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Performance of pearlmillet as influenced by plant geometry and sowing windows

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Abstract
The present study was undertaken to investigate the effect of plant geometry and sowing windows on growth and yield of pearlmillet (*Pennisetum americanum* L.). The experiment was carried out at Agricultural College Farm, Bapatla during *kharif*, 2018, with 4 plant geometry (45x15 cm, 45x30 cm, 60x15 cm and 60x30 cm) and also with 3 dates of sowing (2nd fortnight of July, 1st fortnight of August and 2nd fortnight of August). The results revealed that among the different plant geometry, the maximum plant height, days to 50% flowering and days to maturity were recorded under treatment 60× 30 cm but higher number of tillers m^{-2}, dry matter accumulation, grain yield, stover yield and harvest index were recorded with 45× 15 cm treatment. Among different dates of sowing, the highest plant height, number of tillers m^{-2}, dry matter accumulation, days to 50% flowering, days to maturity, grain yield, stover yield and harvest index were recorded with 2nd Fortnight of Jul.

Keywords: Pearlmillet, plant height, tillers $m^{-2,}$ drymatter accumulation, days to 50% flowering, days to maturity, grain yield, stover yield and harvest index

Introduction

Pearlmillet is sixth most important cereal of the world and stands fourth in order of importance as food grain crop in India. It is the most important food grain crop in arid and semi-arid regions of India and Africa and new grain crop in USA. It is one of the oldest food crops known to man and possibly first cereal grain to be used for domestic purposes (Railey, 2006) [6]. Being a potent source for human beings, it is enormously used for feeding the cattle and poultry birds and popularly known as bajra or cattle millet or bulrush millet. It was considered to be originated from tropical Western Africa.

The most important factor affecting the pearlmillet yield is plant density. Higher number of plants per unit area increases the competition between the plants for resources (moisture, light, nutrients), whereas under low plant population these resources are not properly utilized.

Sowing window and weather are the most important non - monetary inputs which influence crop yield even in photo and thermo- insensitive crops. Sowing time also depends on soil moisture and soil temperature, as well as distribution of rainfall.

Timely planting determines the size of root system, which in turn determines how much stored water that the plant can utilize, vegetative growth for optimum utilization of available soil nutrients and radiant energy (Soler *et al.*, 2008) [7]. Optimum planting time is the chief factor influencing the seed production in pearl millet. Hence, a field trial was carried out to study the performance of pearlmillet under different plant geometry and sowing windows.

Materials and Methods

An experiment was carried out during *kharif*, 2018, at the Agricultural College Farm, Bapatla. The experimental site was at an altitude of 5.49 m above mean sea level (MSL), 15° 55´N latitude, 80° 30´E longitude and about 8 km away from the Bay of Bengal in the Krishna Agro-climatic Zone of Andhra Pradesh, India. The soil of the experimental site was sandy loam in texture, slightly acidic in reaction, low in organic carbon, available nitrogen, available phosphorus and available potassium. Nitrogen @80 kg ha^{-1} was applied in the form of urea (46% N) in 2 equal splits *i.e.*, ½ at basal and remaining ½ at 40 days after sowing. Entire dose of 40 kg ha^{-1} phosphorus in the form of single superphosphate (16% P_2O_5) and 30 kg K_2O ha^{-1} in the form of muriate of potash (60% K_2O) were uniformly applied basally to all the plots.

The treatments consisted of the four plant geometry *viz.*, S_1= 45x15 cm, S_2=45x30 cm S_3=60x15 cm and S_4=60x30 cm and three sowing dates *viz.*, D_1=2nd fortnight of July, D_2=1st fortnight of August and D_3=2nd fortnight of August. The crop was sown at different spacings *i.e.*, as per the treatments and adopted all the standard package of practices.

These treatments were sown in factorial randomized block design with three replications. Observations were recorded under investigation *i.e.* plant height, number of tillers m^{-2}, dry matter accumulation, days to 50% flowering, days to maturity, grain yield, stover yield and harvest index. The data was analyzed by following the analysis of variance (ANOVA) for randomized block design with factorial concept as suggested by Panse and Sukhatme (1985) [5].

