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Adaptability Study of Desho Grass (*Pennisetum glaucifolium)* Varieties in West and Kellem Wollega Zones of Oromia, Ethiopia

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Abstract

The study was conducted with the objectives to identify and select better adaptable, higher herbage yielding forage variety. Four desho grass varieties (Kindu kosha1-DZF-589, Areka-DZF-590, Kindu kosha2-DZF-591, and Kulumsa -DZF-592) were arranged in randomized complete block design (RCBD) with three replications. All agronomic parameters and biomass yield of forage samples were determined and collected data were examined using statistical analysis. The results indicated that plant height was not showed statistically significant variation (P>0.05) among Desho grass varieties. However, number of tiller per plant, number of node per plant, length between node per plant, total green fresh yield, and dry matter yield were significantly difference (P<0.05) among desho grass varieties. The heighest herbage dry matter yield was recorded from Kulumsa-DZF-592, Kindu kosha2-DZF-591 and Areka-DZF-590 desho grass varieties. These varieties are well adapted and suitable for use as animal feeds under the study areas. As a result, these three desho grass varieties were recommended for livestock producers as feed resources to enhance animal production and productivity in the study sitses and other areas with similar agro-ecologies.

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Keywords

Desho grass, herbage yield, variety, economy, poor health care.

Introduction

In Ethiopian agriculture, livestock production plays a fundamental role in the livelihood of the people (Shiferaw *et al.,* 2011). Despite the large livestock population in Ethiopia (CSA, 2015), its contribution to the national economy is below potential, owing to a range of factors including availability and quality of feed, the poor genetic potential of animals for productive traits, poor health care, and poor management practices (Mengistu, 2006; Legesse, 2008). Of these factors, the most limiting is the low quantity and quality of feed (Shapiro *et al.,* 2015). Due to rapid population growth in the Ethiopian highlands, traditional communal grazing areas are increasingly being fragmented into cropland to meet growing demand. In turn, massive pressure is placed on the remaining grazing land as overstocking cow and oxen leads to overgrazing and land degradation (Danano, 2007). This pattern negatively affects agricultural productivity and places a direct threat to the livelihoods of local farmers (Smith, 2010).

Adaptable indigenous fodder species like desho grass is used as mitigation strategies of feed shortage in the country. This perennial grass is native to tropical Africa and widespread from West to East Africa (Leta *et al.,* 2013). Though often considered to be a noxious weed (ISC, 2015), in Ethiopia the grass was first used in

Southern Nations Nationalities and Peoples' Region and is currently used for both soil conservation practices and animal feed in other regions of the country (Welle *et al.*, 2006; Yakob *et al.*, 2015). The grass has the ability to control water loss effectively and recovers rapidly after watering even under severe drought conditions (Noitsakis *et al.*, 1996; Welle *et al.*, 2006). It has an extensive root system that anchors well with the soil and it grows upright with the potential of reaching 90–120 cm based on soil fertility. It can grow anywhere from 1500–2800 masl with an optimum elevation over 1700 m.a.s.l on medium to low soil fertility (SLM Ethiopia). Desho grass has many different uses such as a year round livestock fodder (SLM Ethiopia), for erosion control through strip planting (Welle *et al.*, 2006), to rehabilitate degraded land (Smith, 2010), to improve grazing land management (Danano, 2007). Moreover, desho grass provides a small business opportunity for Ethiopian farmers (sale of cut forage and planting material) (Shiferaw *et al.*, 2011).

Desho grass can provide large amounts of green herbage per unit area (30–109 t/ha/year) (Heuzé and Hassoun, 2015) and can be a year-round fodder for livestock (Leta *et al.*, 2013). Therefore the study was conducted with the objectives to identify better adaptable and high herbage yielding desho grass varieties.

Materials and Methods

Description of the study area

The study was conducted at Mata, Hawagalan in Kellem Wollega, and Nedjo in West Wollega during 2018 and 2019 the main cropping seasons. These sites are located in western Oromia, Ethiopia. The main rainy season covers from April to October. The area is characterized by coffee based farming and a crop-livestock mixed farming system (HSARC, 2012).

