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Evaluation of Desho *(Pennisetum pedicellatum)* Grass Varieties for Dry Matter Yield and Chemical Composition in South Omo Zone, South Western Ethiopia

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Abstract

Desho grass is indigenous grass to Ethiopia and belonging to the family of Poaceae and has high biomass production potential. Therefore, this study was initiated to evaluate dry matter yield and chemical composition of four desho *(Pennisetum pedicellatum)* grass varieties in 2017 and 2018 cropping years at on- station of Jinka Agricultural Research Center under rain fed condition in randomized complete block design with three replications per tested variety. The data on dry matter yield, plant height, tillers per plant, leaf to stem ratio and chemical composition were analyzed using the General Linear Model procedures of SAS. The Areka-DZF#590 gave highest (P>0.001) dry matter yield (27.99t/ha) and whereas the, Kindo kisha-DZF#589 variety gave the lower dry matter yield (14.15t/ha). Likewise, higher (P>0.05) Crude protein (140.12g/Kg, DM) recorded for Areka-DZF#590 and whereas, significantly lowest (P<0.05) Crude protein (90.57g/Kg, DM) obtained for Kindo kasha-DZF#589 variety. Based on this finding, we concluded that farmers who live in comparable agro- ecologies to areas where this study was conducted in South Omo and other areas could plant Areka -DZF#590 variety for higher dry matter yield and crude protein content.

Keywords: Dry matter yield; Desho grass verity; Crude protein

Introduction

Ethiopia has largest livestock population in Africa possessing 60.39 million of cattle, 31.30 million sheep, 32.74 million goats, 2.01 million horses, 8.85 million donkeys, 0.46 million mules, 1.42 million camels and 56.06 million of poultry [1]. However, the overall production and productivity performances of livestock in Ethiopia are generally low due to many livestock production determinants [2]. The poor feed quality and inadequate feed supply is one of top urgent determinants that lead to low livestock production performances in Ethiopia [2]. On the other hand, the demand for livestock products by consumers in country projected at accelerate rate and it is difficult to satisfy the demand of consumer under such conditions unless urgent measure will be taken. Likewise, in study region the livestock feeding system is completely natural pasture based [3,4]. It is obvious that the natural pasture-based feeding system is greatly influenced by feed supply and nutritional dynamics of pasture forages [2, 5]. Moreover, these feed resources could not fulfill the nutritional requirement of animals particularly in the dry season and the supply of these feed resources is inconsistently distributed over the seasons into study district. Furthermore, these feed resources are characterized by high fiber (>55%) and low crude protein (CP) (<7%) contents [6,7] and their feed intake level is limited and they barely satisfy even the maintenance requirements. This is triggering to increase high mortality, longer calving intervals and substantial weight loss [3,6,8,9] and will be made the communities minimum benefits from livestock production. Therefore, in this respect, it is not imagined the surplus production from the livestock unless the immediate action is undertaken in improving dry matter supply and feed quality issues into study area [5]. Therefore, testing locally adaptable and producing adequate quality forages to supplement pasture roughage-based feeding system is only way to overwhelm feed shortage into study area [3,10]. Among the locally adaptable forage species, Desho grass is indigenous grass to Ethiopia and belonging to the family of Poaceae [11] and it is a perennial grass which has an extensive root system that anchors well with the soil and has high biomass production potential. Currently different desho grass varieties had been registered at country level for their biomass production potential [12]. The dry matter yield of desho grass varieties in irrigated condition in central Ethiopia were 28.35, 26.52, 23.37 and 21.95 t/ha dry matter yield respectively, for Areka-DZF#590, Kulumsa-DZF#592, Kindokosha DZF#589 and Kindo kosha-DZF#590 [12]. Moreover, [13] had reported 28.74t/ha, 26.14t/ha 23.59t/ha dry matter yield for Areka-DZF#590, Kulumsa-DZF#592 and Kindo kisha-DZF#591 varieties respectively. Moreover, currently the grass being utilized as means of soil conservation practices, rehabilitate degraded land, as animal feeds and provides a small business opportunity in Ethiopia [11,14,15-18]. Moreover, report by [14] had demonstrated that increasing the proportion of desho grass hay from 0 to 100 % as a basal diet of Washera lambs had improved DM intake, digestibility of nutrients, daily weight gain and feed conversion efficiency. However, with this promising potential desho grass variety, currently released desho grass varieties (eco-type) have not evaluated for dry matter yield and their chemical composition for the study regions. Therefore, this study was initiated with objective of identifying the dry matter yield and chemical composition of desho grass variety.

