Screening Desho Grass (*pennisetum pedicellatum trin*.) Varieties for Yield and Nutritional Quality in Different Environments of Northern Ethiopia

Assen Ebrahim[1] & Nigus Derbew[2]
[1]Department of Animal Sciences, Aksum University, P.O. Box 1010, Aksum, Ethiopia
[2]Department of Animal Science, Shire Agricultural Polytechnic College, P.O. Box 07, Shire, Ethiopia

Corresponding Author**: Assen Ebrahim**

Abstract:
This study aimed to evaluate growth performances, dry matter yield, and chemical constituents of four Desho grass (*Pennisetum pedicellatum*) varieties under irrigation at two different altitudes in Tigray, Ethiopia. A factorial arrangement of treatments was employed with a combination of four Desho grass varieties (Areka DZF-590, Kindu Kosha2 DZF-591, Kindu Kosha 1 DZF-589 and Kulumsa DZF-592) and two altitudes (midland and lowland) between October 2019 and May 2020 (105 days). Results showed that the mean number and length of leaves per plant, number of leaf per tiller and leaf-to-stem ratio varied significantly due to altitude rather than variety. Lower plant cover (91.2 percent), plant height (27.7 cm) and number of tillers per plant (35.3) recorded for KK1-DZF#591 variety. Remarkably higher performance values obtained at midland than lowland altitude. More dry matter yield (ton h^{-1}) was recorded for DZF# 590, KK2-DZF- 589 and Kulumsa-KDZF#592, while the lowest value was from KK1-DZF#591 variety. Highest mean crude protein content obtained at midland compared to lowland altitude, while the mean neutral detergent fiber and acid detergent lignin were higher at lowland area. All Desho grasses varieties evaluated in this study showed higher growth performances and chemical constituents at midland altitude. This study also highlighted that Areka DZF-590, Kindu Kosha2 DZF-591, Kindu Kosha1 DZF-589 and KulumsaDZF-592 could be used for wider cultivation forage due to their better dry matter yield preferably in midland altitude and other similar agro-ecological areas. Feeding experiments are also required to examine the performance of ruminant animals fed Desho grass.

Keywords: Altitude, Desho grass, Environment, Nutritional value, Yield.

Introduction:

Inadequate feed quality and quantity constitute the leading constraint for low productivity of ruminant livestock in Ethiopia (Negash*et al*., 2017). One of the cost effective solutions to overcome this feed shortage and enhance market oriented livestock production would be integrating improved forage plants into the existing farming systems(Mohamed and Gebeyew, 2018). In this view, desho grass (P*ennisetum pedicellatum*) is among the potential forage grasses that can fill the feed shortage gap in Ethiopia(Minichl*et al*., 2019). It is a perennial grass native to tropical Africa and widespread to East Africa(Letaet al.,2013).This grass is also widely available in different regions of Ethiopia such asOromiya, South and Amhara (Mulatie*et al*.,2016; Asmare*et al*., 2017). Desho grass has the potential to produce large amount of biomass to support livestock production during times of feed scarcity. Hence, this grass has gained great attention in recent years mainly due to its important roles as feed for ruminant livestock and soil conservation (Mulatie*et al*.,2016; Birmaduma*et al*., 2019). However, environmentalfactorsimpact the yield and nutritional quality of forage species due to differences in soil types, temperature, and amount and distribution of rainfall (Kebede*et al*.,2017).This signifies evaluating the yield potential and nutritional quality of different forage plants across various environmental locations is the fundamental step before their dissemination and wider utilization by livestock producers. Therefore, it was with this background that four desho grass varieties namely Areka DZF-590, Kindu Kosha 2 DZF-591, Kindu Kosha 1 DZF-589 and Kulumsa DZF-592 which have been proven superior in other regions of the country have been introduced and evaluated for their performances and yield for the first time in Central and Northwest Zones of Tigray, Ethiopia. The aim of the study was to evaluategrowth performance, dry matter yield and chemical constituents of four varieties of Desho grassat two environments of Tigray, Northern Ethiopia.

