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Studies on effect of suitable planting pattern and fertilizer grade on growth and yield parameters of pearl millet

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Abstract
A field experiment was conducted during *kharif* 2019-20 at College of Agriculture, Latur to find out the effect of suitable planting pattern and fertilizer grade on growth and yield parameters of Pearl millet (*Pennisetum glaucum* L.). The experiment was laid out in Factorial Randomized Block Design with two factor combinations i.e. planting patterns and fertilizer grades, consisting three levels each of factors. The results revealed that, the paired row planting with furrow 30/60 cm x 15 cm recorded significantly higher plant height (153.98 cm), number of functional leaves plant^{-1} (24.39), leaf area plant^{-1} (35.26 dm^{2}), stem girth (6.09 cm), dry matter accumulation plant^{-1} (93.27 g) and number of ear heads plant^{-1} (1.42). Application of 80:40:40 kg NPK ha^{-1} recorded significantly higher plant height (151.53 cm), number of functional leaves plant^{-1} (28.09), leaf area plant^{-1} (37.49 dm^{-2}), stem girth (6.01), dry matter accumulation plant^{-1} (91.97 g) and number of ear heads plant^{-1} (1.44). In case of yield attributes, the paired row planting with furrow 30/60 cm x 15 cm recorded significantly higher length of ear head (23.93 cm), breadth of ear head (11.01 cm), weight of ear head (42.21 g), grain yield plant^{-1} (28.03 g), grain yield (2324 kg ha^{-1}) and test weight (13.49 g). While, application of 80:40:40 kg NPK ha^{-1} recorded significantly higher length of ear head (24.03 cm), breadth of ear head (11.12 cm), weight of ear head (41.48 g), grain yield plant^{1} (27.90 g), grain yield (2255 kg ha^{-1}) and test weight (13.46 g).

Keywords: Pearl millet, growth parameters, yield parameters, planting pattern, fertilizer grade.

Introduction
Pearl millet is erect annual quick growing short duration crop. It can be grown in a wide range of ecological condition. Its propensity for high dry matter production at high temperature has made a mark in tropics and subtropics. The contribution of pearl millet in total food grain production is 10.7 per cent. Pearl millet is an annual tillering diploid (2n=14), belongs to family *gramineae* and subfamily *peniceidae*. The origin of pearl millet is Africa where the greatest diversity of morphological types exists.

In India, area under pearl millet cultivation is about 6.93 million hectares, production of 8.61 million tonnes with productivity of 1243 kg/ha (Anonymous, 2017-18) [1]. The higher production of pearl millet is recorded in Rajasthan, Maharashtra, Gujarat, Punjab, Haryana and Uttar Pradesh state in India where, it is grown both in *kharif* and summer seasons. In Maharashtra, pearl millet occupies an area of 0.50 million hectares producing 0.31 million tonnes with productivity of 623 kg/ha (Anonymous, 2017-18) [1].

Poor soil fertility and erratic rains are the most important limitations that affect crop production in arid and semi-arid region. Among the different nutrients, particularly nitrogen (N) and phosphorus (P) plays a vital role in increasing production and productivity of pearl millet. Nitrogen is responsible to increase the utilization of phosphorus and potassium. Nitrogen is most commonly deficient nutrient in Indian soil and gives considerable response in pearl millet crop.

Phosphorous is a major nutrient required by pearl millet which positively stimulate the root development, increase stalk and stem strength, it improve the flower formation and grain production. It also increases the growth attributes, length and width of panicle, test weight, number of grain panicle^{-1}, grain weight panicle^{-1} and finally improve the yield. Potassium is major nutrient required by pearl millet and which play important role in growth and development.

Plant spacing plays a vital role which significantly affects growth, development and yield of pearl millet. Optimum plant density ensures that plants grow properly with their aerial and underground parts by utilizing more sunlight and soil nutrients (*Miah et al.*, 1990) [7].

Closer spacing cause difficulties in intercultural operations in a densely populated crop, the inter-plant competition for nutrients, air and light is very high, which usually results in mutual shading, lodging and thus favours more straw yield than grain yield (*Bhowmik et al.*,2012) [2]. Plant density is a management variable that affects the production and quality of most crops (*Shaw et al*., 2008) [12]. Though optimal plant densities for pearl millet production differ among geographic regions. Crop potential yield may also be affected by intra-row spacing (Jones and Johnson, 1991) [4].

Keeping this view, there is a need to improve yields of pearl millet by refining the existing agronomic practices. Hence, the present study was carried out to study the effect of suitable planting pattern and fertilizer grade on growth and yield parameters of Pearl millet.

