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Effect of Planting Space and Fertilizer Rate on Productivity of Desho Grass (Pennisetum Pedicellatum) in Jinka Agricultural Research Center, Southern Ethiopia

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ABSTRACT

The study was conducted in Jinka agricultural research center south agriculutural research institute Southern Ethiopia with objective of identifying effect of planting space and fertilizer rate on productivity of desho grass. Planting of Desho grass has been conducted in four planting space (level1= 0.25cm between plants and 0.5cm between rows, levele2= 0.5cm b/n plants and 0.75 b/n rows, level 3= 0.75cm b/n plants and 1meter b/n rows, level 4= 1 meter b/n plants and 1.25 meter b/n rows) and five fertilizer rates (control, 0.5 DAP and 0.5ql urea, 1 ql DAP and 1.5 ql urea, 1 ql DAP and 2 ql urea, 1.5 ql DAP and 2 ql urea). The experiment has used a plot size of 3m x 4m. Field trial was arranged in a randomized complete block design (RCBD) with three replications. Plant height, number of tiller per plant and dry matter yield were recorded. The results indicated that planting space evaluated showed statistical significant variation (p<0.05) in dry matter yield (t/ha-1) and number of tillers while there is no statistically significant difference in plant height at harvest (m). It is recommendable that utilization of fertilizer at treatment level 2 is important for farmer whereas it is better to apply treatment level 4 for youth/ non-employed group and investors who are participated in forage seed production. Cost benefit analysis has to be conducted through hay making or animal response.

Keywords: *Dry matter yield, Desho grass, Number of tiller*

INTRODUCTION

Desho grass *(Pennisetum pedicellatum)*, known simply as desho or as desho grass, is an indigenous grass of Ethiopia belonging to the Poaceae family of monocot angiosperm plants. It grows in its native geographic location, naturally spreading across the escarpment of the Ethiopian highlands (Smith, G. 2010). Widely available in this location, it is ideal for livestock feed and can be sustainably cultivated on small plots of land. Thus desho is becoming increasingly utilized, along with various soil and water (Smith, G. 2010) conservation techniques, as a local method of improving grazing land management and combating a growing productivity problem of the local region (IPMS, Ethiopia. 2010)) .

Desho is used as a year round fodder (Leta et al. 2013). To maintain the sustainability of the intervention, the plot is permanently made inaccessible to free grazing livestock; instead a cut-and-carry system is encouraged (Danano D, 2007). Due to its rapid growth rate, desho provides regular harvests, even reaching monthly cuts during the rainy reason. Once a year, just before the dry season, sufficient grass is harvested and stored as hay to feed the livestock until the rains return (Danano D, 2007).

Very little has been done in collection and conservation of indigenous forage species which have invaluable importance in the livelihood of the farmers. Hence, introduction of high yielding and nutritious indigenous forage species like desho grass is the foremost issue to minimize feed shortage both in quality and quantity especially during dry season. The production of desho grass is widely practiced in the region due to its importance for both livestock feed and in soil and water conservation structures (EPPO, 2014). As it has been mentioned above even though, desho grass has multi- functions the optimum planting space and fertilizer rate for optimum yield has not been identified both in regional and national level. Therefore the objective of this study is to identify effect of planting space and fertilizer rate on biomass yield, number of tillers and height at harvesting.

METHODOLOGY

Description of Study Area

The experiment was conducted in 2014 cropping season (April) at Jinka Agricultural Research Center located at 5^o 52' N latitude and 36^o 38' E longitude. Jinka is situated in south Ethiopia at 750 kms from Addis Ababa, at an altitude of 1450 m above sea level. The average annual rainfall of the area for the last twelve years is 1294 mm with a range of 994.1 to 1675.8 mm, while the average annual minimum and maximum temperatures were 16.1^{o}c and 27.6^{o}c, respectively. The main rainy season extends from March to June interrupted by some dry periods in May (BoA2007)

Experimental Design and Materials Used

The experiment was conducted with four planting space (level1= 0.25cm between plants and 0.5cm between rows, levele2= 0.5cm b/n plants and 0.75 b/n rows, level 3= 0.75cm b/n plants and 1meter b/n rows, level 4= 1 meter b/n plants and 1.25 meter b/n rows) and five level of fertilizer rate (0.5 DAP and 0.5ql urea, 1 ql DAP and 1.5 ql urea, 1 ql DAP and 2 ql urea, 1.5 ql DAP and 2 ql urea). Field trials were arranged in a randomized complete block design with three replications. Plot size was 3m * 4m. Spacing between replications and plots was 2m in each. Desho grass was harvested for herbage and dry matter yield at the age of 4 month after planting data like plant height, number of tillers per plant and dry matter yield were recorded. During sampling a 1m * 1m quadrate was randomly thrown in to each plot and three quadrates were harvested by machete from each plot and then it was weighed for its fresh weight right in the field. The dry matter yield was calculated after drying a sample of 500g green forage in an oven at 105^{0}c for 24hours in Jinka agricultural research center which was converted in to hectare. The plant height measured by averaging the natural standing height of ten plants per plot. The main branch number was an average of primary branches on the stem of ten plants per plot.