Materials and Methods:

Study area description

The experiment was conducted under irrigation management at two different environments (midland and lowland) of Tigray, Northern Ethiopia between October 2019 and May 2020 (105 days). It was conducted at Selekleka and Rama located in northwest and central zones of Tigray region, respectively. The midland altitude area was represented by Selekleka situated at 140 08' 57"N latitude and 380 17' 02" E longitudes at an altitude of 1945 meters above sea level (Fig. 1). The lowland altitude was represented by Rama district located at 14°25′N latitude and 38°47′E longitude with an elevation of 1385 meters above sea level.

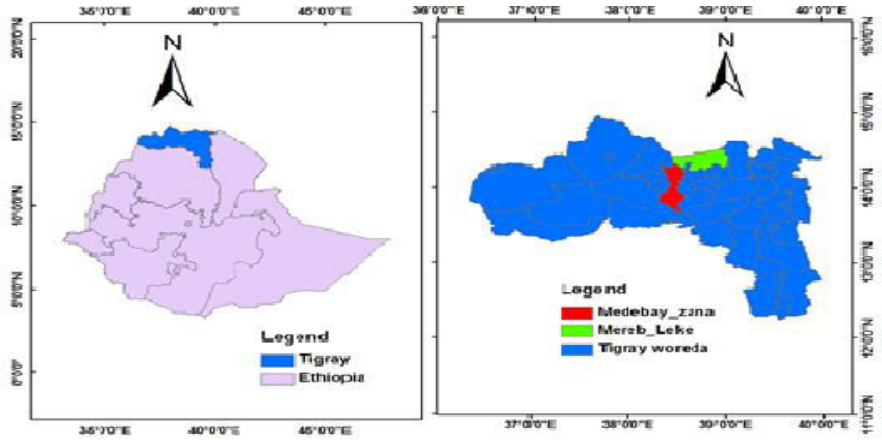

Fig. 1 Map of study area

Planting materials, experimental design and plant establishment

Mature healthy vegetative roots of four Desho grass varieties, namely DZF#590, Kulumsa-KDZF#592, KK2-DZF- 589 and KK1-DZF#591 were brought from Aksum and Alamata Agricultural Research Centers located in Southern and Central zones of Tigray Region, respectively. The total experimental area was 184.6m2(14.2m*13m), and twelve experimental plots were prepared in each site making a total of 24 plots in both altitudes. The plots had dimensions of 4 × 3 m2; spaced 1 m apart and there was a 1 m wide path around the block boundary.

The experimental land was prepared thoroughly by clearing, labeling and by applying first, second and third plowing techniques before sowing in December and harrowed in January 2019.The land was prepared thoroughly by dividing in to three blocks and each of which comprised four plots (2.8*2 m) in each block at each location. Planting was done on a well-prepared seedbedusing mature health vegetative root splits rows on well prepared soil. The spacing between row and plants was 40 cm and 15 cm respectively. The grass was planted in January 2019 and lasted until 14 may 2020 for the experimental period of 105 days. Planting, weeding and harvesting wereappliedaccording to the recommended practice for desho grass(Leta*et al.*, 2013). Soil samples was taken from the experimental area before planting and analyzed for major elements such as K, P, Ca and C, pH, CE, CEC, % of total N, % total OM and texture. Based on the result of soil sample analysis, inorganic fertilizer was applied as per the recommendations for Desho grass. Di-ammonium phosphate (DAP) 25 kg/ha was added at planting. Urea was applied at the rate of 100 kg/ha after 21 days ofplanting according to the recommendationsby Leta*et al.*(2013). Furrow irrigation was applied from hand dug well, which was pumped by motor pumps. Irrigation was done two times per week in the first 3-4 weeks and once per week for the rest of the growing weeks.The experiment was laid-out in a factorial arrangement of two environments (midland and lowland) and four Desho grass varieties in a randomized complete block design whereby each Desho grass variety was replicated three times.

