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Heterosis for grain yield and its component traits in pearl millet in different environments

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ABSTRACT: *In the study ten parents were crossed, to determine the heterosis for grain yield and yield contributing traits in pearl millet using half diallel analysis. The magnitude of heterosis effect was high for grain yield, biological yield, dry fodder yield and harvest index; moderate for days to 50% flowering, days to maturity, productive tillers per plant, plant height, panicle length, panicle girth and test weight and low for protein content in all the three environments. Crosses 26-30 x 31-40, 26-30 x 71-75, 26-30 x RIB-135-144, 31-40 x RIB-20, 31-40 x 71-75, 31-40 x RIB-135-144, 31-40 x 101-105, 41-50 x RIB-20, RIB-20 x 71-75, RIB-20 x RIB-135-144, 61-70 x 71-75, 61-70 x 101-105, 71-75 x 51-60, 71-75 x 101-105 and RIB-135-144 x 101-105 were exhibited the significant heterobeltiosis for grain yield and related traits across the environments. This crosses could be exploited commercially heterosis for breeding programme.*

Keywords: *Pearl millet, heterosis, environments, diallel*

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is a stable diet for the vast majority of poor farmers and also form an important fodder crop for livestock population in arid and semi-arid region of India. It is a cross pollinated crop that originated in western Africa and was introduced to eastern Africa and the Indian sub-continent some 2000 years ago. Heterosis breeding has been recognized as the most suitable breeding methodology for augmenting yield in pearl millet. Selection of suitable parents and assessment of degree of heterosis in the resulting crosses forms an important step. According to Ramamoorthi and Nandarajan, (2001) heterosis breeding was ideal for increasing yield in pearl millet. An extensive survey of pearl millet literature showed 40 per cent average better parent heterosis for grain yield. Therefore the present investigation was conducted to study the extent of hybrid vigour in F_1 for grain yield and its components.

MATERIALS AND METHOD

Ten inbred lines viz. 26-30, 31-40, 41-50, RIB-20, 61-70, 71-75, 75-80, 51-60, RIB-135-144 and 101-105 were crossed in a diallel fashion excluding reciprocals during *kharif* season 2011. Theses ten parents and their 45F_1's were evaluated in randomized block design with three replications under three environments at Agronomy Research Farm, Jobner (Jaipur) during *kharif* season, 2012. Environment created by dates of sowing viz. 2nd July,2012 {first date of sowing(E_1)}, 14th July,2012 {second date of sowing (E_2) and 28th July,2012 {third date of sowing(E_3)}. Each entry was sown in a two row of 3.0m length with row-to-row and plant-to-plant distances of 50 cm and 15 cm, respectively. The observation were recorded on five randomly selected plants from each replication and environment, for the characters namely; days to 50% flowering, days to maturity, productive tillers per plant, plant height, panicle length, panicle girth, biological yield per plant, dry fodder yield per plant, grain yield per plant, harvest index, test weight and protein content while, days to 50% flowering and days to maturity were recorded on plot basis. Heterosis expressed as percent increase or decrease in hybrid (F_1) over its mid parental value and a better parent value in the desirable direction was calculated according to Fonseca and Patterson, 1968).

