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Effect of Plant Population and Fertility on Plant Growth Attributes and Yield Attributing Characters of Transplanted Pearl Millet under Rainfed Condition in Bihar Region

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ABSTRACT: Kharif pearl millet show profuse growth in the favourable situation. So, spacing thereby nutrient requirement need to be figure out for Bihar region. Rainfed pearl millet experiment was plotted at BAU research Farm, Sabour in the year 2019 (*kharif* season) to study performance of plant population and fertility level on growth and yield attributes of transplanted pearl millet in split plot and replicated thrice with three main plot treatments viz. M_1-45 cm × 20 cm, M_2-50 cm × 20 cm and M_3-50 cm × 25 cm and three sub plot treatments viz. S_1- $N_{90}P_{45}K_{45}$ kg ha^{-1}, S_2- $N_{120}P_{60}K_{60}$ kg ha^{-1} and S_3-$N_{150}P_{75}K_{75}$ kg ha^{-1}. Nitrogen applied in three splits, one third at basal along with full dose of phosphorous and potassium and rest of N in two equal splits each at knee high and initiation of panicle respectively. The result revealed that among plant population levels, 45 cm × 20 cm (M_1) had significantly higher tillers/hill and plant dry matter. And, among fertility levels, $N_{150}P_{75}K_{75}$ kg ha^{-1} (S_3) produced significantly higher number of tillers hill^{-1}, plant height and dry matter accumulation. Plant population level 45 cm × 20 cm (M_1) recorded significantly higher number of ear m^{-2} (17.32), ear weight (54.38 g), grain yield (35.86 q ha^{-1}) which was on par with 50 cm × 20 cm while and among fertility levels, $N_{150}P_{75}K_{75}$ kg ha^{-1} (S_3) resulted significantly higher number of ear m^{-2} (17.55), ear weight (54.27 g) and ear length (26.31 cm) and it was at par with S_2.

Keywords: Fertility, pearl millet, Bihar region, growth attributes, yield attributing characters, Proagro 9450.

INTRODUCTION

Pearl millet are among the neglected cereal coarse crops, which grown in commonly grown in dry land regions and rainfed conditions. Generally, crops grown for fodder as well as grain, rural poor community used in their food but due to nutritional excellency like minerals and amino acid, its grain reach to higher society urban population and among health concusses because it is helpful for disease like diabetics, cardiac disease, stomach ulcers, neural degenerative disease like Parkinson's disease and metabolic syndrome (Chandrasekara and Shahidi, 2011). The remedy of malnutrition lies in the process of biofortification which seems to be economical and sustainable way of increasing the availability of essential minerals (Lal *et. al*, 2020a).

World's largest millet producing country is India (annual production of 8.61 mt) and Rajasthan, largest producer among states. In India, bajra is cultivated with productivity of 1243 kg ha^{-1} in 2019-20 (Project Coordinator Review 2020). Some parts of Bihar like Buxer and Ara region where this millet production done under rainfed condition. Otherwise, Bihar is among the states which grow least of this crop.A large difference remains between both dry and green fodder demand and supply (Lal *et al*., 2020b). Pearl millet can fulfil this need.

Fast growing short duration pearl millet crop need to uptake more nutrient from the soil and follow increasing pattern with increase of inorganic fertilizer (Arshewar *et al.*, 2018; Joshi *et al.*, 2018). Adequate nutrient cause better growth of parameters which are responsible for performance of the by accumulation of photosynthates. Pearl millet is very exhaustive crop which require higher dose of nitrogen and has demonstrated varied growth and production response with N application (Gascho *et al.*, 1995). Many researches published which indicate increase in nitrogen fertilizer, increased production efficiency (Singh *et al*., 2010). The optimum population and adequate nutrient availability are essential for good growth of the crop optimum plant population attributed to maintain intra-species competition which aids in proper utilization of space, light, nutrition and moisture. Wider plant spacing would not be beneficial for pearl millet cultivation due to higher amount of unutilized nutrient was remain in the soil. Generally, under optimum spacing root system zone will always be

maximum, hence uptake maximum. So, keeping these points, this study has been proposed to determine an appropriate optimal population and nutrition level for improved characteristics of growth and productivity.

