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Performance of Pearl Millet Hybrids and Their Parents under Variable Environmental Conditions

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ABSTRACT

The experiment was conducted at the research farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar, India during kharif 2016 and 2017 to study the performance of pearl millet hybrids and their parents under variable environmental conditions. At each cropping season, the trials were conducted under rainfed and irrigated conditions with six pearl millet hybrids (HHB 67 (Improved), HHB 197, HHB 272, HHB 226, HHB 234 and HHB 223) and their parental lines i.e., B-Lines (ICMB 843-22, ICMB 97111, HMS 47 B, ICMB 843-22, HMS 7B and ICMB 94555) and R-Lines (H-77/833-2-202, HBL-11, AC 04/13, HBL-11, H-77/833-2-202 and HBL-11). Although pearl millet is a rainfed crop but positive results of irrigation was observed. Results showed that the yield attributing characters and yield was higher under irrigated environment than rainfed condition. The grain yield, stover yield, effective tillers, total tillers were higer in HHB 197 under rainfed situation and HHB 223 under irrigated situation. B-Lines of these hybrids also performed better under different environments but the R-Line AC 04/13 performed better and this line in further can be used in crop improvement programme.

Key words: *Hybrids, B-Lines, R-Lines, Irrigated , Rainfed, Pearl millet, Environment*

INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R. Br. Emend. Stuntz] is one of the major coarse grain crops in the arid and semi arid regions of India. It is grown as subsistence crop largely for its ability to produce grain under hot dry conditions on infertile soils of low water holding capacity where other cereal crops generally fail completely[8]. Pearl millet is mostly grown as rainfed crop during rainy (*kharif*) season. It is an important dual purpose crop. It provides staple food for the poor people in a short period in the relatively dry tracts of the country. Relatively higher protein and β-carotene are especially important from the nutritional point of view for people who rely on millets for food. The average yield of pearl millet in country as well as in the state is quite low as compared to its potential yield because it is grown in the marginal areas with poor management practices.

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Water deficit is one of the major abiotic factors limiting crop productivity in the semi-arid tropics, and climate change is likely to make drought stresses even more severe in the future. It leads to a reduction in the efficiency of important plant processes, including protein synthesis, photosynthesis, respiration, reduction in leaf gas exchange of plants leads to lower biomass accumulation and grain yield[6]. Moisture stress during initial establishment affects the crop stand and so the productivity[2]. The effect of stress on growth and yield depends upon its timing. Terminal drought stress (flowering through grain filling) is more damaging to pearl millet productivity than stress at the vegetative or pre-flowering reproductive crop growth stages. This is because pearl millet's asynchronous tillering behaviour and rapid growth rate allow it to recover rapidly from intermittent drought stress during these earlier stages of plant development, but provide no advantages under unrelieved terminal drought stress. It is most important to resistance to post-anthesis drought stress because the photosynthates produced during this period are transported into the grain. As stress occurrence at post-anthesis stage is vital cause for yield reduction[10]. Farmer's choice of cultivar depends heavily on the availability of favorable growing conditions. In arid areas where drought stress is likely to occur but its timing is highly unpredictable, farmers predominantly grow high tillering local landraces. Studies are conducted with the development of new hybrids, but negligible studies are conducted to evaluate the hybrids and their parents in different environmental conditions in reference to yield and yield attributing characters. So the present study carried to evaluate the performance of pearl millet hybrids and their parents under variable environmental conditions.