Materials and methods

A field experiment was conducted during *kharif* 2019-20 at Experimental Farm, College of Agriculture, Latur to study the effect of suitable planting pattern and fertilizer grade on growth and yield parameters of Pearl millet (*Pennisetum glaucum* L.) The experiment was laid out in Factorial Randomized Block Design with two factor combinations i.e. planting patterns and fertilizer grades, consisting three levels each of factors. The planting pattern were (P_1) planting at 45 cm x 15 cm, (P_2) paired row planting 30/60 cm x 15 cm and (P_3) paired row planting with furrow 30/60 cm x 15 cm, whereas fertilizer grades were (F_1) 40:20:20 kg NPK ha^{-1}, (F_2) 60:30:30 kg NPK ha^{-1} and (F_3) 80:40:40 kg NPK ha^{-1}. the soil of experimental plot was clayey in texture with chemical composition such as low in available nitrogen (125.9 kg ha^{-1}), medium in available phosphorous (17.8 kg ha^{-1}) and very high in available potassium (489.84 kg ha^{-1}). The soil was moderately alkaline in reaction having P^H (7.7). A popular pearl millet in the region, 86R32, which is light brown to grayish in colour released by Rising Sun Seeds Private Limited, Nagpur, Maharashtra, was used in the present study. Sowing of pearl millet was done on 02nd August 2019 after receiving sufficient rainfall by dibbling method. As per treatments, half dose of nitrogenous fertilizers and full dose of phosphatic and potassic fertilizers was applied to the respective plots one day before sowing and remaining half dose of nitrogen fertilizer was applied as band placement method as top dressing one month after sowing. The recommended cultural practices and plant protection measures were taken. At the physiological maturity stage of pearl millet, harvesting was done on 27 November 2019 by cutting the plants close to ground.

Results and discussion

Effect of suitable planting pattern and fertilizer grade on growth parameters

The growth contributing characters of pearl millet were significantly influenced due to suitable planting pattern and fertilizer grade (Table 1). Significantly higher plant height, number of functional leaves, leaf area plant^{-1}, stem girth, dry matter accumulation and number of ear heads plant^{-1} were recorded with the paired row planting with furrow 30/60 cm x 15 cm. These were found significantly superior than planting at 45 cm x15 cm and at par with paired row planting at 30/60 cm x 15 cm.

The significantly highest plant height was obtained 75 DAS (153.98 cm); while, highest number of functional leaves and leaf area were obtained 60 DAS (28.13, 35.26 dm^2 respectively). The higher plant height, number of functional leaves and leaf area might be due to maintenance of proper air, moisture regimes under furrow sowing which might have improved the drainage resulting in good supply of required moisture, available nutrients and soil aeration for better growth and development. These results are similar with results of Kumar *et al*. (2017) [5], Rathor *et al*. (2008) [9] and Radhakumari *et al*. (2016) [8]. Highest stem girth (6.09) was obtained at 75 DAS due to paired row planting with furrow 30/60 cm x 15 cm.

The rate of increase in dry matter accumulation was slow up to 30 DAS and rapid between 30 to 75 DAS. Significantly highest dry matter accumulation (93.27 g) was obtained at harvest. The increase in dry matter accumulation after 30 DAS might be happened due application of remaining half dose of Nitrogen and preparation of furrows which ultimately reflected in dry matter production. Increase in number of earheads plant^{-1} (1.46) may be due to good aeration, nutrients and proper water supply and better root growth. Same result has been given by Radhakumari *et al*. (2016) [8].

The significant variations in growth parameters of pearl millet were due to application of different fertilizer grades. The application of 80:40:40 kg NPK ha^{-1} recorded significantly higher plant height (151.53 cm), number of functional leaves plant^{-1} (28.09), leaf area plant^{-1} (37.49 dm^{-2}), stem girth (6.01), dry matter accumulation plant^{-1} (91.97 g) and number of ear heads plant^{-1} (1.44). This treatment was found significantly superior than fertilizer grade of 40:20:20 kg NPK ha^{-1} and statistically on par with 60:30:30 kg NPK ha^{-1} for all the above characters.

The increase in plant height might be due to quickest and most pronounced effect of nitrogen. Similar findings were also reported by Bhuva *et al*. (2018) [3]. Higher number of functional leaves and leaf area at higher level of fertilizer may be due to nitrogen promotes vegetative growth; phosphorus stimulates root development and potassium increase efficiency of leaf. Similar kind of result was obtained by Radhakumari *et al*. (2016) [8] and Rathor *et al*. (2008) [9]. The increase in stem girth might be due to beneficial effect of application of fertilizer with furrow planting by assimilating more amount of nutrients. Increased dry matter and number of earheads plant^{-1} may be due to adequate supply of fertilizers which resulted in better root development, high photosynthetic rate and better utilization of carbohydrates. This has been reported by Shambhvi *et al*. (2018) [11] and Radhakumari *et al*. (2016) [8].

The effect of interaction between planting pattern and fertilizer grades were not found significant in respect of plant height, functional leaves plant^{-1}, leaf area plant^{-1}, stem girth (cm), dry matter accumulation plant^{-1} and number of ear heads plant^{-1}.