Material and Methods

Description of Study Site

The field experiment was conducted at on- station of Jinka Agricultural Research Center's research in South Omo Zone, Southern Nations, Nationalities and People's Regional State (SNNPRS) during 2017 and 2018 cropping years. The Jinka Agricultural Research Center is located 729km South West of Addis Ababa at geographical coordinate of 360 33'-370 67'E and 50 46'-6057'N with an altitude of 1450m above sea level. The rainfall distribution of the area is bimodal with main rainy season extends from March to May and the second cropping season, from July to October. The average annual rainfall of the area in the last ten years was 1326.7mm the average annual temperatures of 22.4^{o}C. The soil of the experimental site is loamy soil with organic matter content of 5.88 %, total nitrogen content of 0.24%, cation exchange capacity of 32.40cmol kg^{-1}, available phosphorus content of 3.41 mgkg^{-1}and soil pH of 6.41 [19].

Experimental Design and Treatments

The currently released desho grass varieties such as Areka-DZF#590, Kulumsa-DZF#592, Kindo Kisha DZF#589 and Kindo Kisha-DZF#591 desho grass varieties were planted in randomized complete block design with three replications per variety. A total of fifteen experimental plots each with 12m2 (3m*4m) areas were used. Each treatment groups was assigned randomly and independently to each experimental block. The root split was planted in 3m × 4m = 12m^2 plot and splits were planted in four rows per plot with 50cm between row and 30cm between plant with 1m between plots [15].

Land preparation

Land preparation, planting, weeding and harvesting was done according to the recommendations [11].

Data Collection

The growths data like plant height (cm), leaf to stem ratio (LTSR) and tillers per plant were measured when plant was at three-month age by harvesting samples from 50cm by 50cm area by using hand shears. In order to measure dry matter yield, the harvested fresh sample was measured right in field by spring weight balance and 500g subsample per plot was brought to Jinka Agricultural Research Center and chopped in to pieces and 300g sampled sample was placed to oven dried at 105^{o}C for overnight for dry matter determination and dry matter yield (t/ha) was calculated by [20] formula. The dry matter yield (t/ha) = TFW × (DWss /HA × FWss) ×10 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 to t/ha. Plant height was measured using a steel tape from the ground level to the highest height at forage harvesting stage and mean height of five randomly selected plants per plot was recorded for each plot. In order to measure leaf to stem ration, the morphological parts were separately weighed to know their sample fresh weight, oven dried for 24 hours at a temperature of 105^{o}C and separately weighed to estimate the proportions of these morphological parts. Accordingly, leaves were separated from stems and the leaf to stem ratio (LSR) was estimated based on the dry matter basis of each component.

Chemical Composition Measurements

A 500g partially dried sample from the previously harvested sample was taken and kept in a pre-weighed separate /individual cloth bags and sent to Debre Birehan Agricultural Research Center. The dried samples ground to pass 1-mm for use in chemical composition analysis. The DM, CP and Ash contents were determined procedures of [21]. The NDF content was determined according to procedure of [22] and whereas, ADF determined by procedure of [23].

Data Analysis

The data such as plant height, leaf to stem ratio, dry matter yield, tillers per plant and chemical composition were subjected to analysis of variances (ANOVA) using the General Linear Model (GLM) procedure of Statistical Analysis System (SAS) software (Version, 9.1). The significant differences among the means were declared at $P \leq 0.05$ and means were separated using Duncan's least significant difference (LSD) test with model of $Yijk = \mu + Vi + Yj + Vi^* Yj + eijk$, where; yijk = all dependent variables; μ = overall mean; Vi = the effect of variety; Yj = the effect of testing year; Vi*

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Yj = the interaction effects of variety and year and eijk = random error.

