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ON FARM PERFORMANCE EVALUATION OF DESHO GRASS (*PENNISETUM PEDICELLATUM*) FOR FORAGE BIOMASS YIELD AND NUTRITIONAL QUALITY AT MIDLAND AND HIGHLAND AGRO-ECOLOGIES OF EASTERN HARARGHE, ETHIOPIA

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SUMMARY

The experiment was undertaken at midlands and highland agro-ecologyies of East Hararghe zone. The aim of the research was to determine the forage dry matter yield and quality of four lines of Desho grass (*Pennisetum pedicellatum*) to select promising lines for wider use among livestock producer communities. Randomized Complete Block Design (RCBD) with four replications was used. The combined analysis revealed that, the agronomic performance of ground cover, plant height, dry matter yield in ton per hectare and dry matter leaf to stem ratio were not differ significantly (P>0.05) between four Desho grass lines at midland agro ecology while plant height, dry matter yield in ton per hectare and dry matter leaf to stem ratio were not differ significantly (P>0.05). Tiller number per plant was the only parameter which was significantly different at both agro ecologies. Combined data analysis also revealed that forage nutritional quality significantly varied among the desho grass lines. Even though, the dry matter yield in ton per hectare was not differ significantly (P>0.05) among the desho grass lines, large amount of dry matter yield in ton per hectare of 25.43- 28.72 and 24.51-25.06 t/ha was produced at mid and highland agro ecology, respectively. Therefore, all lines of Desho grasses were well adapted and performed good under midland and highland condition of east Hararghe zone and in similar environments/agro ecologies. Thus, these Desho grass lines should be further demonstrated and scaled-up at midland and highland agro ecologies and similar agro-ecologies of Hararghe areas.

Key words : Desho grass, dry matter yield, leaf to stem ratio, ground cover, plant height, tiller number

Despite Ethiopia has large livestock population (CSA, 2016), the productivity of livestock is low with the major hindrances being shortage of feed resources in terms of quantity and quality of (ILRI, 2009; Demeke *et al.,* 2017). The current report of CSA (2015) 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. To combat these nutritional constraints, the use of locally available forage species which are adaptable to the local agro-ecological conditions and used as feed resources are highly recommended as they are familiar with the smallholder farmers grown with low inputs (Anele *et al*., 2008). According to Lukuyu *et al*. (2011), it is very important to have chemical composition and utilization information of locally available feeds for their inclusion into livestock feeding programs.

Among locally available multipurpose and potential feed resource in the country, *Desho* grass *(Pennisetum pedicullatum)* is the most appropriate one (EPPO, 2014; Leta *et al.*, 2014). *Desho* grass (*Pennisetum pedicellatum*) is native to tropical countries including Ethiopia (Ecocrop, 2010; Leta *et al*., 2013; EPPO, 2014). In Ethiopia *desho* grass is known as a perennial plant originated in Southern region of the country. *Desho* grass is suitable for intensive management and performs well at an altitude ranging from 1500 to 2800 m.a.s.l (Leta *et al*., 2013). 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 (Ecocrop, 2010). The grass is drought resistant plant, used as feed for ruminants (FAO. 2010; EPPO, 2014).

The grass has the ability to recover after water stress even under severe drought conditions (Noitsak is *et al*., 1994). Moreover, Desho grass serves as a

business opportunity for farmers in Ethiopia (Shiferaw *et al*., 2011; Tilahun *et al.,* 2017). Currently the grass is utilized as a means of soil conservation practices and animal feed in the highlands of Ethiopia (Welle *et al*., 2006; Ecocrop, 2010). The merits of the grass to provide multi-cut forages suggests that it is a potential feed source in the dry season when feed availability in the tropics is critical (Brias and Tesfaye, 2009). To obtain the highest yield, *desho* grass should be cut four months after sowing at 8 cm from ground level (Leta *et al*., 2013). *Desho* is a perennial grass and is palatable to cattle, sheep and other herbivores (FAO, 2010). The combined benefits of *desho* grass suggest the use of the grass as potential feed source and means of soil conservation in the mixed crop livestock production systems of Ethiopia.

