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Effect of Planting Density and Nitrogen Levels on Growth and Yield of Fodder Pearlmillet (*Pennisetum glaucum* L.)

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A B S T R A C T

A field experiment was conducted during the *Zaid* season 2018 at the Crop Research farm of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad (U.P.) to study Effect of planting density and nitrogen levels on growth and yield of *kharif* dual purpose pearlmillet (*Pennisetum glaucum* L.)". The experiment consisted of three planting density *viz.*, comprising 2 planting density D1, Normal distance (45 cm x 10 cm); D2, High density (22.5 cm x 10 cm) *fb* alternate row harvest at 45 DAS and 4 nitrogen levels (N1, N = 60 kg ha^{-1}; N2, N = 80 kg ha^{-1}; N3, N = 100 kg ha^{-1} and N4, N = 120 kg ha^{-1}) was laid out in randomized block design with three replications. The result revealed that treatment T_4 (Normal distance + 120 kg ha^{-1} Nitrogen) produced significantly the highest dry matter accumulation at 20,40, 60, 80 DAS & Harvest (0.92 g, 12.73 g,72.51 g, 81.10 g and 82.17 g) which was statistically at par with T_8 (High density planting *fb* alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}), no of leaves at 20,40,60 DAS are non-significant at 80 DAS (8.73) and harvest (8.80) the higher no of leaves were recorded with T_8 (High density planting *fb* alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}), higher green fodder yield, stover yield, biological yield was recorded with T_4 (Normal distance + 120 kg ha^{-1} Nitrogen) which was at par with T_8 (High density planting *fb* alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}).

Introduction

Pearl millet (*Pennisetum glaucum* L.) popularly known as Bajra, cattle millet, bulrush millet belongs to the grass family or gramineae. In the world, it's rank sixth followed by rice, wheat, corn, barley and sorghum (Anonymous, 2013). However, in India, it is fourth most important cereal crop after rice, wheat and sorghum. India is the largest producer of Pearl millet in the world. In India major producing state are Rajasthan (46%), Maharashtra (19%), Gujarat (11%), Uttar Pradesh (8%) and Haryana (6%), (Sonawane *et al.*, 2010). It is a dual purpose crop, its grain is used for human consumption and its fodder as cattle feed. Pearl millet is a small seeded caryopsis. It is nutritionally superior to many cereals as it is a good source of protein (11%) having higher digestibility (12.1%), fats (5%), carbohydrates (69.4%) and minerals (2.3%). Grains are also used as feed for cattle and poultry etc. Green fodder is used either as such or it is preserved as hay or

silage which has proved extremely useful in dry regions especially during lean periods. High density planting is the other technology which can solve the problem high density planting followed by alternate row harvesting for fodder at different growth stages may provide a partial solution to the problem of fodder shortage. The most important factor affecting the pearl millet yield is the plant density. Higher number of plants per unit area increases the competition between the plants for resources (moisture, light, nutrients etc.), whereas, under low plant population/plant density these resources are not fully utilized. Yield of a crop depends on the final plant density. Fertilizer management is one of the important cost effective factors known to augment the crop production. Among the plant nutrients nitrogen is one of the most important and expensive nutrients and it has marked effect on plant growth in cereal crops. It constituents of protein and nucleic acid which favors the synthesis of protoplasm in plant body, promotes photosynthesis, size of plant, yield contributing characters and yield of crops (Meena *et al.,* 2012).

Material and Methods

The experiment was carried out during Zaid season 2018 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Prayagraj (U.P.), which is located at 25º 24' 42" N latitude, 81º 50' 56" E longitude and 98 m altitude above the mean sea level. This area is situated on the right side of the river Yamuna by the side of Allahabad Rewa Road about 5 km away from Allahabad city.

The soil of experimental field was sandy loam, pH of soil was 7.4 with 0.39% organic C, having available N, P, K, 185.5, 36 and 98 kg h^{-1} respectively. The experiment involving hybrid 'Bajra-9119' was laid out in randomized block design with eight treatments replicated thrice, comprising 2 planting density D1, Normal distance (45 cm x 10 cm); D2, High density (22.5 cm x 10 cm) *fb* alternate row harvest at 45 DAS and 4 nitrogen levels (N1, N = 60 kg ha^{-1}; N2, N = 80 kg ha^{-1}; N3, N = 100 kg ha^{-1} and N4, N = 120 kg ha^{-1}).

