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Evaluation of Desho (*Pennisetum pedicellatum*) Grasses for Adaptability and Yield Performance in Different Agro-Ecologies of East Showa and West Arsi Zone of Oromia, Ethiopia

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Research Article

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ABSTRACT

This experiment was undertaken at Adami Tulu Agricultural Research Center (ATARC), Shashemene and Kofele districts for two consecutive years of 2019 and 2020 cropping season with the objectives to evaluate the adaptability and yield performance of Desho grass varieties for forage production. Four Desho grass varieties (Areka-DZF#590, KK2-DZF#589, KK1-DZF#591 and Kulumsa-DZF#592) were used. Randomized Complete Block Design (RCBD) with three replications was employed. The result revealed that, the agronomic performance of plant height was none significance ($P>0.05$) at Kofele and Shashamane experiential sites except ATARC. The highest plant height was recorded at Shashamane (105.92 cm). Total dry biomass yield in ton per hectare was showed significance difference ($P<0.05$) at all experiential sites. High total dry biomass yield was recorded at Kofele study site from Areka-DZF#590 and KK2-DZF#589 varieties (23.71 and 23.02 t/ha, respectively), second was at Shashamane from Areka-DZF#590 (21.02t/ha) and the last was at ATARC from KK1-DZF#591(15.12t/ha).

This indicated the total biomass yield production increased with the increment of altitude (from low land to high land). Areka-DZF#590 variety is well performed in total biomass yield production in ton per hectare at Kofele and Shashamane than the other tested varieties. Leaf length was none significance different (P>0.05) at all study sites. Leaf to stem ratio was significance difference (P<0.05) at Kofele and Shashamane experiential sites, but none significance (P>0.05) at ATARC. Crude Protein (CP) contents of the grass was none significance difference between all varieties at all study sites. The obtained CP value was sufficient for normal rumen function. Therefore, all varieties of Desho grasses were well adapted and performed good under at all study sites. An Areka-DZF#590 variety is recommended for both Kofele and Shashamane study sites, but KK1-DZF#591 was recommended for low land area. Further research is needed to exploit its potential by application of different agronomic practices by irrigation especially at low moisture areas.

INTRODUCTION

Shortages of animal feed resources have been identified as one of the major factor limiting the production and productivity of livestock. In West Arsi and East Showa Zones, livestock feed is based on natural pastures, fallow and stubble grazing and crop residues. However, natural pasture and crop residues are poor in quantity and quality [1]. Thus, the existing feed resources do not meet the nutrient requirements for growth and reproduction of animals. One approach for alleviating the problem is identification and development of forage species suitable for the existing climatic condition. Hence, production of adaptable perennial forage species with high herbage yield and quality are very important for tackling feed shortage and rehabilitating degraded natural pasture/grazing lands.

Desho (*Pennisetum pedicellatum*) is one of adaptable multipurpose perennial grass which has an extensive root system that anchors well in the soil. It grows in mid and high altitudes (1500-2800 masl) with a wide adaptation to wide ranges of well-drained soils and topographies, with optimum elevation over 1700 masl on medium to low soil fertility [2]. It has vigorous vegetative growth and a high biomass production capacity 30-109 of green herbage/ha/year and crude protein of 5.4% [3]. The grass is convenient for smallholder farmers as a backyard enterprise for cut and carries feeding systems. It can be preserved as hay and silage for use as dry season feed. It also provides good soil cover and used as erosion control and grazing land improvement [2,3].

Regardless of the importance of this grass, adaptable and high yielding varieties of Desho grass have not been identified for forage production in the study areas. Hence, this study is designed to evaluate the adaptability and yield performance of Desho grass varieties under West Arsi and East Showa conditions with the objective to evaluate the adaptability and yield performance of Desho grass varieties for forage production.

MATERIALS AND METHODS

Description of study areas

The study was conducted at ATARC, Shashemene (Kararu Filacha) and Kofele Farmers Training Center (Hula bara and Girmichu) under rain fed conditions. ATARC represents low land, Shashemene mid, while Kofele is found at

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highland agro-ecology. This was based on Traditional agro-ecological zones classification of Ethiopia (as cited in Alemayehu, 2006) [4].

Adami Tulu Agricultural Research Center is located in the Central Rift Valley (CRV), 167 km south of Addis Ababa on Hawassa road. It lies at a latitude of 7˚9'N and 38˚7'E longitude. It has an altitude of 1650 meter above sea level and a bimodal unevenly distributed average annual rainfall of 760 mm. Rainfall extends from February to September with a dry period in May to June, which separates the preceding ''short'' rains from the following "long'' rains. The pH of soil is 7.88 fine sandy loams with sandy clay having sand, silt, and clay in proportion of 34%, 48% and 18% respectively.