Results and Discussion

Dry matter yield, plant height, tiller per plant and LTSR of desho grass variety

The effects of desho grass varieties under rain fed condition in on-station of Jinka Agricultural Research Center on dry matter yield, plant height, tillers per plant and LTSR are illustrated in Table 1. The results revealed that the Areka-DZF#590 variety had significantly (p<0.001) taller plant height and more tillers per plant at harvesting stage than Kulimisa-DZF#590, Kindo Kisha-DZF#591 and Kindo Kisha-DZF#589 desho grass varieties. However, the plant height and tillers per plant were insignificant (p>0.001) for the Kulimisa-DZ#F590, Kindo Kisha-DZF#590 and Kindo Kisha-DZF#589 desho grass varieties. Likewise, the Areka-DZF#590 variety had significantly (p<0.001) higher dry matter yield than Kulimisa-DZF#590, Kindo Kisha-DZF#590 and Kindo Kisha-DZF#589. However, dry matter yield was insignificant (P>0.0001) for Kindo Kisha-DZF#590 and Kindo Kisha-DZF#589 varieties. On the other hand, result from this study revealed that there was no significance (p>0.05) difference among the tested desho grass varieties for LTSR. The higher dry matter yield and taller plant height for Areka- DZF#590 desho grass variety from this study is due to high genetic potential of variety to adapt the tested agro-ecology.The previous studies reported by different scholars were demonstrated that the wider range of dry matter yield difference between desho grass varieties could be attributed due to differences in genetic potential of varieties [12-14]. The result obtained on dry matter yield from this study for Areka-DZ#F590 variety is comparable to previously reported values of 28.35 and 28.74t/ha by [12] and [13] respectively. However, the lower dry matter yield obtained from this study for Kulumsa-DZF#592, Kindo Kisha-DZF# 591 and Kindo Kisha-DZF#589 as compared to previously reported values of 26.52, 23.37 and 21.95 t/ha by [12] and 26.14 23.59 and 20.30 t/ha by [13] respectively. Furthermore, finding from our study for plant height was higher for Areka-DZ#F590 and Kulimsa-DZF#591 but slightly comparable for Kindo Kisha-DZF#591 and Kindo Kisha-DZF#589 varieties to previously reported values which ranged from 71.27-96.30cm by [13] and [12] respectively. The tillering performance is an important morphological characteristic to be considered during selection of appropriate forage crops to improve dry matter yield production. The difference in tillers produced per plant among the tested varieties of desho grass from our study could be attributed to genetic variations among the varieties to adapt given environment. The variation in tiller number among different varieties of desho grass was also observed by different scholars in Ethiopia [12-14]. The leaf to stem fractions were affected by tillering performance, plant height and age of harvesting. The leaf fraction has significant implications on the nutritive quality of the forage as leaves contain higher levels of nutrients and less fiber than stems [24]. The previous study reported by [25] indicated that the leaf fraction is an important factor affecting diet selection, quality and intake of forage. The leaf fraction is associated with high nutritive value of the forage because leaf is generally of higher nutritive value [26] and the performance of animals is closely related to the amount of leaf in the diet. The result for leaf to stem fraction for tested desho grass varieties from our study was higher than reported values by [12,13]. Generally, inconsistency in dry matter yield, plant height, tillers and leaf to stem ratio from our study as compared to previously reported studies by different scholars for same tested desho varieties might be due to difference in soil parameters, harvesting age, management and agro ecological differences (rainfall, temperature and humidity).

Table 1: The dry matter yield, plant height, tillers per plant and leaf to stem ratio of desho grass varieties under rain fed condition at Jinka Agricultural Research Center in South Omo.

Tested Varieties	Dry Matter Yield(t/ha)	Plant Height(cm)	Tiller per Plant	LTSR
Kulumsa-DZF#592	20.77^{b}	116.06^{b}	51.83^{b}	1.09
Areka-DZF#590	27.99^{a}	161.32^{a}	78.5^{a}	1.27
Kindo Kisha-DZF#591	15.45^{c}	98.19^{b}	43.83^{b}	0.93
Kindo Kisha-DZF#589	14.15^{c}	89.78^{b}	45.17^{b}	1.03
F-value	15.18	9.29	7.57	1.55
P-vale	0.001	0.001	0.003	0.245
SEM	2.28	14.81	8.3	0.16
LSD	4.89	31.77	17.82	0.35

(Means with the same letter (a, b, c) in across column for dry matter yield, plant height, tillers per plant and LTSR at 50% flowering stage are not significantly different (p>.001). SEM = Standard error of mean; LSD = Least Significance difference).

