

Effect of fertilizer application on morphological parameters and dry matter yield of Desho grass (*Pennisetum glaucifolium*) Areka-DZF-590 variety under rain fed conditions

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Abstract

The purpose of this experiment was to assess the morphological parameters and dry matter yield of Desho grass grown for two years under various fertilizer treatments. The field experiment was carried out at Robit Bata Kebele in the Bahir Dar Zuria district of the Amhara region, Ethiopia. In the trial, four fertilizer rates (0,100kg, 300kg N and manure) on *Pennisetum glaucifolium* Areka-DZF-590 were used. Each 9-m² plot in the treatments was arranged in a 3x2 factorial configuration in a randomized complete block design with three replications. Morphological data were collected from 10 randomly selected plants grown in the middle rows of each plot. All recorded datasets were managed using Microsoft Excel 2010 and subjected to a general linear model procedure of SAS (9.0) at a significance level of alpha <0.05. The findings demonstrated that the morphological characteristics and dry matter yield were strongly impacted by the interaction of fertilizer application and years. The tallest plant (69.93 and 75.36cm), the highest number of tillers per plant (49.33 and 127.13), the longest number of leaves per plant (236.22 and 753.32) and the highest dry matter yield (12.5 and 21.88 t/ha) were measured at manure fertilizer in the first and second years, respectively. The morphological parameters and dry matter yield increased as the fertilizer level increased and the production years were also extended. Moreover, the highest net benefit (33010.4 and 57653.85birr) was obtained from manure, and the lowest net benefit (21681.6 and 42254.55birr) was obtained from an unfertilized plot in the first and second years, respectively. Therefore, in the research areas and other agro-ecologies where there is similar agro-ecology, the desho grass-Areka-DZF-590 with manure fertilizer would have a more advantageous production performance to meet forage quantity and economic feasibility.

Key words: Ethiopia; Fertilizer application; Forage yield; *Pennisetum glaucifolium* Areka-DZF-590 variety

Introduction

Ethiopia has the huge livestock population in Africa, it was estimated to be 70 million cattle, 42.9 million sheep, 52.5 million goats, 2.15 million horses, 10.80 million donkeys, 0.38 million mules, 8.1 million camels, 57 million chickens, and 6.99 million beehives (CSA, 2021). In the country, the livestock sector contributed about 17–25.3% to the national GDP, 39–49% to the agricultural GDP, 12–15% of the export earnings, 60–70% of employment opportunities and 50% of household incomes (Shapiro et al., 2017). However, livestock productivity in Ethiopia in comparison to the livestock potential is low due to the attributes of inefficient nutritional and management practices, disease and parasitic occurrence, low genetic potential, lack of extension services, and inadequate information to improve animal performance (Mengistu et al., 2017; Gelayenew et al., 2020).

Among these constraints, inadequate quantity and quality of feed combined with high feed prices are the most important confronts for the livestock production sector (Shapiro et al., 2017; Ebro et al., 2022). The pastures and diversity of forages including grasses are very important for dairy (Vieyra-Alberto et al 2018) and meat (Salvana et al, 2019) animals. Low dry matter yield and poor nutritional values characterize the two major feed resources (natural pasture and crop residues). These are the major available feed resources in the Bahir Dar Zuria District. The communal grazing lands in Bahir Dar Zuria District are overgrazed. In such cases, grasses were purchased from church and school compounds, and collected weeds from croplands were fed through a cut and carry system. As a result, animals could not get sufficient and balanced nutrients from natural pasture and crop residues due to their high fiber and low protein content (Gashaw & Defar, 2017). Therefore, to minimize such kinds of feed challenges, produce improved forages with fertilization for more than one year rather than depending on natural pasture and crop residue. In response to these immense challenges, producing stable improved forage in the livestock sector is mandatory. For that reason, the application of fertilizer to desho grass *var. areka DZF-590* over the years is important to increase the biomass and quality of feeds. Hence, Desho (*Pennisetum glaucifolium*)-*Areka*-DZF-590 are known for their higher plant height, biomass yield and nutritional values, and the application of fertilizer to enhance the forage yield and quality (Mihret et al., 2018).