Shashamane is one of the districts in the Oromia Regional State of Ethiopia. Part of the West Arsi Zone located in the Great Rift Valley; Shashamene is bordered on the south by the Sidamo Region, on the West by Shala, on the north by Negele Arsi, on the East by the Kore, and on the Southeast by Kofele. It's located at south 240 km from the Addis Ababa. It has latitude of 7˚12' north and a longitude of 38˚ 36' east.

Kofele is one of the districts in the Oromia Regional State of Ethiopia. It is named after the administrative center of the woreda, Kofele. Part of the West Arsi Zone, Kofele is bordered on the south by the Kokosa, on the West by the Sidamo Region, on the north by Kore, on the East by Gedeb Asasa, and on the South east by Dodola. Its latitude and longitude of 7˚00′N 38˚45′E with an elevation of 2695 meters above sea level.

Forage establishments

About four Desho grass varieties (Areka-DZF#590, KK2-DZF#589, KK1-DZF#591 and Kulumsa-DZF#592) were collected from different research centers. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Plot size with 3 m * 3 m and spacing of 50 cm, 1 m and 1.5 m respectively between rows, plots and block were used. The plant was established by root splitting. NPS and urea were applied at planting and after establishment at the rate of 100 and 25 kg per ha [5]. 25 kg of urea was applied after each harvesting cycle for maintenance [6]. Management practices were done uniformly for all experimental plots.

Collected data

Both Destructive (Herbage yield and leaf to stem ratio) and non-destructive (plant height and number of tillers per plant) sampling techniques were applied.

Dry matter yield determination and chemical analyses

The biomass yield of different Desho grass varieties were harvested at 50% flowering at 10 cm above the ground. Weight of the total fresh biomass yield was measured from each plot in the field and a subsample was taken from each plot to the laboratory, upon arrival at laboratory it was oven dried for 72 hours at temperature of 60°C for partial DM determination. The oven dried samples were weighed to determine the total dry matter yield. Then the result was converted in to dry matter ton per hectare for comparison as (10 x TotFW x (DWss /HA x FWss) [7]. Where,

TotFW = Total fresh weight, DWss = reweight subsample, FWss = Fresh weight subsamples and HA = Harvesting area. Sampled leaf was separated from stem to determine leaf to stem ratio. Crude protein was calculated as N × 6.25 (Kjeldahl methods).

Statistical analysis

Collected data were organized, summarized and analyzed by using SAS. LSD test at 0.05 probability levels to compare the treatment means [8].

RESULTS AND DISCUSSION

Performance of Desho grass at on station Adami Tulu Agricultural Research Center (ATARC) experimental site

The results of agronomic performance of Desho grass varieties tested for adaptability at ATARC were present in table 1. The plant height was none significance among the used varieties (P>0.05) except KK2-DZF#589 variety. The tallest mean plant height was recorded from KK1-DZF # 591, while the shortest was from KK2-DZF#589 (Table 1). The average mean value of the current result of plant height is higher than the report, which recorded 87.6 cm [9]. This may be due different agro ecology, soil fertility, time of harvesting and management practices. The total biomass yield was none significant among the used varieties (P>0.05) except Areka-DZF#590. This variety was lower in total biomass yield (11.66t/ha) as compared with other variety. The present result was a line with the report [10]. This variety is also the highest in plant height (104.38 cm) from the tested variety. Plant height recorded in the current work was higher than the work (39.40 cm). This may be due different agro ecology, soil, variety, time of harvesting and management aspects. At ATARC condition KK1-DZF#591, KK2-DZF#589 and Kulumsa-DZF#592 are the best in total biomass yield production.

Number of Tillers Per Plant (NTPP) was none significant (P>0.05) in the all study area. The NTPP recorded in the current work was higher than report [10]. Leaf Length Per Plant (LLPP) in the present work was higher than the finding [11], but lower than the work [12]. This result was might have been vary due to harvesting stage, soil fertility, agronomic practices and other management. Leaf Steam Ratio (LST) shows none significance difference. The current result (0.78) was lower than the finding [11] at harvesting of 90 and 120 days (1.24 and 1.17), but agree with at harvesting of 150 days (0.82). This might have been due to reduction in leaf proportion and an increase in the stem fraction of the grass at the advanced stage of harvesting [13].