Measurement of agronomic performance parameters and dry matter yield

Data was recorded throughout the experimental periodonplot cover (%), plant vigor(%), leaf to stem-ratio, number of tillers per plant,plant height (cm), leaf length per plant, leaf number per plant, leaf number per tiller and dry matter yield (t/ha).Plant height and leaf length were measured from 10 plants that were randomly selected from middle rows of each plot at 105 daysafter planting. Plant heightwas measured from ground level to the tip using measuring tape. The numbers of tillers and leaves were computed as mean counts taken from 10 plants that were randomly selected from middle rows of each plot at 105 daysafter planting. The leaf tostemratio was determined by harvesting all plants in three consecutive rows, randomly selected in the middle of each plot and separating these plants into stem and leaf.

An area of $4.2m^2$(1.5*2.8m)freshly harvested grass was used to calculate above ground dry matter (DM) yield andthe harvested herbage was weighed for its fresh weight right in the field using a field balance with a sensitivity of 0.01 g. about 500g representative samples of green forage were taken from each plot at each site and dried in a draft oven at 65°C for 72hrs beforeconducting chemical analysis to determine the dry matter yield(ton/ha). Plant height was measured by averaging the natural standing height of ten plants per plot. The main branch number was calculated as an average of primary branches on the stem of ten plants per plot.

Nutritional analysis

Dry matter (DM), ash and crude protein (CP) were determined according to the procedures described by AOAC (1990). The Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) weredetermined following the procedures described by Van Soest and Robertson (1991).

Statistical analysis

Data for agronomic performances, dry matter yield and chemical constituents were computed using the General Linear Model (GLM) procedure of SAS version 9.3 (SAS Institute, 2011). Least significance difference (LSD) test was employed for separation of treatment means at $p< 0.05$ level. The 2 × 4 factorial ANOVA considering two environments and four desho grass varieties was employed to test the overall effects and interactions between altitudes and varieties. The statistical model used was: $Y_{ij}= \mu+ V_i$ (i=1-4) $+A_j$ (j=1-2) + $(VA)_{ij}+ \varepsilon_{ij}$; where:$Y_{ij}$= response variable, μ= is the overall mean,V_i= effects of variety (j four Desho grass varieties) ,Aj= effects of environment (i = midland and lowland), $(VA)_{ij}$=effects of interaction between variety and environment and ε_{ij}; =random error. Pearson correlation analysis was applied to examine the association among morphological parameters, nutritional parameters and yield of desho grass varieties.

Results:

Effect of altitudes and variety on growth performance parameters

Except for number of tillers per plant (NTPP), interaction between desho grass varieties and environments had significant effect ($p<0.05$) on percent vigor (V), percent plant cover (PC) and plant height (PH) (Table 1).The mean PCand PHwere higher for DZF# 590 varietyat midland; while the lowest values for these parameters was recorded for KK1-DZF#591variety at lowland altitude.The values for PC, PH and NTPPwere significantly ($p<0.05$) higher at midland compared to lowland altitude.MorePC was scored from three varieties (KK2-DZF-589, Kulumsa-DZF #592 and DZF# 590), while the lowest was from KK1-DZF#591 variety.The result further indicated that DZF# 590 produced higher ($p<0.05$) mean PH and the lowest was for KK1-DZF#591 variety.