The yield and nutritional qualities of forage are influenced by numerous factors such as seasonal variations, stage of maturity, ecological conditions and management practices (Giovanni *et al.,* 2011). However, there is no adequate information on the agronomic characteristics, productivity and chemical composition of Desho grass in east Hararghe, Ethiopia. Therefore, the current study was conducted with the objective of evaluating Desho grass for its agronomic performance, yield and chemical composition at different agro-ecologies.

MATERIALS AND METHODS

Description of the study area

The study was conducted at Meta, Kersa and Kombolcha districts representing midlands and highland of east Hararghe, Ethiopia.

Meta

The study was conducted in Meta District of the Eastern Hararge Zone, Oromia Regional State. Meta District is located at 445 km from the capital Addis Ababa and 80 km west of Harar town. Meta District is located between 9°0′09″ to 9°0′31″ N latitude and 41°0′29″ to 41°0′44″ E longitude (Meta District Livestock Office, 2015). Altitude of Meta District is 2830 meters above sea level. The annual rainfall amount ranges from 600-900 mm and the temperature ranges between 15 °C-37 °C. Gara Muleta Mountain, one of the highest mountains in Oromia Regional State, is found in this District (Meta District Livestock Office, 2015).

Kersa

Kersa woreda is bordering Haromaya woreda in the East, Kurfa Calle woreda in the south, Dire Dawa City administration in the north and Meta Woreda in the West. The capital city of the woreda is located at 478km south of Addis Ababa and 42km to the West of Harar Town which is the capital city of East Hararghe zone. The woreda contains 35 rural kebeles and the altitude ranges from 1,550 to 2,800 meters above sea level.

Kombolcha

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 meters above sea level. Agro climatically, the district ranges from *Woina-dega (mid-altitude)* to Kola (low lands). The annual rainfall ranges from 600mm to 900mm with a bimodal and erratic pattern. The mean annual temperature of the area ranges between 16-25°C.

Experimental treatments and design

The experiment was conducted under rain-fed conditions from 2018-2020 growing season in midlands and highlands of East Hararghe zone. Three districts namely Meta, Kersa and Kombolcha used for the study. For midlands the whole three district used while only Meta district used for highland experimental site. Two experimental sites/locations from each district used for midland agro-ecology and six experimental sites/locations from Meta district used for highland agro-ecology. The experiment was laid out in randomized complete block design having four replications and a plot of size 4 m x 3 m in both mid and highland locations. Four *Desho* grass lines were obtained from Wando Genet Research Center. The experimental materials were planted using vegetative root splits in rows. The spacing between rows and plants were 0.50 and 0.25 m, respectively. Land preparation, planting, weeding and harvesting was made according to the recommendations (Leta *et al*., 2013). NPS and urea were applied at planting and after establishment at the rate of 100 and 25 kg per ha.

Harvesting was done by hand using a sickle, leaving a stubble height of 8 cm above the ground

(Leta *et al.*, 2013). 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 (Leta *et al.*, 2013) in both agro ecologies. The leaf to stem ratio was determined by measuring 2kg of fresh weight from the selected two middle rows, 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 soon after mowing using a field balance. Sub-samples were taken from each plot at each site to determine dry matter yield. Finally the sub-samples were dried in oven at 65^{O}C for 72 hours and stored in airtight bags to be used for chemical analysis.

Statistical Analysis

All collected data were analyzed using the general linear model procedure of SAS (SAS 2002) version 9.1. Mean were separated using least significant difference (LSD) at 5% significant level. The statistical model for the analysis data was:

$$Yijk = \mu + Aj + Bi + eijk$$

Where; Yijk= response of variable under examination, μ = overall mean, Aj = the jth factor effect of treatment/ cultivar, Bi = the ith factor effect of block/ replication, eijk = the random error.