Crude Protein (CP) contents of the tested varieties were none significance difference (P>0.05). However, numerically better CP (13.5%) was obtained from KK1-DZF#591 variety. The mean of the current result (12.5%) was higher than the work of [3,10,9], which records 5.4%, 7.3% and 9.5% CP, respectively. The mean value of the CP content of Desho grass in the current study was higher than the critical value of 7% required for normal rumen

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microbial function [14]. Pasture and other roughage feeds are classified as high, medium and low quality according to their CP contents. Accordingly, roughage feeds with CP content of 9.92 to 15.2%, 6.6 to 9.1% and 3 to 6.5% were classified as high, medium and low quality roughage feeds, respectively [15]. Based on this report, the mean value of CP contents of Desho grass in the current study can be classified as high (Table 1).

Table 1. Agronomic performance of Desho grass at ATARC.

Parameters							
Variety	**PH(cm)**	**LL(cm)**	**TDMY(t/h)**	**CP%**	**NTPP(counts)**	**LSR**	**Cover**
KK1-DZF # 591	104.38[a]	49.98	15.12[a]	13.5	90.84	0.79	89.77
KK2-DZF # 589	88.49[b]	45.57	14.04[ab]	13	89.09	0.78	89.735
Kulumsa-DZF #592	97.96[ab]	47.01	13.80[ab]	10.4	87.04	0.78	89.35
Areka-DZF # 590	102.92[ab]	48.13	11.66[b]	13.1	86.42	0.77	89.98
mean	98.44	47.67	13.66	12.5	88.35	0.78	89.73
CV (%)	15.36	13.29	21.54	25.7	28.84	13.6	0.705
LSD(0.05)	14.51	ns	2.82	ns	ns	ns	ns

[a,b] = Means with the same letter in the same row are not significantly different, PH=Plant Height. LL=Leaf Length, TDMY = Total Dry Matter Yield, NTPP = Number of Tiller Per Plant LSR=Leaf to Stem Ratio, CV= Coefficient of Variation kk= kindo kosha, LSD= Least Significance Different and ns= non-significant

Performance of desho grass at Shashamane (Kararu Filicha) study site

The results of agronomic performance of Desho grass varieties tested for adaptability at Shashamane were present in table 2. The agronomic performance of plant height, leaf length and number of tiller per plant were not differ significantly ($P>0.05$) between the four desho grass varieties tested at mid agro ecology. However, total dry matter yield ton per hectare was significant ($P<0.05$) high for Areka-DZF#590 variety. Areka-DZF#590 variety produced 21.02 t/ha dry matter yield. The current result obtained was lower the finding of Tekalegn et al. 2017 which recorded 28.35 t/ha. The former result was recorded may due to application of irrigation. KK2-DZF#589 variety

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was the second highest in total biomass yield production (18.02 t/ha) than the other left varieties. Leaf to steam ratio recorded from Areka-DZF#590 variety also the highest as compared with other varieties. This variety is well performed by all recorded agronomic performance in this agro ecology. Crude Protein (CP) contents of the tested varieties were none significance difference (P>0.05) at study site. The mean value of the current result (8.3%) was a line with a work [10,9], which records 7.3% and 9.5% CP, respectively, but higher than the report [3]. The mean value of the CP content of Desho grass in the current study was higher than the critical value required for normal rumen microbial function [14]. According to the classification [15], the CP contents feeds, the current result can be classified as medium in CP contents.

Table 2. Agronomic performance of Desho grass at Shashamane trial site.

Parameters							
Variety	**PH(cm)**	**LL(cm)**	**TDMY(t/ha)**	**CP%**	**NTPP(counts)**	**LSR**	**Cover**
KK1-DZF# 591	103.67	43.88	14.76^{c}	6.9	102.17	0.64^{bc}	91.02
KK2-DZF# 589	104.83	43.68	18.02^{b}	8.1	110	0.72^{ab}	89.95
Kulumsa-DZF#592	105.5	39.08	15.79^{c}	8.8	102.67	0.62^{c}	89.435
Areka-DZF # 590	109.67	40.62	21.02^{a}	9.7	117.17	0.74^{a}	89.285
mean	105.92	41.82	17.4	8.3	108	0.68	89.92
CV (%)	14.59	12.51	8.09	15.5	13.53	11.72	1.35
LSD(0.05)	ns	ns	1.7	ns	ns	0.1	ns