METHOD AND MATERIALS

The conducted during kharif 2019 at Agricultural Research Farm, Bihar Agricultural University, Sabour. During crop season, the cumulative rainfall was recorded 460.3 mm with the average maximum and minimum temperature were 31.79°C and 22.86°C respectively. The plan of layout of experiment was arranged in split plot and replicated thrice. For main plot, spacing (45 cm × 20 cm (M_1), 50 cm × 20 cm (M_2) and 50 cm × 25 cm (M_3)) and three sub-plot fertility levels (S_1- $N_{90}P_{45}K_{45}$ kg ha^{-1}, S_2- $N_{120}P_{60}K_{60}$ kg ha^{-1} and S_3- $N_{150}P_{75}K_{75}$ kg ha^{-1}) were taken into consideration. Fertilizer applied at basal (1/3rd N, full dose of phosphorous (DAP) and potassium (MOP)) and remaining nitrogen was applied in two equal splits (top dressing of nitrogen by urea) each at knee high stage and panicle initiation stage respectively.

The experimental plot was prepared by discing of the land for incorporation of finger millet left over field and cross ploughing with cultivator followed by planking in order to pulverize the soil. Transplanting was done at first mid fortnight of August with 20 days old seedlings of Proagro 9450 variety. Field data of growth attributes was collected at 30, 60 DAT and at harvest whereas yield attributes was taken at harvesting stage. The data were analysed statistically by applying (ANOVA) technique at P=0.05.

RESULT AND DISCUSSION

A. Growth Parameter

(i) Plant height: The analysed data of height of pearl millet represent in Table 1. Pearl millet enhanced its growth after 30 DAT up to harvest, the crop growth rate was higher from 30 DAT to 60 DAT but growth rate was declined latter on. In case of plant height with respect to different plant population, there was no significant difference found. While, Plant height influence significantly by fertilizer application of N, P and K. Fertility level S_3 ($N_{150}P_{75}K_{75}$ kg ha^{-1}) at 30, 60 DAT and at harvest recorded maximum plant height (91.63 cm, 210.83 cm and 236.14 cm) which was statistically higher than fertility level S_1($N_{90}P_{45}K_{45}$ kg ha^{-1}). Higher plant height due to increase in fertilizer application and greater root encroachment area increases nutrient availability to the plant that enhances meristematic cell division, helps in cell elongation which aids in good height. Similar results were reported by Jain and Dahama (2005); Chandana *et al*., (2018); Reddy *et al*., (2021).

Table 1: Effect of plant population and fertility levels on plant height (cm) of pearl millet.

Treatments	30 DAT (cm)	60 DAT (cm)	At harvest (cm)
Plant population			
M_1 (45 cm × 20 cm)	88.42	202.57	234.07
M_2 (50 cm × 20 cm)	87.81	201.83	231.24
M_3 (50 cm × 25 cm)	87.42	200.82	230.02
SEm±	0.31	0.40	0.83
CD (P=0.05)	NS	NS	NS
Fertility level (kg N: P_2O_5: K_2O ha^{-1})			
S_1 ($N_{90}P_{45}K_{45}$)	85.04	192.68	227.46
S_2 ($N_{120}P_{60}K_{60}$)	86.97	201.71	231.73
S_3 ($N_{150}P_{75}K_{75}$)	91.63	210.83	236.14
SEm ±	0.27	0.58	0.53
CD (P=0.05)	0.82	1.78	1.63
Interaction M × S	NS	NS	NS

(ii) Dry matter accumulation (g m^{-2}): Screening of data (Table 2) revealed that, at 30, 60 DAT and at harvest, M_1 (45 × 20 cm) pearl millet accumulated significantly higher dry matter (248.28 g m^{-2} ,954.32 g m^{-2} and 1238.86 g m^{-2}) than M_3(50 cm × 25 cm). Fertility level S_3 ($N_{150}P_{75}K_{75}$ kg ha^{-1}) gave significantly higher dry matter accumulation (235.10 g m^{-2}, 872.68 g m^{-2} and 1177.30 g m^{-2}) at 30, 60 DAT and at harvest over S_1. The interaction effect of plant population and fertility level on dry matter accommodation (g m^{-2}) was found to be non-significant at 30 DAT and 60 DAT. But it was significant at harvest, as represent in Table 3.

