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Growth and yield of summer Pearlmillet (*Pennisetum glaucum* L.) as influenced by planting density and nitrogen levels

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Abstract
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 = 60 kg ha^{-1}). was laid out in randomized block design with three replications. The result revealed that treatment T_8 (High density planting *fb* alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}) produced significantly the highest plant height at 20 ,40, 60, 80 DAS & Harvest (10.44 cm,31.45 cm,166.10 cm,173.36 cm 175.37 cm), At 40 DAS higher no of tillers plant^{-1} (2.47 no) were recorded with the treatment T_8 (High density fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}) at 40,60,80 DAS and harvest are non-significant, yield atributes show that T_4 Normal density planting along with 120 kg Nitrogen ha^{-1} recorded highest ear head length, grain weight earhead^{-1}, 1000 grain weight, grain yield and harvest index which was at par with T_8 High density planting along with 120 kg Nitrogen ha^{-1} fb alternate row harvest at 45 DAS.

Keywords: Pearlmillet, nitrogen levels, tiller, grain yield, harvest index

Introduction
Pearlmillet [*Pennisetum glaucum* (L.)] is one of the important millet crops of arid and semiarid climatic conditions of the world. It has been estimated that pearlmillet embodies a tremendous productivity potential, particularly in areas having extreme environmental stress conditions on account of drought. Pearlmillet provides staple food for the poor people in relatively short period in dry tracts of the country. 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%). In India, among the food crops it ranks fourth position in area next to rice, wheat and sorghum. Grains are also used as feed for cattle and poultry etc. Green fodder is preserved as hay or silage which has proved extremely useful in dry regions especially during lean periods. India is the largest producer of pearlmillet having 7.45 m ha area with annual production of 9.72 m tonnes and with productivity of 1172 kg ha^{-1}. In Uttar Pradesh, it is grown in an area of 0.09 m ha, with the production of 1.73 m tonnes and productivity of 1914 kg ha^{-1} (MoA & FW 2016-17). Pearl millet hybrids are grown in about 3.0 m ha area (ICRISAT, 2007). However, with regard to production, it follows rice, wheat, sorghum and maize. It is mainly cultivated in Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana in India. Density of planting and optimum level of nitrogen are pre-requisites for attaining higher grain yields. Pearl millet production can be achieved by growing varieties/hybrids with improved tolerance to drought, resistance to diseases and response to higher rates of fertilizer applications. 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. Increase in planting density and seed rate significantly increases the plant height, green and dry matter yield and dry matter contents (Ali *et al.* 2012 and Rana *et al*. 2012) [7, 3]. Rate of nitrogen application with different quantity as per requirement of crop growth stages is utmost important for efficient utilization of nitrogen as well as maximization of crop yield.

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 = 60 kg ha^{-1}).

Plant height (cm): Five plants were selected randomly from each plot and tagged them. The height of these plants were measured from the ground level up to the last leaf of the plant. First observation was taken 20 DAS and subsequent observations were taken at 20 days' interval, *i.e.*, 40, 60, 80 DAS and harvest.

Number of tillers hill^{-1} (no.): The number of tillers per hill were counted at 20, 40, 60, 80 DAS and harvest from each plot.

Length of ear head (cm): Five earheads of pearlmillet were used to measure the length from the basal whorl to the tip of the ear head. The length of earhead was measured in centimeter and mean length was calculated.

Grain weight ear head^{-1} (g): Grains from randomly sampled 5 ear heads were separated, weighed, averaged and expressed as grain weight per ear head.

1000-grain weight (g): A random sample of grains was taken from the produce of the net plot, 1000-grains of pearlmillet were counted and their weight was recorded as test weight

Grain yield (t ha^{-1}): Seed yield from the harvest area (1.0 m^2) were dried in sun, cleaned and weighed separately from each plot for calculating the grain yield in t ha^{-1}.

Harvest index (%): Harvest index was obtained by dividing the economic yield (seeds) by the biological yield (seed + stover). It was calculated for each of the plots and was represented in percentage. The following formula was used (Donald, 1962).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (t ha}^{-1}\text{)}}{\text{Biological yield (t ha}^{-1}\text{)}} \times 100$$

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). The data generated for one season and analysed statistically.

Results and Discussion

Growth Characters

Plant height (cm): At 20, 40, 60, 80 DAS and Harvest was statistically significant with plant height (10.44 cm,31.45 cm,166.10 cm,173.36 cm 175.37 cm respectively) were observed with treatment of T_8 (High density planting fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}). At Harvest, treatments T_4 (Normal distance + 120 kg ha^{-1} Nitrogen) and T_7 (High density fb alternate row harvest at 45 DAS+100 kg nitrogen ha^{-1}) was statistically at par with treatment of T_8 (High density planting fb alternate row harvest at 45 DAS+120 kg ha^{-1} Nitrogen).