Table1:**Effects of variety, altitude and their interaction on percent plant vigor, plot cover, plant height and number of tiller per plant of fourdesho grass varieties**

Factors			Parameters		
altitude *variety		PV (%)	PC (%)	PH(cm)	NTPP
Midland	DZF# 590	92.5^{abc}	97.2^{a}	42.6^{a}	42.1
	KK1-DZF#591	90^{c}	92.7^{cde}	32.1^{cd}	38.1
	KK2-DZF- 589	93.5^{ab}	96.5^{ab}	39.3^{ab}	43.9
	Kulumsa-KDZF#592	90.7^{bc}	95.5^{abcd}	35.7^{bc}	42.0
Lowland	DZF# 590	90.2^{c}	93.3^{bcd}	32.6^{cd}	36.9
	KK1-DZF#591	89.8^{c}	89.7^{e}	23.4^{e}	32.5
	KK2-DZF- 589	91.5^{bc}	92.0^{de}	26.7^{de}	36.9
	Kulumsa-KDZF#592	94.8^{a}	95.8^{abc}	30.3^{cd}	37.8
P-value		0.024	0.005	0.038	0.949
Altitude	Midland	91.7	95.5^{a}	37.4^{a}	41.6^{a}
	Lowland	91.6	92.7^{b}	28.2^{b}	36.0^{b}
	Mean	91.6	94.1	32.8	38.8
	P-value	0.91	0.005	0.0009	0.006
Variety	DZF# 590	91.3	95.3^{a}	37.6a	39.6
	KK1-DZF#591	89.9	91.2^{b}	27.7c	35.3
	KK2-DZF- 589	92.5	94.3^{a}	33.01^{b}	40.2
	Kulumsa-KDZF#592	92.8	95.7^{a}	33.0^{b}	39.9
	Mean	91.6	94.1	32.8	38.8
	P-value	0.057	0.008	0.002	0.189

**means with different letters with in a column are significantly different ($p<0.05$)*
PV=Percent plant vigor; PC=Plot cover; PH=Plant height and NTPP=Number of tiller per plant

Number of leaf per plant (NLPP) and leaf length per plant (LLPP) varied significantly ($p<0.05$) attributed to the interaction between altitude and variety (Table 2). Larger NLPP was obtained from three desho grass varieties (DZF# 590, KK1-DZF#591 and KK2-DZF- 589) at midland altitude, whereas the lowest mean value for this parameter was recorded from KK2-DZF-589 and Kulumsa-KDZF#592 desho grass varieties at lowland altitude. Larger LLPP was for Kulumsa-KDZF#592 Desho grass variety at lowland, but the lowest value was for KK1-DZF#591 and Kulumsa-KDZF#592 varieties at midland altitude. The values for NLPP, number of leaf per tiller (NLPT), LLPP and leaf-to-stem ration (LSR) varied significantly ($p<0.05$) attributed to altitude, but no variation for same parameters due to varietal difference (Table 2). Desho grass varieties planted at midland resulted significantly higher ($p<0.05$) values for similar variables compared to lowland altitude.

Table 2: Effects of variety, altitude and their interaction on NLPP, NLPT, LLPP and LSR of fourdesho grass varieties

Factors			Parameters		
altitude *variety		NLPP	NLPT	LLPP	LSR
Midland	DZF# 590	311.6^{a}	7.4	24.3^{ab}	0.72
	KK1-DZF#591	281.1^{a}	7.3	20^{cd}	0.71
	KK2-DZF- 589	325.5^{a}	7.4	18.6^{d}	0.72
	Kulumsa-KDZF#592	306.6^{ab}	7.2	18.2^{d}	0.72
Lowland	DZF# 590	229.1^{c}	6.1	24^{ab}	0.55
	KK1-DZF#591	208.0^{bc}	6.4	23.2^{bc}	0.63
	KK2-DZF- 589	228.8^{c}	6.2	25.1^{ab}	0.66
	Kulumsa-KDZF#592	252.6^{c}	6.6	27.3^{a}	0.71
P-value		0.009	0.72	0.02*	0.14
Altitude	Midland	306.2^{a}	7.4^{a}	24.9^{a}	0.72^{a}
	Lowland	229.6^{b}	6.4^{b}	20.3^{b}	0.64^{b}
	Mean	267.9	6.8	24.9	0.64
	P-value	0.000	0.000	0.0002	0.0056
Variety	DZF# 590	270.3	6.9	24.2	0.64
	KK1-DZF#591	244.6	6.8	21.6	0.67
	KK2-DZF- 589	277.1	6.08	21.9	0.69
	Kulumsa-KDZF#592	279.6	6.9	22.7	0.72
	Mean	267.9	6.8	24.9	0.64
	P-value	0.33	0.92	0.25	0.20

