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Effect of different dates of sowing on growth and yield of pearl millet (*Pennisetum glaucum* L.) varieties under semi-arid region

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Abstract

Pearl Millet is the major source of energy and protein for millions of people. Millet produces high quality grains than any other cereals under extreme conditions: like unfertile soil, intense heat and prolong drought. An experiment was conducted during the *Kharif* season of 2016 at College of Agriculture, RVSKVV, Gwalior. With the treatment combination of three Date of Sowing (20th, 30th July and 9th August) and five varieties of pearl millet (Big B, Crystal Dhoom, Boss-65, Ankur-045 and 86M86). The experiment was laid out in split plot design with three replications. The result revealed that yield attribute and B:C Ratio (benefit cost ratio) were recorded significantly higher in the variety Crystal Dhoom on first date of sowing (20th July). Variety Crystal Dhoom recorded significantly higher grain yield 1989.70 Kg/ha followed by varieties Boss-65 1162.54 Kg/ha, Ankur-045 1792.75 Kg/ha, 86M86 1675.52 Kg/ha and Big B 1768.18 Kg/ha respectively. The highest Net Return (Rs/ha) 19066 (Rs/ha) was recorded in variety Crystal Dhoom followed by varieties Boss-65, 5713 (Rs/ha), Ankur-045 14550 (Rs/ha) 86M86, 13321 (Rs/ha) Big B gave 15066 (Rs/ha) respectively. Significant variations were observed in different growth and yield parameters among the sowing dates. First sowing date (20th July) statistically showed maximum grain yield 1976.94 Kg/ha followed by second date of sowing (30th July) 1737.82 Kg/ha and third date of sowing (9th August) 1318.45 Kg/ha respectively. Similarly First sowing date (20th July) statistically showed maximum Net Return (Rs/ha) 17941 (Rs/ha) followed by second date of sowing (30th July) 14919 (Rs/ha) and third date of sowing (9th August) 7770 (Rs/ha) respectively.

Keywords: Pearlmillet, varieties, yield, B:C ratio

Introduction

Pearl millet (*Pennisetum glaucum* L.), a member of the family *Poaceae*, is highly drought tolerant *kharif* crop grown under rainfed condition. Millet produces high quality grains than any other cereals under extreme conditions: like unfertile soil, intense heat and prolong drought (Jan *et al.*, 2015) [3] Pearl millet is commonly known in India as *Bajra*. Pearl millet (*Pennisetum glaucum* L.) is the most drought tolerant of all domesticated cereals and can yield grain under rainfall as low as 200 to 250mm (Bidinger and Hash, 2003) [1] making it one of the reliable cereals in the direct rain fed regions of the arid and semi-arid tropics. India is the largest production of pearl millet in Asia, both in terms of area (about 8.1 million ha.) and production (9.6 million tons) with productivity of 1186 kg/ha. (All India Coordinated Research Project on Pearl Millet, Jodhpur 342-304, Rajasthan, 2011-2015 www.aicpmip.res.in). India is the largest producer of this crop, both in terms of area (7.8 million ha.) and production (9.25 million tons), with an average productivity of 1270kg/ha. (All India Coordinated Research Project on Pearl Millet, Jodhpur 342-304, Rajasthan, 2016).

Sowing time is the most important non-monetary input influencing crop yield. Sowing at optimum time improves the productivity by providing suitable environment at all the growth stages. Upadhyay *et al.* (2001) [9] have reported higher grain yield of summer pearl millet when sown on 15 March and found reduction in grain yield with delay in sowing. Identifying suitable time of sowing for pearl millet is important to have proper growth and development of plants.

Agriculture and food security are likely to be affected by climate change. It is likely that such changes will have a negative effect on the food security of resource poor farmers in semi-arid

and arid areas of Madhya Pradesh. Today, more attention is being paid due to increasing evidence of less seasonal rainfall, terminal heat, frequent occurrence of extreme weather events coupled with scanty water resources (Singh *et al.*, 2010) [7]. many research and development has been done on intervention include development of early maturing, short duration varieties and water conservation and water harvesting techniques for supplemental irrigation facilities.

