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Effect of Sowing Dates on Yield of Pearl Millet [*Pannisetum glaucum* (L.) R. Br.] Hybrids under Semi-arid Region of Rajasthan

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Abstract: Millets are considered as nutri-cereals which give higher economic return even under extreme climatic and soil conditions of arid and semi-arid regions. An experiment was conducted during the kharif 2021 and 2022 at Krishi Vigyan Kendra, Lunkaransar. Bikaner, with the treatment combination of three date of sowing (15th July, 30th July and 15th August) and seven hybrids of pearl millet (HHB-67 improved, HHB-197, HHB-299, MPMH-17, HHB-273, HHB-226 and BHB-1602) to find out the best combination of sowing date and hybrid. The results of the study revealed that yield attribute, yield, net returns and B:C Ratio (benefit cost ratio) were significantly higher at first sowing date (15th July) and recorded statistically maximum seed yield of 2119 kg ha^{-1}, net return of 30086 Rs ha^{-1} with B:C ratio of 2.72. This was followed by second date of sowing (30th July) in terms of yield and economic return. Among hybrids, MPMH-17 recorded significantly higher grain yield (1969 kg ha^{-1}) followed by HHB-299 (1862 kg ha^{-1}), HHB-273 (1690 kg ha^{-1}), HHB-197 (1674 kg ha^{-1}), HHB-67 (1551 kg ha^{-1}), HHB-226 (1442 kg ha^{-1}) and BHB-1602 (1428 kg ha^{-1}) respectively. The highest seed yield (2606 kg ha^{-1}) and net returns (40358 Rs. ha^{-1}) was recorded with hybrid MPMH-17 sown on 15th July which was statistically at par with sowing on 30th July.

Key words: B:C ratio, Hybrids, Pearl millet, Yield,

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Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is one of the most important millet crop grown in India especially in arid region (Mann *et al.*, 1976; Yadav *et al.*, 2021). It is a highly out crossing plant and is protogynous pollinated by wind (Lemgharbi *et al.*, 2016). The leading pearl millet growing states in country includes Rajasthan (46%), Maharashtra (19%), Gujarat (11%), Uttar Pradesh (8%) and Haryana (6%). Among cultivated cereals in the world, it is ranked sixth in terms of acreage after rice, wheat, maize, barley and sorghum and in India, it is fourth most important cereal after rice, wheat and sorghum. India is the largest producer of pearl millet in the world. It is mainly grown during *kharif* for grain and fodder in the arid and semi-arid regions of India. In these regions, around 300 million people of whom 30-40% are poor, depend on its rainfed

cultivation for their sustenance. Millet produces higher quality grains than any other cereal under extreme conditions *viz.* poor soil, intense heat and prolong drought (Jan *et al*., 2015). Better adaptation of pearl millet to water stress and nutrient-deprived soils than other cereal crops is the primary reason of its large scale cultivation in arid and semi-arid regions (Yadav *et al.,* 2017; Menaka and Vanangamudi, 2008). Therefore, pearl millet is a central component of the food security of the rural poor people in dry areas and is the cheapest source of energy, protein, iron and zinc. These qualities make pearl millet the major contributor to protein, iron, and zinc intake in the regions where it is grown (Vadez *et al.,* 2012). Grains of pearl millet are mainly used for human consumption in the form of diverse food items and dry stover of pearl millet are primarily fed to large bovine population that is regarded as the most critical component for providing stability in the risk-prone crop-livestock farming system in water-limited regions (Yadav *et al.,* 2017).