Number of tillers (plant^{-1}): At 40 DAS higher no of tillers plant^{-1} (2.47 no) were recorded with the treatment T_8 (High density fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}) however treatments 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).

Grain weight earhead^{-1} (g): The observations of grain weight earhead^{-1} of pearlmillet was statistically analyzed, being shown in table 2 clearly showing that highest grain weight earhead^{-1} (20.03 g) 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}) and T_3 (Normal distance + 100 kg ha^{-1} Nitrogen) were statistically at par with treatment T_4 (Normal distance + 120 kg ha^{-1} Nitrogen).

1000 grain weight (g): The observations of grain weight earhead^{-1} of pearlmillet was statistically analyzed, being shown in table 2 clearly showing that highest grain weight earhead^{-1} (3.28 g) 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}), T_3 (Normal distance + 100 kg ha^{-1} Nitrogen) and T_7 (High density fb alternate row harvest at 45 DAS+100 kg nitrogen ha^{-1}) were statistically at par with treatment T_4 (Normal distance + 120 kg ha^{-1} Nitrogen).

Grain yield (t ha $^{-1}$): The observations of grain yield of pearlmillet was statistically analyzed, being shown in table 2. clearly showing that highest grain yield (2.92) 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}), T_3 (Normal distance + 100 kg ha^{-1} Nitrogen) and T_7 (High density fb alternate row harvest at 45 DAS+100 kg nitrogen ha^{-1}) were statistically at par with treatment T_4 (Normal distance + 120 kg ha^{-1} Nitrogen).

Harvest Index (%): The observations of harvest index of pearlmillet was statistically analyzed, being shown in table 2. clearly showing that highest harvest index (11.81) were recorded with the treatment T_7 (High density fb alternate row harvest at 45 DAS+120 kg nitrogen ha^{-1}). but it was non – significant

Conclusion

The highest plant height was recorded with high density planting along with 120 kg Nitrogen ha^{-1} fb alternate row harvest at 45 DAS, highest tillers were recorded for normal density planting along with 120 kg Nitrogen ha^{-1}. Normal density planting along with 120 kg Nitrogen ha^{-1} recorded highest ear head length, grain weight earhead^{-}1, 1000 grain weight, grain yield and harvest index.

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

Treatments	Plant height (cm)					No of tillers (plant $^{-1}$)			
	20 DAS	40 DAS	60 DAS	80 DAS	Harvest	40 DAS	60 DAS	80 DAS	Harvest
Normal Distance + 60 kg/ha Nitrogen	9.15	27.81	162.17	166.69	168.48	1.87	2.13	2.20	2.27
Normal Distance + 80 kg/ha Nitrogen	9.49	29.02	163.65	167.97	169.63	2.07	2.20	2.27	2.33
Normal Distance+ 100 kg/ha Nitrogen	10.14	29.64	164.49	168.95	170.24	2.33	2.40	2.53	2.60
Normal Distance+ 120 kg/ha Nitrogen	10.44	30.89	165.54	173.34	174.81	2.40	2.67	2.73	2.80
High Density + 60 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	9.37	29.05	163.52	168.99	170.67	2.20	2.20	2.27	2.33
High Density+ 80 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	9.69	29.89	164.25	169.65	170.82	2.27	2.33	2.47	2.53
High Density+ 100 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	10.11	30.83	165.98	171.14	174.32	2.40	2.47	2.53	2.60
High Density+ 120 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	10.43	31.45	166.10	173.36	175.37	2.47	2.53	2.60	2.67
F test	S	S	S	S	S	S	NS	NS	NS
SEm±	0.12	0.48	0.42	1.21	1.49	0.08	0.19	0.17	0.12
CD (p =0.05)	0.38	1.47	1.28	3.68	4.52	0.24	0.58	0.51	0.36

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

Treatments	Ear head length (cm)	Grain weight earhead^{-1} (g)	1000 grain weight (g)	Grain yield (t ha^{-1})	Harvest Index (%)
Normal Distance + 60 kg/ha Nitrogen	26.67	17.80	2.55	2.42	24.71
Normal Distance + 80 kg/ha Nitrogen	27.43	18.70	2.85	2.46	23.62
Normal Distance+ 100 kg/ha Nitrogen	28.29	19.40	3.13	2.67	24.42
Normal Distance+ 120 kg/ha Nitrogen	29.36	20.03	3.28	2.92	24.70
High Density + 60 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	26.06	16.61	2.51	2.36	24.75
High Density+ 80 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	27.57	17.50	2.79	2.46	25.35
High Density+ 100 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	27.95	18.20	3.11	2.65	24.77
High Density+ 120 kg/ha Nitrogen *fb* alternate row harvest at 45 DAS	28.49	18.97	3.15	2.74	23.80
F test	S	S	S	S	NS
SEm±	0.48	0.35	0.08	0.09	1.24
CD (p =0.05)	1.45	1.06	0.24	0.28	3.77

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