Evaluation of Desho Grass *(Pennisetum Pedicellatum)* Productivity under Different Fertilizer Combinations and Spacing at Gamo Gofa Zone, Ethiopia

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Abstract: *Desho grass is a perennial drought tolerant feed to contribute a lot for dry season feed demand of Ethiopian livestock. A field experiment was conducted at Chano Substation, Southern Ethiopia, to determine dry matter yield of desho grass using factorial combination of five fertilizer rates (0:0, 11.5:43.5, 15:59.5, 20:64 and 25:91.5 kg /ha P:N) and four spacing (plant: row) (25:50, 50:75, 75:100 and 100:125 cm) in RCBD with three replications. Plant height, tiller number and dry matter yield were computed with Least Significant Difference. With increase in P: N rate from 0:0-25:91.5 kg/ha; plant height increased from 61 to 93 cm and tiller number shown an increment from 214.2 to 308.6. The respective increase in tiller number with plant and row spacing from narrower (25; 50cm) to wider (100:125 cm) was 248.5 to 346. Dry matter yield increased from 9.27 to 25.54 ton/ha for the fertilizer rate from control to 20:64 kg/ha. Dry matter yield increased for wider spacing from 25;50 cm to 75;100 cm having the yield of 14 to 26.61 ton/ha. The present experiment suggests that at low lands of Southern Ethiopia the optimum dry matter yield could be obtained at phosphorus and nitrogen rate of 20;64 kg/ ha with 75;100 cm plant and row spacing of Desho grass.*

Keywords: Nitrogen, Phosphorus, Plant spacing, Row spacing

1. Introduction

Desho grass (*Pennisetum pedicellatum*) is an indigenous forage species of Ethiopia with different names in different countries of Africa: As annual kyasuwa grass in Nigeria, Barrein in Mauritius and Desho in Ethiopia (EPPO, 2014). In Ethiopia Desho grass is a perennial plant which was first identified in the Southern region of the country at Chencha in 1991 and was utilized for soil conservation and animal feed (Welle *et al.*, 2006). The grass is drought tolerant and is used as feed for ruminant animals (FAO, 2010; EPPO, 2014). It has potential to address some of the challenges of feed scarcity, since it produces high dry matter yields of forage per unit area and ensures a sustained forage supply due to its multi-cut nature (ECOCROP, 2010). Desho grass is suitable for intensive management and performs well at elevations of 1500-2800 masl (Leta *et al*., 2013). Asmare (2016) suggests that desho grass is both potential feed source and a means of soil conservation in the mixed crop-livestock production systems of Ethiopia.

Desho grass responds well to fertilizer application and could be combined with fodder legumes either in mixtures or in rotational cropping. In short rotation with maize or groundnuts, the grass yields better than traditional forage grasses, especially when fertilized, while the roots and stubble also increase organic matter in soil (Leta *et al*., 2013). It requires compost or manure of about 1,000 – 4,500 kg/ha and 25-100 kg/ha of urea fertilizer for establishment and maintenance (Danano, 2007).

Crude protein concentrations of desho grass, 9.6% on dry matter basis during early growth 1.6% at the straw stage have been reported at low elevation (Asmare *et al*., 2016), with lower values at mid elevation (8.6% CP) and high elevation (7.5% CP). The grass is widely used as green fodder for cattle in different parts of the world (Cisse *et al*., 2002).

In Ethiopia, factors like shortage of land, shortage of planting materials, poor soil fertility and lack of awareness (Yenesew *et al*., 2014) limit forage production and there is no predetermined agronomic practice for optimal production of desho grass yet. Therefore the objective of this study was to determine some morphologic traits and dry matter yields of desho grass at different levels of phosphorus and nitrogen fertilizer and plant and row spacing.

2. Materials and Methods

2.1 Description of study areas

The experiment was conducted on the Arba Minch Research Center at Chano Substation ($6^0$2' N, $37^0$33' E; 1170 meter above sea level), Southern Ethiopia, from September 2014-April 2015. The nearby town of Arba Minch, 10 km from the experimental site, has average rainfall of 1,000 mm per annum and the monthly average minimum and maximum temperatures are 16 and 37°C, respectively.

2.2 Soil chemical and physical properties of the study site

Laboratory analysis for particle size (texture), pH, available phosphorus, total nitrogen, organic carbon and cation exchange capacity for composite soil (0-30 cm) samples collected from the experimental site before planting are shown in Table 1.