**means with different letters with in a column are significantly different (p<0.05) NLPP=Number of leaf per plant; NLPT=number of leaf per tiller; LLPP=Leaf length per plant; LSR=Leaf to stem ratio.*

Effects of altitudes and variety on dry matteryield and chemical constituents

Except variety, dry matter yield (t/ha) was not affected ($p>0.05$) due to altitude and interaction between these two variables (Table 3). Significantlymore ($p<0.05$) dry matter yield (ton/hectare) was obtained from three desho grass varieties (DZF# 590, KK2-DZF-589 and Kulumsa-KDZF#592) while thelowest value was from KK1-DZF#591 Desho grass variety.All the chemical constituents (crude protein, ash, acid detergent fiber, neutral detergent fiber and acid detergent lignin) of the testedDesho grass varieties were significantly ($p<0.05$) affected due to altitude, variety and their interaction (Table 3).Highest crude protein (CP) content (14.9%) was recorded at midland and lower value (13.7%) at lowland altitude. More CP (15.9%) value has been scored from KK1-DZF#591 Desho grass variety and lower value was from Kulumsa-KDZF#592 (13.6%) variety.The total ash content was more ($p<0.05$)for KK1-DZF#591 (14.1%) variety at midland elevation (Table 6). Desho grass variety that produced more (13.4%) total ash was from KK1-DZF#591, and the least value for this parameter was from Kulumsa-KDZF#592 variety. Desho grass varieties grown in lowlandresulted significantly higher (12.9%) total ash than midlandaltitude (11.6%). The result further revealed that KK1-DZF#591 produced low contents of ADF, NDF and ADL at midland area. Except for ADF, varieties planted at midland resulted significantly lower ($p<005$) NDF and ADL content compared to lowland altitude. Considering variety, KK2-DZF- 589 scored the highest ($p<0.05$) concentration of ADL, NDF and ADL; while the lowest values for these parameters was found from KK1-DZF#591 variety.

Table 3:Effects of variety, altitude and their interaction on chemical composition of four desho grass varieties

Factors				Chemical composition,% DM				DM yield (ton h^{-1})
altitude *variety		DM	Ash	CP	ADF	NDF	ADL	
Midland	DZF# 590	33.82	10.86^{e}	14.90^{c}	47.08^{b}	60.00^{a}	8.2^{a}	21.74
	KK1-DZF#591	9.60	14.12^{a}	15.80^{b}	40.42^{f}	51.17^{f}	5.9^{e}	14.63
	KK2-DZF-589	29.86	11.69^{d}	14.88^{d}	48.93^{a}	59.46^{b}	8.24^{a}	21.07
	Kulumsa-KDZF#592	29.59	9.78^{g}	14.20^{e}	44.68^{e}	56.44^{e}	7.6^{d}	17.8
Lowland	DZF# 590	50.92	13.97^{b}	12.50^{h}	44.68^{e}	56.44^{e}	7.6^{c}	22.78
	KK1-DZF#591	38.16	12.86^{c}	15.94^{a}	46.80^{c}	57.64^{d}	8.2^{a}	9.49
	KK2-DZF-589	37.89	12.86^{c}	13.66^{f}	46.80^{c}	58.63^{c}	8.2^{b}	17.74
	Kulumsa-KDZF#592	34.47	10.86^{f}	13.66^{g}	46.80^{d}	57.64^{d}	8.2^{a}	22.52
	P-value	0.13	0.0002	0.0002	0.0002	0.0002	0.0002	0.5
Altitude	Midland	25.7^{b}	11.6^{b}	14.9^{a}	44.7^{a}	56.7^{b}	7.5^{b}	18.9
	Lowland	40.3^{a}	12.9^{a}	13.7^{b}	40.4^{b}	57.58^{a}	8.1^{a}	18.1
	Mean	33.05	12.3	14.4	45.7	57.04	7.9	18.5
	P-value	0.0009	0.0002	0.0002	0.0002	0.0002	0.0002	0.76
Variety	DZF# 590	42.37^{a}	12.4^{c}	13.7^{c}	45.8^{b}	58.2^{b}	7.9^{b}	22.26^{a}
	KK1-DZF#591	23.9^{b}	13.4^{a}	15.9^{a}	43.6^{d}	54.4^{d}	7.1^{d}	12.1^{b}
	KK2-DZF-589	33.9^{ab}	12.8^{b}	14.3^{b}	47.8^{a}	59.05^{a}	8.2^{a}	19.4^{a}
	Kulumsa-KDZF#592	32.03^{ab}	10.3^{d}	13.6^{d}	45.7^{c}	57.04^{c}	7.9^{c}	20.2^{a}
	Mean	33.05	12.3	14.4	45.7	57.04	7.9	18.5
	P-value	0.02	0.0002	0.0002	0.0002	0.0002	0.0002	0.04