Results and Discussion

Effect of plant geometry

Among the various plant geometry, spacing S_4 (60x30 cm) exhibited significant maximum value for plant height (117.4 cm, 156.2 cm and 111.26 cm, respectively), as compared to S_1 (45 x15 cm), S_2 (45x30 cm) and S_3 (60x15 cm) at 30 DAS, 60 DAS and at maturity, respectively (Table 1.). However, number of tillers per m^2 (28.1, 29.3 and 30.4, respectively), dry matter accumulation (1053, 5738 and 9663 kg ha^{-1}, respectively) were highest at S_1 compared to other spacings at 30 DAS, 60 DAS and at maturity respectively (Table 1.). Plant geometry had no significant effect on days to 50% flowering and days to maturity (Table 2.).

Significantly taller plants were recorded with wider spacing of S_4, which was quite opposite to the usual assumption of increase in plant height with decrease in spacing due to competition for light and also due to overcrowding of plant population. Increase in plant height at wider spacing might be due to greater light interception, efficient utilization of soil moisture and also due to minimum inter and intra plant competition for available nutrients. Similar results were reported by Ijoyah *et al.* (2015) [3] and Isah *et al.* (2017) [4]. Maximum number of tillers m^{-2} were recorded with S_1 which was due to more number of plants per unit area. Among different spacings, accumulation of maximum drymatter was recorded at a closer spacing S_1 which was due to more biomass accumulation with more number of plants per unit area. Wider spacing provides vigorous growth of plants with more drymatter accumulation per plant but total drymatter accumulation was higher with higher the plant density.

Plant geometry significantly influenced the grain and stover yields. Significantly higher grain yield (2817 kg ha^{-1}), stover yield (6796 kg ha^{-1}) and harvest index (29.4%) were observed in S_1 followed with S_3 (2577 kg ha^{-1}, 6557 kg ha^{-1} and 28.2%, respectively), S_2 (1614 kg ha^{-1}, 5877 kg ha^{-1} and 21.3%, respectively) and S_4 (1335 kg ha^{-1}, 5347 kg ha^{-1} and 19.7%, respectively) (Table 3.).

Increased grain and stover yield at higher plant density could be attributed to better utilization of sun light by higher photosynthetic area and efficient moisture use from upper and lower soil layers. Similar results were reported by Isah *et al.* (2017) [4].

Effect of sowing time

Sowing time significantly influenced the growth parameters at different growth stages. Significantly maximum plant height (131.9 cm, 171.2 cm and 207.6 cm, respectively) (Table 1.), number of tillers per m^{-2} (26.5, 28.5 and 28.5, respectively), dry matter accumulation (1038, 5316 and 9059 kg ha^{-1}, respectively) at 30 DAS, 60 DAS and at maturity, respectively, were recorded with 2nd fortnight of July (D_1) crop when compared with other dates of sowing *i.e.*, 1st fortnight of August (D_2) and 2nd fortnight of August (D_3). 2nd fortnight of July (D_1) sown crop had taken more number of days to 50% flowering (57) and days to maturity (88) as compared to D_2 and D_3.

Among different dates of sowing, significantly taller plants, number of tillers m^{-2} and drymatter accumulation were recorded with D_1 which was due to prevalence of optimum micro climatic conditions *viz.*, temperature, sunshine hours and longer days during crop growth period, also due to the fact that crop experienced longer period of vegetative stage and also due to more bright sunshine hours coupled with optimum day length which in turn might had increased the photosynthesis and in turn drymatter accumulation. Similar results were reported by Deshmukh *et al.* (2013) [2] and Chouhan *et al.* (2015) [1].

It was observed that there was a gradual but steady reduction in the number of days taken for 50% flowering and days to maturity from D_1 to D_3. Pearl millet crop sown during D_1 took more number of days to 50% flowering (57) which was significantly superior to D_2 (51) (Table 2.). Date of sowing significantly influenced both grain and stover yields but could not influence harvest index under investigation. The maximum grain yield (2263 kg ha^{-1}) and stover yield (6746 kg ha^{-1}) were recorded at 2nd fortnight of July (D_1) as compared other two dates of sowing i.e., D_2 (2100 kg ha^{-1} and 6164 kg ha^{-1}, respectively) and D_3 (1895 kg ha^{-1} and 5523 kg ha^{-1}, respectively) (Table 3.).