Plant dry weight (g)

Dry weight of plants was recorded at 20, 40, 60, 80 DAS and Harvest. For this observation five plants were uprooted randomly from each plot, except 1 m^2 area. These plants were dried in partial shade and then kept in oven for 72 hrs at 70 ^{0}C and weight was recorded. The average dry weight (g $plant^{-1}$) was calculated for each observation.

Number of leaves $plant^{-1}$ (no.)

The no of leaves per plant were counted at 20, 40, 60, 80 DAS and Harvest from each plot.

Green forage yield (t ha^{-1})

Net area from each plot was harvested at 45 DAS from D2 plots. After making bundles the fresh weight was recorded and finally per hectare green forage yield was worked out.

Stover yield (t ha^{-1})

Stover yield from harvest area (1.0 m^2) was dried in sun, bundled, tagged and weighed separately from each plot for calculating the stover yield in tonnes ha^{-1}.

Biological yield (t ha^{-1})

Net area from each of the plots was harvested and sun dried separately. Total weight of these plants (stover + grain) from each net plot was recorded and computed as biological yield ha^{-1}.

Statistical analysis

The data recorded during the course of investigation was subjected to statistical analysis by ‘‘Analysis of variance technique’’. The significant and non-significant treatment effects were judged with the help of ‘F’ (variance ratio) table. The significant differences between the means were tested against the critical difference at 5% probability level. Statistical analysis was performed for randomized block design (Gomez *et al.,* 1983).

Results and Discussion

Growth characters

Dry weight

At 20, 40, 60, 80 DAS and Harvest was statistically significant with plant dry weight (0.92 g, 12.73 g,72.51 g,81.10 g and 82.17 g respectively) were observed with treatment of T_4 (Normal distance + 120 kg ha^{-1} Nitrogen). At 20 DAS, treatments T_8 (High density fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}) and T_3 (Normal distance + 100 kg ha^{-1} Nitrogen) were statistically at par with treatment T_8 (High density fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}), at 40 DAS, treatments

T_7 (High density planting fb alternate row harvest at 45 DAS+100 kg nitrogen ha^{-1}) and T_8 (High density planting fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}) was statistically at par with treatment T_4 (Normal distance + 120 kg ha^{-1} Nitrogen), at 60 DAS, treatments T_8 (High density planting fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}) and T_3 (Normal distance + 100 kg ha^{-1} Nitrogen) was statistically at par with treatment T_4 (Normal distance + 120 kg ha^{-1} Nitrogen), at 80 DAS, treatments T_8 (High density planting fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}) and T_3 (Normal distance + 100 kg ha^{-1} Nitrogen) was statistically at par with treatment T_4 (Normal distance + 120 kg ha^{-1} Nitrogen) and at Harvest, treatment T_8 (High density planting fb alternate row harvest at 45 DAS+120 kg ha^{-1} Nitrogen) was statistically at par with treatment of T_4 (Normal distance + 120 kg ha^{-1} Nitrogen).

No of leaves

At 20 DAS, higher no of leaves $plant^{-1}$ (3.33 no) were recorded in the treatment of T_4 (Normal distance + 120 kg ha^{-1} Nitrogen), but it was non – significant, at 40 DAS, higher no of leaves $plant^{-1}$ (7.33 no) were recorded with the treatment T_8 (High density fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}), but it was non – significant, at 60 DAS, higher no of leaves $plant^{-1}$ (8.33 no) were recorded with the treatment T_8 (High density fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}), but it was non – significant, at 80 DAS, higher no of leaves $plant^{-1}$ (8.73 no) were recorded with the treatment

T_8 (High density planting fb alternate row harvest at 45 DAS+120 kg ha^{-1} Nitrogen) though T_7 (High density planting fb alternate row harvest at 45 DAS+100 kg ha^{-1} Nitrogen) and T_4 (Normal distance + 120 kg ha^{-1} Nitrogen) was statistically at par with treatment of T_8 (High density planting fb alternate row harvest at 45 DAS+120 kg ha^{-1} Nitrogen) and at Harvest higher no of leaves $plant^{-1}$ (8.80 no) were recorded with the treatment T_8 (High density planting fb alternate row harvest at 45 DAS+120 kg ha^{-1} Nitrogen) though T_4 (Normal distance + 120 kg ha^{-1} Nitrogen) and T_7 (High density planting fb alternate row harvest at 45 DAS+100 kg ha^{-1} Nitrogen) was statistically at par with treatment of T_8 (High density planting fb alternate row harvest at 45 DAS+120 kg ha^{-1} Nitrogen) (Table 1).