But until now very fewer literatures are available on cultivation of pearl millet with suitable time of sowing and variety for the region, keeping in view of the importance the study was aimed to investigate the effect of different dates of sowing on performance of pearl millet (*Pennisetum glaucum* L.) varieties under Gwalior condition.

Materials & Methods

The study was conducted at Research Farm, Department of Agronomy, College of Agriculture, RVSKVV, Gwalior (M.P.) during the kharif season of 2016. Gwalior is situated in Gird zone at the latitude of 26°13' North and longitude 76°14' east with an altitude of 211.52 meters from mean sea level, in Madhya Pradesh. This Region comes under semi-arid sub tropical climate with extreme weather condition having hot and dry summer and cold winter. Generally monsoon set during the last week of June.

The maximum temperature goes up to 46°C during summer and minimum as low as 2°C during winter. The average rainfall ranges between 80 to 90 cm, most of which is

received in the month of July, August, and September, with an average maximum and minimum temperature during growing period as 41.6 °C and 13.2 °C, respectively the total rainfall received during the rainy season from June to October 2016 was 573.00 mm. This was followed by few winter showers. The average annual rainfall is around 900 mm which is mostly received during the middle of July to mid of September. Both the mechanical and chemical analysis of soil were done before the start of experiment. Soil of the experimental field was analyzed mechanically and chemically.

Mechanical Analysis

The mechanical analysis was done by Bouyoucos hydrometer method as described by bouyoucos (1927). The results of analysis are as follows (Table 1).

Chemical analysis

The chemical analysis was done for pH, organic carbon, Electrical Conductivity (EC), available nitrogen, phosphorus and potassium. pH was analyzed by digital pH meter. The organic carbon was determined by Walkley and Black method (1934) [10]. The electrical conductivity (EC) was estimated by electrical conductivity meter. The available nitrogen was estimated by Kjeldahl method. The available phosphorus was determined by Olsen's Spectrophotometer method and available potassium was determined by flame photometer the results are presented in table 2.

Table 1: Mechanical composition of soil

S. No.	Properties	Value	Method employed
A	Physical properties		
1.	Sand (%)	56.75	Bouyoucos hydrometer method
2.	Silt (%)	19.82	
3.	Clay (%)	21.00	
4.	Textural class	Sandy loam	Triangular method (Loyn and Buckman 1952) [4]

Table 2: Chemical properties of soil

S. No.	Properties	Value	Method employed
1.	Available nitrogen (kg/ha)	212.0	Alkaline permagnate method (Subbiah and Asija, 1956) [8]
2.	Available phosphorus (kg/ha)	14.45	Olsen's method (Olsen <i>et al.</i> , 1954) [5]
3.	Available potassium (kg/ha)	255.75	Neutral normal ammonium acetate by using flame photometer (Jackson, 1973) [2]
4.	Soil reaction (pH)	7.4	1:2.5 Soil:water suspension, using glass electrode pH meter (Jackson, 1973) [2]
5.	Electrical conductivity (dsm ⁻¹)	0.29	Electrical conductivity (Jackson, 1973) [2]
6.	Organic carbon (%)	0.26	Walkley and Black's rapid titration method (Black, 1964)

Five Pearl millet varieties Big B, Crystal Dhoom, Boss 65, Ankur – 045 and 86M86 was used for the experiment. Three dates of sowing (20th July, 30th July and 09th August) had been used in Split Plot Design with three replications.