Table 2: Effect of plant population and fertility levels on dry matter accumulation (g m^{-2}) of pearl millet.

Treatments	30 DAT (g m^{-2})	60 DAT (g m^{-2})	At harvest (g m^{-2})
Plant population			
M_1 (45 cm × 20 cm)	248.28	954.32	1238.86
M_2 (50 cm × 20 cm)	219.41	847.80	1142.81
M_3 (50 cm × 25 cm)	197.36	749.21	1042.48
SEm±	1.29	2.61	3.62
CD (P=0.05)	5.08	10.25	14.20
Fertility level (kg N: P_2O_5: K_2O ha^{-1})			
S_1 ($N_{90}P_{45}K_{45}$)	210.78	825.68	1098.39
S_2 ($N_{120}P_{60}K_{60}$)	219.17	852.98	1148.46
S_3 ($N_{150}P_{75}K_{75}$)	235.10	872.68	1177.30
SEm ±	2.24	2.37	4.75
CD (P=0.05)	6.91	7.31	14.63
Interaction M x S	NS	NS	S

Significantly higher crop dry matter was noticed with treatment M_1S_3 (45 cm × 20 cm and $N_{150}P_{75}K_{75}$ kg ha^{-1}) i.e. 1281.43 g m^{-2} and it was superior over other treatments at harvest. This is because of the fact that increase in fertilizer application and less unutilized area increases nitrogen availability to the plant that enhances meristematic cell division, helps in cell elongation which aids in good dry matter accumulation of the crop. Similar results were reported by Jat and Shaktawat (2003); Jain and Dahama (2005); Chandana *et al*., (2018).

(iii) Number of tillers hill $^{-1}$: M_1 produced significantly higher tillers/hill at 30 DAT (6.70) and at harvest (4.00) and it was at par with M_2, although, there was no significant difference at 60 DAT. At all recoded stages, the number of tillers/hill was notably influenced by fertility level. Fertility level S_3 ($N_{150}P_{75}K_{75}$ kg ha^{-1}) recorded statistically higher tillers/hill at all the crop growth stages i.e. at 30 DAT (6.83), 60 DAT (6.41) and harvest (4.16) and it was at par with S_2 ($N_{120}P_{60}K_{60}$ kg ha^{-1}) at 30 DAT and 60 DAT but superior over S_1 ($N_{90}P_{45}K_{45}$ kg ha^{-1}) at all growth stages. The interaction effect of plant population and fertility level on tillers $hill^{-1}$ was non-significant. The increase in number of tillers $plant^{-1}$ with increase fertilizer and optimum plant geometry which increase nitrogen uptake in cytokinin production, increasing the cell division and growth leading to higher tillers $plant^{-1}$. Midha *et al*., (2015); Meena and Jain (2013) noticed related results.

Table 3: Interaction effect of plant population and fertility levels on dry matter accumulation (g/m^2) at harvest.

Treatments	S_1 ($N_{90}P_{45}K_{45}$) (g m^{-2})	S_2 ($N_{120}P_{60}K_{60}$) (g m^{-2})	S_3 ($N_{150}P_{75}K_{75}$) (g m^{-2})	Mean (g m^{-2})
M_1 (45 cm × 20 cm)	1183.73	1251.40	1281.43	1238.86
M_2 (50 cm × 20 cm)	1119.57	1144.50	1164.37	1142.81
M_3 (50 cm × 25 cm)	991.87	1049.47	1086.10	1042.48
Mean (g m^{-2})	1098.39	1148.46	1177.30	
	M x S			
SEm (±)	7.63			
C.D at 5%	23.50			

Table 4: Effect of plant population and fertility levels on tillers $hill^{-1}$ of pearl millet.