Table.1 Effect of planting density and nitrogen levels on growth attributes of Pearlmillet (*Pennisetum glaucum* L.)

Treatments	Green fodder yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})
Normal Distance + 60 kg/ha Nitrogen	-	7.38	9.81
Normal Distance + 80 kg/ha Nitrogen	-	7.95	10.41
Normal Distance+ 100 kg/ha Nitrogen	-	8.25	10.92
Normal Distance+ 120 kg/ha Nitrogen	-	8.89	11.81
High Density + 60 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	7.00	7.18	9.54
High Density+ 80 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	12.15	7.24	9.70
High Density+ 100 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	15.01	8.06	10.71
High Density+ 120 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	17.26	8.77	11.51
F test	-	S	S
SEm±	-	0.08	0.10
CD(p=0.05)	-	**0.25**	**0.32**

Table.2 Effect of planting density and nitrogen levels on yield attributes of Pearlmillet (*Pennisetum glaucum* L.)

Treatment combination	Dry matter accumulation (g plant^{-1})					No of leaves (no)				
	20 DAS	40 DAS	60 DAS	80 DAS	Harvest	20 DAS	40 DAS	60 DAS	80 DAS	Harvest
Normal Distance + 60 kg/ha Nitrogen	0.71	10.56	68.67	76.38	77.07	3.13	6.60	7.53	7.63	7.67
Normal Distance + 80 kg/ha Nitrogen	0.78	11.11	69.72	78.08	79.19	3.13	6.93	8.07	8.27	8.33
Normal Distance+ 100 kg/ha Nitrogen	0.87	11.69	71.01	79.29	80.03	3.13	7.00	8.20	8.40	8.47
Normal Distance+ 120 kg/ha Nitrogen	0.92	12.73	73.77	81.10	82.17	3.33	7.27	8.27	8.60	8.67
High Density + 60 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	0.72	10.71	67.08	75.01	76.36	3.00	6.40	7.87	8.13	8.20
High Density+ 80 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	0.79	10.86	68.59	77.18	78.10	3.13	6.60	8.13	8.33	8.40
High Density+ 100 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	0.83	11.98	69.45	78.51	79.08	3.20	7.33	8.27	8.47	8.60
High Density+ 120 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	0.85	12.70	70.35	79.53	80.55	3.27	7.33	8.33	8.73	8.80
F test	S	S	S	S	S	NS	NS	NS	S	S
SEm±	0.03	0.25	1.18	0.83	0.64	-	-	-	0.09	0.08
CD(p=0.05)	**0.08**	**0.76**	**3.59**	**2.52**	**1.94**	-	-	-	**0.26**	**0.24**

Green forage yield

A perusal of table 2 clearly showing that highest green fodder yield (17.26 t ha^{-1}) were recorded with the treatment T_8 (High density fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}).

Although, it showed constant increase in fodder yield with increasing levels of nitrogen, it is produced as additional yield to the main grain and stover yield in high density rows fallowed by alternate row harvest.

Stover yield

A perusal of table 2 clearly showing that highest stover yield (8.89) were recorded with the treatment T_4 (Normal distance + 120 kg ha^{-1} Nitrogen). Although, the treatment T_8 (High density fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}were statistically at par with treatment T_4 (Normal distance + 120 kg ha^{-1} Nitrogen).

Biological yield

A perusal of table 2 clearly showing that highest biological yield (11.81) were recorded with the treatment T_4 (Normal distance + 120 kg ha^{-1} Nitrogen). Although, the treatment T_8 (High density fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}) were statistically at par with treatment T_4 (Normal distance + 120 kg ha^{-1} Nitrogen).

Normal density planting along with 120 kg Nitrogen ha^{-1} recorded highest green fodder yield, stover yield and biological yield.

Since the findings are based on the research done in one season it may be repeated for further confirmation.

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