



Herbage Accumulation and Nutritive Value of Desho Grass (*Pennisetum pedicellatum*) in Midland and Highland Agro-Ecologies of Eastern Oromia, Ethiopia

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Abstract: Determining the forage yield and nutritional value of forage crops constitutes prerequisite to improve the productivity of livestock. Thus, identifying the grass lines to the specific agro-ecology can help to reduce the feed gap in Eastern Oromia. The experiment was carried out at midland and highland agro ecologies of East Hararghe zone of Oromia during 2018-2020 main cropping seasons to identify the most adaptable, high yielder in forage biomass and nutritive value Dasho grass line/s. Four Dasho grass (*Pennisetum pedicellatum*) lines (Kindo kosha-DZF-591, Araka-DZF-590, Kulumsa, Kindo kosha-DZF#589) were evaluated in randomized complete block design with four replications. Data on tiller number, plot cover, plant height, biomass yield, Ash, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were recorded during the investigation. The combined analysis of the current study revealed that Desho grass lines had significant difference in tiller number per plant ($p < 0.05$), however, no significant ($p > 0.05$) difference observed in forage dry matter, plot cover, plant height and leaf to stem ratio at both agro ecologies. When the nutritive value was observed, the Ash, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) contents were shown significant ($p < 0.001$) difference among the Desho grass lines considered in the trial. Kulumsa-DZF-592 had significantly higher crude protein and lower acid detergent fiber (ADF) and acid detergent lignin (ADL) contents. Generally, the high forage biomass yield and moderate nutritional contents in crude protein (CP), acid detergent fiber (ADF) of Desho grass lines suggested that they have excellent forage yield and nutritional value that deserves special attention to the grass. Therefore, all the Desho grass lines were well adapted and produced optimum forage biomass yield and moderate nutritional value at midland and highland agro-ecologies of East Hararghe Zone environmental conditions. Particularly, Kindo kosha-DZF#589 (28.72 t/ha) and Kulumsa-DZF-592 (28.51 t/ha) were well performed at midland agro-ecology while Kindo kosha-DZF-591 (25.06 t/ha) and Araka-DZF-590 (24.93 t/ha) were at highland agro-ecology. Thus, further research on demonstration and scaling up should be implemented at both agro-ecologies of the study areas.

Keywords: Forage, Biomass Yield, Plot Cover, Nutritional Value, Plant Height, Tiller Number

1. Introduction

Despite Ethiopia has large livestock population [5], the productivity of livestock is low. The current report of CSA [4] revealed that 56, 30 and 1.2% of the total livestock feed supply of the country is derived from grazing on natural pasture, crop residues and agro industrial byproducts,

respectively. Feed shortage in terms of quantity and quality is the major constant for livestock production in Ethiopia [6, 10]. The current report of CSA [15] revealed that 56, 30 and 1.2% of the total livestock feed supply of the country is derived from grazing on natural pasture, crop residues and agro industrial byproducts, respectively. Since, natural pasture and crop residues are source of low quality feed it

might be not met even the maintenance requirement for animal. To combat these nutritional constraints, use of improved forage species which are adaptable to wide agro-ecological conditions and grown with low inputs is important [2]. According to Lukuyu *et al.* [12], to evaluate any feed and inclusion into livestock feeding program it is very important to have chemical composition and utilization information of locally available feed resources.

Among locally available potential feed resource in Ethiopia, *Desho* grass (*Pennisetum pedicellatum*) is the most appropriate one [8, 11]. *Desho* grass is native to tropical countries including Ethiopia [7, 8, 11]. *Desho* grass is known as a perennial plant originated in Southern region of Ethiopia. It is palatable to cattle, sheep and other herbivores [10] and suitable for intensive management and performs well at an altitude ranging from 1500 to 2800 m.a.s.l. [11]. It has the potential of meeting the challenges of feed scarcity since it provides more forage per unit area and ensures regular forage supply due to its multi-cut nature suggests that it is a potential feed source in the dry season when feed availability in the tropics is critical. The grass is drought resistant plant, used as feed for ruminants [8, 9].

Desho grass serves as a business opportunity for farmers in Ethiopia [14, 17]. Currently the grass is utilized as a means of soil conservation practices and animal feed in the highlands of Ethiopia [7, 18]. To obtain the highest yield of *Desho* grass should be cut within 4 months after sowing at 8 cm from ground level [11]. The yield and nutritional qualities of forage are influenced by numerous factors such as seasonal variations, stage of maturity, ecological conditions and management practices. However, there is no adequate information on the agronomic characteristics, productivity and chemical composition of *Desho* grass in east Hararghe zone of Oromia, Ethiopia. Therefore, the current study was initiated with the objective to identify the adaptable and high yielding *Desho* grass line under mid and high altitudes of East Hararghe. Zone of Oromia, Ethiopia.