Treatments and Experimental design

Four Desho grass varieties (Kulumsa-DZF-592, Kindu kosha1-DZF-589, Kindu kosha 2-DZF-591, Areka-DZF-590) were evaluated using randomized complete block design (RCBD) with three replications. These varieties were introduced from Debrezeit Agricultural Research center. The gross plot comprised of eight rows of 3 m length (8 x 0.5 m x 3 m = $12m^2$). The spacing between plots and blocks was maintained 1m and 1.5m, respectively. Fertilizer was applied at the rate of 100 kg ha^{-1} DAP and 25 kg ha^{-1} UREA at planting time. Weeding was done as early as possible to eliminate re-growth of undesirable plants and to promote fodder grass growth by increasing soil aeration; the plots were kept weed-free throughout the growth period (Orodho, 2006).

Data collected

The morphological parameters such as plant height and node length per plant were measured with measuring tape and the number of tillers and nodes per plant were computed as the mean of counts taken from five plants that were randomly selected from the middle rows of each plot at 120 days after planting in all locations. Harvesting was done by hand using sickle leaving stubble height of 8cm and optimum harvesting stage (120 days) according to recommendations made by (Leta *et al.*, 2013; MoALR, 2017). A fresh herbage yield of Desho grass was measured immediately after each harvest using a portable sensitive balance. Subsamples were taken from each plot at each site to determine the fresh yield and dried in the air until constant weight for dry matter yield determination.

Data Analysis

All the agronomic data collected were analyzed using SAS statistical software version 9.3 (2011). The treatments were compared for their significance using the calculated least significant difference (LSD) values at a 5% level of probability. The following model was used for combined analysis:

$Y_{ij} = \mu + B_i + T_j + €_{ij}$;

where,

$\mathbf{Y_{ij}}$= measured response of variety i in block j; $\boldsymbol{\mu}$ = overall mean; $\mathbf{B_i}$= i^{th} effect of block; $\mathbf{T_j}$ = j^{th} effect of treatment; $\mathbf{€_{ij}}$ = random error effect of variety i in block j.

Results and Discussion

Agronomic parameters of desho grass

Number of plant survival

The number of plant survival of Desho grass grown in all location is presented in Figure 1. Even though, desho grass planted at Nedjo location was more survived than the two locations might be due to incremental day interval of vegetative desho plant took to plant as well as due to variations in moisture, temperature and soil characteristics of three locations. Amongst the varieties tested across locations and years, the Higher number of plant survived/plot was obtained from Kidu kosha1-DZF-589 followed by Kulumsa-DZF-592 and Areka-DZF-590whereas the lower number of plant survived was obtained from Kindu kosha2-DZF-591.

Plant height at forage harvest

Mean performance of plant height of desho grass varieties were presented in Table 1. The mean of current results of desho grass varieties across two years showed that plant height was significantly different (P<0.05) among the tested desho grass varieties at Mata. The highest plant height was recorded from Kulumsa-DZF-592 (143.67 cm) followed by Kindu kosha1-DZF-591 and Kindu kosha2-DZF-589 while the lowest plant height was recorded from Areka-DZF-590 (119.80 cm).

This significance difference observed among desho grass varieties might be attributed to the variations in the genetic makeup of the species, soil and environmental adaptability (Zaman, 2006). On the other hand, plant height was not significantly different (P>0.05) at Hawagalan and Nedjo locations among the evaluated desho grass varieties. The absence of plant height different among the desho grass varieties of the current finding was similar with the findings reported by Tekalegn *et al.,* (2017) for similar desho grass varieties tested at Wondogenet Agricultural Research Center. Plant height was varied among the experimental locations and such variation might be due to many factors likes, season, weather, soil type and fertility, soil moisture, agro ecology, and other factors (Kilcher, 1981).