^{a,b,c} = Means with the same letter in the same row are not significantly different, PH=Plant Height. LL=Leaf Length, TDMY = Total Dry Matter Yield, NTPP = Number of Tiller Per Plant LSR=Leaf to Stem Ratio, CV= Coefficient of Variation, kk= Kindo Kosha, LSD= Least Significance Different and ns= non-significant

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Performance of desho grass at Kofele (Hula bara and Gurmichu) study sites

The results of agronomic performance of Desho grass varieties tested for adaptability at Kofele were present in Table 3. The agronomic performance of plant height, leaf length and number of tiller per plants were none significance difference (P>0.05) among the tested varieties. However, total biomass yield and leaf to stem ratio were significantly difference (P<0.05). KK2-DZF#589 and Areka-DZF#590 are higher in total biomass yield production than the rest two varieties. They produce 23.02 and 23.71 t/ha, respectively. Areka-DZF#590 variety is the best in total biomass production at Kofele and shashamane study sites, but the lowest in ATARC. The current result is similar with the work [10].

Crude Protein (CP) contents of the tested varieties were none significance difference (P>0.05) at study sites. The mean of the current result (7.5%) was a line with a work [10,9], which reports 7.3% and 9.5% CP, respectively, but higher than the report [3]. The mean value of the CP content of Desho grass in the current study was higher than the critical value required for normal rumen microbial function [14]. According to the classification [15], the CP contents feeds, the current result can be classified as medium in CP contents (Table 3).

Table 3. Agronomic performance of Desho grass at Kofele.

Parameters							
Variety	**PH(cm)**	**LL(cm)**	**TDMY(t/ha)**	**CP%**	**NTPP(counts)**	**LSR**	**Cover**
KK1-DZF# 591	102.33	42.12	18.67^{b}	9.3	99.58	0.87^{b}	89.7
KK2-DZF # 589	101.62	44.4	23.02^{a}	6.8	100.4	1.02^{a}	88.95
Kulumsa-DZF #592	101.67	42.57	19.02^{b}	7.5	112.37	0.94^{ab}	89.45
Areka-DZF # 590	101.43	43.33	23.71^{a}	6.5	113.19	0.97^{ab}	89.25
mean	101.76	43.1	21.14	7.5	106.38	0.95	89.3
CV (%)	18.41	12.68	10.6	27.5	23.17	9.83	1.4
LSD(0.05)	ns	ns	2.7	ns	ns	0.1	ns

^{a,b} = Means with the same letter in the same row are not significantly different, PH=Plant Height. LL=Leaf Length, TDMY = Total Dry Matter Yield, NTPP = Number of Tiller Per Plant LSR=Leaf to Stem Ratio, CV= Coefficient of Variation KK= Kindo Kosha, LSD= Least Significance Different and ns= non-significant

Generally, the better yield performances were observed at Kofele as compared to the other two sites. The mean average value of the total biomass yield recorded at ATARC, shashamane and Kofele were 13.66, 17.40 and 21.14 t/ha, respectively. This indicated the total biomass yield production increased with the increment of altitude. The grass can grow at altitude range of 1500–2800 m above sea level [16] and performs best at altitude greater than 1700 m.a.s.l [6]. The highest average mean value of plant height is recorded at mid agro ecology (105.92 cm) and the lowest is at lowland agro ecology (98.44 cm).

CONCLUSIONS AND RECOMMENDATIONS

The result revealed that the highest total biomass yield was recorded at high land study site and the second was at mid agro ecology. This indicated the grass performance is high at high moisture area. However, the highest crude protein content was recorded at low moisture area (ATARC). Leaf length, number of tiller per plant and leaf to steam ratio were none significant at ATARC site, however, plant height and total dry matter yield were shows significant difference. KK1-DZF#591 is performed well at this site. Plant height, leaf length per plant and number of tiller per plant were none significance at Shashamane and kofele study sites. But, total biomass yield and leaf to steam ratio were shows significance difference. Therefore all tested varieties under all study sites were well adapted and well performed. Among the tested varieties Areka-DZF#590 was performed more in total biomass yield production particularly at Shashamane and Kofele study sites, therefore this varieties is recommended for both study sites. KK1-DZF#591 was the best at ATARC in total biomass production. Crude protein contents of the tested Desho grass varieties were none significance difference at all study sites. The obtained CP value was sufficient for normal rumen function for livestock production. Further research is needed to exploit its potential by application of different agronomic practices by irrigation especially at low moisture areas.

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