2. Materials and Methods

2.1. Description of the Study Area

The experiment was conducted under rain-fed conditions from 2018-2020 growing season at midland and highland agro ecology of East Hararghe zone. The experimental study was conducted at the three districts namely Meta, Kersa and Kombolcha. For each agro ecology six locations were used over the three years.

Meta District is located at 445 km from the capital Addis Ababa and 80 km West of Harar town. It is located between 9°0'09" to 9°0'31" N latitude and 41°0'29" to 41°0'44" E longitude. Altitude of Meta District is 2830m a.s.l. The annual rainfall amount ranges from 600-900 mm and the temperature ranges between 15°C-37°C. Kersa district is bordering Haromaya district in the East, Kurfa Calle district in the South, Dire Dawa City administration in the North and Meta District in the West. The capital city of the

district is located at 478km South of Addis Ababa and 42 km to the West of Harar town. The district contains 35 rural Peasant associations (PA) and the altitude ranges from 1,550 to 2,800 m a.s.l. Kombolcha district is one of the eighteen districts of East Hararghe Zone of Oromia Regional State. It is located at about 17 km north of Harar town and 542 km East of Addis Ababa, the nation's capital city. The altitude of the district ranges from 1200-2460 m a.s.l. Agro climatically, the district ranges from *Woina-dega* (mid-altitude) to Kola (low lands). The annual rainfall ranges from 600 mm to 900 mm with a bimodal and erratic pattern. The mean annual temperature of the area ranges between 16-25°C.

2.2. Experimental Treatments and Design

The experimental materials were obtained from Wando Genet Research Center, Ethiopia. The experiment was conducted on randomized complete block design (RCBD) with four replications and the genotypes assigned randomly to plots within the block. The experimental fields were ploughed and harrowed to a fine seedbed. Plot size was 4 x 3 m (12 m²). The root splits were planted with the intra and inter row spacing of 0.25 m and 0.5 m respectively. Land preparation, planting, weeding and harvesting was made according to the recommendations [11]. NPS and urea were applied at the rate of 100 and 50 kg per ha.

2.3. Data Collection and Forage Chemical Analysis

Harvesting was done by hand using a sickle, leaving a stubble height of 8 cm above the ground [11]. The morphological parameters such as plant height were measured with measuring tape. The number of tillers was computed as mean of counts taken from ten plants that was randomly selected from the middle rows of each plot at 120 days after planting [11]. The leaf to stem ratio was determined by measuring 2 kg of fresh weight from the selected two middle rows (1 m²), separating in to leaves and stems, drying and weighing each component separately. Fresh herbage yield of the grass was measured immediately after each harvest and weighed on the field using a field balance. Sub-samples were taken from each plot at each site to determine dry matter yield and nutritional quality. The sub-samples were dried in oven dry at 65°C for 72 hours and stored in airtight bags to be used for chemical analysis. The samples were analyzed for percent dry matter, Ash, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL).

2.4. Statistical Analysis

The values on agronomic parameters, dry matter yields and nutritive value were statistically evaluated by analysis of variance (ANOVA) using general linear model (GLM) procedure of Statistical Analysis Software to perform ANOVA [13]. Mean were separated using least significant difference (LSD) at 5% significant level.

3. Results and Discussion

3.1. Agronomic Performances of Desho Grass Lines at Midland Agro Ecology

Combined analysis of variance for measured agronomic parameters and herbage yields of Desho grass lines tested over year and locations is presented in Table 1. The analysis of variance shown that the lines had no significant ($p > 0.05$) difference on plot cover and plant height. However, numerically different mean value of plot cover and plant height were observed among the tested Desho grass lines. The mean ground cover (96.35%) of the lines is within the range of mean ground cover reported (95.8-99.2%) by Tekalegn *et al.* [16] for Dasho grass lines at Wondogenet Agricultural Research Center, Southern Ethiopia. The similarities of the findings were indicated that the ability of Desho grass adapted to different environments and soil types. This might be due to indigenous ecotype of Desho grass for Ethiopia [15]. Similarly, Desho grass lines had no significant ($p > 0.05$) difference on plant height. The mean plant height was ranged from 125.6-151 cm. This result is in agreement with Shiferaw *et al.* [15] who reported that Desho grass grows upright with the potential of reaching 120 cm based on soil fertility. However, the result of the current study is higher than the figure reported by Bimrew *et al.* [13] (94 cm) for Desho grass at mid land altitude of Northern, Ethiopia.