**means with different letters with in a column are significantly different ($p<0.05$)*
CP=Crude protein; ADF=Acid detergent fiber, NDF=Neutral detergent fiber; ADL=Acid detergent lignin.

Correlations of growth parameters, dry matter yield and chemical constituents

The correlation among agronomic performances, dry matter yield and chemical constituents of Desho grass is shown in Table 4. The PH was positively correlated with NTPP, NLPP and NLPT, but it was not correlated with other growth performance characteristics and chemical constituent parameters. Similarly, NTPP was positively correlated with NLPP but it was not correlated with other plant characteristics and chemical composition. Dry matter yield (t/h) had positive correlation with all agronomic performance parameters, NDF and ADF, but negatively correlated to CP and total ash content. The NDF was positively correlated with ADF and ADL but was not correlated with the other agronomic performance traits and chemical constituents. The ADF was also positively correlated with acid detergent lignin but not with the other plant characteristics.

Table 4: Correlation analysis of morphological, yield and nutritional parameters of four desho grass varieties

	Vigor	PC	PH	NTPP	NLPP	NLPT	LLPP	LSR	DM%	DM yield t ha^{-1}	Ash	CP	NDF	ADF	ADL
Vigor	1														
PC	0.48*	1													
PH	0.29	0.77***	1												
NTPP	0.31	0.67***	0.69***	1											
NLPP	0.3	0.68**	0.75***	0.88***	1										
NLPT	0.19	0.45***	0.57***	0.42*	0.8***	1									
LLPP	0.23	-0.07	-0.22	-0.31ns	-0.46ns	-0.48n	1								
LSR	0.3	0.23	0.16	0.19	0.33*	0.4*	-0.24	1							
DM%	-0.04	-0.06	-0.03ns	0.07	-0.14ns	-0.38	0.37	-0.66	1						
DM yield t ha^{-1}	0.43*	0.37	0.33	0.37	0.32	0.16	0.06	0.3	0.1	1					
Ash	-0.39	-0.58ns	-0.47ns	-0.41	-0.49ns	-0.39	0.14	-0.49	0.04	-0.21	1				
CP	-0.24	-0.21	0	-0.02ns	0.19	0.4*	-0.41	0.29	-0.53	-0.5	0.03	1			
NDF	0.4	0.3	0.23	0.18	0.08	-0.11	0.27	0.07	0.5*	0.25	-0.42	-0.22	1		
ADF	0.46*	0.24	0.13	0.14	0.05	-0.11	0.22	0.08	0.45*	0.19	-0.39	-0.16	0.96***	1	
ADL	0.39	0.16	0	0.02	-0.1	-0.26	0.37	-0.01	0.57***	0.17	-0.39	-0.29	0.96***	0.95***	1

