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Influence of fertility level, plant population and age of seedling on quality growth parameter of kharif transplanted pearl millet (*Pennisetum glaucum* L.)

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Abstract
A field experiment was conducted during *kharif* session 2018 at Research Farm, Bihar Agricultural University, Sabour, Bhagalpur to find out the influence of fertility level, plant population and age of seedling on growth parameter of kharif transplanted pearl millet. The experiment was laid out in a Factorial Randomized Block Design (FRBD) with three replications and twelve treatment combinations, comprising three levels of fertilizer along with four combinations of spacing and age of seedling. Result shows that application of treatment F_3 (150:75:75 kg NPK ha^{-1}) was recorded significantly higher no of leaf (20.69), Plant height (236.92 cm), Tillers $plant^{-1}$ (4.21) and Dry matter accumulation (1235.67 g m^{-2}) at harvest but days to 50 percent flowering higher in $N_{90}P_{45}K_{45}$ fertility level and which was statistically at par with F_2 at all the growth stages. Among the plant population and age of seedling number of leaf (20.64), plant height (238.56), Dry matter accumulation (1260.58) and Tillers $plant^{-1}$(4.21) significantly higher in treatment T_2, T_3, T_2, T_3 respectively. Among the levels of plant population and age of seedling, T_3 treatment had significantly higher grain yield (3.95 t ha^{-1}), net return (Rs.71788/ha) and B: C ratio (3.19) but being statistically similar with T_1 treatment.

Keywords: Indian mustard, path coefficient analysis

Introduction

Pearl millet is grown as stable cereal on an estimated area of 25-36.9 million hectares. Millets are important crops in the semiarid tropics of Asia and Africa (especially in India, Mali, Nigeria, and Niger), with 97% of millet production in developing countries (Donough *et al.*, 2000) [9]. The crop is favoured due to its productivity and short growing season under dry, high-temperature conditions. India is the world's largest producer of millet, with eight African countries and China making up the rest of the top ten producers (Adam Scott, 2015) [2]. It is nutritionally better than many cereals, as it is a good source of protein (11.6%), minerals particularly, iron (8.8%) and also fat (5%).Besides being a potent source of food for human beings, it is enormously used for feeding the cattle and the poultry birds. Pearl millet is a quick growing, drought tolerant and dual-purpose crop i.e., high yielding and nutritious crop, used by amassed and excellent succulent fodder when harvested before the formation of grains. Efficient fertilizer management plays an important role in increasing the crop yield through efficient utilization of limited moisture. Nitrogen is closely associated with vegetative growth, development and plant metabolism. Though nitrogen and phosphorus management of pearl millet cultivars has been studied by various researchers (Kumar *et al*. 2003; Sewhag *et al.*, 2003, Parihar *et al*. 2005; Singh *et al.*, 2006) [5, 11, 9, 12]. Optimum plant population increases vegetative growth and maximum yield of crop. With the advancement of the technology some pearl millet hybrids have been developed which are more fertilizer responsive (Parihar, 2005) [9], responds well to good management (Kumar *et al*. 2003) [5] and require optimum plant density for realizing its potential yield. Very few works have been reported in this regard. On the other hand, plant population is one of the important factors for higher production which determines the optimum plant density of a crop. An optimum plant stand enhances the efficiency of pearl millet by exploiting growth factors in an effective manner, which ultimately influences yield attributes and yield of the crop.
Therefore, the present study was conducted to investigate the effect of fertility, plant population and age of seedling of transplanted pearl millet.

Materials and Methods

The experiment was carried out during *kharif* season of 2018 at crop research Farm, Bihar Agricultural university, Sabour, Bhagalpur, which was located at located south of river Ganges. Its geographical location comes under Agro-climatic Zone III A of Bihar and Middle Gangetic plain region of India. The latitude, longitude and altitude of this place are 25° 23' N, 78° 07' E and 37.19 meters above the mean sea level, respectively. The soil of experimental field was sandy loam in texture, slightly alkaline in pH (7.6), low in availability of nitrogen (218.90 kg ha^{-1}), medium in available phosphorous and medium in availability of potash.The experiment was laid out in a Factorial Randomized Block design (FRBD) with three replications and twelve treatment combinations, comprising three levels of fertilizer F_1(90: 45: 45 kg N P K ha^{-1}), F_2(120: 60: 60 kg N P K ha^{-1}), F_3(150: 75: 75 kg N P K ha^{-1}) and integrations of plant population and age of seedling T_1(15 Days old Seedling at 50 x 20 cm), T_2 (15 Days old Seedling at 50 cm x 25 cm), T_3 (20 Days old Seedling at 50 x 20 cm) and T_4(20 Days old Seedling at 50 x 25 cm). The nitrogen application was done in three splits.