The result of this study revealed that grass lines

significantly ($p < 0.001$) difference in number of tillers per plant at midland. The mean tiller per plant yield of the lines was ranged 115.9 -138.2. This result is higher than the report of Bimrew *et al.* [13] (47.66) for Desho grass at mid land altitude of Northern, Ethiopia. This suggests a selection for increased tiller number per plant as an effective method for increasing biomass production and greater yields which is supported by Das *et al.* (2004), who found that tiller density was correlated with biomass production in grasses.

3.2. Dry Matter Yield and Leaf to Stem Ratio

The result of combined analysis also showed that herbage dry matter yield did not significantly ($p > 0.05$) difference among the tested Desho grass lines. Even though the dry matter yield in ton per hectare was not differ significantly ($p > 0.05$) among Desho grass lines, optimum dry matter yield ranging from 24.67- 28.72 t/ha was produced. The mean herbage dry matter yield (24.67-28.72 t/ha) of the lines is within the range of mean herbage dry matter yield reported by Tekalegn *et al.* [16] (28.43-30.9 t/ha) for similar Desho grass lines at Wondogenet Agricultural Research Center, Southern, Ethiopia.

The mean leaf to stem ratio of the Desho lines was 1.08, which is higher than the finding of Tekalegn *et al.* [16] who reported that 0.72 for Desho grass lines, but it is lower than the finding of Bimrew [3] who reported that leaf to stem ratio 1.18 harvested at 120 days at mid land altitude.

Table 1. The combined mean of agronomic parameters and biomass yield of Desho grass lines at midland agro ecology.

Treatments	PC%	PH (cm)	TN	DMY (t/ha)	LSR
Kindo kosha-DZF-591	97.15	131	125.6 ^b	25.43	1.16
Araka-DZF-590	96.5	126.2	115.9 ^c	24.67	1.05
Kulumsa	94	133.2	131.8 ^{ab}	28.51	1.02
Kindo kosha-DZF#589	97.75	151	138.2 ^a	28.72	1.09
CV (%)	3.9	10.1	3.2	8.8	9.8
LSD	5.39	21.9	6.56	3.80	0.17
p-value	NS	NS	***	NS	NS

PC=Plot cover, PH=plant height, TN=tiller number, DMY=Total dry matter yield, LSR= Leaf to stem ratio, CV= coefficient of variation

3.3. Agronomic Performance of Desho Grass Lines at Highland Agro Ecology

The combined analysis result for ground cover, plant height and tiller number of four Desho lines are indicated in table 2. The results showed that significant ($p < 0.05$) difference was observed on ground cover and tiller number per plant among the Desho grass lines evaluated in the trial. The line Kindo kosha-DZF-591 was recorded the highest tiller number per plant (107) followed by Kindo kosha-DZF#589 (95.75) and Kulumsa-DZF-592 (92.5). This is higher than the value (49.47) obtained by Bimrew *et al.* (2017) for Desho grass at high land of Northern, Ethiopia. The result not indicated significant difference ($p > 0.05$) on plant height among the tested Desho grass lines. However, numerically the maximum plant height (166.65 cm) was

recorded from Kindo kosha-DZF-591 followed by Kindo kosha-DZF#589 (107.75 cm). This result is in agreement with that of Shiferaw *et al.* [14] who reported that Desho grass grows upright with the potential of reaching 90–120 cm based on soil fertility, but it is higher than the report of Bimrew *et al.* [3] (87 cm) for Desho grass lines at high land areas of Northern, Ethiopia.

3.4. Dry Matter yield and Leaf to Stem Ratio

Combined analysis result for herbage dry matter yields and leaf to stem ratio of Desho grass lines are presented in Table 2. Dasho lines had no significant ($p > 0.05$) difference in both herbage dry matter yield and leaf to stem ration. Although the mean least square was not shown significant difference on dry matter yield, the treatment mean value is ranges between 24.51-25.06 t/ha. The results in the current study is

greater than the reports of Bimrew *et al.* [3] (19.9 t/ha) and Tilahun *et al.* [17] (15.7 t/ha), respectively, for Desho grass lines at highland agro ecology. However, it is lower than the result obtained (28.43-30.9 t/ha) by Tekalegn *et al.* [16] at Wondogenet Agricultural Research Center, Southern, Ethiopia.

The mean leaf to stem ratio of the Desho lines was 1.11. This result is higher than the finding reported by Tekalegn *et al.* [16] (0.44-0.55), but it is comparable with the finding of Bimrew [3] who reported 1.15 that leaf to stem ratio for Desho grass lines at highland areas.

Table 2. The combined mean of agronomic parameters and biomass yield of Desho grass at highland agro ecology.