Therefore, desho grass *var. Areka DZF-590* with the application of fertilizer has the potential to increase the biomass and quality of forages and to ensure feed availability for year-round feeding. Reliance on long-term forage crops should ensure that animal feed is continuously available year-round. However, the application of fertilizer on the desho grass *var. Areka DZF-590* and fertilizer application rate are an extremely critical issue to achieving high yields and quality forages. Most of the livestock farmers in Ethiopia do not apply manure or chemical fertilizers to forage grasses. Even if the farmer applied fertilizer, there is a lack of knowledge on the optimum dosage of fertilizer application for desho grass *var. Areka DZF-590* and the effect on quality and quantity of forage production has been a challenge for most livestock farmers. Even though, there is no comprehensive and adequately informative attempt or scientific evidence regarding the ideal level of fertilizer application rate for the highest herbage biomass and quality of grown forages, an appropriate fertilizer rate combination must be developed for the desho grass *var. areka DZF-590*. Due to the above profound problems, this research was designed.

Materials and Methods

Study site

The current study was conducted at Robit Bata Kebele, Bahir Dar Zuria district, in the West Gojjam Zone of the Amhara Regional State of Ethiopia (Figure 1). It is bordered on the south by Yilmana Densa, on the southwest by Mecha, on the northwest by the Gilgel Abay River, which separates it from Semien Achefer, on the north by Lake Tana, and the east by the Abay River, which separates it from the south Gondar Zone. The area is located at a distance of 564 km northwest, far from the national capital city, Addis Ababa. Its geographical coordinates is between 11°25'N-11°55'N latitude and 37°04'E-37°39'E longitude. Its altitude ranges from 1750 to 2300 m.a.s.l, with the mean annual rainfall ranging from 800 to 1250 mm and the mean annual temperature ranging between 10 and 32 °C (BDZWoa, 2016). Natural pasture (communal and private), crop residues, hay, crop aftermath, attela and birint, agro-industrial by-products, indigenous browse trees/shrubs and improved forage are being used as livestock feed resources (Fentahun et al., 2020).

Site selection, land preparation and planting

The experimental site was selected purposely based on the preference of the ILRI project, which is based on suitable agro-ecological conditions for forage development. After selecting the site, the land was cleared of weeds and unwanted debris, then ploughed three times by oxen and harrowed to a fine tilth before planted, plots and blocked were outlaid. Based on the slope and fertility of the experimental land, the homogeneity of the experimental plots in each block was considered. After proper land preparation, Desho grass-*Areka*-DZF-590 was planted in rows on well-prepared soil by using the root-splitting method. The planting method of desho grass, two-thirds of the root splits were

buried at a depth of 10-15cm, and the apical third was left on the ground (Cameron & Lemcke, 2008). The experiment was carried out for two consecutive years (2021 and 2022). The experimental site was kept free of weeds throughout the experimental period (for two consecutive years) by manual weeding each year as necessary.

Fertilizer collection, analysis and application

Cattle manure was purchased from Robit Bata kebele farmers, while urea fertilizer was purchased from the Bahir Dar City local market. According to the recommendation of De Morais Raimundo et al. (2022), the cattle manure was collected 14 days before the application and sub-samples were taken for chemical analysis before application to determine the quantities of the nutrient composition of the fertilizer to be applied. The cattle manure used in the experiment had a moisture (47%), pH (7.4), total nitrogen (TN) (1.5%), organic carbon (OC) (17.5%), and available phosphorus (Pav) (32.8 mg/kg) properties.