Sowing time is highly correlated with growing degree days (GDD) which 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. Agriculture and food security are likely to be affected by climate change. Today, more attention is required for standardization of its sowing time in view of irregular events of rainfall, terminal heat, frequent occurrence of extreme weather events coupled with scanty water resources (Singh *et al*., 2010). Previous studies in pearl millet suggest that crop should be sown soon at the onset of rainy season for getting more GDD for enhancing production in rainfed areas (Jadhav *et al.,* 1994), Varietal differences have also been observed with respect to GDD and phenological phases (Bishnoi *et al.,* 1985). Hence, identifying suitable time of sowing for pearl millet is important to have proper growth and development of plants. Development of new early maturing and short duration varieties have made such work imperative. The present study was undertaken to address this issue so as to enhance yield and economic gains.

Materials and Methods

The field experiment was conducted at Krishi Vigyan Kendra, Bikaner-II (Lunkaransar), Swami Keshwanand Rajasthan Agricultural University, Bikaner during *kharif* 2021 and 2022. The climate of the area is typically semi-arid. The rainfall is monsoonal and varies between 100 to 350 mm during July to September. The experiment was laid out in a split plot design with three replications consisting 21 treatment combinations of three sowing dates viz.,15th July (D_1), 30th July (D_2) and 15th August (D_3) and seven pearl millet hybrids HHB-67 (Improved), HHB 197, HHB-299, MPMH-17, HHB-273, HHB-226 and BHB-1602. Pre sowing irrigation was applied for uniform germination in case of no rainfall at the time of sowing. The recommended dose of nitrogen (100 kg N ha^{-1}) and phosphorus (40 kg P_2O_5 ha^{-1}) were applied. Full dose of phosphorus and half dose of nitrogen were applied at time of sowing and remaining half dose of nitrogen was applied 25-30 days after sowing as top dressing. The crop was line sown in rows at 45 cm distance as per treatments using seed rate of 4.0 kg ha^{-1}. The crop was maintained weed free by hand weeding twice at 30 and 45 days after sowing. The observations were recorded from five randomly selected plants in each treatment for growth and yield attributes. The observed data were analyzed for statistical significance using procedure given by Panse and Sukhatme (1967).

Results and Discussion

Effect of sowing dates

The individual year data were pooled and are presented in table 1 and 2. The results indicated that plant height, days to 50 % flowering, days to maturity, days to maturity, effective tillers per plant, panicle length, panicle diameter and 1000 grain weight were recorded significantly higher with 1st date of sowing (15th July) over rest two sowing dates. The mean plant height was 12.29% higher with 15 July sowing compared to 15 August sowing. Similarly, days to 50% flowering, days to maturity, number of effective tillers, panicle length, panicle diameter and 1000-grain weight recorded 9.15, 7.70, 23.53, 8.78, 5.91 and 3.10% higher values of these parameters with 15 July sowing compared to 15 August sowing.

In terms of grain and stover yield, harvest index, net return and B:C ratio, 15 July sowing was also found significantly superior over late sowing dates. The 15 July sown crop increased

Table 1. Effect of date of sowing on yield attributes of pearl millet hybrids (average of 2021 and 2022)

Treatments	Yield attributes of pearl millet						
	Plant height (cm)	Days to 50 % flowering	Days to maturity	Effective tillers per plant	Panicle length (cm)	Panicle diameter (cm)	1000 grain weight (g)
Date of sowing							
15th July	150.14	49.07	84.57	3.15	19.82	2.33	9.31
30th July	147.24	47.62	82.66	2.99	19.39	2.29	9.24
15th Aug	139.41	43.70	77.48	2.55	18.22	2.20	9.03
SEm ±	1.35	0.68	0.89	0.08	0.20	0.02	0.04
CD at 5%	4.40	2.20	2.91	0.25	0.66	0.05	0.11
Pearl millet hybrids							
HHB-67 improved	143.19	44.16	78.09	2.88	19.09	2.00	9.16
HHB-197	157.75	43.94	77.80	2.89	20.06	2.52	9.42
HHB-299	150.40	52.78	89.47	3.28	19.21	2.56	9.07
MPMH-17	141.57	48.36	83.63	2.79	18.85	2.21	9.16
HHB-273	140.84	47.99	83.15	2.75	18.74	2.20	9.15
HHB-226	142.90	46.52	81.20	2.86	19.04	2.22	9.20
BHB-1602	142.55	43.84	77.66	2.84	18.99	2.22	9.19
SEm ±	1.81	0.91	1.20	0.10	0.27	0.02	0.05
CD at 5%	5.12	2.56	3.38	0.29	0.76	0.06	0.13