Effect of years on dry matter yield, plant height, tillers per plant and leaf to stem ratio

The effect of testing years on dry matter yield, plant height, tillers per plant and leaf to stem ratio are listed in Table 2. The findings from this study revealed that significantly (P<0.001) higher dry matter yield and plant height were observed in cropping year 2 (2018) as compared to cropping year1 (2017). However, tillers per plant and leaf to stem ratio were not significantly (P>0.001) affected by cropping years but higher leaf to stem ratio

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was obtained from cropping year2. The higher dry matter yield, plant height, tillers per plant and Leaf to stem ratio were observed in cropping year2 (2018) is due to higher rainfall availability in cropping year2 than cropping year1 which is displayed in Figure 1. It is apparent that sufficient amount of rainfall makes faster plant growth and triggered more tiller per plats which are responsible for more dry matter yield. In support to the findings from our study the previous study reported by different scholars had demonstrated that dry matter yield of forage species is greatly influenced by weather conditions such as rainfall, temperature and precipitations [27-29].

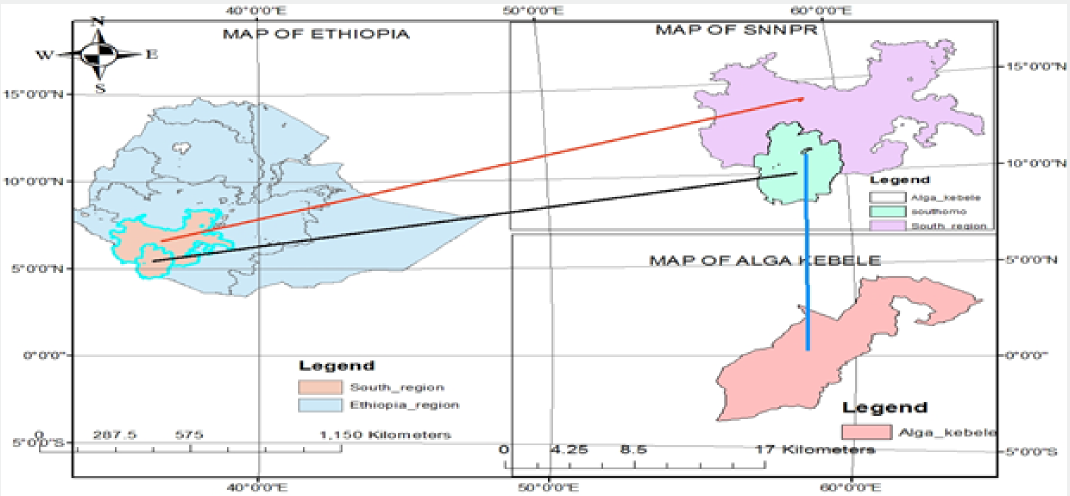

Figure1: Map of study area in South Omo Zone, Jinka town, Alga kebele.

Table 2: The dry matter yield, plant height, tillers per plant and LTSR of desho grass varieties affected by Cropping years at on-station of Jinka Agricultural Research Center in 2017 and 2018 main cropping years.

Parameters Measured	Cropping Years			
	Year1(2017)	Year2(2018)	Mean	LSD
Dry matter yield (t/ha)	14.74^{b}	24.44^{a}	19.59	3.5
Plant height (cm)	89.33^{b}	143.34^{a}	116.3	22.5
Tillers per plant	48.67	61	54.83	12.6
Leaf to stem ratio	1.11	1.04	1.07	0.25

(Means with the different letter (a, b) in across row for dry matter yield, plant height, tillers per plant and leaf stem ratio at 50% flowering stage are significant each other); LSD= Least significant difference).

Year by variety interaction effect on dry matter yield, plant height, tillers per plant and leaf to stem ratio;