Application of 1/3rd of N through Urea, full dose of P_2O_5 through di-ammonium phosphorus and K_2O through MOP were applied as a basal and remaining 1/3rd N knee high stage and 1/3rd N at panicle initiation stage respectively. Data has been taken from the field at 30, 60 DAS (days after sowing) and at harvest of pearl millet.

Randomly five plants were selected with the help of Fisher's table from net area of each plot and were marked for recording detailed observations as well as for studying all the plant characters. The height of plant was measured in centimetre by scale from ground level to the tip of flag leaf. Height was measured at three stages 30 DAT, 60 DAT and harvest. The leaves of five selected plant from each plot were counted carefully and averaged to obtain the number of leaves $plant^{-1}$. Plant along with tillers were removed from an area of half meter linear length in sample rows from each treatment at 30, 60DAT and at harvest for recording drymatter accumulation. The samples were shade dried for two days and later dried in hot air oven at 60 ± 5 ºC till constant weights were obtained and dry weights were presented as g m^{-2}.The tillers of five selected plant from each plot were counted carefully and averaged to obtain the number of tillers $plant^{-1}$.This was taken by counting of the number of days from planting to when half (50%) the plants in a plot reached 50% stigma emergence. Yield and yield attributes were studied before and after harvesting as per investigation required. Crop was harvested when grains are hard enough with nearly 15-20 per cent moisture and plants showed physiological maturity. Harvesting was done by removing ear heads first and cutting down the plant later from each plot separately. The ear heads after harvesting were sun dried at the threshing floor. Threshing was done thereafter by beating ear heads with sticks. The threshed grains were dried in sun to bring the moisture content to 12-14 per cent and then final weights were recorded. The net returns and benefit: cost ratio of different treatments were worked out on the basis of prevailing market prices. To test the significance, experimental data collected on various aspects of investigation on pearlmillet were statistically analysed with procedure described by Cochran and Cox (1967).

Result and Discussion

Effect of fertility levels

Growth parameter was recorded periodically at an interval of 30 days, starting from 30 days after transplanting up to harvest stage. The data on growth parameter influenced by various treatments are presented in Table 1. All the growth parameter significantly affected by the different treatment of seedling age and plant population at all growth stages.

Number of leaves $plant^{-1}$ was significantly influenced by the fertility level at all the stages of crop growth. At 30 DAT, 60 DAT and at harvest, fertility level F_3 (N150P75K75 kg ha^{-1}) recorded higher no. of leaves $plant^{-1}$i.e., 32.84, 41.37 and 20.69 cm, respectively, which were statistically at par with F2 (N120P60K60 kg ha^{-1}) but superior over F_1 (N90P45K45 kg ha^{-1}). Plant height at 30, 60 and at harvest. At 30 DAT maximum plant height (88.21 cm) was recorded with fertility level F3 (N150P75K75 kg ha^{-1}) which was statistically at par with F2 (N120P60K60 kg ha^{-1}) whereas, shortest growth stature (83.01 cm) was found with fertility level F1. At 60 DAT significantly higher plant height (212.32 cm) was recorded with F_3 which was statistically at par with F_2 and the lowest plant height (197.87 cm) recorded with F_1. At harvest, maximum plant height (236.92 cm) was recorded with F_3, which was superior over F_1 but statistically at par with F_2. The higher value of plant height was recorded with 20 days old seedling. It might be due to poor root development and survival with early transplanted seedlings (15 days old). The findings of Kumari *et al*. 2017 [7] and Singh *et al*. 2017 [13] are closely related to this.

The number of tillers $plant^{-1}$was significantly influenced by fertility level at all crop growth stage of pearl millet. Fertility level F3 (N150P75K75 kg ha^{-1}) gave higher number of tillers $plant^{-1}$at all the crop growth stages i.e. at 30 DAT (7.09), 60 DAT (6.79) and harvest (4.21) which was statistically at par with F_2 (N120P60K60 kg ha^{-1}) but superior over F_1 (N90P45K45 kg ha^{-1}).