Number of tiller per plant

There was no significant different (P>0.05) for the Numbers of tiller per plant (NTPP) of desho grass at forage harvesting stage among the tested varieties at all locations. The mean number of tiller per plant of the present finding at each location was lower than the findings of Tilahun *et al.,* (2017) who reported that the average number of tiller per plant (78.6) of desho grass at Northern highland of Ethiopia. Similarly, it was lower than the findings reported by Heliso *et al.,* (2019). This difference might be due to differences in agro ecology like altitude, temperature, rainfall, soil, harvesting stage, plant spacing and other factors. Results from the analysis of variance for number of tiller per plant revealed significant effect of location and year (P<0.05) among Desho grass varieties (Table 1). The highest NTPP (53.67) was recorded for Kindu kosha2-DZF-591 which was comparable with Areka-DZF-590 and Kulumsa-DZF-592, while the lowest was recorded for Kindu kosha1-DZF-589variety. The reason for higher NTPP was probably due to the lower plant survival rate per plot which resulted in low resource competition among the plants. The overall mean for tiller number per plant observed in the present study (49.43) was comparable with (48.57) reported by Bimrew (2016), but lower than the findings (78.6, 214, 66.74) reported by different authors (Tilahun *et al.,* 2017; Heliso *et al.,* 2019; Worku *et al.,* 2017).

Number of node and Length between node per plant

There was significantly different results (P<0.05) were observed for number of node per plant (NNPP) and length between node per plant (LBNPP) among the desho grass varieties at Mata while no statistically significant difference (P>0.05) was observed between the varieties at Hawagalan and Nedjo locations over the study years. Pooled over the four varieties, the highest number of node per plant (NNPP) and length between node per plant (LBNPP) values (15.18 and 6.20 cm) were obtained for Kindukosha1-DZF-589 and Kulumsa-DZF-592, respectively while the lowest values of number of node per plant (NNPP) (13.16) and length between node per plant (LBNPP) (5.26 cm), for Kulumsa-DZF-592 and Kindu kosha1-DZF-589 in that order.

Forage Yield

Green forage yield

Results for analysis of variance for green forage yield indicated significant differences observed (P<0.05) between the tested Desho grass varieties at the study sites. The combined mean green forage yield of desho grass varieties was 42.31 t/ha with values ranging from 39.15 t/ha for Areka-DZF-590 to 47.58t/ha for Kulumsa-DZF-592. The green forage yield among the Desho grass varieties in the present study was contrary with the findings of Gadisa *et al.,* (2019) who reported for similar desho grass varieties at Mechara, Eastern Ethiopia. O'Connor (1982) suggested that differences in response among grass species result largely from climatic conditions under different conditions grasses have different growth rates.

Table.1 Mean plant height (cm) and number of tiller per plant of Desho grass varieties tested across locations and years (2018 and 2019)

Varieties	Hawagalan		Mata		Nedjo		Combined mean	
	PH (cm)	NTPP	PH (cm)	NTPP	PH (cm)	NTPP	PH (cm)	NTPP
KK1-DZF-589	117.3	54.86	129.87^{ab}	36.40	75.66	37.00	107.62	42.76^{b}
Areka-DZF-590	110.53	64.13	119.80^{b}	48.66	74.80	43.60	98.07	52.13^{a}
KK2-DZF-591	100.33	60.06	140.33^{ab}	53.20	80.77	47.73	106.9	53.67^{a}
Kulumsa-DZF-592	99.6	61.73	143.67^{a}	50.33	71.66	35.53	108.58	49.20^{ab}
Mean	106.95	60.20	133.42	47.15	76.61	40.96	105.29	49.43
LSD$_{(5\%)}$	17.95	18.84	23.59	19.75	20.26	16.42	10.65	8.319
CV(%)	8.40	15.66	8.85	20.96	13.23	20.07	10.35	17.21
SL	ns	ns	*	ns	ns	ns	ns	*

$^{a-b}$Means with different letters in a column significantly different (P<0.05). KK1= Kindu kosha 1; Kindu kosha 2; PH= plant height; NTPP= number of tiller per plant; cm= centimeter; LSD=least significant difference; CV= coefficient variation; SL = significant level; * = significant at P<0.05; ** = significant at P<0.01; ns = non significant.

