st Harvest Dmy (T/Ha) and 2nd Harvest Dmy (t/Ha) of Elephant Grass Genotypes Across Locations

Genotypes	DMY (t/ha/year)		Overall TDMY/t/ha/year	DMY of 1st H		DMY of 2nd H	
	Fedis	Erer		Fedis	Erer	Fedis	Erer
16803	46.18^{a}	44.3^{a}	45.24^{a}	30.02^{a}	28.8^{a}	16.16^{a}	15.51^{a}
16840	41.39^{b}	33.31^{cd}	37.35^{b}	26.9^{b}	21.65^{cd}	14.49^{b}	11.66^{bc}
15743	39.15^{b}	34.29^{c}	36.72^{bc}	25.45^{bc}	22.29^{bc}	13.7^{bc}	12.0^{bc}
16793	36.81^{c}	34.1^{c}	35.45^{bcd}	23.92^{c}	22.16^{bc}	12.88^{bc}	11.93^{bc}
16795	39.67^{b}	37.04^{bc}	38.36^{b}	25.79^{bc}	24.08^{b}	13.89^{bc}	12.96^{b}
16784	39.71^{b}	39.06^{b}	39.39^{b}	25.81^{bc}	25.39^{b}	13.9^{bc}	13.67^{b}
16786	39.67^{b}	35.22^{bc}	37.44^{b}	25.79^{bc}	22.89^{bc}	13.88^{bc}	12.33^{bc}
16836	38.5^{bc}	38.44^{b}	38.47^{b}	25.02^{bc}	24.98^{b}	13.47^{bc}	13.45^{b}
16798	34.53^{de}	33.32^{cd}	33.92^{cd}	22.44^{cd}	21.66^{cd}	12.08^{cd}	11.66^{bc}
Zihone 02	32.31^{de}	29.96^{de}	31.14^{d}	21.0^{d}	19.48^{d}	11.31^{cd}	10.49^{cd}
16805	31.34^{e}	29.71^{e}	30.52^{d}	20.37^{d}	19.31^{d}	10.97^{d}	10.4^{d}
G.mean	38.11	35.34	36.73	24.77	22.97	13.34	12.37
CV (%)	12.5	13.8	13.1%	11.5	10.8	12.4	13.6
P-value	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Note: $^{a, b, c, d}$ Means in a columns, values followed by different letters differ significantly ($p < 0.05$), TDMY = total dry matter yield, DMY = dry matter yield, t = ton, ha = hectare, yr = year, 1st H = dry matter yield of 1st harvest, 2nd H = dry matter yield of 2nd harvest, G mean = grand mean.

the study of Mekonnen *et al*. (2019) who reported a dry matter yield of (27.5-45.43 t/ha/year for elephant grass. The current study's result is higher than the result obtained by Farrell *et al.* (2002) which is 30 t/ha/ per year, however, lower than the study of Rengsirikul *et al*. (2013) who reported 60 t/ha annually. In contrast to this finding, Orodho (2006) reported that Napier grass had a higher dry matter production through multiple cuttings, with values ranging from 50 to 150 t/ha per year. Elephant grass also gives dry matter yield of 41.05 t/ha at four months of harvesting and Ansah *et al*. (2010) clarified that this might be due to the proportional increment of dry matter yield with advance in age of cutting. Roy *et al.* (2013) reported that the annual dry matter yield of Napier grass at the smallholder farmer level is 57 t/ha. However, Kabrizi *et al.* (2013) revealed that with multiple harvesting, elephant grass yields 17 to 47 t/ha/year in dry matter. This variation is due to differences in cultivars/genotypes, agro-ecological conditions, and management practices. Deribe *et al. (*2017) found that elephant grass genotypes had lower dry matter yields, ranging from 6.95 to 17.90 t/ha from a single cutting, in contrast to the current study.