Data Analysis

The data collected on Dry matter yield, plant height and number of tillers was subjected to analysis of variance by using the general linear model (GLM) procedure in (SPSS) and mean separation was done using Duncan multiple range at 5% probability level.

RESULT AND DISCUSSION

Effect of Space on Number of Tillers

There is significant difference on number of tillers at ($p<0.05$) in all planting space (table 1) i.e. as planting space increases the number of tillers per plant increase. Hence, as increase in number of tillers per plants there will be increase in biomass yield and also increase the number of tillers to be sold at individual farmer's level. So, it can be recommended that if there is no land problem farmers can increase dry matter yield through increasing planting space.. This study is in line with study conducted by John L. Snider et.al. 2012. Who reported that as row space increase there is probabilty Danano, 2007 reported that 10 cm x 10cm for grazing land management and optimum biomass yield

Effect of Space on Height at harvesting

There is no significant difference at ($p<0.05$) height at harvesting among all planting space (table 1). This study is in contrary to report by (Schmitt and Wulff, 1993) higher plant densities can sometimes stimulate increases in plant height due to internodes elongation and plant height has also been shown to decline with excessively high plant densities (Van Der Werf et al., 1995)

Effect of Fertilizer Rate on Number of Tillers

This study indicated that there is significant difference ($p<0.05$) in number of tillers per plant as the fertilizer rate increase. This is in agreement with other reports for other grass species (Kizima et al., 2014) who reported that application of optimal level of Nitrogen fertilization significantly affects the appearance of new tillers and increases the dynamics of tiller population of Cenchrus ciliaris. Moreover, the present result are also supported by the findings of (Mushtaque et al., 2010) who reported that Nitrogen triggers the activation of dormant buds and enhances the vegetation sward filling through the highest rate of tiller replacement, which supports a higher proportion of very active healthier young tillers for each plant, which results in higher tiller density and consequently increases biomass production.

Table1. *Effect of planting space on number of tiller, Dry matter yield and height at harvesting*

Dependent Variable	Space	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Number of tillers/plant	space 1	54.6[d]	1.053	52.539	56.794
	space 2	60.9[c]	1.053	58.806	63.061
	space 3	71.4[b]	1.053	69.339	73.594
	space 4	79.9[a]	1.053	77.806	82.061
Dry matter yield ton/ha	space 1	10.3[c]	.013	10.08	10.60
	space 2	11.2[b]	.013	10.90	11.42
	space 3	11.9[a]	.013	11.58	12.11
	space 4	12.2[a]	.013	11.91	12.44
Height at harvesting in M	space 1	1.05[a]	.020	1.005	1.086
	space 2	1.09[a]	.020	1.046	1.127
	space 3	1.12[a]	.020	1.075	1.156
	space 4	1.09[a]	.020	1.051	1.133

Effect of Fertilizer Rate on Dry Matter Yield

This study indicated that there is significant difference (p<0.05) in DMY as the fertilizer rate increase. Nitrogen application had highly significant effect on DM yield and nitrogen concentration in most of the tropical grasses. N-application resulted in improved dry matter yield (diriba, 2000) for other grass species. The yield of green leaf mass per unit of crop land increase with N-application, the number of green leaves per tiller is little affected by N-fertilization. In the case of very low level; the number of live leaves may decrease along with the proportion of green material in total yield (Daniel, 1996). Different studies conducted on different grass species indicated that the dry matter yield and harvestable stand density of Panicum colorutum with the increasing level of N-fertilizer from 0- 95 kg ha-1 increased from 9.48 to 15.39 tons per hectare and 366.5g to 495.2g per 0.6m2, respectively (Diriba, 2000). Abdi Hassan 2014, reported that DMY influenced with increase in urea fertilizer significantly (P < 0.05) the highest total dry mater yield obtained from Cenchrus ciliaris due to more number of tillering and density of the leaves. Similarly, the present result is supported by the findings of VLasorolla et al., (2011) who reported that the application of urea fertilizer level of 0, 50 and 100kg had significant effect on dry matter yield of Panicum maximum. The current study also agrees with those reports by (Polat et al., 2007) who found that overall mean of forage dry matter yield increase with increasing level of N fertilizer application.

Effect of Fertilizer rate on Height at harvesting

This study indicated that there is no significant difference (p<0.05) in height during harvesting per plant as the fertilizer rate increase. This is in line with other reports for different grass species. Abdi Hassan, 2014 reported that no difference (P < 0.05) at harvesting height among the different nitrogen rates for *Cenchrus ciliaris* and *Panicum maximum*. Height is therefore mainly of species characteristics. The present study is in agreement with other studies conducted for different grass species that reported, the effect of nitrogen fertilizer application on the plant height of Panicum maximum was not significant difference (Lawson, 2008) and Sudan grass (Awad et al., 2012). The absence of interaction effect between grass species and nitrogen application obtained in this study is also in agreement with the results reported by Tegegn (2001) who found no interaction effect of nitrogen fertilizer rates and grass species on the height.