grain yield by 21.02 and 91.25%, stover yield by 16.20 and 62.67%, biological yield by 18.08 and 73.04%, harvest index 2.69 and 10.70%, net return 34.58 and 240.96% and B:C ratio by 19.30 and 81.33%, respectively over 30th July and 15th August sowing. The higher growth, yield and yield attributes with 15 July sowing might be associated with longer period of moisture availability and favourable environmental conditions that triggers plant growth and development. The early sown crop availed prolonged photoperiod for vegetative growth that causes plant to attain maximum plant height as compared to late sown crop. These results are in line with those of Maas *et al.*, (2007) who reported that crop which was sown

Table 2. Effect of date of sowing on yield attributes and yields of pearl millet hybrids (pooled of 2021 and 2022)

Treatments	Yield attributes and yield of pearl millet					
	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)	Net Returns (Rs. ha^{-1})	B:C Ratio
Date of sowing						
15th July	2119	3164	5283	40.03	30086	2.72
30th July	1751	2723	4474	38.98	22356	2.28
15th Aug	1108	1945	3053	36.16	8824	1.50
S Em ±	27	33	60	0.12	571	0.03
CD at 5%	88	109	196	0.39	1861	0.11
Pearl millet hybrids						
HHB-67 improved	1551	2469	4020	38.29	18085	2.03
HHB-197	1674	2630	4304	38.47	20737	2.18
HHB-299	1862	2858	4719	38.94	24693	2.41
MPMH-17	1969	2987	4955	39.19	26943	2.54
HHB-273	1690	2650	4340	38.58	21077	2.20
HHB-226	1442	2350	3792	37.64	15863	1.91
BHB-1602	1428	2332	3760	37.62	15557	1.89
SEm ±	39	47	86	0.16	813	0.05
CD at 5%	109	133	241	0.45	2293	0.13

Table 3. Interactions effect of date of sowing and hybrids on yield of pearl millet (pooled of 2021 and 2022)

Pearl millet hybrids	Seed yield (kg ha^{-1})			Stover yield (kg ha^{-1})		
	Sowing dates			Sowing dates		
	15th July	30th July	15th Aug	15th July	30th July	15th Aug
HHB-67 improved	1754	1542	1357	2689	2471	2246
HHB-197	2197	1738	1086	3264	2708	1919
HHB-299	2421	2057	1107	3534	3094	1945
MPMH-17	2606	2159	1140	3758	3218	1985
HHB-273	2192	1752	1126	3257	2725	1967
HHB-226	1846	1519	962	2839	2443	1769
BHB-1602	1819	1487	977	2806	2404	1788
	Sowing dates with in hybrid	Hybrids within sowing date		Sowing dates with in hybrid	Hybrids within sowing date	
SEm ±	27	40		33	49	
CD at 5%	88	122		109	150	

Pearl millet hybrids	Biological yield (kg ha^{-1})			Harvest Index (%)		
	Sowing dates			Sowing dates		
	15th July	30th July	15th Aug	15th July	30th July	15th Aug
HHB-67 improved	4443	4012	3603	39.50	38.02	37.34
HHB-197	5461	4447	3004	40.22	39.08	36.11
HHB-299	5955	5151	3052	40.64	39.93	36.26
MPMH-17	6364	5377	3125	40.94	40.15	36.47
HHB-273	5449	4477	3093	40.22	39.13	36.39
HHB-226	4685	3962	2730	39.39	38.33	35.20
BHB-1602	4624	3891	2765	39.32	38.20	35.33
	Sowing dates with in hybrid	Hybrids within sowing date		Sowing dates with in hybrid	Hybrids within sowing date	
SEm ±	60	89		0.12	0.17	
CD at 5%	196	271		0.39	0.53	