On the same day, manure and artificial fertilizer were manually applied to the surface. Split applications of fertilizer have been recommended, as the growth response is greater in the period immediately following the application of fertilizer (Watson et al., 1977). Urea fertilizer application, in which one half was applied at the time of planting and the remaining half was applied for second harvesting, while for manure, in which about 2/3 was applied at the time of planting and the remaining 1/3 was applied for second harvesting due to the slow release of nutrients. In the second year, the same amount of urea and manure was applied at the start of the rain after the uniform cutting of all the plots as in the first year.

Experimental treatments

The study was conducted under a 4x2 factorial arrangement in a randomized complete block design (RCBD) with three replications. The treatments were composed of control with no fertilizer, 30 tons/ha of cattle manure, 100kg N/ha and 300kg N/ha, on Desho (*Pennisetum glaucifolium*) Areka-DZF-590 was observed over two production years (2021 and 2022). The experiment has 4 treatments, 12 experimental plots and an individual plot size of 9 m² (3 m*3 m). The space between the plot and block was 1m and 1.5m, respectively. The spacing between rows and plants was 0.5 m x 0.25 m (Gadisa et al., 2019). There were seven (7) rows per plot and seven (7) plants per row. The treatments were assigned randomly into plots within each replication.

Morphological Parameter Sampling and Data collection methods

The samples were collected year-round for two consecutive years. On the same day, harvests were made twice per year by hand using a sickle, leaving a stubble height of 5-10cm from the soil to allow for more growth of new shoots (Tudsri et al., 2002). In each plot, ten plants were randomly selected to record the plant height, number of tillers per plant, number of leaves per plant, leaf length per plant and leaf width per plant. Fresh biomass yield (kg), dry matter yield (t/ha), and leaf-to-stem ratio were also determined.

Plant height (cm)

The plant height was measured on the primary shoot from the soil surface (base) to the tip of the upper leaves of the main stem by using a measuring tape (Rayburn et al., 2007). The mean plant height from each treatment was determined by measuring the height of ten randomly selected plants from the middle rows of each plot, leaving the outer edge rows due to the border effect, and then the average height was calculated.

Number of tillers per plant

The number of tillers per plant was recorded by counting all shoots that arise from the main plant and excluding the main shoot from which the shoots arise (Mijena et al., 2022). The number of tillers per plant was counted from the same-tagged ten randomly selected plants from the middle rows and then the mean was calculated.

Number of leaves per plant (NLPP)

The number of leaves per plant was counted from all tillers, including the main shoot by taking ten randomly selected plants from the middle rows. By multiplying the NLPT by the NTPP, the total NLPP was obtained, and then the mean number of leaves per plant was calculated.

Leaf length per plant (cm)

The leaf length per plant was measured from the base of the collar region of the leaf to the tip of fully expanded leaves. It was measured from ten randomly selected sample plants in the middle rows by using a meter.

Leaf width per plant (cm)

The leaf width per plant was measured from the middle region of the leaf. It was measured from ten randomly selected sample plants in the middle row by using a meter.

Leaf-to-stem ratio (LSR)

The leaf-to-stem ratio was determined by manually separating sub-samples into leaves and stems, and weighed them separately for leaf and stem. The dried sample of each component was weighed and LSR was calculated as the ratio of the dry weight of leaves (g) to the dry weight of stems (g) (Nguku et al., 2016).

Sampling Methods for Fresh Biomass and Dry Matter Yield (DMY) (t/ha)

The harvestable plant for fresh biomass and dry forage yield determination was cut down at 5-10cm above the ground (Tudsri et al., 2002). The plot size of each treatment was 9m² and from each plot, there were five middle rows (2nd, 3rd, 4th, 5th and 6th) with a net harvestable area of 4m² per plot by considering border effects, which left 50cm lengthwise from each side. A fresh biomass yield of grass was measured immediately after harvesting and weighed on the field soon after mowing using a portable balance with a sensitivity of 0.01g. Based on the fresh biomass yield from the sample area of each plot, the total dry matter yields for each plot were thereafter converted to metric tons per hectare (Gelayenew et al., 2020). The dry matter percentage was determined by taking about 500g (weighted by a field sensitive balance) of sub-samples of fresh weight from each plot and chopped into short lengths (2-5cm) and then packed with an airtight bag and subjected to oven drying at 65°C for 72 hours to estimate the dry matter yield (ton/ha). The dry matter percentage was determined by dividing the dry weight of the subsample by the weight of the fresh subsample and multiplying by 100.