Table 1: Selected physico-chemical properties of the experimental soil at 0-30 cm depth

Soil Properties	Quantity
pH	6.2
Organic carbon (%)	1.16
Available phosphorus (mg/kg)	14.5
Total nitrogen (%)	0.2
Cation exchange capacity (cmol(+)/kg)	29.5
Texture (Sandy loam)	
Sand (%)	64
Silt (%)	21
Clay (%)	15

Source: Own laboratory result

2.3 Treatments and experimental design

Factorial combinations of 5 fertilizer (phosphorus: nitrogen) rates (0:0, 11.5:43.5, 15:59.5, 20:64 and 25:91.5 kg/ha) x 4 plant spacing (between plants: between rows) (25:50, 50:75, 75: 100 and 100:125 cm) were laid out in a randomized complete block design with 3 replications. Planting was done on 15 September 15 2014 on plots of 3 x 4 m, each plot having 4 rows x 2 m long. The distance between plots was 1 m and that between blocks 1.5 m. Phosphorus fertilizer as di-ammonium phosphate was applied at planting time and N as urea was applied at the 2-leaf stage of establishment. Weeds were controlled with frequent hand weeding throughout the experiment.

2.4 Data collection and analysis

Plant height (cm), tiller number and dry matter (ton/ha) were recorded on 2 central rows. The recorded data were subjected to analysis of variance (ANOVA) followed by means separation using the Genstat statistical software (VSN international, 2013).

3. Results and Discussion

The main effects of fertilizer rates (P: N combinations), plant spacing and their interaction were highly significant ($P<0.01$) for plant height, total dry matter yield and tiller number ($P<0.05$) (Table 2).

Table 2: Analysis of Variance

Source of Variation	DF	PH (cm)	Tiller number	DMY (ton/ha)
Replication	2	31.67^{ns}	7704^{ns}	12.9^{ns}
Fertilizer Rate	4	1934.52***	19272***	675.19***
Spacing	3	3655.01***	26737***	429.86***
Fertilizer Rate x Spacing	12	663.3***	4896*	81.1***
Error	38	30.19	2074	6.26
CV (%)		6.7	16	13.1

DF: degree of freedom, PH: plant height, DMY: dry matter yield, CV: coefficient of variation

3.1 Plant height

In the absence of fertilizer, plant and row spacing had no effects on plant height (P>0.05) with a mean height of 61.1 cm. When fertilizer was applied plant height tended to increase, with the effect being more pronounced at wider spacings and the highest fertilizer levels (Table 3). The greatest plant height occurred at the highest fertilizer level (P: N) of 25P:91.5N kg/ha and widest spacing of 100:125 cm (128.7 cm).

As to the present experiment, the increase in nitrogen and phosphorus fertilizer application increase plant height of *Pennisetum glaucum* (El-tilib *et al.,* 2006) and desho grass (Worku *et al*., 2017). The highest plant height of desho grass at wider spacing and high level of fertilizer in the present research agrees with Shiferaw *et al.* (2011) which grows upright with the potential of reaching 90 to 120 cm based on soil fertility. Plant spacing was not affecting plant height (Tilahun *et al*., 2017; Worku *et al*., 2017). That is due to the physiological functioning of nitrogen and phosphorus fertilizers to involve in growth and development of desho grass. Plant height is an important parameter contributing to yield in forage crops (Tessema *et al*., 2002).

Table 3: Effect of phosphorus and nitrogen fertilizer and spacing on plant height of desho grass at Chano Substation in 2014

P:N (kg/ha)	Plant: Row spacing (cm)			
	25:50	50:75	75:100	100:125
0	60.3^{gh}	62.0^{gh}	61.0^{gh}	61.0^{gh}
11.5:43.5	74.7^{ef}	79.8^{de}	102.2^{bc}	101.5^{bc}
15:59.5	68.3f^{g}	60.2^{gh}	85.2^{d}	98.2^{c}
20:64	58.5^{h}	68.0f^{g}	106.0^{bc}	109.3^{b}
25:91.5	101.0^{bc}	55.2^{h}	87.7^{d}	128.7^{a}
CV (%)	6.7			
$LSD_{0.05}$: Fertilizer rate = 4.54; Spacing = 4.06; Interaction = 9.08				

Means followed by common letters are not statistically different (P>0.05); CV: coefficient of variation, $LSD_{0.05}$: Least significant difference at p = 0.05

3.2 Tiller number per plant

In the absence of fertilizer plant and row spacing had no effect on tiller numbers (P>0.05) with a mean figure of 214 tillers/plant (Table 4). Application of fertilizer increased the number of tillers with highest numbers (406 and 418 tillers) being recorded at the widest plant: row spacing and the high applications of fertilizer (P<0.05).

The plant tiller number was higher in wider plant and row spacing (Tilahun *et al*., 2017; Worku *et al*., 2017). The present result also agrees with (Lakhana *et al*., 2005; Pathan and Bhilare 2009; Kizima *et al*., 2014) for the increment of tiller number per plant with increasing level of fertilizers. That may be due to the plant under and above ground resource competition would be lower in wider spacing than narrower which favors the development of more tiller number per plant. Having higher number of tiller advantages the farmer to satisfy the need of planting material. Effective tillers are having leaves and there may add forage feed to livestock (Mushtaque *et al*., 2010).