3.3. Plant Height

ANOVA result showed that there were significant ($p < 0.05$) variations in plant height among elephant grass genotypes across locations both at 1st harvest and 2nd harvest Table 4. The tallest and the shortest plant height recorded in the present study were 167.8 cm and 109.8 cm for ILRI-16798 and ILRI-16836 genotypes, respectively during 1st harvest while 114.96 cm and 75.33 cm for ILRI-16798 and ILRI-16836 genotypes, respectively during 2nd harvest. The results of plant height during the 1st harvesting from the current study is in agreement with the result obtained by Tessema *et al*. (2002a) which ranges from 100 to 150 cm. On the other hand, the plant height at the 2nd harvesting was lower than the result reported by (Tessema *et al*., 2002b). In line with the current findings, Tamrat *et al.* (2021) reported that plant height of Napier grass values ranges from 114.85 to 135.87 cm, while (Tessema *et al*., 2022) reported lower plant height of 63.91 to 85.72 cm for elephant grass genotypes. The current plant height result of 2nd harvesting at 2 months was lower than with some genotypes in the range reported by Getnet (2003) at 2 months of age elephant grass genotypes attained the optimum plant harvesting stage (1-1.5 m) for forage and Deribe *et al.* (2017) found that 1-1.3 m at the age of 2 months. The

Table 4: Mean Plant Height (cm) of Elephant Grass Genotypes During 1st Harvest and 2nd Harvest Across Locations

Genotypes	Pht of 1st H		1st H Mean	Pht of 2nd H		2nd H Mean
	Fedis	Erer		Fedis	Erer	
ILRI-16803	112.3e	113.5e	112.9d	75.23e	79.66cd	77.44d
ILRI-16840	127.9bc	118.5de	123.2cd	85.67d	82.88c	84.27cd
ILRI-15743	127.43bc	118.07de	122.8cd	85.36d	79.13cd	82.25cd
ILRI-16793	164.9ab	143.4b	154.2ab	110.5ab	100.58b	105.54ab
ILRI-16795	132.1bc	120.6cd	126.4cd	88.54bc	84.3c	86.42cd
ILRI-16784	155.1b	120.4cd	137.8bc	103.92b	84.22c	94.07bc
ILRI-16786	131.4bc	117.1de	124.3cd	88.04bc	81.9cd	84.97cd
ILRI-16836	111.1e	108.5e	109.8d	74.43e	76.23d	75.33d
ILRI-16798	167.9a	167.7a	167.8a	112.49a	117.43a	114.96a
Zihone 02	150.3b	161.2ab	155.8ab	100.73b	112.61ab	106.67ab
ILRI-16805	119.5de	135.2bc	127.4cd	80.08de	94.8bc	87.44cd
G. mean	136.36	129.47	132.95	84.08	90.34	90.85
CV (%)	12.6	12.3	14.5	14.5	14.9	14.8
P-value	0.001	0.001	0.001	0.001	0.002	0.001

Note: a, b c d Means in a columns, values followed by different letters differ significantly ($p < 0.05$), Pht = plant height, 1st H = first harvest, 2nd H = 2nd harvest, G mean = grand mean.

findings by Van De Wouw *et al.* (1999) also revealed that the height of the elephant grass genotypes at the end of the establishment year varied from 1.4 m to 4.2 m that is in contrast to the current study. The difference might be due to the varietal difference and agro-ecological condition. Gomide *et al.* (2015) reported that shorter varieties had a greater proportion of leaves compared to taller varieties. In fact, higher leaves content can result in higher nutritional value.

3.4. Tiller Performance

The result revealed that the tiller number of elephant grass in the current study was significantly ($p < 0.05$) different among genotypes (Table 5). Tiller number ranges from 11.72 to 16.33 during 1st harvest at 3 months and 17.58 to 24.5 during 2nd harvest at 2 months. The result of the tiller number of the current study is in agreement with Tamrat *et al* (2021) that reported tiller number ranged from 17.32 to 19.48 at first harvesting but lower than the same author reported at second harvesting values ranged from 30.83 to 43.83. The number of tillers per plant of the current study result is also lower than the value reported by Gezahagn *et al*. (2016) (26.4 to 38.2). This difference might be due to varietal and agro-ecological differences. At both the first and second harvesting, the genotype ILRI-16803 produced a higher tiller number, while the Zehone-02 variety yielded a lower tiller number.