RESULTS

Agronomic characteristics of *Desho* grass lines at Midland Agro-ecology

Ground cover, plant height and tiller numbers

In the midland agro ecology, the results obtained indicate that ground cover was not significantly (P>0.05) different among the desho grass lines evaluated. Even though the combined mean value between grasses lines was not indicated significance difference (P>0.05) on plot cover, higher ground cover (97.75) was produced. Also the results obtained indicate that plat height was not significantly (P>0.05) different among the desho grass lines examined. The number of tillers per plant was significantly (P<0.001) difference at the midland altitude agro ecology. It is only parameters that showed significant difference among the agronomic characteristics tested.

Dry matter yield and leaf to stem ratio

The result of the agronomic performance; leaf dry matter yield, stem dry matter yield and total dry matter yield were not differ significantly (P>0.05) among Desho grass lines. Even though, the dry matter yield in ton per hectare was not differ significantly (P>0.05) between desho grass lines, large amount of dry matter yield ranges from 24.67- 28.72 ton per hectare was produced. The analysis of variance was not shown significance difference (P>0.05) on leaf to steam ratio.

TABLE 1
The combined mean of agronomic data and biomass yield of Desho grass lines at midland agro-ecology

Lines	GC%	Ph (cm)	TNPP	DMY (t/ha)	LSR
Kindo kosha-DZF-591	97.15	131	125.6 b	25.43	1.16
Araka-DZF-590	96.50	126.2	115.9 c	24.67	1.05
Kulumsa	94.00	133.2	131.8ab	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
P-value	0.48	0.126	<0.001	0.082	0.368
Sign. Level	NS	NS	**	NS	NS

GC=Ground cover, Ph=Plant height, TNPP=Tiller number per plant, DMY=Total dry matter yield, LSR= Leaf to stem ratio, CV= Coefficient of variation.

Agronomic characteristics of *Desho* Grass lines at Highland Agro-ecology

Ground cover, plant height and tiller numbers

In the highland agro ecology, the results obtained indicate that ground cover and tiller number per plant were significantly different among the desho grass lines evaluated (Table 2). The lowest ground cover was obtained by Kulumsa. Kindo kosha-DZF-591 had recorded the highest tiller number per plant (107) followed by Kindo kosha-DZF#589 (95.75) and Kulumsa-DZF-592 (92.5). However, no significant different obtained in plant height among the desho grass lines.

Dry matter yield and leaf to stem ratio

The result of the present study revealed that leaf dry matter yield, stem dry matter yield, total dry

TABLE 2
The combined mean of agronomic data and biomass yield of Desho grass lines in highland agro-ecology

Lines	GC%	Ph (cm)	TNPP	DMY (t/ha)	LSR
Kindo kosha-DZF-591	90.50a	116.25	107a	25.06	1.111
Araka-DZF-590	87.50ab	110.50	91c	24.93	1.120
Kulumsa	85.50b	103.25	92.5bc	24.51	1.113
Kindo kosha-DZF#589	89.00 ab	107.75	95.75b	24.62	1.097
CV (%)	2.1	6.5	2.1	1.5	3.2
P-value	0.017	0.381	<0.001	0.177	0.82
Sign. Level	*	NS	**	NS	NS

GC=Ground cover, Ph=plant height, TN=tiller number per plant, DMY=Total dry matter yield, LSR= Leaf to stem ratio, CV= Coefficient of variation.

matter yield and leaf to stem ratio were not differ significantly (P>0.05) among Desho grass lines examined (Table 2). Although, they are not differ significantly large dry matter yield (24.51-25.06 t/ha) was produced from the desho grass lines examined.

Desho grass lines nutritional quality analysis

The nutritional qualities of the desho grass lines were presented in Table 3. DM, Ash, CP, NDF, ADF and ADL contents were significantly (P<0.001) different among the desho grass lines. Kindulosha line recorded the highest values of dry matter content while Araka-DZF-590 is the second in dry matter content. Kulumsa-DZF-592 and Kindo kosha-DZF#589 maintained lower DM content. Kindo kosha-DZF-591 and Kulumsa-DZF-592 lines recorded the highest Ash content. Araka-DZF-590 and Kindo kosha-DZF#589 showed lower Ash content than the other desho lines. A crude protein (CP) value was significantly different among the desho grass lines. Desho grass line Kulumsa-DZF-592 accumulated the higher CP content than the other evaluated desho grass lines while Kindo kosha-DZF-591 had the lowest CP content.