at 15thJune produced significantly taller plants compared to late sown crop. Similar results were also observed by Tomar *et al.,* (2020). Similarly, Teare *et al.,* (1993) reported timely and early sown crop produced maximum (29.5 cm) panicle length compared to late sown crop in which panicle length reduced up to (33%). Tomar *et al.,* (2020) also reported that the delayed sowing produced significantly lower ear-heads as compared to early date of sowing.

Effect of pearl millet hybrids

Data presented in table 1 and 2 for various growth and yield attributes revealed hybrid HHB-197 gave the maximum plant height (150.14 cm), effective tillers per plant (20.06) and 1000 grain weight (9.42 g) among the hybrids. The pearl millet hybrid HHB-299 took significantly more days to 50% flowering (52.78) and days to maturity (89.47). The pearl millet hybrid MPMH-17 recorded maximum seed yield (1969 kg ha^{-1}), stover yield (2987 kg ha^{-1}), biological yield (4955 kg ha^{-1}), harvest index (39.19 %), net returns (26943 Rs. ha^{-1}) and B:C ratio (2.54) which was significantly higher over all other hybrids. This pearl millet hybrid MPMH-17 increased seed yield by 26.95, 17.62, 5.75, 16.51, 36.55 and 37.89%, stover yield by 20.98, 13.57, 4.51, 12.72, 27.11 and 28.09%, biological yield by 23.26, 15.13, 5.00, 14.17, 30.67 and 31.78%, harvest index by 2.35, 1.87, 0.64, 1.58, 4.12 and 4.17%, net returns by 48.98, 29.93, 9.11, 27.83, 69.85 and 73.19% and B:C ratio by 25.12, 16.51, 5.39, 15.45, 32.98 and 34.39%, respectively, as compared to pearl millet hybrid of HHB-67, HHB-197, HHB-299, HHB-273, HHB-226 and BHB-1602. The higher grain yield with hybrid

Table 4. Interactions effect of date of sowing and hybrids on economics of pearl millet (pooled of 2021 and 2022)

Pearl millet hybrids	Net Returns (Rs. ha^{-1})			B:C Ratio		
	Sowing dates			Sowing dates		
	15th July	30th July	15th Aug	15th July	30th July	15th Aug
HHB-67 improved	22236	17960	14060	2.27	2.03	1.80
HHB-197	31756	22099	8356	2.81	2.26	1.48
HHB-299	36463	28803	8812	3.08	2.64	1.50
MPMH-17	40358	30962	9507	3.30	2.77	1.54
HHB-273	31640	22386	9206	2.81	2.28	1.53
HHB-226	24363	17480	5747	2.39	2.00	1.33
BHB-1602	23788	16805	6077	2.36	1.96	1.35
	Sowing dates with in hybrid	Hybrids within sowing date		Sowing dates with in hybrid	Hybrids within sowing date	
SEm ±	570.73	843.12		0.03	0.05	
CD at 5%	1861	2576		0.11	0.15	

MPMH-17 was attributed to its longer duration to reach maturity which might have helped to produce more photosynthates and enough time to translocate them to developing grains and also this hybrid had higher effective tillers plant^{-1}, longer ear head length, 1000-seed weight and higher biomass yield. These findings are supported by Oosterom *et al.* (2002), Srikant *et al.* (2000), Tahir *et al.* (2008) and Singh and Chauhan (2010). Similarly, Maqsood & Ali (2007), Sarr *et al.* (2008) and Singh *et al.* (2017) also reported significant differences in pearl millet genotypes with respect to grain yield and straw yield.