The interaction effect of planting year and variety on dry matter yield, plant height, tillers per plant and leaf to stem ratio are presented in Table 3. The results from this study on dry matter, plant height, tillers per plant and leaf to stem ration were significantly higher (P<0.001) for planting year2 as compared to planting year1. Accordingly, the Areka- DZF#590 desho grass variety gave higher (P<0.001) dry matter yield (34.59t/ha) than Kulimisa-DZFf#590, Kindo Kisha-DZF#591 and Kindo Kisha-DZF#589 varieties by keeping planting year constant. However, Kindo Kisha-DZF#589 variety gave significantly lowest (P<0.001) dry matter yield (14.22t/ha) as compared to Areka-DZF#590, Kulimisa-DZF#590 and Kindo Kisha-DZF#591 in planting year2. Likewise, in planting year1 (2017), the Areka-DZF#590 variety gave higher (p<0.001) dry matter yield than Kindo Kisha-DZF#591 and Kindo Kisha-DZF#589 varieties but, it was comparable (p>0.001) to Kulumisa-DZF##590. The better dry matter yield for all varieties obtained in planting year2 than planting year1 from this study indicated that the genetic make-up of varieties influenced by environmental factors which is clearly exhibited that different varieties have differential response to different planting years. The previous study reported by [30] had demonstrated that relatively warmer climatic condition and better rainfall condition are the major reasons for getting better dry matter yield in forage species.

Chemical composition of desho grass varieties

The chemical compositions of tested varieties are presented in Table 4. The findings from this study revealed that Kindo-

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KishaDZF#591 variety had higher(p>0.05) ash content than Areka-DZF#590 and Kulumisa-DZF#590 but, it was comparable to Kindo Kisha-DZF#589. However, the Areka-DZF#590 variety had higher (P>0.05) CP and lower NDF whereas, the Kindo Kisha-DZF#589 had gave lowest (P>0.05) CP and higher NDF contents. The similarity in crude protein and NDF for all tested varieties is due to similarity in genetic make-up of varieties to accumulate similar nitrogen contents in a given environments. The result obtained from our study on CP values for all tested varieties were higher than previously reported values by different authors. Accordingly, [31] reported that CP values which ranges from 6.93-9.38% under different spacing and harvesting stages [32] reported CP values which ranges from 7.86- 8.84% under different agro-ecologies. The NDF and ADF are frequently used as standard for forage quality testing. The NDF approximates the total cell wall constituents and is used to predict intake potential in livestock and whereas, ADF primarily represents cellulose and lignin and is often used to calculate digestibility of feeds [33]. The value obtained from our study for NDF was lower than previously reported values which ranged 72.78-77.68% by [31] and but it was relatively comparable to values reported by [32] which ranged from 58.82-63%. Moreover, the ADF value obtained from out study was higher than the previous reported values by [31] which ranged from 54.27-45.06%. Generally, by [34] classification, the feeds containing NDF values of less than 45% could be classified as high quality, those with values ranging from 45% to 65% as medium and those with values higher than 65% as low quality. Based on this classification all tested varieties except local check variety can be classified as medium quality forages class.

Table 3: The year by variety interaction effect on dry matter yield, plant height, tillers per plant and LTSR of desho grass varieties at Jinka Agricultural Research Center during 2017 and 2018 main cropping years.

Tested Desho Grass Varieties	Testing Years	Parameters Measured			
		DMY(t/ha)	Plant height(cm)	Tillers per plant	Leaf to stem ratio
Kulumsa-DZF#592	2017	16.71^{cd}	82.33^{cd}	55^{b}	1.25^{ab}
	2018	24.83^{b}	149.78^{ab}	48.67^{b}	0.92^{bc}
Areka-DZF#590	2017	21.38^{bc}	134.33^{b}	60.33^{b}	1.01^{bc}
	2018	34.59^{a}	188.31^{a}	96.67^{a}	1.53^{a}
Kindo Kisha-DZF#591	2017	6.78^{e}	80.67^{cd}	38.67^{b}	1.10^{abc}
	2018	24.12^{b}	115.71^{bc}	49^{b}	0.74^{c}
Kindo Kisha-DZF#589	2017	14.07^{d}	60^{d}	40.67^{b}	1.08^{abc}
	2018	14.22^{d}	119.56^{bc}	49.67^{b}	0.98^{bc}
	LSD (%5)	6.92	44.93	25.2	0.5

Means with the different letter (a, b, c, d, e) in across column for dry matter yield (DMY), plant height (PH), tillers per plant and leaf stem ratio at 50% flowering stage are significant each other); LSD= Least significant difference.