Treatment details

(I) Main plot (Sowing dates)

D₁: 20th July

D₂: 30th July

D₃: 09th August

(II) Sub plot – Varieties

V₁: Big B

V₂: Crystal Dhoom

V₃: Boss 65

V₄: Ankur – 045

V₅: 86M86

Table 4: Treatment combination

T ₁	D ₁ V ₁	T ₉	D ₂ V ₄
T ₂	D ₁ V ₂	T ₁₀	D ₂ V ₅
T ₃	D ₁ V ₃	T ₁₁	D ₃ V ₁
T ₄	D ₁ V ₄	T ₁₂	D ₃ V ₂
T ₅	D ₁ V ₅	T ₁₃	D ₃ V ₃
T ₆	D ₂ V ₁	T ₁₄	D ₃ V ₄
T ₇	D ₂ V ₂	T ₁₅	D ₃ V ₅
T ₈	D ₂ V ₃		

The nutrients were applied @ 40 kg P₂O₅/ha and 20 kg K₂O/ha. Single super phosphate (16% P₂O₅) and Murate of potash (60% K₂O) were used respectively as a source of phosphorus and potash. While the urea (46% N) was used as a source of nitrogen to fulfill the nitrogen requirement of crop. Fertilizers containing half dose of nitrogen, full dose of phosphorus and potash were drilled 8 cm deep in every plot before sowing and rest dose of nitrogen was top dressed after

25 DAS. Pearl millet varieties were sown by nari plough with 45 cm row to row distance at the rate of 5 kg seed/ha. Irrigation was given as / requirement of irrigation during long dry spells and early withdrawal of monsoon at different critical stages of crop. The seed were sown as per the treatment combination. The observations were recorded on five randomly selected plants in each replication for all the characters. Pre harvest observations- plant height (cm) at 30, 60 DAS and harvest stage of crop, Number of tillers/ plant, Number of leaves/plant, Number of productive tiller/plant, post-harvest observations- grain yield kg/ha, Stover yield kg/ha, Harvest Index (%). The data collected on various characters were analyzed separately according to procedure given by Panse and Sukhatme (1967) [6].

Result & Discussion

After analysis of data the following results were obtained. In case of the grain yield / plot was recorded after harvest and grain yield (Kg/ha) was worked out with use of factor. The recorded data were statistically analyzed and presented in Table 3 which indicated that there was a significant difference in grain yield due to different dates of sowing and varieties.

No of tillers/plant

The maximum tillers were produced with 20th July date of sowing at all the growth stages which was followed by 30th July sowing of Pearl millet while, the minimum was recorded with 9th August. The significant difference due to date of sowing was observed may be due to the delayed sowing.

Table 5: Effect of different treatment on number of tillers/plant of Pearl millet at 30, 60 DAS and at harvest

Treatment Details	Number of tiller / plant		
	30 DAS	60 DAS	At harvest
D ₁	1.45	1.67	1.83
D ₂	1.38	1.59	1.76
D ₃	1.07	1.31	1.46
SEm±	0.06	0.07	0.03
CD (at 5%)	0.23	0.26	0.12
V ₁	1.36	1.49	1.72
V ₂	1.61	1.87	1.97
V ₃	1.02	1.24	1.55
V ₄	1.28	1.58	1.63
V ₅	1.23	1.42	1.53
SEm±	0.07	0.09	0.08
CD (at 5%)	0.20	0.26	0.22
Interaction I (D×V)	NS	NS	NS
Interaction II (V×D)	NS	NS	NS

The varieties were also gave significant difference regards to number of tiller/plant. The maximum number of tiller was produced by the Cryster Dhoom variety 1.61 and 1.97 at 30 DAS and harvest stage respectively. However, the minimum was produced by the boss 65 variety- 1.02 at 30 DAS. The varieties were produced significantly different number of tiller / plant in Pearl millet at 60 DAS crop stage. The maximum number of tillers were found under crystal Dhoom variety (1.87) which was significantly superior over all other varieties tested in experiment at 60 DAS stage. At harvest growth stage variety V₂ (1.97) produced maximum number of tillers / plant which was significantly superior over all other varieties tested in experiment. It was followed by and comparable to each other V₁ (1.72), V₄ (1.63) and V₅ (1.53). However, the minimum number of tillers/plant were produced by V₃ (1.55) table 5