Dry matter accumulation at various growth stages of pearl millet was highly influenced by different fertility level. Fertility level F3 (N150P75K75 kg ha^{-1}) gave significantly higher dry matter accumulation (272.42 g m^{-2}) after 30 days of transplanting which was superior over F2 and F1. However, at 60 DAT and at harvest it was noticed that higher dry matter accumulation 923.79 g m^{-2} and 1235.67 g m^{-2}, respectively were recorded with fertility level F3 (N150P75K75 kg ha^{-1}) which remains at par with F_2 (N120P60K60 kg ha^{-1}) but superior over F1 (816.09 g m^{-2} and 1094.19 g m^{-2}). Thakur *et al*. 2018 reported that The optimistic result of increasing fertilizer doses on plant height of transplanted pearl millet may be explained as nitrogen required for the formation of chlorophyll and phosphorus for the synthesis of nucleic acids.

Days to 5% flowering influenced by different treatments are presented in Table. 1. Days to 50% flowering was not significantly influenced by fertility level.

Fertility levels and plant population and age of seedling significantly affected the gross return as well as net return. The highest gross return (₹ 94149.34) and net return (₹ 70345.05) were recorded with F3 which was found statistically at par with F_2 (₹ 91391.17 and ₹ 68939.15 respectively). The lowest value gross return (₹ 86012.25) and net return (₹ 64793.00) were recorded with F_1. However, the fertility level failed to exert significant influence on B: C ratio.

Effect of plant population and Age of seedling

Number of leaves plant^{-1}significantly affected by plant population and age of seedling of transplanted pearl millet. At 30 DAT, 60 DAT and at harvest, T_2 (15 days old seedling at 50 cm x 25 cm) recorded maximum no. of leaves plant-1 33.21, 41.73 and 20.64, respectively, which were statistically at par with T_4 (20 days old seedling at 50 cm x 25 cm) but superior over T_1 and T_4 at all the growth stages.

Plant height was also influenced by combination of plant population and age of seedling at 60 DAT and at harvest. The maximum plant height (213.91 cm) was recorded with T_3 (20 days old seedling at 50 cm x 20 cm) which was statistically at par with T1 (205.31 cm) i.e.15 days old seedling at 50 cm x 20 cm and T_4 (204.52 cm) i.e. 20 days seedling at 50 cm x 25 cm at 60 DAT and at harvest maximum plants height (238.56) was recorded with T_3 (20 days old seedling at 50 cm x 20 cm) which 33 was statistically at par with T_1 (15 days old seedling at 50 cm x 20 cm) but it was at par with T_1 (234.44 cm) only. Treatments failed to exert significant effect on plant height at 30 DAT. This might be due to optimum plant population attributed to maintain intra-species competition which might help in proper utilization of natural resources i.e. space, light, moisture, nutrient uptake and translocation which ultimately linked with the plant growth and development in terms of plant height, number of tillers plant^{-1}, dry matter accumulation (g m^{-2}).

Tillers plant^{-1} Treatment T_2 produced significantly higher number of tillers plant^{-1}at all the growth stages i.e. at 30 DAT (7.03), 60 DAT (6.72) and harvest (4.07) which was statistically at par with T_4, T_3 at 30 DAT, T_1 & T_4 at 60 DAT and T_4 at harvest.

Dry matter matter accumulation significantly affected by Combination of plant population and age of seedling. At 30 DAT maximum dry matter accumulation (270.14 g m $^{-2}$) with T_1 (15 days old seedling at 50 cm x 20 cm) which was statistically at par with T_3 (20 days old seedling at 50 cm x 20 cm) but superior over T_2 and T_4. At 60 DAT and at harvest significantly higher dry matter accumulation recorded with treatment T_3 (20 days old seedling at 50 cm x 20 cm) i.e. 949.96 and 1260.58 g m-^{2}, respectively which was statistically at par with T_1 (20 days old seedling at 50 cm x 25 cm) but superior over T_2 and T_4. The interaction effect due to fertility level, plant population and age of seedling on dry matter accommodation (g m^{-2}) was found to be non-significant during experiment. The treatment T3 was recorded significantly higher grain yield (3.95 t ha-1) (Table 2) and remained at par with T1 due to closure plant spacing occupied maximum number of plant than wider spacing