Interaction effect of sowing dates and pearl millet hybrids

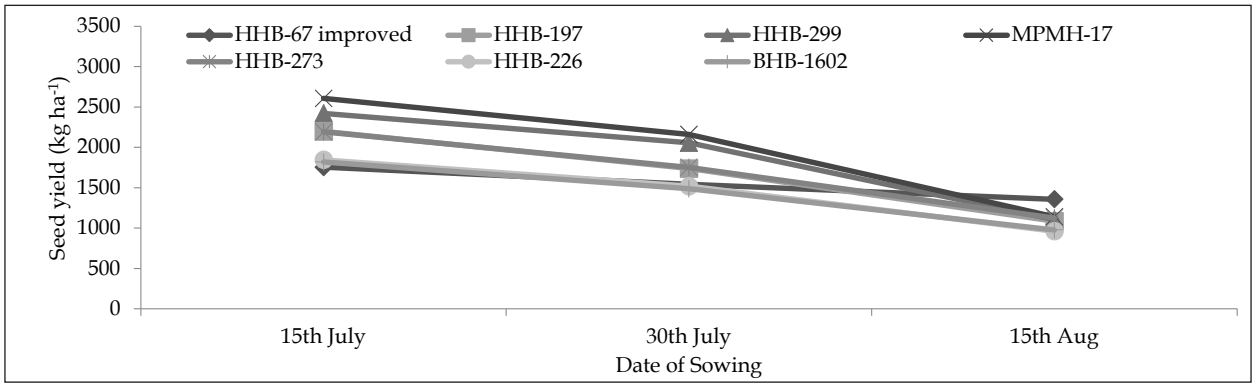

Fig. 1. Interactions effect of date of sowing and hybrids on seed yield of pearl millet

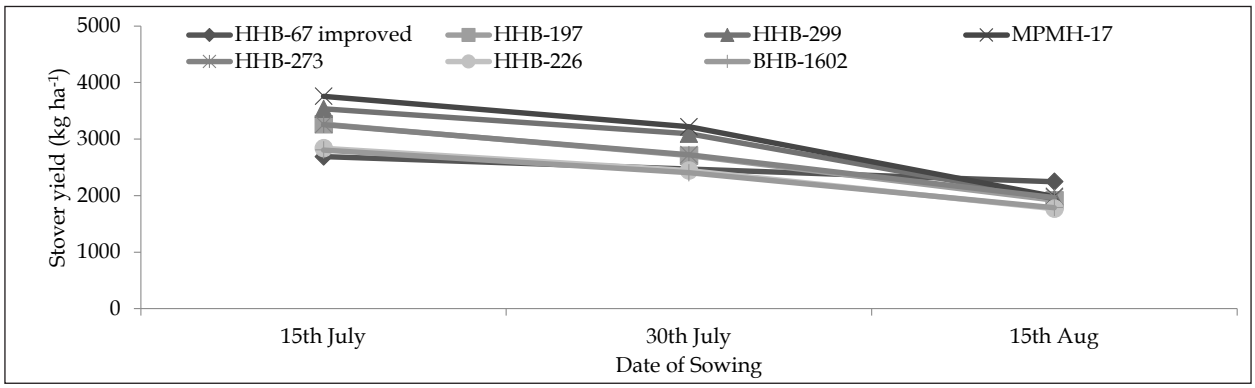

Fig. 2. Interactions effect of date of sowing and hybrids on stover yield of pearl millet