Ear-head length (cm)

Length of ear head was measured with the scale and the recorded data were analyzed statistically and presented in Table 6. Length of ear-head was significantly influenced by different dates of sowing and varieties of Pearl millet. Length of ear head ranged from 17.78 to 20.07 cm under different date of sowing. It is evident from the results, that the delayed sowing produced significantly lower ear-heads as compared to another date of sowing. The maximum length of ear head was recorded under the D₁ (20th July) 20.07 cm which was comparable to 30th July (D₂) 19.55 cm and significantly superior over the delayed sowing on 9th August (D₃) 17.78 cm. It is revealed from Table 6 the longest ear head (20.96 cm) was noted in V₂ (Crystal Dhoom) which was statistically superior to all other varieties tested in the experiment expect V₁. However, rest of the four varieties were produced comparable length of ear head to each other, while the minimum length was produced by the variety boss-65 (17.97 cm).

Table 6: Effect of different treatment on ear head Length (cm) of Pearl millet at harvest

Treatment Details	Ear head Length (cm)
D ₁	20.07
D ₂	19.55
D ₃	17.78
SEm±	0.31
CD (at 5%)	1.22
V ₁	19.02
V ₂	20.96
V ₃	17.97
V ₄	18.78
V ₅	18.94
SEm±	0.61
CD (at 5%)	1.78
Interaction (D×V) _I	NS
Interaction (V×D) _{II}	NS

Number of grains/ear head

The number of grains / ear head is an important yield attributing character which is directly related to grain yield of Pearl millet. The statistically analyzed data are presented in table 7.

The maximum number of grains was recorded under the D₁ (20th July) 3034.93 however the minimum was recorded under the delayed sowing on 9th August (D₃) 2370.67 number of grains /ear head. However the D₂ (30th July) can produced comparable 2714.67 seeds /ear head to D₁.

Table 7: Effect of number of grain / ear head of Pearl millet at harvest

Treatment Details	Number of seed /ear head
D ₁	3034.93
D ₂	2714.67
D ₃	2370.67
SEm±	84.88
CD (at 5%)	333.22
V ₁	2827.11
V ₂	2918.00
V ₃	2505.89
V ₄	2751.78
V ₅	2531.00
SEm±	103.03
CD (at 5%)	300.73
Interaction I (D×V)	NS
Interaction II (V×D)	NS

The maximum number of grains (2918.00 ear head⁻¹) was noted in crystal Dhoom (V₂) and it was significantly higher over other treatments except V₁-Big B (2827.11Cob⁻¹) and V₄- Ankur-045 (2751.78). However, the Minimum number of grains (2505.89 ear head⁻¹) was observed under V₃ (Boss-65).

Grain yield

The maximum grain yield 3.20 kg/plot and 1976.94 kg/ha was recorded in 20th July sowing (D₁) while, the minimum was recorded in 9th August (D₃) delayed sowing of Pearl millet 2.14 kg/ha and 1318.45 kg/ha respectively. The difference in grain yield was observed may be due to the delayed sowing.

The maximum grain yield (3.22 kg/ha and 1989.70 kg ha⁻¹) observed with crystal Dhoom variety (V₂) was closely followed (2.90 kg/ha and 1792.75 kg ha⁻¹) respectively by variety Ankur-045 (V₄). However, the minimum was recorded in the (V₃) Boss-65 (1.88 kg/ha and 1162.54 kg ha⁻¹) respectively.

The interaction of dates of sowing and varieties was found not significant as regards to grain yield.

Stover yield (kg /ha)

The Straw yield / hectare was recorded after harvest. The recorded data were statistically analyzed and presented in Table 8 which indicated that there was a significant difference in stover yield due to different dates of sowing and varieties.