Economics

Plant population and age of seedling also significantly affected net return and B: C ratio Table 2. The highest net return (₹ 71788.00) and B: C ratio (3.19) was recorded with T_3 which found statistically at par with T_1 but it was found superior over T_4 and T_2

Table 1: Effect of fertility, plant population and age of seedling on no. of leaves plant^{-1}, plant height, tiller plant^{-1}, dry matter accumulation (gm^{-2}) and days to 50% flowering of pearl millet

Treatment	No. of leaves plant^{-1}			Plant height (cm)			Tillers plant^{-1}			Dry matter accumulation (g m^{-2})			Days to 50% flowering
	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest	
Fertility level (kg N: P_2O_5: K_2O ha^{-1})													
F_1 ($N_{90}P_{45}K_{45}$)	25.77	32.47	16.24	83.01	197.87	221.92	6.13	5.85	3.53	219.44	816.09	1094.19	50.58
F_2 ($N_{120}P_{60}K_{60}$)	29.72	37.63	18.80	88.21	206.68	232.83	6.76	6.30	3.93	249.87	893.39	1207.02	50.25
F_3 ($N_{150}P_{75}K_{75}$)	32.84	41.37	20.69	91.36	212.32	236.92	7.09	6.79	4.21	272.42	923.79	1235.67	49.50
S.Em±	1.10	1.44	0.69	1.62	2.90	3.63	0.17	0.14	0.07	7.37	15.48	17.61	0.65
CD (P=0.05)	3.23	4.23	2.02	4.75	8.50	10.64	0.49	0.42	0.21	21.60	45.39	51.63	NS
Plant population and seedling age													
T_1 (15 DOS at 50 cm x 20 cm)	28.20	35.53	17.77	86.93	205.31	234.44	6.38	6.26	3.80	270.14	930.79	1224.23	50.22
T_2 (15 DOS at 50 cm x 25 cm)	33.21	41.73	20.64	87.19	198.75	220.89	7.03	6.72	4.07	238.30	826.84	1121.61	48.89
T_3 (20 DOS at 50 cm x 20 cm)	26.40	33.27	16.63	87.89	213.91	238.56	6.54	5.98	3.73	268.52	949.96	1260.58	51.00
T_4 (20 DOS at 50 cm x 25 cm)	29.95	38.10	19.26	88.10	204.52	228.33	6.69	6.29	3.96	212.00	784.44	1109.42	50.33
S.Em ±	1.27	1.67	0.80	1.87	3.35	4.19	0.19	0.16	0.08	8.51	17.87	20.33	0.75
CD (P=0.05)	3.73	4.89	2.34	NS	9.82	12.28	0.57	0.48	0.25	24.95	52.41	59.62	NS
Interaction F x T	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of fertility, plant population and age of seedling on grain yield (t/ha), net return (Rs), B: C ratio of pearl millet

Treatment	Grain yield (t/ha)	Net return (Rs.)	B:C Ratio
Fertility level (kg N: P_2O_5: K_2O ha^{-1})			
F_1 ($N_{90}P_{45}K_{45}$)	3.57	64793.00	3.05
F_2 ($N_{120}P_{60}K_{60}$)	3.84	68939.15	3.07
F_3 ($N_{150}P_{75}K_{75}$)	3.95	70345.05	2.96
CD (P=0.05)	0.21	4004.52	NS
Plant population and seedling age			
T_1 (15 DOS at 50cm x 20cm)	3.85	69795.82	3.10
T_2 (15 DOS at 50cm x 25cm)	3.62	64196.15	2.86
T_3 (20 DOS at 50cm x 20cm)	3.95	71788.00	3.19
T_4 (20 DOS at 50cm x 25cm)	3.73	66322.96	2.96
CD (P=0.05)	0.24	4624.03	0.21
Interaction F x T	NS	NS	NS

Conclusion

It might be attributed to transplanting of pearl millet at optimum spacing of 50 cm x 25 cm with 20 days old seedlings that had ability to establish quickly by absorbing root injury shocks and promoting development of seminal roots as well as favouring proper utilization of natural resources (Singh *et al.*, 2003; Singh *et al.*, 2017) [5, 13].

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