$$\text{DMY (t/ha)} = (10 \times \text{TFW} \times \text{SSDW}) / (\text{HA} \times \text{SSFW}) \quad (\text{Gelayenew et al., 2020}) \dots \text{eq.(1)}$$

Where: 10=constant for conversion of yields in kg/m² to tone/ha;

TFW = Total Fresh Weight from harvesting area (kg);

SSDW = Sub-Sample Dry Weight (g);

HA = Harvestable Area (m²), and

SSFW=Sub-Sample Fresh Weight (g).

Partial Budget Analysis

The information on all variable costs related to the cost of manure and urea fertilizer was recorded during the purchasing at Robit Bata Kebele farmers and Bahir Dar City local market, respectively. The biomass yield of each treatment was recorded in each production year. The purchased price of manure per quintal was 6,000 birr for each year, while the price of urea was 1,800 and 4,500birr per quintal in 2021 and 2022 at Bahir Dar City during our experimental periods, respectively. To estimate the price of fresh grass, the farmer estimate 1 kg of grass by 4.03 birr. The partial budget analysis was employed using the procedure recommended by CIMMYT (1988).

Adjusted DM yield (ADMY): The farmers using the same technologies would obtain yields 10% less than those obtained by the researchers would. $\text{ADMY} = \text{Biomass yield} - (\text{biomass yield} \times 0.1)$

Gross benefit (GB) = adjusted dry matter yield × field/farm gate price for the grass

Total variable costs (TVC): This was calculated as the sum of all variable costs for a particular treatment.

Net benefit (NB) = Gross field benefit – total variable cost

Dominance analysis (D): This was carried out by first listing the treatments in order of increasing costs that vary or increasing net benefits. Any treatment that has net benefits that are less or equal to those of a treatment with lower costs that vary is dominant.

Marginal rate of return (MRR)

$$= \frac{\text{NB from superior dominant plot} - \text{NB from preceding inferior dominant plot}}{\text{TVC from superior dominant plot} - \text{TVC from preceding inferior dominant plot}} \times 100\%$$

Statistical data analysis

Microsoft Excel (2010) was utilized for the management and recording of data. Following the collection and recording of data, the normality of the data was assessed using the Shapiro-Wilk test. Following the validation of data normality, the General Linear Model (GLM) approach of the Statistical Analysis System (SAS, 2004 version 9.0) was utilized to conduct an Analysis of Variation (ANOVA) on data related to morphological parameters and DM yields. As per Duncan's (1995) description, a mean comparison was conducted with the assumptions met, utilizing Duncan's Multiple Range Test (DMRT) at a 5% level for variables whose F-values showed significant differences at $P < 0.05$. The statistical model for the analysis of the data was:

$$Y_{ijk} = \mu + F_i + Y_j + F_i * Y_j + E_{ijk}$$

Where; Y_{ijk} = all dependent variables (morphological data and DM yield)

μ = overall mean

F_i = the fixed effect of i^{th} fertilizer levels ($i=0$, 30t/ha cattle manure, 100kg U/ha and 300kgU/ha)

Y_j = the random effect of j^{th} production years ($j=1^{\text{st}}$ year and 2^{nd} year)

$F_i * Y_j$ = interaction effect between fertilizer application and production years

E_{ijk} = residual error

Results and Discussion

The effect of fertilizer levels and years on morphological characteristics and Dry matter yield are presented in table 1.