*Level of significance: ***=P<0.001; **=P<0.01;*=P<0.05; ns=P>0.05, V=Vigor; PC=plot cover; PH=plant height;NTPP=number of tillers per plant; NLPT=number of leaves per tiller;NLPP=number of leaves per plant; LLPP=leaf length per plant; LSR= leaf to steam ratio;DM=Dry matter; CP=crude protein; NDF=Neutral detergent fiber; ADF=Acid detergent fiber; ADL=Acid detergent lignin.*

Discussion:

Effects of altitudes and variety on growth performances

The overall mean PH (32.8 cm) for the four desho grass variety in this study is by far lower than the overall average value (68.2 cm) recorded from the first harvest of the same desho grass varieties at Wondogenet(Tekalegn*et al*., 2017).This discrepancy might partly be due to soil type, harvesting at difference dates, precipitation and temperature of the area(Birmaduma*et al*., 2019).The significant effect of altitude on PH in this study is not in line with Asmare et al. (2017) who reported lack of variation between two environmental conditions (high and mid altitudes) on desho grass height in northwestern Ethiopia.Higher (41.6) NTPP was obtained at midland than lowland (36) location in this study, which is against Asmare*et al*. (2017)who reported lack of significant altitude difference on the same parameter. The same authors found about (43.3) NTPP for desho grass at midland altitude of north western Ethiopia, which is slightly higher than the mean value (41.6) obtained at midland altitude of the current study.In another experiment, Maleko*et al.* (2019)also documentedthe significant effect of variety and altitude on NTPP for Napier grass. Overall, theabsenceof significant variation among the four testdesho grass varieties in our study with respect to NTPP might signify that all varieties would recover faster after defoliation. Thevalue forNLPP (306.2) at midland altitude of this study is slightly lower than the value (310) reported byAsmare*et al*. (2017) atmidlandaltitude in north western Ethiopia. This variation might be partly due difference in time of harvest and soil fertility of the experimental areas. The more NLPP recorded at midland altitude may be due to favorable environmental conditions for desho grass compared to lowland areas.

Desho grass varieties planted at midlandresulted significantly higher ($p<0.05$) LLPPcompared to lowland altitude. In another study, Bimrew(2016) also reported variation in leaf length per plant attributed to altitude and the authors indicated the presence of higher valueat highland compared to midland altitude. This difference might attributed tovarious environmental factors including temperature and soil characteristics (Paking and Hirata, 1999).The overall mean LLPP (24.9 cm) for the four desho grass varieties in the current study is comparable to the value (25.1 cm) reported by Asmare*et al*. (2017) in northwestern Ethiopia. Themidland had significantly more ($p<0.05$) LSR than lowland altitude. This result is not consistent with Asmare*et al.*(2017) who reported no significant ($p>0.05$) difference between highland and midland altitudes in northwestern Ethiopia. About 0.62 mean value of LSR has been reported for the same desho grass varieties (Birmaduma*et al*., 2019)which agreed with the combined LSR (0.64) obtained in the current study. The mean SLR was higher than the mean value of desho grass varieties produced during the first harvesting (Tekalegn*et al*., 2017). With respect to variety, high LSR was from Kulumsa-KDZF#592 (0.71) and low LSR was for DZF# 590 (0.54).In another experiment,Birmaduma*et al*. (2019) did not obtain significant difference among the four desho grass varieties for the same parameter.