Table.2 Mean number of nodes and length between node per plant of desho grass varieties tested across locations and years (2018 and 2019)

Varieties	Hawagalan		Mata		Nedjo		Combined mean	
	NNPP	LBNPP (cm)	NNPP	LBNPP (cm)	NNPP	LBNPP (cm)	NNPP	LBNPP (cm)
KK1-DZF-589	14.86	6.05	15.60^{a}	6.44^{b}	15.07	3.28	15.178^{a}	5.26^{b}
Areka-DZF-590	13.26	6.04	12.80^{b}	7.940^{a}	13.87	3.39	13.31^{b}	5.79^{ab}
KK2-DZF-591	12.93	6.18	15.53^{a}	7.54^{ab}	13.20	3.77	13.78^{b}	5.83^{ab}
Kulumsa-DZF-592	12.60	6.57	13.93^{ab}	8.45^{a}	12.60	3.56	13.156^{b}	6.2^{a}
Mean	13.41	6.21	14.47	7.59	13.68	3.50	13.85	5.76
LSD$_{(5\%)}$	2.51	1.30	2.72	1.18	3.20	0.78	1.29	0.65
CV(%)	9.36	10.48	9.43	7.80	11.71	10.72	9.49	11.6
SL	ns	ns	*	*	ns	ns	*	*

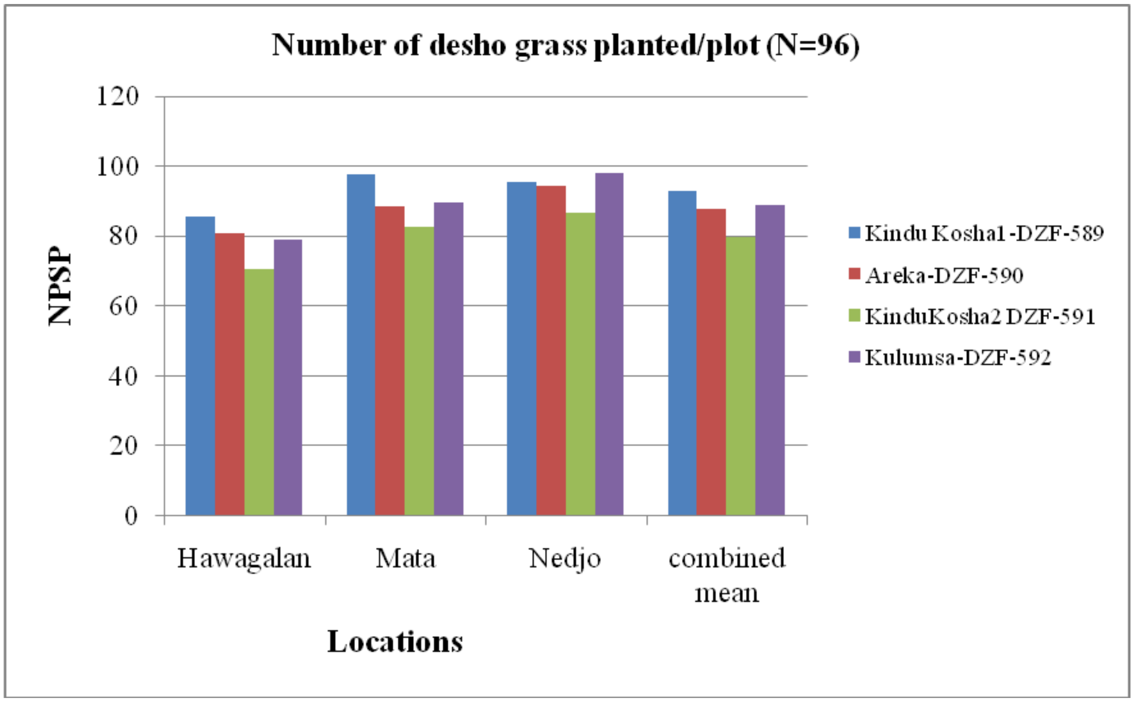
$^{a-b}$Means with different letters in a column significantly different (P<0.05). KK1= Kindu kosha 1; Kindu kosha 2; PH= plant height; NNPP= number of node per plant; LBNPP= length between node per plant; cm= centimeter; LSD=least significant difference; CV= coefficient variation; SL = significant level; * = significant at P<0.05; ** = significant at P<0.01; ns = non significant.