MATERIAL AND METHODS

The field investigation was carried out during *kharif* 2016 and 2017 in the Research Area of Bajra Section, Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar in the semi-arid climate at 29° 17' N latitude and 75° 47'E longitude at an altitude of 215.2 meters above mean sea level in the subtropical climatic zone of India. The average rainfall is about 400 mm and most of which is received from South-West monsoon during July to September. Mean relative humidity (7.00 AM) remains nearly constant at about 80 to 90 per cent from July to end of March and decreases to about 40 to 50 per cent in the end of April till June. Mean weekly values of important weather parameters during the crop season recorded at the Meteorological Observatory of the Research Farm, Hisar. The mean maximum temperature varied from 32.7 to 36.0^{0}C and 33.0 to 36.0^{0}C whereas minimum temperature ranged from 23.5 to 26.9^0 C and 22.0 to 28.0^{0}C during 2016 and 2017 crop seasons, respectively. The total amount of rainfall received during the crop seasons was 227 and 344 mm, respectively during 2016 and 2017. The soil had a sandy loam texture, pH (1:2 soil/water ratio) of 8. and electrical conductivity (1:2 soil/water ratio) of 0.14 dS m^{-1}, 0.26 percent organic carbon, 135 kg ha^{-1} available nitrogen, 14.0 kg ha^{-1} available phosphorus and 305 kg ha^{-1} available potassium. At each cropping season, the trials were conducted under rainfed and irrigated (three irrigations applied to cope drought stress) conditions with six pearl millet hybrids (HHB 67 (Improved), HHB 197, HHB 272, HHB 226, HHB 234 and HHB 223) and their parental lines i.e., B-Lines (ICMB 843-22, ICMB 97111, HMS 47 B, ICMB 843-22, HMS 7B and ICMB 94555) and R-Lines (H-77/833-2-202, HBL-11, AC 04/13, HBL-11, H-77/833-2-202 and HBL-11). The experiment was laid out in a randomized block design with three replications. The seed rate was 5 kg ha^{-1} with a spacing of 45 cm x 10 cm. The plots were fertilized as full dose of phosphorus (62.5 kg under irrigated and 20 kg ha^{-1}for rainfed condition) and half dose of nitrogen (62.5 kg for irrigated and 20 kg ha^{-1}under rainfed condition) were applied as per the treatments at the time of sowing and rest of the nitrogen was top dressed after thinning and gap filling. All agronomic practices were carried out uniformly for all treatments.

Number of plants was recorded by adding the number of plants from four quadrates (0.5 X 0.5) thrown at four different spots in each plot at 20 DAS and at harvest and plant population on hectare basis was calculated. The total number of tillers plant^{-1} at harvest were counted in each plot from five tagged plants and divided by five to calculate average number of tillers plant^{-1}. The numbers of tillers plant^{-1} that produced ear head filled with grains were counted as effective tillers plant^{-1}. A random sample of grain was drawn from the produce of each plot. 1000 -grains from each sample were counted by seed counter and their weight was recorded.

RESULTS AND DISCUSSION

Grain yield under irrigated condition was 18.6%, 28.44% and 32.1% higher, respectively of hybrids, B-Lines and R-Lines as compared to their rainfed environment similarly stover yield, 1000 grain weight, total tillers plant^{-1} and effective tillers plant^{-1} were also significantly higher in irrigated environment (Table 1&2).

Under rainfed situation HHB 197 (30.33 q ha^{-1}) obtained highest yield than all other hybrids, but was statistically at par with HHB 226 (28.67 q ha^{-1}) and HHB 272 (28.41 q ha^{-1}). The Hybrid 'HHB 67 Improved' recorded lowest grain yield under rainfed (23.86 q ha^{-1}) environment as compared to others hybrids. The significantly highest grain yield recorded by the HHB 223 (37.36 q ha^{-1}) and HHB 197 (36.57 q ha^{-1}) under the irrigated environment. The hybrid HHB 67 Improved' (28.76 q ha^{-1}) recorded lowest grain yield under irrigated environment as compare to others hybrids.

Among different B-lines, ICMB 94555 (8.61 q ha^{-1}) statistically at par with ICMB 97111 recorded significantly higher grain yield than all others and lowest yield was recorded with the HMS 7 B line (6.75 q ha^{-1}) under rainfed environment. The maximum grain yield of 11.80 q ha^{-1} was recorded by the ICMB 94555 under the irrigated environment but remained statistically at par with ICMB 97111 (11.31 q ha^{-1}). Within R-Lines, AC-04/13 produced significantly higher grain yield under rainfed (7.50 q ha^{-1}) as well as irrigated (10.24 q ha^{-1}) environments as compared to others. The line H 77/833-2-202 recorded the lower grain yield in both rainfed (4.41 q ha^{-1}) and irrigated (6.66 q ha^{-1}) situations.

Higher yield recorded due more number of total and effective tillers, under the rainfed environment, HHB 197 produced significantly more number of tillers plant^{-1} (3.2 & 2.3) as compared with other hybrids. Under the irrigated environment hybrid HHB 223 (3.8 & 3.0), HHB 226 (3.8 & 2.7) and HHB 197 (3.7 & 2.9) produced more number of total and effective tillers plant^{-1} respectively as compared to other hybrids. The performance of B-line (ICMB 94555) was superior in term of total and effective tillers plant^{-1} under rainfed (2.7 & 1.8) as well as irrigated (3.2 & 2.3) environment in comparison to other B-Lines. R-line AC 04/13 produced more number of total and effective tillers plant^{-1} as compared to others, under both rainfed (2.8 & 1.9) and irrigated (3.1& 2.3).