Table 1: Effect of suitable planting pattern and fertilizer grade on growth parameters

Treatments	Plant height	Number of functional leaves plant^{-1}	Leaf area plant^{-1}	Stem girth	Dry matter accumulation plant^{-1}	Number of ear heads plant^{-1}
A) Planting pattern (P)						
P_1 - Planting at 45 cm X 15 cm	137.47	21.44	30.29	5.26	79.57	1.23
P_2 - Paired row planting 30/60 cm X cm	145.64	23.16	34.78	5.53	84.93	1.41
P_3 - Paired row planting with furrow30/60 cm X 15 cm	153.98	24.39	35.26	6.09	93.27	1.46
SE±	4.188	0.68	1.127	0.20	2.96	0.04
CD at 5%	12.555	2.03	3.379	0.60	8.86	0.13
B) Fertilizer grades (F)						
F_1 - 40:20:20 NPK kg ha^{-1}	135.62	20.98	27.31	5.17	79.26	1.23
F_2 - 60:30:30 NPK kg ha^{-1}	149.93	23.74	35.52	5.71	86.54	1.38
F_3 - 80:40:40 NPK kg ha^{-1}	151.53	24.27	37.49	6.01	91.97	1.47
SE±	4.188	0.68	1.127	0.20	2.96	0.04
CD at 5%	12.555	2.03	3.379	0.60	8.86	0.13
C) Interaction (P X F)						
SE±	7.254	1.17	1.953	0.35	5.12	0.08
CD at 5%	NS	NS	NS	NS	NS	NS
General mean	145.70	23.00	33.44	5.63	85.92	1.36

Effect of suitable planting pattern and fertilizer grade on yield parameters

Yield contributing characters of pearl millet were also significantly influenced due to suitable planting pattern and fertilizer grade (Table 2). The maximum length of ear head (23.93 cm), breath of ear head (11.01 cm), weight of ear head (42.21 g), grain yield plant^{-1} (28.03), grain yield (2324 kg ha^{-1}) and test weight (13.49 g) were observed by paired row planting with furrow 30/60 cm X 15 cm which were found significantly superior than planting at 45 cm x15 cm and at par with paired row planting at 30/60 cm x 15 cm. These results are in conforming to the result of Kumar *et al.* (2018) [6], Radhakumari *et al*. (2016) [8].

Table 2: Effect of suitable planting pattern and fertilizer grade on yield parameters

Treatments	Length of earhead	Breadth of ear head	Weight of ear head	Grain yield plant^{1}	Grain yield (kg ha^{-1})	Test weight
A) Planting pattern (P)						
P_1 - Planting at 45 cm X 15 cm	137.47	21.44	30.29	5.26	79.57	1.23
P_2 - Paired row planting 30/60 cm X cm	145.64	23.16	34.78	5.53	84.93	1.41
P_3 - Paired row planting with furrow30/60 cm X 15 cm	153.98	24.39	35.26	6.09	93.27	1.46
SE±	4.188	0.68	1.127	0.20	2.96	0.04
CD at 5%	12.555	2.03	3.379	0.60	8.86	0.13
B) Fertilizer grades (F)						
F_1 - 40:20:20 NPK kg ha^{-1}	135.62	20.98	27.31	5.17	79.26	1.23
F_2 - 60:30:30 NPK kg ha^{-1}	149.93	23.74	35.52	5.71	86.54	1.38
F_3 - 80:40:40 NPK kg ha^{-1}	151.53	24.27	37.49	6.01	91.97	1.47
SE±	4.188	0.68	1.127	0.20	2.96	0.04
CD at 5%	12.555	2.03	3.379	0.60	8.86	0.13
C) Interaction (P X F)						
SE±	7.254	1.17	1.953	0.35	5.12	0.08
CD at 5%	NS	NS	NS	NS	NS	NS
General mean	145.70	23.00	33.44	5.63	85.92	1.36

Application of 80:40:40 kg NPK ha^{-1} recorded significantly higher length of ear head (24.03 cm), breath of ear head (11.12 cm), weight of ear head (41.48 g), grain yield plant^{1} (27.90 g), grain yield (2255 kg ha^{-1}) and test weight (13.46 g). This treatment was found significantly superior than fertilizer grade of 40:20:20 kg NPK ha^{-1} and statistically on par with 60:30:30 kg NPK ha^{-1} for all the above characters. Significant variation in grain yield among three grades of fertilizer may probably be due to variation in the expression of growth and yield attributes. Other scientists Kumar *et al.* (2018) [8], Senthikumar *et al*. (2018) [10], Bhuva *et al*. (2018) [3] and Thumar *et al*. (2016) [13] also reported similar results.

It was revealed from the data on mean length of ear head (cm), breath of ear head, weight of ear head, grain yield plant^{1}, grain yield (kg ha^{-1}) and test weight were not significantly influenced due to the interaction between planting pattern and fertilizer grades.

Conclusion

On the basis of above findings, it may be inferred that for achieving maximum growth and yield parameters, sowing of pearl millet at 30/60 cm X 15 cm and opening of furrow and application of fertilizer grade of 80:40:40 NPK kg ha^{-1} was found most beneficial to pearl millet crop.

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