Lines	PC%	PH (cm)	TN	DMY (t/ha)	LSR
Kindo kosha-DZF-591	90.50 ^a	116.25	107.00 ^a	25.06	1.11
Araka-DZF-590	87.50 ^{ab}	110.50	91.00 ^c	24.93	1.12
Kulumsa	85.50 ^b	103.25	92.50 ^{bc}	24.51	1.11
Kindo kosha-DZF#589	89.00 ^{ab}	107.75	95.75 ^b	24.62	1.10
CV (%)	2.1	6.5	2.1	1.5	3.2
LSD (0.05)	2.86	8.93	3.23	0.57	0.06
P-value	*	NS	**	NS	NS

PC=Plot cover, PH=plant height, TN=tiller number, DMY=Total dry matter yield, LSR= Leaf to stem ratio, CV= coefficient of variation

3.5. Nutritional Value of Desho Grass Lines

The nutritional contents of the Desho grass lines are presented in Table 3. The result from dry matter yield (DM), Ash, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) contents were shown significantly ($p < 0.001$) different among the Desho grass lines. The highest (91.75%) DM% concentration was obtained from Kindulosha-DZF-591 Desho grass lines followed by Araka-DZF-590 (91.03%), while Kulumsa-DZF-592 was produced lower DM value (89.56%) as compared with other tested lines. The highest Ash content was produced from Kindo kosha-DZF-591 (14.37%), while the lowest ash value (13.66%) was produced by Kindo kosha-DZF#589. The highest mean crude protein value was recorded from Kulumsa-DZF-592 (13.51), but

Kindo kosha-DZF-591 line was produced the lowest (11.16%) crude protein value. The highest NDF concentration was obtained from Kulumsa-DZF-592 line (72.42%), while the lowest value was recorded from Kindo kosha-DZF#589 (63.68%). The highest (34.33%) ADF content was recorded by Kindo kosha-DZF-591 whereas the lowest value (30.82%) was produced by Kindo kosha-DZF#589. Likewise, the highest (9.28%) ADL concentration was recorded by Kindo kosha-DZF-591 line, while the lowest value (4.77%) was noted by Kulumsa-DZF-592. The highest ADF concentration in the grasses shows less digestible than the other lines with lower ADF value. This is consistent with work of Albayrak *et al.* [1] who reported that as the ADF increases the digestibility of the forage usually decrease causing consumption of the forage by animal to decrease.

Table 3. The combined mean value of chemical composition of the Desho grass lines at both agro ecology.

Treatments	DM%	Ash%	CP%	NDF%	ADF%	ADL%
Kindo kosha-DZF-591	91.75 ^a	14.27 ^a	11.16 ^d	71.08 ^b	34.33 ^a	9.28 ^a
Araka-DZF-590	91.03 ^b	13.76 ^b	12.8 ^b	60.53 ^d	32.18 ^b	9.08 ^a
Kulumsa-DZF-592	89.56 ^d	14.37 ^a	13.51 ^a	72.42 ^a	31.08 ^c	4.77 ^c
Kindo kosha-DZF#589	90.67 ^c	13.66 ^b	11.96 ^c	63.68 ^c	30.82 ^c	6.49 ^b
CV (%)	1.1	1.5	1.7	1.9	1.5	7.8
LSD	0.07	0.08	0.26	0.76	0.58	0.70
P-value	**	**	**	**	**	**

DM: Dry matter, CP: Crude protein, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, ADL: Acid detergent lignin, LSD: least significant difference, CV: coefficient of variation

4. Conclusions

Results of the present study showed that the Desho grass lines evaluated were varied in terms of nutritional value parameters. However, the result revealed that non-significant differences observed in dry matter yield ton per hectare among the four Desho grass lines. Moreover, maximum herbage dry matter yield was produced at both agro ecologies by the four Desho grass lines. Therefore, all the Desho grass lines were well adapted and produced optimum forage biomass yield and moderate nutritional value at midland and

highland agro-ecologies of East Hararghe Zone environmental conditions. Particularly, Kindo kosha-DZF#589 (28.72 t/ha) and Kulumsa-DZF-592 (28.51 t/ha) were well performed at midland agro-ecology while Kindo kosha-DZF-591 (25.06 t/ha) and Araka-DZF-590 (24.93 t/ha) were at highland agro-ecology. Thus, further research on demonstration and scaling up should be implemented at the study areas.

Conflict of Interest

The authors declared that there is no conflict of interest.

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Appendix

Partial images of Desho grass lines studied.



Figure 1. Desho grass lines at experimental site of Kombolcha district.



Figure 2. Desho grass lines at experimental site of Meta district.



Figure 3. Desho grass lines at experimental site of Kersa district.



Figure 4. Farmer cut the grass and carries it to the livestock (cut and carry forage systems).

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