Test weight also follows the same pattern among hybrids it was significantly higher in HHB 197 and HHB 223 over others except HHB 272 and HHB 67 Improved. Under the irrigated environment HHB 223 and HHB 197 exhibited the more test weight over others except HHB 272. Among B-Lines ICMB 97111 and ICMB 94555 under rainfed environment whereas ICMB 94555 and ICMB 97111 under irrigated environment were recorded with significantly more test weight over other tested lines. The R-line AC 04/13 was recorded with significantly more test weight as compared to other tested lines under both the environments. Such effect was due to the genetic variability between the pearl millet genotypes[5]. Kumar *et al.*[7], also found significant differences among the 26 hybrids of pearl millett for earhead girth and test weight at Bawal, Haryana.

The stover yield of hybrid HHB 197 (76.18 q ha^{-1}) was hishest under rainfed environment than followed by HHB 226 (73.81 q ha^{-1}), HHB 272 (73.42 q ha^{-1}) and HHB 223 (71.25 q ha^{-1}). The similar trend was also observed in irrigated environment. The stover yield of B-Lines differed significantly under rainfed and irrigated environments. The stover yield of ICMB 94555 (22.30 q ha^{-1}) was significantly higher under rainfed environment than other B-lines but it was at par with the

ICMB 97111 (21.90 q ha^{-1}) and ICMB 843-22. Similarly in the irrigated environment significantly higher stover yield was also observed in the ICMB 94555 (30.03 q ha^{-1}) over ICMB 843-22. There was significantly higher stover yield of (19.70 q ha^{-1}) was produced by AC 04/13 under rainfed environment and similar trend was found in irrigated situation *i.e.* AC 04/13 (25.75 q ha^{-1}) produced significantly higher stover yield over other R-lines. Plant population at harvest stage of the crop did not differed significantly among different hybrids, B-Lines and R-Lines during both the years. But more population was recorded under irrigated environment.

The better performance of hybrids, B-lines and R-Lines in these above parameters under irrigated environment might be due to the higher rate of water flow from the soil to plant helps in better stomatal conductance and more leaf area which help to sustain better transpiration in pearl millet thereby improving the ear head numbers, its size (in terms of length and girth), 1000 grain weight and final grain yield. Under the irrigated condition due to the most favorable water availability, plants fill their grains using a combination of current photosynthesis and more translocation of photosynthates to reproductive organ from other parts of the plant. Our results are in close conformity with Jordan[3], Khippal and Hooda[5], Saifullah *et al*.[9], Yadav *et al.*[11,1]. Difference in stover yield might be due to increase in plant height, leaf area, more light interception which result in more photosynthesis, higer biomass production plant^{-1} ultimately leads to more stover yield[4].

Table 1: Effect of different treatments on Total number of tillers, Number of effective tillers at harvest, 1000 grain weight

Hybrids		Total number of tillers plant^{-1}		Number of effective tillers plant^{-1} at harvest		1000 grain weight (g)	
		Pooled Rainfed	Pooled Irrigated	Pooled Rainfed	Pooled Irrigated	Pooled Rainfed	Pooled Irrigated
HHB 67 Improved		2.8	3.2	1.8	2.1	9.74	9.94
HHB 197		3.2	3.7	2.3	2.9	10.26	11.00
HHB 223		2.9	3.8	1.9	3.0	10.24	11.03
HHB 226		3.1	3.8	2.2	2.7	9.17	9.71
HHB 234		2.8	3.3	1.9	2.3	8.72	9.46
HHB 272		3.0	3.4	2.0	2.5	9.93	10.50
Mean		**3.0**	**3.5**	**2.0**	**2.6**	**9.67**	**10.27**
SEm ±		**0.04**	**0.04**	**0.04**	**0.03**	**0.19**	**0.24**
CD at 5%	**H**	**0.1**	**0.1**	**0.1**	**0.1**	**0.59**	**0.76**
	Env.	**0.1**		**0.1**		**0.48**	
B- Lines							
ICMB 843-22		2.5	2.8	1.6	1.8	6.75	7.10
ICMB 97111		2.6	3.0	1.7	2.1	8.83	8.99
ICMB 94555		2.7	3.2	1.8	2.3	8.80	9.04
ICMB 843-22		2.6	2.8	1.6	1.8	6.75	7.13
HMS 7 B		2.0	2.9	1.2	1.9	5.74	6.52
47 B		2.1	2.9	1.3	2.0	5.97	6.73
Mean		**2.4**	**2.9**	**1.5**	**2.0**	**7.14**	**7.85**
SEm ±		**0.04**	**0.06**	**0.03**	**0.04**	**0.18**	**0.20**
CD at 5%	**B-Lines**	**0.1**	**0.2**	**0.1**	**0.1**	**0.56**	**0.60**
	Env.	**0.1**		**0.1**		**0.42**	
R-Lines							
H 77/833-2-202		2.4	2.7	1.5	1.7	6.35	6.84
HBL 11		2.7	2.9	1.7	2.0	6.53	7.04
HBL 11		2.6	2.9	1.7	2.0	6.56	7.08
HBL 11		2.6	3.0	1.7	2.1	6.53	7.09
H 77/833-2-202		2.5	2.7	1.5	1.8	6.26	6.81
AC 04/13		2.8	3.1	1.9	2.3	7.25	7.78
Mean		**2.6**	**2.9**	**1.7**	**2.0**	**6.58**	**7.10**
SEm ±		**0.07**	**0.06**	**0.03**	**0.03**	**0.11**	**0.16**
CD at 5%	**R-Lines**	**0.2**	**0.2**	**0.1**	**0.1**	**0.34**	**0.51**
	Env.	**0.1**		**0.1**		**NS**	