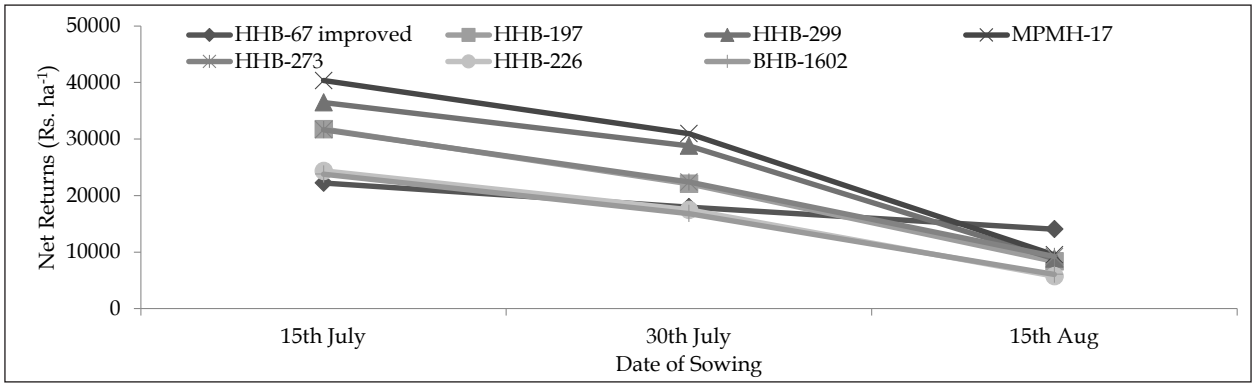

Fig. 3. Interactions effect of date of sowing and hybrids on Net Returns (Rs. ha^{-1}) of pearl millet

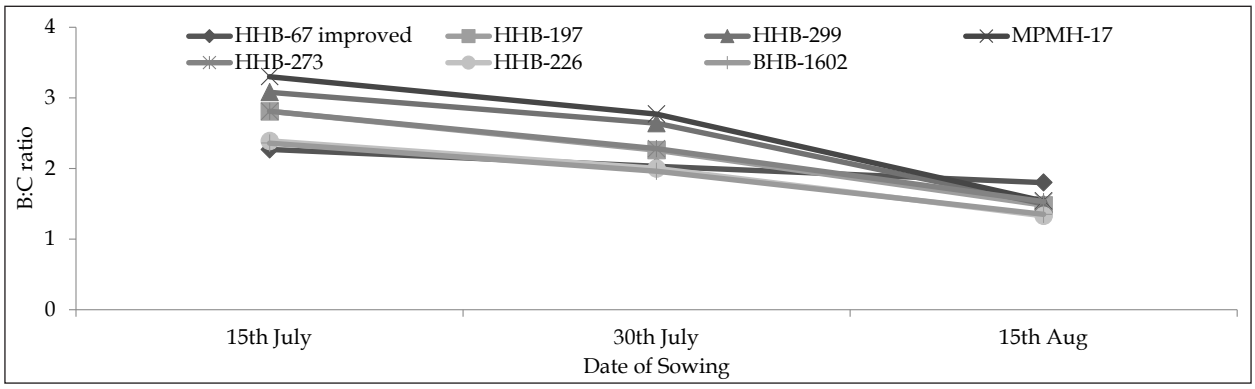

Fig. 4. Interactions effect of date of sowing and hybrids on B:C Ratio of pearl millet

The interaction effects of sowing time and different hybrids showed statistically significant during pooled mean of both the years (Table 3 and 4 and Fig 1-4).

Pearl millet hybrid MPMH-17 sowing at 15th July as well as 30th July while remaining at par with each other recorded maximum grain yield (2606 and 2159 kg ha^{-1}), stover yield (3758 and 3218 kg ha^{-1}), biological yield (6364 and 5377 kg ha^{-1}), harvest index (40.94 and 40.15 %), net returns (40358 and 30962 Rs. ha^{-1}) and B:C ratio (3.30 and 2.77) over other combinations of hybrids of pearl millet with sowing dates. However, hybrid HHB-67 performed better under conditions of late sowing (15th August) than other hybrids.

Conclusions

From the study it is inferred that the pearl millet hybrid MPMH-17 is found most suitable for sowing at 15th July as well as 30th July. The sowing dates of 15th July as well as 30th July provided favorable weather condition for better growth and yield under Rajasthan condition to the hybrid.

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