Table 5: Mean Tiller Number During 1st Harvest and 2nd Harvest of Elephant Grass Genotypes Across Locations

Genotypes	Tiller Number (TN) of 1st H		Over All Mean TN of 1st H	Tiller Number (TN) of 2nd H		Over All Mean TN of 2nd H
	Fedis	Erer		Fedis	Erer	
ILRI-16803	17.25a	15.42a	16.33a	25.9a	23.1a	24.50a
ILRI-16840	15.25b	9.41d	12.33cd	22.9b	14.1d	18.50bc
ILRI-15743	14.31b	12.85bc	13.58bcd	21.5bc	19.3bc	20.37bc
ILRI-16793	14.97b	13.83bc	14.40bcd	22.5b	20.7b	21.60bc
ILRI-16795	14.94b	14.53ab	14.74bcd	22.4b	21.8ab	22.10bc
ILRI-16784	11.33d	12.58c	11.96d	17.0d	18.9bc	17.94c
ILRI-16786	16.08ab	15.42a	15.75 bc	24.1ab	23.1a	23.63abc
ILRI-16836	13.19bc	14.69ab	13.94bcd	19.8cd	22.0ab	20.92bc
ILRI-16798	13.22bc	12.78bc	13.00bcd	19.8cd	19.2bc	19.50bc
Zihone 02	12.86bc	10.58cd	11.72d	19.3cd	15.9cd	17.58c
ILRI-16805	13.72bc	12.44c	13.08bcd	20.6bc	18.7bc	19.62bc
G. mean	14.28	13.14	13.71	21.44	19.71	20.57
CV (%)	17.3	16.5	22.6	18.7	17.4	25.9
P-value	0.001	0.001	0.01	0.001	0.001	0.001

Note: a, b c d Means in a columns, values followed by different letters differ significantly ($p < 0.05$), 1st H = first harvest, 2nd H = second harvest, TN = Tiller number, G mean = grand mean.

3.5. Leaf to Stem Ratio

ANOVA result revealed that leaf to stem ratio of the current study was significantly different ($p < 0.05$) among the genotypes (Table 6). Leaf to stem ratio ranges from 1.54 to 2.72 during the first harvesting (at 3 months) and 1.7 to 3.0 during the second harvesting (at 2 months). The current study's findings are consistent with those of Nyambati *et al.* (2010), whose results ranged from 1.7 to 3.1, as well as with Tessema and Alemayehu (2010), who reported results ranging from 0.8 to 8.7, and Zailan *et al.* (2018), who reported values ranging from 0.74 to 3.18) in Malaysia. The current study's result is higher than and some genotypes within the range given by Islam *et al*. (2023) (0.3 to 2.4) and Halim *et al*. (2013) (0.57 to 1.63). Also, the current result is higher than the study of Tamrat *et al.* (2021) which ranges from 0.86 to 1.0. This difference might be due to varietal differences of Elephant grass. The current result was supported by Zailan *et al.* (2018) who reported that the leaf to stem ratio was significantly affected by cultivar and harvesting age. Genotypes ILRI-16803 and ILRI-16836 hold higher nutrients than other genotypes and the performance of animals is closely related to the amount of leaf in the diet because leaf is generally of higher nutritive value than stem (Deribe *et al*., 2017). Zailan *et al*. (2018) found out that the leaf to stem ratio (LSR) is one of the criteria for evaluating the quality of the pasture because the higher proportion of leaves compared to stem indicates a better nutritive value.

Table 6: Mean Leaf to Stem Ratio During 1st Harvest and 2nd Harvest of Elephant Grass Genotypes Across Locations