Table.3 Combined mean values of forage yield (in both fresh and DM bases) of Desho grass varieties tested across locations and years (2018 and 2019)

Varieties	Forage yield (ton/ha)							
	Hawagalan		Mata		Nedjo		Combined mean	
	GFY	DMY	GFY	DMY	GFY	DMY	GFY	DMY
KK 1-DZF-589	51.41^{a}	6.689^{ab}	48.34^{b}	7.05^{b}	25.52^{b}	4.48	41.76^{b}	6.07^{b}
Areka-DZF-590	47.11^{a}	7.102^{a}	44.33^{b}	6.90^{b}	27.70^{ab}	4.51	39.71^{b}	6.17^{ab}
KK2-DZF-591	40.87^{b}	5.622^{b}	49.10^{b}	7.83^{ab}	30.65^{a}	5.11	40.21^{b}	6.19^{ab}
Kulumsa-DZF-592	50.52^{a}	7.101^{a}	59.80^{a}	9.20^{a}	32.43^{a}	5.33	47.58^{a}	7.21^{a}
Mean	47.48	6.63	50.39	7.74	29.07	4.86	42.31	6.41
LSD (5%)	5.40	1.09	6.27	1.75	4.79	0.90	3.29	1.08
CV (%)	9.19	13.35	10.05	18.23	13.29	14.97	11.58	15.74
SL	**	*	**	*	*	ns	*	*

*$^{a-b}$Means with different letters in a column significantly different (P<0.05). KK1= Kindukosha1; Kindu kosha2; GFY= green forage yield; DMY=dry matter yield; LSD=least significant difference; CV= coefficient variation; ha =hectare; SL = significant level; * = significant at P<0.05; ** = significant at P<0.01; ns = non significant.*

Fig.1 Average number of plant survived per plot



NPSP = number of plant survived per plot

Herbage Dry matter yield

Results for analysis of variance for herbage Dry matter yields (DMY) revealed that significance differences observed (P<0.05) between the varieties at Hawagalan and Mata, and mean values were recorded 6.63 t/ha and 7.74 t/ha, respectively, while non significant results obtained at Nedjo site with mean value of 4.86 t/ha. The combined mean DM yields of Desho grass varieties was 6.41 t/ha with values ranging from 6.07 t/ha for Kindu kosha1-DZF-589 to 7.21 t/ha for Kulumsa-DZF-592 (Table 3).

Similarity in herbage DM yields at Nedjo site among the desho grass varieties in the present study was in line with the findings of Tekalegn *et al.*, (2017) who reported that similar values in DM yields of desho grass varieties at Wondogenet, Southern Ethiopia. Gadisa *et al.*, (2019) also reported significant differences in herbage DM yields for similar desho grass varieties at Mechara, Eastern Ethiopia which supports the result obtained at Hawagalan and Mata locations in the present study.

In contrary to the current study, Bimrew (2016) reported higher herbage DMY (14.65 - 16.84 t/ha) for desho grass produced at different altitudes of northern Ethiopia. Similarly, forage DMY of desho grass in this study was lower than the results reported by different Authors (Gadisa *et al.*, 2019 (24.69 t/ha); Tekalegn *et al.*, 2017 (25.05 t/ha); Tilahun *et al.*, 2017 (16.1 t/ha); Heliso *et al.*, 2019 (19.06 t/ha); Worku *et al.*, 2017 (11.4 t/ha)). However, the pooled mean herbage dry matter yield (6.41 t/ha) of desho grass in this experiment was higher than the finding of Yegrem *et al.*, (2019) who reported lower mean herbage DM yield (3.51 t/ha) of desho grass at East Gojjam, Northwest Ethiopia. The significant differences observed were probably due to different agro-ecology, agronomic activities like harvesting stage, spacing, cutting cycle, fertilizer, various soil and climate conditions.

Recommendations

The adaptation trail of four desho grass varieties (Kulumsa-DZF-592, Kindu kosha1-DZF-589, Kindu kosha2-DZF-591, Areka-DZF-590) were conducted at Mata, Hawagalan in Kellem Wollega, and Nedjo in West Wollega during 20018 and 2019 main cropping seasons. In this study several parameters number of tiller, node per plant, node length and dry matter yield were shown significant differences among the tested desho grass varieties while plant height was not brought any change between desho grass varieties. Based on the high herbage dry matter production potential, three varieties:

Kulumsa-DZF-592, Kindu kosha2-DZF-591 and Areka-DZF-590 were selected as adapted improved forage varieties used for animal feeds in livestock industry. Therefore, these three varieties were recommended and further be demonstrated and scaled up in the study sites and other areas with similar agro-ecologies.

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