Table 4:

Tested Varieties	DM%	Ash%	CP	NDF	ADF
Kulumisa-DZF#592	89.67	7.33^{b}	11.84	57.73	44.63^{ab}
Areka-DZF#590	89.33	7.29^{b}	14.12	55.12	43.62^{b}
Kindokisha-DZF#592	90	10.22^{a}	13.39	56.7	47.23^{ab}
Kindokisha-DZF#589	90.33	7.85^{ab}	9.57	63.42	50.23^{a}
F-value	0.12	3.08	1.6	1.89	2.71
P-vale	0.95	0.09	0.26	0.21	0.11
SEM	2.17	1.36	2.74	4.56	3.11
LSD	4.2	2.57	5.18	5.58	5.86

(Means with the same letter (a, b) in across column for DM%, Ash, CP, NDF and ADF at 50% flowering stage are not significantly different (p>.05). DM%= dry matter percent, CP = Crude protein; Ash%= Ash percentage; NDF= Neutral detergent fiber; ADF= Acid detergent fiber; SEM= Standard error of mean; LSD: Least Significance difference).

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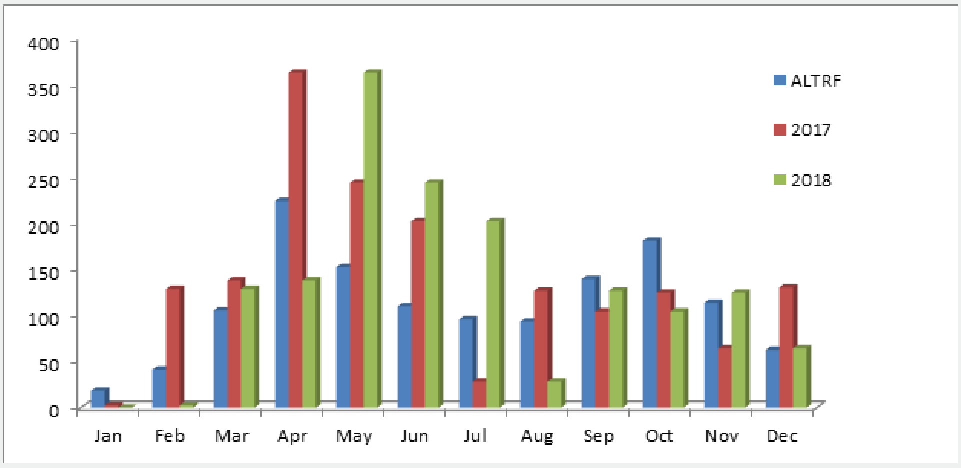

Figure 2: Cumulative amount of rain fall (mm) into study area during trial periods.

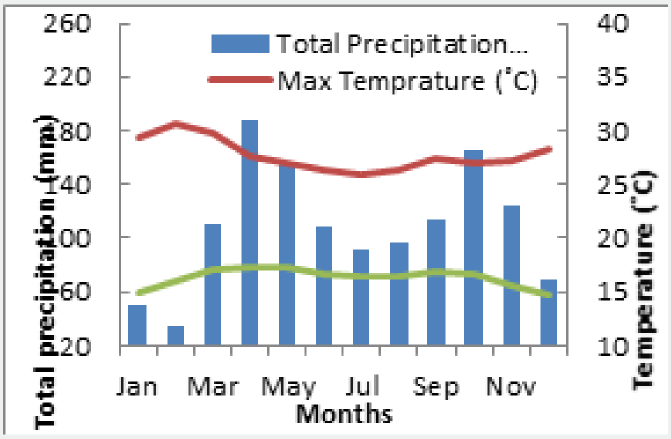

Figure 3: The mean temperature (Temp (Co)) and cumulative precipitation (mm) in to study area during trial years.

Conclusion

The Areka-DZF#590 variety gave highest dry matter yield, plant height and tillers per plant whereas, the Kindo-KishaDZF#589 variety gave the lowest dry matter yield, plant height and tillers per plant. Likewise, the Areka-DZF#590 variety had higher CP and lower NDF whereas, the Kindo Kisha-DZF#589 had gave lowest CP and higher NDF contents. Based on results from this study we concluded that farmers who live in comparable agro ecology to which this study was made in South Omo Zone and other areas having comparable agro-ecology could plant Areka DZF#590 desho grass variety for higher dry matter yield and crude protein content.

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Conflict of interest

We declare that this manuscript is our original work and no competing claims among us. We also confirmed that availability of raw data and all the necessary materials are based on the interest of the publisher.

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