The combined mean of NDF, ADF and ADL content was significantly different ($p< 0.001$) among the desho grass lines.Kulumsa-DZF-592 recorded the highest value of NDF value while the lowest value was obtained by Kindo kosha-DZF#589. On the other hand, the highest ADF and ADL value was recorded by Kindo kosha-DZF-591 and Araka-DZF-590. However, the lowest ADF and ADL value obtained Kulumsa-DZF-592 and Kindo kosha-DZF#589. The highest ADF value among the tested grass lines shows that they less digestible than the other with lower ADF value. This is consistent with work of Albayrak *et al.* (2011) who reported that as the ADF increases the digestibility of the forage usually decrease causing consumption of the forage by animal to decrease.

DISCUSSIONS

Desho grass lines at Midland Agro-ecology

Higher ground cover (97.75) was produced. This finding was comparable with Tekalegn *et al.* (2017) who report 95.8% and 99.2% plot cover of desho grass lines at Wondogenet Agricultural Research Center, Southern Ethiopia. The similarity of the findings indicated that the ability of Desho grass adaptability at different environments and soil types. This might be due to Desho grass is indigenous ecotype for Ethiopia (Smith, 2010). Also the results obtained indicated that a recommended desho grass plant height range from 125.6-151 cm was obtained. This result is almost in agreement with Shiferaw *et al.* (2011) who reported that Desho grass grows upright with the potential of reaching 120 cm based on soil fertility. However, The current result was higher than the report of Bimrew et al. (2017) who reported that plant height for Desho grass was 94 cm at mid land altitude of Northern, Ethiopia. Plant

TABLE 3
The combined chemical composition of desho grass lines at East Hararghe zone

Treatments	DM%	Ash%	CP%	NDF%	ADF%	ADL%
Kindo kosha-DZF-591	91.75a	14.27a	11.16d	71.08b	34.33a	9.28a
Araka-DZF-590	91.03b	13.76b	12.8b	60.53d	32.18b	9.08a
Kulumsa-DZF-592	89.56 d	14.37a	13.51a	72.42a	31.08c	4.77c
Kindo kosha-DZF#589	90.67c	13.66b	11.96c	63.68c	30.82c	6.49b
CV (%)	1.1	1.5	1.7	1.9	1.5	7.8
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sgn. Level	**	**	**	**	**	**

OM: Organic matter, CP: Crude protein, NDF: Neutral Detergent Fiber, ADF: Acid Detergent Fiber, ADL: Acid Detergent Lignin, LSD: least significant difference, CV: coefficient of variation.

height is an important parameter contributing to yield in forage crops.

The current result plant height (115.9 -138.2) obtained was higher than the report of Bimrew *et al.* (2017) who reported that tiller number per plant 47.66 for Desho grass at mid land altitude of Northern, Ethiopia. Overall, large number of tiller number per plant was obtained. This might be the reason for the greater biomass yield of the evaluated desho grass lines. Similarly, Das *et al.* (2004) found that tiller density was correlated with biomass production in grasses. This suggests a selection for increased tiller number per plant as an effective method for increasing biomass production and greater yields.

The result of the agronomic performance; leaf dry matter yield, stem dry matter yield and total dry matter yield were not differ significantly (P>0.05) among Desho grass lines. Even though, the dry matter yield in ton per hectare was not differ significantly (P>0.05) between desho grass lines, large amount of dry matter yield ranges from 24.67- 28.72 ton per hectare was produced. These findings was in lined with Tekalegn et al. (2017) who reported for similar Desho grass lines dry matter yield were produced 30.3, 28.43 and 30.9 t/ha, respectively at Wondogenet Agricultural Research Center, Southern, Ethiopia. All lines of Desho grasses were well adapted and performed under midland condition of east Hararghe zone. The result recorded from the current finding was higher when compared with Tekalegn *et al.* (2017) who reported that leaf to stem ratio 0.72. However, the current finding was similar with the finding of Bimrew (2016) who reported that leaf to stem ratio 1.18 harvested at 120 days at mid land altitude.