Plant Height (PH) (cm)

The interaction effects of fertilizer rate and production years had a very high significant ($P < 0.001$) effect on the plant height (Table 1). The highest PH (69.93 and 75.36cm) was measured from application of manure fertilizer in the first and second years, respectively. The shortest PH (33.67 and 51.3cm) was recorded from unfertilized plot in the first and second years, respectively, with the overall mean of 60.88cm. This might be due to the reason, the application of manure to improves soil nutrient availability, which includes organic matter (OM), total nitrogen (TN), dissolved organic carbon (OC) and ammonium (NH_4^+) contents which are necessary for plant growth (Ma et al., 2022). In the current result, the PH at manure $>300\text{kg} >100\text{kg N} > \text{zero}$ application of fertilizer levels and types in both years. This result in line with the report of Abera et al. (2021), who reported that the level of nitrogen fertilizer increased from 0, 41 and 73 kg/ha, the PH of desho grass was also increased from 21.25, 22.08 and 23.92cm, respectively. The interaction result revealed that for 0, 100, 300 kg N/ha and manure fertilizer, the maximum PH recorded in year 2 compared to year 1. The significant difference of PH across the experimental years suggests that the different distribution of rainfall, temperature. This result was consistent with the finding of Walie et al. (2022), who conducted research on desho and Napier grass at Guder watershed that the PH of second year (75.3cm) taller than the first year (55.5cm).

Number of tillers per plant (NTPP) (counts)

The result of the current study showed that there was very highly significant ($P < 0.001$) effect of fertilizer rate and production years on the NTPP (Table 1). Significantly ($P < 0.001$), the maximum number of tillers per plant (49.33 and 127.13) were counted at manure fertilizer in the first and second years, respectively. Whereas, the minimum number of tillers (24.27 and 37.77) was observed from unfertilized plot in the first and second years, respectively, with the overall mean of 68.36. The more NTPP were produced from cattle manure applied in both years, due to the addition of manure can increase the growth of tillers and improve the structure of the soil to become more crumb by increasing the root growth of the soil pores. In the current study, the NTPP at manure $>300\text{kg} >100\text{kg N} > \text{zero}$ application of fertilizer levels and types in both years. This current result was in line with Bedeke et al. (2017), who indicated that there was a significant ($P < 0.05$) difference on the NTPP of desho grass increased from 54.6 to 79.6 as the fertilizer levels increased from 100 to 350 kg N/ha. The NTPP increased when the production years was extended. This study was in line with Walie et al. (2022), who reported that the mean NTPP increased when the production years extended, which in the 2018 (36.3) lower than 2019 (95.9) at Aba Gerima watershed.

Number of leaves per plant (NLPP) (counts)

The interaction effect of fertilizer application and production years had a very highly significant ($P < 0.001$) effect on the NLPP (Table 1). The maximum NLPP (236.22 and 753.32) was recorded from manure in the first and second years, respectively, while the minimum NLPP was obtained from (113.62 and 428.09) without application of fertilizer in the first and second years, respectively, with the overall mean of 386.22. In the current study, the higher NLPP was recorded from fertilized grass as compared to unfertilized grass which is manure $>300\text{kgN/ha} >100\text{kgN/ha} > 0$ in both years. This result was in line with findings of Priyadarshani et al. (2013), there were increased trends in the number of leaves with increased the levels of fertilizer application. However, this result was disagreed with Riyana et al. (2018), who showed that the manure has no significant effects on number of leaves per plant.

Leaf length per plant (LLPP) (cm)

The interaction between fertilizer application and production years had a very highly significant ($P < 0.001$) effect on the LLPP (Table 1). The longest length of leaves per plant (31.03 and 37.35cm) was recorded from manure application of fertilizer in the first and second years, respectively, while the shortest (17.11 and 20.53cm) was obtained from without application of fertilizer in the first and second years, respectively, with an overall mean of 27.3. In the current study, the longer length of leaf was obtained from fertilized grass as compared to unfertilized grass. This result was in line with Mihret et al. (2018), longer LLPP of desho grass was recorded at NPS (30.48 cm) and manure (27.37 cm) than without fertilizer (19.87 cm). The present finding of LLPP in year 2 at 0, 100kg, 300kg N/ha and manure fertilizer levels and types were longer than year 1 in their respective fertilizer levels and types.