Table 4: Effect of phosphorus and nitrogen fertilizer and spacing on tiller number of desho grass at Chano Substation in 2014

P:N (kg/ha)	Plant: Row Spacing (cm)			
	25:50	50:75	75:100	100:125
0	215[ef]	215[ef]	216[ef]	211[f]
11.5:43.5	298[bcd]	294[bcd]	277[cdef]	326[bc]
15:59.5	287[cde]	310[bc]	261[cdef]	369[ab]
20:64	210[f]	270[cdef]	308[bc]	406[a]
25:91.5	232[def]	299[bcd]	285[cdef]	418[a]
CV (%)	16			

$LSD_{0.05}$: Fertilizer rate = 37.64; Spacing=33.66; Interaction = 75.27

Means followed by common letters are not statistically different (P>0.05); CV: coefficient of variation, $LSD_{0.05}$: Least significant difference at p = 0.05

3.3 Dry matter yield

In the absence of fertilizer plant and row spacing had no significant effects on DM yield (P>0.05) with mean yield of 9.27 t DM/ha (Table 5). Yields responded to increasing levels of fertilizer with highest yields being recorded at 20P:64N or 25P:91.5N for all spacings (P<0.05), while at all fertilizer levels the highest yields were at the 75:100 cm plant: row spacing (P<0.05). The highest yield recorded (41.13 t DM/ha) was for the highest fertilizer application and the 75:100 cm spacing.

As to the present experiment, the highest dry matter yield was reported at 150 DAP: 200 Urea kg/ha for desho grass (Worku *et al*., 2017) and at the nitrogen rate of 90-120 kg/ha for millet (Hegde *et al*., 2006; Bhilare *et al*., 2010). Dry matter yield of 28.35 t/ha was recorded with 100 kg/ha DAP and 50*50 cm spacing (Tekalign *et al*., 2017). There was highest total dry matter yield recorded for desho grass at 50*100 cm spacing (Yenesew *et al*., 2014) and for napier grass at narrower (50*40 cm) spacing under intensive management of nitrogen application and irrigation (Sumran *et al*., 2009) whereas for desho grass at present experiment the dry matter yield of highest ton recorded at 75*100 cm spacing. The results for dry matter yield indicate that wider spacing produces higher dry matter per clump as has been reported by the Vetiver Information Network (VIN, 1992) when intra-row spacing of 15 and 30 cm were compared. The significant increase in dry matter yield with increase in fertilizer rate was in agreement with the results reported by Yasin *et al*. (2003) may be due to the additional tillers developed which brought an increase in leaf formation, leaf elongation and stem development (Crowder and Cheda, 1982).

Table 5: Effect of phosphorus and nitrogen and spacing on dry matter yield (t/ha) of Desho grass at Chano Substation in 2014

P:N (kg/ha)	Plant: Row Spacing (cm)				
	25:50	50:75	75:100	100:125	Mean
0	9.03^{h}	9.03^{h}	9.73^{h}	9.27^{h}	9.27^{d}
11.5:43.5	11.97^{gh}	9.83^{h}	21.97^{de}	15.33^{fg}	14.78^{c}
15:59.5	17.7^{f}	12.2^{gh}	28.4^{bc}	15.2^{fg}	18.38^{b}
20:64	13.13^{gh}	31.77^{b}	31.83^{b}	25.43^{cd}	25.54^{a}
25:91.5	18.63^{ef}	22.67^{de}	41.13^{a}	26.87^{c}	27.33^{a}
Mean	14.09^{c}	17.1^{b}	26.61^{a}	18.42^{b}	19.06
CV (%)	13.1				
$LSD_{0.05}$: Fertilizer rate =2.07; Spacing=1.85; Interaction = 4.12					

Means within a column followed by common letters are not statistically different, CV: coefficient of variation, $LSD_{0.05}$: Least significant difference at p = 0.05

4. Conclusion

This study has shown that the tallest plant height and higher number of tiller recorded at higher level of nitrogen and phosphorus fertilizer application with a wider plant and row spacing. The total green forage and dry matter yield increment recorded with increasing level of phosphorus and nitrogen fertilizer rate and wider plant and row spacing for desho grass production at low lands of the study area. At low lands of Arbaminch research center, Gamo Gofa area, the optimum dry matter and green forage yield could be obtained at phosphorus and nitrogen rate of 20:64 kg ha^{-1} with 75:100 cm plant and row spacing. Further study should be conducted on response of fertilizer rate and type to chemical composition and mineral content of different variety of desho grass.

Conflict of interest

Authors clearly declare that there is no conflict of interest in publication of this work.

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