Desho Grass Lines at Highland Agro-ecology

In the highland agro ecology, Kindo kosha-DZF-591 had recorded the highest tiller number per plant (107) followed by Kindo kosha-DZF#589 (95.75) andKulumsa-DZF-592 (92.5). This result was higher than the tiller number per plant value (49.47) obtained by Bimrew *et al.* (2017) for Desho grass at high land altitude of Northern, Ethiopia. The average plant height obtained was agreed with Shiferaw *et al.* (2011) who reported that Desho grass grows upright with the potential of reaching 90-120 cm based on soil fertility. However, this finding was higher when compared with Bimrew *et al.* (2017) who reported that plant height for Desho grass was 87 cm at high land altitude of Northern, Ethiopia.

The total dry matter yield (24.51-25.06/ha) of the current finding was greater than the report of Bimrew *et al.* (2016) who reported for similar Desho grass lines dry matter yield of 19.9 t/ha at high land agro ecology and Tilahun *et al.* (2017) who reported 15.7 t/ha at 120 days of harvesting . However, the current finding was lower than the result obtained

Photos taken during the experimental time

Fig. 1. Desho grass lines experimental site at Kersa district.

Fig. 2. Desho grass lines experimental site at Meta district.

Fig. 3. Desho grass lines experimental site at Kombolcha district.

(30.3, 28.43 and 30.9 t/ha) by Tekalegn *et al.* (2017) at Wondogenet Agricultural Research Center, Southern, Ethiopia. The current result of leaf to stem ratio was higher than Tekalegn et al. (2017) who reported that leaf to stem ratio of Desho grass lines were 0.47, 0.44 and 0.55 during first harvesting cycle ofKulumsa-DZF-592-DZF #592, KK1-DZF # 591 and KK2-DZF # 589, respectively at Southern Ethiopia. However, the finding was similar with the finding of Bimrew (2016) who reported that leaf to stem ratio 1.15 harvested at 120 days at high land altitude.

Desho grass lines nutritional quality analysis

Kindulosha line recorded the highest values of dry matter content while Araka-DZF-590 is the second in dry matter content. Kulumsa-DZF-592 and Kindo kosha-DZF#589 maintained lower DM content. Kindo kosha-DZF-591 and Kulumsa-DZF-592 lines recorded the highest Ash content. Araka-DZF-590 and Kindo kosha-DZF#589 showed lower Ash content than the other desho lines. A crude protein (CP) value was significantly different among the desho grass lines. Desho grass line Kulumsa-DZF-592 accumulated the higher CP content than the other evaluated desho grass lines while Kindo kosha-DZF-591 had the lowest CP content.

The combined mean of NDF, ADF and ADL content was significantly different among the desho grass lines.Kulumsa-DZF-592 recorded the highest value of NDF value while the lowest value was obtained by Kindo kosha-DZF#589. On the other hand, the highest ADF and ADL value was recorded by Kindo kosha-DZF-591 and Araka-DZF-590. However, the lowest ADF and ADL value obtained Kulumsa-DZF-592 and Kindo kosha-DZF#589. The highest ADF value among the tested grass lines shows that they less digestible than the other with lower ADF value. This is consistent with work of Albayrak *et al.* (2011) who reported that as the ADF increases the digestibility of the forage usually decrease causing consumption of the forage by animal to decrease.

CONCLUSIONS

The results revealed non-significant differences in total dry matter yield ton per hectare

Fig. 4. Farmers harvesting desho grass after data collected at experimental site.

and dry matter leaf to stem ratio among the four Desho grass lines. Although, they are statistically not different large amount of forage dry matter produced from the evaluated desho grass lines. Therefore, all lines of Desho grasses were well adapted and performed at midlands and highland agro ecologies of East Hararghe zone. Among the lines particularly Kulumsa-DZF-592 and Kindo kosha-DZF#589 were performed more in dry matter ton per hectare at midland agro ecology. Further research is needed to exploit its potential under a range of livestock production performances.

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