The maximum straw yield 3757.54 kg/ha was recorded in 20th July sowing (D₁) which was comparable to D₂ (30th July) sowing 3688.84 kg/ha. However, the minimum was recorded in 9th August (D₃) delayed sowing of Pearl millet 3261.68 kg/ha. The difference in stover yield was observed may be due to the delayed sowing.

The maximum stover yield (4006.38 kg /ha⁻¹) observed with crystal Dhoom variety (V₂) was closely followed and comparable to (3670.02 kg/ha) variety Big B (V₁). However, the minimum was recorded in the (V₃) Boss-65 (3277.63 kg/ha).

The interaction of date of sowing and varieties was found not significant as regards to Stover yield.

Table 8: Grain Yield (kg / plot and Kg / ha), Stover Yield (Kg / ha) and Biological Yield (Kg /ha) of Pearl millet. at harvest as influenced by different treatments

Treatment Details	Grain Yield		Stover Yield (kg /ha)	Biological Yield (kg /ha)	Harvest Index (%)
	Kg /plot	Kg /ha			
D ₁	3.20	1976.94	3757.54	5734.48	34.47
D ₂	2.82	1737.82	3688.84	5426.65	31.78
D ₃	2.14	1318.45	3261.68	4580.13	28.76
SEm±	0.06	37.16	49.26	63.86	0.56
CD (at 5%)	0.24	145.89	193.38	250.71	2.22
V ₁	2.86	1768.18	3670.02	5438.19	32.46
V ₂	3.22	1989.70	4006.38	5996.08	33.13
V ₃	1.88	1162.54	3277.63	4440.18	26.23
V ₄	2.90	1792.75	3505.26	5298.01	33.58
V ₅	2.71	1675.52	3387.46	5062.97	32.94
SEm±	0.10	58.72	131.22	128.46	1.31
CD (at 5%)	0.28	171.40	383.02	374.96	3.83
Interaction (D×V) I	NS	NS	NS	NS	NS
Interaction (V×D) II	NS	NS	NS	NS	NS

Net income

Data encamped in Table 9, propel that all the early sowing gave the more net return than delayed sowing. The maximum net return was recorded in 20th July sowing (Rs.17941/ha) while the minimum was recorded in 9th August delayed sowing (Rs.7770/ha).

The maximum net return was found with variety crystal Dhoom (Rs. 19066/ha) which was by Big B (Rs.15066/ha). However, the minimum net return was found in variety Boss-65 (Rs.5713/ha).

Benefit: Cost ratio

Data encamped in Table 9 propel that all the early sowing gave the more B:C ratio than delayed sowing. The maximum Benefit cost ratio was recorded in 20th July sowing (1.91) while the minimum was recorded in 9th August delayed sowing (1.39).

The maximum B: C ratio was found with variety crystal Dhoom (1.96) which was closely followed by Big B (1.76). However, the minimum benefit cost ratio was found in variety Boss-65 (1.29).

Table 9: Economics of Pearl millet as affected by different dates of sowing and varieties

Treatment	Cost of cultivation (Rs/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	B:C
Date of sowing				
D ₁	19814	37755	17941	1.91
D ₂	19814	34733	14919	1.75
D ₃	19814	27584	7770	1.39
Variety				
V ₁	19814	34880	15066	1.76
V ₂	19814	38880	19066	1.96
V ₃	19814	25527	5713	1.29
V ₄	19814	34364	14550	1.73
V ₅	19814	33135	13321	1.67

Conclusion

From the above study it is concluded that the Pearl millet variety Crystal Dhoom is found to be most suitable for sowing at 20th July. The growth and yield of Pearl millet variety crystal Dhoom and sowing date 20th July provides favorable weather condition for better growth and yield under Gwalior condition. In case of late sowing condition the weather parameters were not favorable for the Crystal Dhoom variety, thus affecting of growth and yield character which ultimately reduced the yield.

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