Genotypes	LSR of 1st H		1st H Mean	LSR of 2nd H		2nd H Mean LSR of
	Fedis	Erer		Fedis	Erer	
ILRI-16803	2.85a	2.6a	2.72a	3.14a	2.86a	3.00a
ILRI-16840	2.39b	2.05bc	2.22cd	2.63bc	2.25bc	2.44cd
ILRI-15743	2.62ab	2.13bc	2.38bc	2.88b	2.35bc	2.61bc
ILRI-16793	2.53b	1.75c	2.14cd	2.78b	1.92c	2.35cd
ILRI-16795	2.02bc	1.84c	1.93de	2.22cd	2.02c	2.12de
ILRI-16784	2.10bc	2.18bc	2.14cd	2.31cd	2.39bc	2.35cd
ILRI-16786	2.16bc	2.30b	2.23cd	2.38cd	2.53b	2.45cd
ILRI-16836	2.71ab	2.38b	2.54abc	2.98ab	2.61b	2.80abc
ILRI-16798	1.88cd	1.25e	1.57e	2.07d	1.37e	1.72e
Zihone 02	1.62d	1.46d	1.54e	1.78e	1.61d	1.70e
ILRI-16805	2.25bc	1.43d	1.84de	2.47bc	1.58de	2.02de
G. mean	2.28	1.94	2.11	2.51	2.14	2.23
CV (%)	15.6	14.3	17.9	17.2	16.4	19.7
P-value	0.001	0.001	0.001	0.001	0.001	0.001

Note: a, b c d Means in a columns, values followed by different letters differ significantly ($p < 0.05$), LSR = leaf to stem ratio, 1st H = 1st harvest, 2nd H = 2nd harvest, G mean = grand mean.

3.6. Nutritional Quality Analysis

The mean value of nutritional composition of elephant grass genotypes tested is presented in Table 7. ANOVA result revealed that total ash, NDF, IVDMD, and DOMD of elephant grass were significantly ($p < 0.05$) different among the genotypes while the other quality parameters showed non-significant results. The CP value recorded by genotypes in the current study ranges from 12.02-14.73%. The CP content of the current study is in agreement with the study of Usman *et al.* (2014) which reported 14%. The non-significant difference in CP content of elephant grass is in agreement with Tamrat *et al.* (2021) and Gezahagn *et al.* (20l6) but in contrast with Tessema (2002a) who reported significant differences in CP content. The CP content of the current study is higher than the study of Tamrat *et al* (2021) who reported values ranging from 8.34 to 9.83% and the reports of Tessema (2002a) 10.63%. The NDF content of the current study is lower than the study of Tamrat *et al.* (2021) which is 71.71 to 80.84%. Decrease in NDF content has been associated with increasing digestibility and hence feed intake (McDonald *et al*., 2002). ADF and ADL content of the current study was non-significant among the genotypes and yielded 35.53 to 40.1 and 4.17 to 5.11, respectively. The result of ADL content of the current study is in agreement with the study of Tessema and Alemayehu (2010) which is 3.12 to 4.61% except for genotype ILRI-15743 which recorded 5.11%. The ANOVA result revealed that IVDMD and IVOMD were significantly different among genotypes. IVDMD of the current study ranges from 54.27 to 69.16% and IVOMD ranges from 45.16 to 60.98%. Compared to studies by Tamrat *et al*. (2021) and Lyimo *et al*. (2016), whose reported mean values of 59.5% and 59.3%, respectively, the IVDMD of the current study is higher. This difference might be due to varietal, agro-ecological, and harvesting stage differences.

Table 7: Mean Nutritive Value of Elephant Grass Genotypes Across Locations (Fedis and Babile)

Genotypes	DM%	In % DM							
		Ash	CP	NDF	ADF	ADL	IVDMD	IVOMD	ME MJ/kg DM
16803	91.82	6.46[a]	14.73	69.81[b]	36.51	4.17	66.15[ab]	57.81[ab]	9.26[ab]
16840	91.54	5.89[ab]	14.64	70.43[ab]	36.64	4.29	65.91[ab]	57.53[ab]	9.20[ab]
15743	91.76	4.45[ab]	11.30	72.55[a]	40.10	5.11	54.27[e]	45.30[e]	7.25[b]
16793	91.61	4.94[ab]	14.04	71.58[ab]	36.55	4.21	60.17[cd]	51.43[cd]	8.23[ab]
16795	91.72	5.19[ab]	13.11	70.76[ab]	37.57	4.46	63.59[bc]	55.06[bc]	8.81[ab]
16784	91.68	6.54[a]	13.90	69.80[ab]	36.72	4.46	65.80[ab]	57.41[ab]	9.19[ab]
16786	91.82	3.85[b]	12.29	72.81[a]	39.57	4.67	54.27[e]	45.16[e]	7.23[b]
16836	91.74	6.61[a]	13.37	70.18[ab]	37.45	4.42	62.08[c]	53.46[bc]	8.55[ab]
16798	91.74	4.53[ab]	12.40	71.06[ab]	36.70	4.31	61.95[c]	54.38[bc]	8.70[ab]
Zihone 02	91.94	4.35[ab]	12.02	71.73[ab]	37.51	4.67	60.85[cd]	52.15[cd]	8.34[ab]
16805	91.33	6.33[ab]	13.76	67.55[b]	35.53	4.34	69.16[a]	60.98[a]	9.76[a]
G. mean	91.69	5.28	13.17	70.75	37.65	4.52	61.79	53.25	8.52
CV (%)	1.4	16.4	10.9	2.6	4.9	18.6	2.0	3.1	9.1
p-value	Ns	0.001	Ns	0.002	Ns	Ns	0.001	0.001	0.002