Under the interaction of plant geometry and sowing time, all the growth parameters, yield attributes and yield were found to be non-significant.

Table 1: Effect of different sowing time, plant geometry and their interaction on plant height (cm), number of tillers m^{-2} and drymatter accumulation (kg ha^{-1}) of pearlmillet

Treatment	Plant Height			Tillers per m^2			Drymatter accumulation		
	30 DAS	60 DAS	Maturity	30 DAS	60 DAS	Maturity	30 DAS	60 DAS	Maturity
Spacings (S)									
S_1 (45 × 15 cm)	94.1	138.7	169.2	28.1	29.3	30.4	1053	5738	9663
S_2 (45 × 30 cm)	102.0	144.3	178.9	19.8	23.1	25.0	886	3115	7542
S_3 (60 × 15 cm)	107.6	148.7	184.5	27.5	28.0	27.7	1005	5011	9184
S_4 (60 × 30 cm)	117.4	156.2	192.7	18.4	21.5	22.3	864	2744	6733
S.Em±	2.81	4.23	4.85	0.90	0.79	0.85	8.0	115.7	343.7
CD (0.05)	8.2	12.4	14.2	2.6	2.3	2.4	23	339	1008
Dates of sowing (D)									
D_1 (2nd fortnight of July)	131.9	171.2	207.6	26.5	28.5	28.5	1038	5316	9059
D_2 (1st fortnight of August)	105.2	150.2	175.8	23.5	26.0	26.8	948	4156	8314
D_3 (2nd fortnight of August)	78.7	119.4	160.6	20.5	22.0	23.7	870	2985	7468
S.Em±	2.43	3.66	4.20	0.78	0.68	0.73	6.9	100.2	297.7
CD (0.05)	7.1	10.7	12.3	2.2	2.0	2.1	20	293	873
Interaction (S × D)									
S.Em±	4.86	7.33	8.41	1.5	1.3	1.4	13.9	200.4	595.4

CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	8.0	8.6	8.0	11.5	9.3	9.6	9.5	8.3	10.7

Table 2: Effect of different sowing time, plant geometry and their interaction on days to 50% flowering and days to maturity of pearlmillet

Treatments	Days to 50% flowering	Days to maturity
Spacings (S)		
S_1 (45 × 15 cm)	51	82
S_2 (45 × 30 cm)	52	84
S_3 (60 × 15 cm)	52	82
S_4 (60 × 30 cm)	54	84
SEm±	1.1	1.0
CD (0.05)	NS	NS
Dates of sowing (D)		
D_1 (2nd fortnight of July)	57	88
D_2 (1st fortnight of August)	51	82
D_3 (2nd fortnight of August)	48	79
SEm±	0.9	0.9
CD (0.05)	2	2
Interaction (S × D)		
SEm±	1.9	1.8
CD (0.05)	NS	NS
CV (%)	6.5	3.8

Table 3: Effect of different sowing time, plant geometry and their interaction on grain yield and stover yield (kg ha^{-1}) and harvest index (%) of pearlmillet

Treatments	Grain yield	Straw yield	HI
Spacings (S)			
S_1 (45 × 15 cm)	2817	6796	29.4
S_2 (45 × 30 cm)	1614	5877	21.3
S_3 (60 × 15 cm)	2577	6557	28.2
S_4 (60 × 30 cm)	1335	5347	19.7
SEm±	60.5	58.1	0.6
CD (0.05)	177	170	1
Dates of sowing (D)			
D_1 (2nd fortnight of July)	2263	6746	24.8
D_2 (1st fortnight of August)	2100	6164	24.7
D_3 (2nd fortnight of August)	1895	5523	24.5
SEm±	52.4	50.3	0.5
CD (0.05)	153	147	NS
Interaction (S × D)			
SEm±	307.7	100.7	1.0
CD (0.05)	NS	NS	NS
CV (%)	9.6	8.0	9.9

Conclusion

It can be concluded that crop sown at plant geometry of 45 × 15 cm (S_1) and 2nd fortnight of July sown crop (D_1) performed well with significantly higher drymatter accumulation, grain yield, stover yield and harvest index.

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