Effects of altitudes and variety on dry matteryield

Altitude did not affect dry matter yield (t/ha) in the current study. This resultis not consistent withAsmare*et al*. (2018) who reported significant effect of altitude on desho grass dry matter yield.The variety that produce low amount of dry matter yield(t/ha)wasKK1-DZF#591, which might be due tolowPC, PC, NTPP and dry matter content recorded for the same grass variety.The mean dry matter yield (18.5 t/ha) produced from the four desho grass varieties in this study is lower than the mean value (24.6ton/hectare produced from the same grass during early/first harvest (Birmaduma*et al*., 2019). This result was also lower than the results of Tekalegn*et al.*(2017) who found about21.3 (t/ha) overall dry matter yields from first harvest of the same desho grass varieties. The discrepancy could be associated with the different agro-climatic condition and soil fertility of the test areas.The current finding also showed higher mean dry matter yield compared to the mean value for the same parameter from different Napier grass accessions andBrachiaria grass cultivars in Ethiopia (Maleko*et al.,* 2019;Wubetie*et al*., 2019)

Effects of altitudes and variety on chemical constituents

Desho grass varieties grown at midland area of this experiment resulted about 15 percent crude protein. This is higher than the mean CP (8.6%) obtained from desho grass harvested at about 90 days of planting at midlandaltitude of north western Ethiopia 9 (Asmare*et al*., 2017). This variation mightattributed to the fact that chemical composition and overall quality of a given forage is affected by soil nutrient and climatic factors (Arzani*et al*., 2008;Tessema*et al*., 2011). The combined CPcontent from the four varieties in the current study is higher than the values from Napier grass varieties (Maleko*et al*., 2019) and Brachiaria brizantha ecotypes (Wassie *et al*., 2018). According to Machogu (2013), forages with a CP content ranging 9-12% are highly palatable. In this regard, the CP contents of all desho grass varieties in the present study are well above the aforementioned range suggesting the high nutritional qualities of all varieties evaluated in the current study. The CP content in this study is high in all the varieties compared with the mean value in different Brachiaria grass ecotypes (10.94-11.35%) (Wassie *et al*., 2018) anddesho grass (8.4%) (Asmare*et al*., 2017).The NDF (56.7%) content of desho grass varieties at midland was better than the value (76%) found at midland area of northwestern Ethiopia (Asmare*et al*.,2017).Feeds with more than 65% NDF content are classified as lowland quality feeds (Singh*et al.,*1992)In this regard, the average NDF values desho grass varieties in both altitudes of the present study was less than this critical level indicating the better feeding value of all the desho grass varieties. About 40.3% ADF and 4.7% ADL contents of desho grass harvested at 90 daysafter planting, which are lower than the values obtained in the midland altitude of the current study. The overall mean (45.7%) ADF from test varieties in the present study is lower than the value (47%) reported from Brachiaria grass ecotypes in north western Ethiopia (Wassie *et al*., 2018).The four desho grass varieties evaluated in the current study could be considered to be high quality as they contained less than 55% (Kazemi*et al*., 2012)ADF in both altitudes. In addition, the ADL contents of the four desho grasses varieties in both altitudes were below the maximum level of 10% which was indicated to limit DM intake (Reed *et al.,*1986).

Correlations of agronomic performances, dry matter yield and chemical constituents

The positive correlation between dry matter yield (t/ha) agronomic charactersconsidered in this study agreedwith Asmare*et al.* (2017)for the same grass variety and Maleko*et al.*(2019) for Napier grass. Leaf-to-stem ration was negatively correlated with leaf length per plant agreed with Maleko*et al.*(2019) for Napier grass.Negative influence of structuralcarbohydrates on nutritional quality was also reportedon*Megathyrsusmaximus*accessions(Carvajal-Tapia *et al.,* 2023)

Conclusion:

The study highlighted that most of the desho grass agronomic performance traits and all the chemical constituents were affected by the interaction between altitude and variety; suggesting thatdifferent performances couldbe expectedamong the two test environmental conditions.Deshograss varieties evaluated in the present experiment showed better growth performances and nutritional qualitiesat midlandcompared with lowland altitude. Varities such as Areka DZF-590, Kindu Kosha2 DZF-591, Kindu Kosha1 DZF-589 and Kulumsa DZF-592 could be establishedpreferably at midland altitudeand other similar agro-ecological areasfor wider cultivation due to their better dry matter yield performance.However, further feeding experiments are also required to examine the performance of ruminant animals fed desho grass.

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