Leaf width per plant (LWPP) (cm)

The interaction between fertilizer rate and production years had shown very a highly significant ($P < 0.001$) effect on the LWPP (Table 1). The widest leaf width per plant (1.93 and 4.69cm) was recorded from manure fertilizer application in the first and second years, respectively, whereas the narrowest leaf width (1.13 and 3.11cm) was

recorded from without fertilizer in the first and second years, respectively. The second year at all fertilizer type and level applied had wider LWPP than the first year.

Leaf to stem ratio (LSR)

The interaction of fertilizer levels and production years had a very highly significant ($P < 0.001$) effects on the LSR (Table 1). The highest leaf to stem ratio (1.27 and 1.85) was measured from manure fertilizer in the first and second years, respectively, whereas the lowest LSR (0.31 and 1.16) was observed from control in the first and second years, respectively. The overall mean value of the current results was 1.30, which means, the dry weight of the leaf was greater than the dry weight of stem of grasses. Number leaf per tiller, leaf length, leaf width, and tiller number is the most important characteristics used to determine the leaf to stem ratio and forage quality. The leaf fraction has significant implications for the nutritive quality of the forage, as leaves contain higher levels of nutrients and less fiber than stems (Hidosa et al., 2015).

Dry matter yield (DMY) (t/ha)

The interaction effect of fertilizer rate and production years on dry matter yield in this study was highly significant ($P < 0.001$) effect (Table 1). The highest dry matter yield (10.76 and 17.55 t/ha) was recorded from manure application in the first and second years, respectively, while the lowest DMY (6.21 and 11.65 t/ha) from without fertilizer in the first and second years, respectively, with the overall mean of 11.81 t/ha. The superior DMY (t/ha) was recorded from manure fertilizer reflects that the ability of grass which is rapidly regenerate, increasing in plant height, number of leaves per tiller, number of tillers per plant, and other morphological parameters of grass could be increasing forage yield. In the current study, the DMY (t/ha) increased from 0 to 100 to 300 kg N/ha and manure in both years. This result was in line with Bedeke et al. (2017) indicated that DMY of desho grass was increased from 8.32 to 13.6 t/ha as the fertilizer level increased from 100 to 250 kg N/ha. The current result of DMY increase as the production year extended. The second year at all fertilizer type and level applied had more DMY than the first year with its respective fertilizer type and level. This result was agreed with Hidosa et al. (2020) reported that the higher DMY of desho grass varieties was recorded in 2018 (24.44 t/ha) than in 2017 (14.74 t/ha). This could be attributes to the genetic potential of grass adapting to the tested environmental factors such as soil characteristics, moisture, and temperature over a year.

Partial budget analysis

The overall partial budget analysis of the current study was presented in Table 2 for 1st year and Table 3 for 2nd year). The highest net benefit (33010.4birr) in the first year was obtained from at manure, while the lowest net benefit was recorded from 300kg (21681.6birr) (Table 2.). Similar with year 1, the highest net benefit in the second year was obtained at manure fertilized plot (57653.85birr) while the lowest net benefit (42254.55birr) was recorded from unfertilized plot (Table 3). Generally, the higher net benefit of desho grass was obtained from manure fertilizer than others and the second year had the higher net benefit than year 1.

Table 1: Interaction effects of fertilizer rate and years on morphological characteristics and DMY