Treatments	30 DAT (tillers$hill^{-1}$)	60 DAT (tillers$hill^{-1}$)	At harvest (tillers$hill^{-1}$)
Plant population			
M_1 (45 cm × 20 cm)	6.70	6.24	4.00
M_2 (50 cm × 20 cm)	6.63	6.08	3.81
M_3 (50 cm × 25 cm)	6.42	5.98	3.57
SEm±	0.03	0.13	0.08
CD (P=0.05)	0.13	NS	0.30
Fertility level (kg N: P_2O_5: K_2O ha^{-1})			
S_1 ($N_{90}P_{45}K_{45}$)	6.26	5.73	3.48
S_2 ($N_{120}P_{60}K_{60}$)	6.66	6.16	3.74
S_3 ($N_{150}P_{75}K_{75}$)	6.83	6.41	4.16
SEm ±	0.06	0.14	0.13
CD (P=0.05)	0.18	0.42	0.40
Interaction M × S	NS	NS	NS

(iv) Yield attributes and yield: Yield attributing characters (Table 5) were significantly higher under S_3 ($N_{150}P_{75}K_{75}$ kg ha^{-1}) although, ear weight, grain yield and stover yield under S_3 ($N_{150}P_{75}K_{75}$ kg ha^{-1}) were closely on par with S_2 ($N_{120}P_{60}K_{60}$ kg ha^{-1}). However, the data of test weight of pearl millet crop had not noticeably changed. Plant population and fertility level on yield attributing characters didn't shown interaction effect.

Table 5: Effect of plant population and fertility levels on number of ears m^{-2}, ear length, ear weight and test weight of pearl millet.

Treatments	No. of ears (ears m^{-2})	Ear length (cm)	Ear weight (g)	Test weight (g)
Plant population				
M_1 (45 cm × 20 cm)	17.32	25.72	54.38	11.36
M_2 (50 cm × 20 cm)	16.84	25.68	54.02	10.91
M_3 (50 cm × 25 cm)	16.06	25.46	50.12	10.17
SEm±	0.20	0.06	1.08	0.33
CD (P=0.05)	0.79	NS	4.32	NS
Fertility level (kg N: P_2O_5: K_2O ha^{-1})				
S_1 ($N_{90}P_{45}K_{45}$)	15.81	24.26	50.67	10.31
S_2 ($N_{120}P_{60}K_{60}$)	16.87	25.29	52.32	10.82
S_3 ($N_{150}P_{75}K_{75}$)	17.55	26.31	54.27	11.43
SEm ±	0.14	0.07	1.08	0.38
CD (P=0.05)	0.43	0.22	3.34	NS
Interaction M × S	NS	NS	NS	NS

Good growth of the crop attributed good yield attributing characters of the crop due to effective utilization and absorption of nutrients through extensive root system developed by the crop with application of adequate nutrient supply through inorganic fertilization. Similar results were reported by Jat and Shaktawat (2003); Chandana *et al*., (2018); Kakarla *et al*., (2021). Optimum plant population has least intra-species competition which aids in proper utilization of space, light, nutrition and moisture leads to higher nutrient uptake and translocation to sink from source. Whereas, Wider plant spacing would not be beneficial for pearl millet cultivation due to higher amount of unutilized nutrient was remain in the soil increase the availability and absorption of nutrients from the soil which boot metabolic activity, translocation and synthesis of nutrients resulted in higher yield attributing characters. Similar result was reported by Kumari *et al*., (2017); Singh *et al*., (2017).

CONCLUSION

It could be concluded that plant population and fertility levels had constructive outcome in all growth parameters and yield attributes of pearl millet crop. Based on this research, it can be concluded that spacing of 50 cm × 25 cm among all plant population levels and $N_{150}P_{75}K_{75}$ kg ha^{-1} among other fertility levels was maximum in respect of growth parameter as well as yield attributes. However, to stand up with a specific conclusion and recommendation, experiment need to be re-conducted over different agro-climatic zones of Bihar.

FUTURE SCOPE

Pearl millet growth mainly depends upon suitable weather condition, if crop sown in kharif. But sometimes crop can be affected much by water logging situation. So, future research needs to conducted to avoid these problems.

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Conflict of interest. Nil.

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