Note: [a, b c d] Means in a columns, values followed by different letters differ significantly ($p < 0.05$), DM = dry matter, CP = crude protein, NDF = Neutral detergent fiber, ADF= Acid detergent fiber, ADL = Acid detergent lignin, IDMD = *in-vitro* dry matter digestibility, DOMD = digestible organic matter digestibility, ME = metabolizable energy, G. mean=grand mean.

3.7. Reaction to Major Diseases

Head smut and stunting disease are economically important diseases for elephant grass. Fortunately, all tested genotypes including the standard check (Zehone-02) were not affected by these diseases throughout the study periods.

3.8. Dry Matter yields stability

An analysis of variance revealed that genotype by environment interactions were statistically significant ($p < 0.001$) for dry matter yield among genotypes Table 2. Yield stability parameters for eleven (11) elephant grass tested for three years

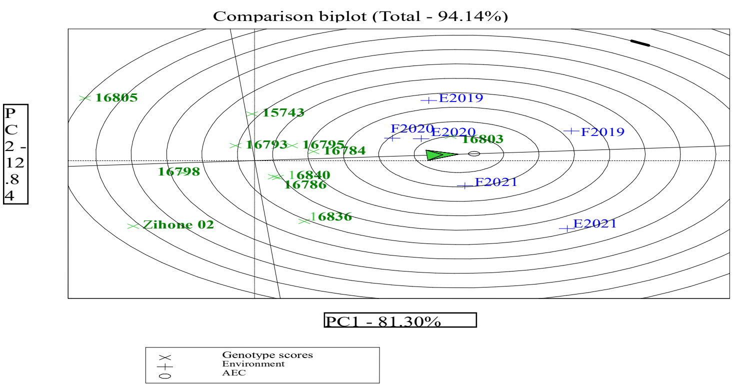

Figure 1: GGE Biplot Ranking Genotypes for Herbage Dry Matter Yield t/Ha of Elephant Grass Tested at Two Locations For 3 Year

at two locations were studied based on the methods of Eberthart and Russel (1966). Analysis using the GGE biplot confirmed that genotype ILRI-16803 had unity regression coefficient associated with the highest mean herbage dry matter yield. This implying that it has good general adaptability compared to the remaining genotypes studied under these environments and similar agro-ecologies. Figure 1 showed that stability and adaptability of ILRI -16803 and other elephant grass genotypes across years and locations.

4. Conclusion and Recommendation

The current study result revealed that there was significant difference among elephant grass genotypes in survival rate, dry matter yield, plant height, tiller number and leaf to stem ratio. Also chemical composition TA% and NDF% were significantly different while DM%, CP%, ADF% and ADL% were non-significant among the genotypes. The IVDMD was also significantly different among genotypes. There was no incidence of diseases on candidate genotype and other genotypes during the study period across locations and years. Candidate genotype (ILRI-16803) was showed highest herbage dry matter yield and leaf to stem ratio over other genotypes and standard check (Zehone-02 variety). This candidate genotype had 31.17% dry matter yield advantage than Zehone-02 variety used as standard check. Therefore, one candidate variety (ILRI- 16803) was selected to be released as variety.

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Conflicts of Interest

The authors declared that there is no conflict of interest

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