Fertilizer rate	Year	PH _(cm)	NTPP _(counts)	NLPP _(counts)	LLPP _(cm)	LWPP _(cm)	LSR	DMY _(t/ha)
Control	2021	33.67 ^e	24.27 ^{de}	113.62 ^h	17.11 ^{bc}	1.13 ^c	0.31 ^d	6.21 ^f
100kg N	2021	55.27 ^c	29.67 ^{de}	150.72 ^g	25.30 ^b	1.2 ^c	1.11 ^{abc}	7.32 ^e
300kg N	2021	68.93 ^b	44.67 ^c	206.18 ^f	28.31 ^b	1.35 ^c	1.16 ^{abc}	7.47 ^e
Manure	2021	69.93 ^b	49.33 ^c	236.22 ^e	31.03 ^a	1.93 ^c	1.27 ^{ab}	10.76 ^d
Control	2022	51.30 ^{cd}	37.77 ^d	428.09 ^d	20.53 ^{bc}	3.11 ^b	1.16 ^{ab}	11.65 ^c
100kg N	2022	57.30 ^c	108.7 ^b	494.50 ^c	30.09 ^a	4.1 ^a	1.78 ^{ab}	16.04 ^b
300kg N	2022	75.33 ^a	125.07 ^a	707.12 ^b	31.03 ^a	4.22 ^a	1.79 ^a	17.52 ^a
Manure	2022	75.36 ^a	127.13 ^a	753.32 ^a	37.35 ^a	4.69 ^a	1.85 ^a	17.55 ^a
Overall mean		60.88	68.36	386.22	27.3	2.61	1.30	11.81
SEM±		7.26	13.92	8.57	9.9	0.003	0.002	0.77
CV%		5.79	7.23	0.94	8.45	1.92	0.64	7.65
Frt*yr		<.0001	<.0001	<.0001	<0.001	<.0001	<.0001	<.0001

Table 1: Partial budget analysis of desho grass variety in different fertilizer level and type grown in year 1

Descriptions	fertilizer type and levels (Treatments)			
	control	100 kg urea	300 kg urea	manure
DMY (Kg)	6210	7320	7470	10760
ADMY (Kg) (A)	5590	6590	6720	9680
Cost of urea	0	1800	5400	0
Cost of FYM	0	0	0	6000
(TVC) (B)	0	1800	5400	6000
Price (birr/ kg) (C)	4.03	4.03	4.03	4.03
Gross benefit (A*C)(D)	22527.7	26557.7	27081.6	39010.4
Net benefit (D-B)(birr)	22527.7	24757.7	21681.6	33010.4
Change in TVC (Δ TV)	0	1800	5400	6000
Change in net benefit (Δ NR)	16937.7	2230	-846.1	10482.7
MRR (%) = (Δ NR/ Δ TVC)*100	ND	123.89	D	174.71

Table 2: Partial budget analysis of desho grass variety in different fertilizer level and type grown in year 2

Descriptions	fertilizer type and levels (Treatment)			
	control	100 kg urea	300kg urea	manure
DMY (Kg)	11650	16040	17520	17550
ADMY (Kg) (A)	10485	14436	15768	15795
Cost of urea ETB Kg-1	0	4500	13500	0
Cost of manure in ETB Quintal-1	0	0	0	6000
(TVC) (B)	0	4500	13500	6000
Price (birr/kg) (C)	4.03	4.03	4.03	4.03
Gross benefit (A*C)(D)	42254.55	58177.08	63545.04	63653.85
Net benefit (D-B)(birr)	42254.55	53677.08	50045.04	57653.85
Change in TVC (Δ TV)	0	4500	13500	6000
Change in net benefit (Δ NR)	31769.55	5292.9	1660.86	9269.67
MRR (%) = (Δ NR/ Δ TVC)*100	ND	117.62	12.30	154.49

Conclusion

The interaction effects of fertilizer application and production years had significant ($p < 0.001$) effect on morphological characteristics, and dry matter yield observed in this study. The morphological characteristics and DMY increased as the level of fertilizer increased and the production year also extended. The highest PH, NTPP, NLPP, LLPP, LWPP, LSR and DMY were obtained from manure fertilizer application in both years. Based on this evaluation, desho grass-*Areka DZF-590* with manure fertilizer application was recommended due to adaptive and better production performance to fulfill the shortage of forage quantity to enhance the livestock production and productivity in the study area and similar agro ecologies.

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Conflict of interest

Authors declare no conflict of interest

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