Table 2: Effect of different treatments on grain yield, stover yield and plant population

Hybrids		Grain yield (q ha^{-1})		Stover Yield (q ha^{-1})		Population at harvest (000 ha^{-1})	
		Pooled Rainfed	Pooled Irrigated	Pooled Rainfed	Pooled Irrigated	Pooled Rainfed	Pooled Irrigated
HHB 67 Improved		23.86	28.76	64.70	75.60	170.9	175.3
HHB 197		30.33	36.57	76.18	91.15	177.5	180.8
HHB 223		26.72	37.36	71.25	91.59	177.1	181.5
HHB 226		28.67	33.69	73.81	84.85	174.8	178.4
HHB 234		26.24	31.82	68.18	81.56	174.3	178.5
HHB 272		28.41	33.66	73.42	84.81	173.8	177.7
Mean		**27.37**	**33.64**	**71.26**	**84.93**	**174.7**	**178.7**
SEm ±		**0.64**	**0.65**	**2.15**	**2.19**	**2.9**	**2.4**
CD at 5%	**H**	**2.03**	**2.04**	**6.77**	**6.90**	**NS**	**NS**
	Env	**1.44**		**4.84**		**NS**	
B- Lines							
ICMB 843-22		8.04	10.13	21.18	26.73	169.6	174.3
ICMB 97111		8.36	11.31	21.90	29.25	174.0	178.7
ICMB 94555		8.61	11.80	22.30	30.03	172.3	178.6
ICMB 843-22		8.02	10.53	21.58	28.00	169.0	172.6
HMS 7 B		6.75	10.73	18.09	28.25	167.4	174.6
47 B		7.19	11.04	19.15	29.07	168.2	175.9
Mean		**7.80**	**10.90**	**20.70**	**28.55**	**170.1**	**175.8**
SEm ±		**0.14**	**0.23**	**0.78**	**0.62**	**3.1**	**3.6**
CD at 5%	**B-Lines**	**0.44**	**0.76**	**2.46**	**1.96**	**NS**	**NS**
	Env.	**0.43**		**1.57**		**NS**	
R-Lines							
H 77/833-2-202		4.41	6.66	12.26	17.63	167.1	171.6
HBL 11		5.08	7.80	13.83	19.96	170.2	176.5
HBL 11		5.12	7.72	13.42	19.75	170.8	176.2
HBL 11		5.15	7.41	13.40	19.09	169.9	175.3
H 77/833-2-202		4.48	7.02	12.46	18.46	165.9	170.2
AC 04/13		7.50	10.24	19.20	25.75	175.3	179.2
Mean		**5.3**	**7.8**	**14.09**	**20.11**	**169.8**	**174.8**
SEm ±		**0.20**	**0.25**	**0.75**	**0.82**	**2.7**	**3.1**
CD at 5%	**R-Lines**	**0.64**	**0.79**	**2.36**	**2.58**	**NS**	**NS**
	Env.	**0.51**		**1.75**		**NS**	

CONCLUSION

The B-Lines which were superior performer under rainfed and irrigated environments, their hybrids were also superior in term of yield attributing characters and yield but among the R-Lines, AC 04/13 performed better and its potential can be used further. Among the hybrids HHB 197 under rainfed environment and HHB 223 under irrigated environment was higher yielder. It is suggested that if there is no any assured irrigation and crop production based only on rainfall farmer can grow HHB 197 for more economic yield.

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