Interaction Effect of Planting Space and Fertilizer Rate on Number of Tillers, Dry Matter Yield and Height at Harvesting

There is significant interaction effect on number of tillers and dry matter yield (p<0.05) between fertilizer rate and planting space. On the other hand there was no significant interaction on height at harvesting (p<0.05) between fertilizer rate and planting space (appendix table 1). The absence of interaction effect between plant space and nitrogen application on plant height is also in agreement with the results reported by Tegegn (2001) who found no interaction effect of nitrogen fertilizer rates and grass species on the height.

Table2. *Effect of Fertilizer rate on Dry matter yield, Number of tillers and height at harvesting*

Dependent Variable	Fertilizer Rate	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Number of tillers/plant	fertilizer 1	43.6[e]	1.177	41.28	46.04
	fertilizer 2	65.4[d]	1.177	63.03	67.79
	fertilizer 3	70.6[c]	1.177	68.20	72.96
	fertilizer 4	75.0[b]	1.177	72.62	77.37
	Fertilizer 5	79.1[a]	1.177	76.70	81.46
Dry matter yield in tone/ha	fertilizer 1	8.32[d]	.015	8.02	8.61
	fertilizer 2	9.09[c]	.015	8.80	9.39
	fertilizer 3	12.73[ab]	.015	12.43	13.02
	fertilizer 4	13.11[a]	.015	12.81	13.40
	Fertilizer 5	13.66[a]	.015	13.36	13.95
Height at harvesting in M	fertilizer 1	.90[b]	.022	.85	.94
	fertilizer 2	.91[b]	.022	.86	.95
	fertilizer 3	1.07[b]	.022	1.01	1.12
	fertilizer 4	1.2[a]	.022	1.22	1.29
	Fertilizer 5	1.3[a]	.022	1.24	1.33

Conclusion and Recommendation

- Higher DM Yield was obtained with fertilizer rate **4** and space level 3, which statistically significant at ($p<0.05$) than the other treatment combinations. However this combination is not affordable for farmers both in terms of land and price of fertilizer. But this combination might be recommended for youth group which are organized for forage seed production who provide desho tillers as seed.
- Hence, 0.5 Qt DAP and 0.5 Qt Urea per hectare and 0.25 meter by 0.5 meter spacing were recommended for farmers.
- Furthermore it needs economic analysis be it through sell of tillers and/or feed desho as basal feed source for animals.
- On the other hand experiment has to be conducted with different space b/n plant and fixed row space has to be conducted.

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APPENDIX TABLE

Appendix Table 1. *Interaction effect between planting space and fertilizer rate on number of tillers, dry matter yield and height at harvesting*

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	number of tillers	16022.583[a]	19	843.294	50.750	.000	.960
	Dry matter yield in kg/1m2	3.610[b]	19	.190	74.131	.000	.972
	height at harvesting	1.730[c]	19	.091	15.088	.000	.878
Intercept	number of tillers	267333.750	1	267333.750	16088.290	.000	.998
	Dry matter yield in kg/1m2	77.703	1	77.703	30313.124	.000	.999
	height at harvesting	70.612	1	70.612	11700.381	.000	.997
Fertilizer rate	number of tillers	9233.833	4	2308.458	138.924	.000	.933
	Dry matter yield in kg/1m2	2.953	4	.738	287.993	.000	.966
	height at harvesting	1.591	4	.398	65.916	.000	.868
Space	number of tillers	5638.317	3	1879.439	113.106	.000	.895
	Dry matter yield in kg/1m2	.297	3	.099	38.566	.000	.743
	height at harvesting	.038	3	.013	2.109	.114	.137
Fertilizer rate * space	number of tillers	1150.433	12	95.869	5.769	.000	.634
	Dry matter yield in kg/1m2	.361	12	.030	11.735	.000	.779
	height at harvesting	.101	12	.008	1.390	.211	.294
Error	number of tillers	664.667	40	16.617			
	Dry matter yield in kg/1m2	.103	40	.003			
	height at harvesting	.241	40	.006			
Total	number of tillers	284021.000	60				
	Dry matter yield in kg/1m2	81.416	60				
	height at harvesting	72.583	60				

Corrected Total	number of tillers	16687.250	59				
	Dry matter yield in kg/1m2	3.713	59				
	height at harvesting	1.971	59				
a. R Squared = .960 (Adjusted R Squared = .941)							
b. R Squared = .972 (Adjusted R Squared = .959)							
c. R Squared = .878 (Adjusted R Squared = .819)							

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