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RESULT AND DISCUSSION

Wide range of variability exists among parents and their F_1 hybrids for all the traits under study. Out of the 45 hybrids, the range of heterobeltiosis (as percent) in for characters in different environment were -32.79 to14.88 in E_1, -17.54 to 7.83 in E_2 and -17.06 to 8.67 in E_3 (days to 50% flowering), -21.15 to 5.75 in E_1, -18.25 to 10.29 in E_2 and -12.94 to 5.93 in E_3 (days to maturity), -60.67 to 121.43 in E_1, -55.88 to 59.09 in E_2 and -21.05 to 46.67 in E_3 (productive tillers per plant), -16.35 to 69.95 in E_1, -32.71 to 45.69 in E_2 and -24.03 to 59.00 in E_3 (plant height), -16.18 to 59.30 in E_1, -41.91 to 77.32 in E_2 and -39.16 to 49.24 in E_3 (panicle length), -40.47 to 93.18 in E_1, -53.95 to 80.05 in E_2 and -54.38 to 46.30 in E_3 (panicle girth),-35.43 to 277.21 in E_1, -31.11 to 110.48 in E_2 and -27.34 to 71.26 in E_3 (biological yield per plant), -41.17 to 333.93 in E_1, -39.69 to 145.98 in E_2 and -33.61 to 100.45 in E_3 (dry fodder yield per plant), -2.28 to 101.78 in E_1, -31.57 to 82.41 in E_2 and -36.66 to 113.85 in E_3 (grain yield per plant), -65.67 to 71.15 in E_1, -35.11 to 90.39 in E_2 and -45.89 to 76.26 in E_3(harvest index), -37.48 to 56.13 in E_1, -26.94 to 87.87 in E_2 and -35.53 to 96.70 in E_3 (test weight) and -32.29 to 23.31 in E_1, -32.79 to 15.74 in E_2 and -33.62 to 28.73 in E_3 (protein content) (table 1).

The significant desirable heterotic effects over their respective better parent were noticed in 34; 28 and 16 crosses for grain yield per plant in E_1, E_2 and E_3 environments (table 2) indicated that number of crosses exhibited differences in performance in different environments (sowing dates) for character studied. This is expected because of highly significant F_1 x environment interactions was observed. Similar result was found by Yadav (2006), Izge *et al*., (2007), Kumar and Singhania (2007), Chauhan *et al*., (2010) and Jethva *et al*., (2012).

Maximum heterobeltiosis percentage in environments of different characters were -32.79 (26-30 x RIB-20) in E_1, -17.54 (71-75 x 51-60) in E_2 and -17.06 (76-80 x RIB-135-144) in E_3 for days to 50% flowering, -21.15 (26-30 x RIB-20) in E_1, -18.25 (RIB-20 x 51-60) in E_2 and -14.52(41-50 x 71-75) in E_3 for days to maturity, 121.43 (26-30 x 41-50) in E_1, 59.09 (26-30 x 41-50) in E_2 and 46.67(26-30 x 41-50) in E_3 for productive tillers per plant, -16.35(61-70 x RIB-135-144) in E_1, -32.71(61-70 x 71-75) in E_2 and -24.03(71-75 x 51-60) in E_3 for plant height, 59.30 (71-75 x 101-105) in E_1, 77.32 (26-30 x 31-40) in E_2 and 49.24 (26-30 x 31-40) in E_3 for panicle length, 93.18 (41-50 x 71-75) in E_1, 80.05 (26-30 x RIB-20) in E_2 and 46.23(41-50 x RIB-135-144) in E_3 for panicle girth, 277.21(41-50 x 71-75) in E_1, 110.48 (26-30 x RIB-20) in E_2 and 71.26 (26-30 x 41-50) in E_3 for biological yield per plant, 333.93 (41-50 x 61-70) in E_1, 145.98 (26-30 x RIB-20) in E_2 and 100.45 (26-30 x 41-50) in E_3 for dry fodder yield per plant, 101.78 (RIB-20 x 61-70) in E_1, 82.41(26-30 x RIB-135-144) in E_2 and 113.85 (26-30 x RIB-135-144) in E_3 for grain yield per plant, 71.15 (26-30 x 71-75) in E_1, 90.35(61-70 x 71-75) in E_2 and 76.29 (31-40 x 101-105) in E_3 for harvest index, 56.13 (26-30 x 31-40) in E_1, 87.87 (26-30 x RIB-135-144) in E_2 and 96.70 (26-30 x RIB-135-144) in E_3 for test weight and 23.31(RIB-20 x 76-80) in E_1, 15.74 (76-80 x 101-105) in E_2 and 28.73(31-40 x 61-70) in E_3 for protein content (table 3). These findings were support by Yadav (2006), Izge *et al.,* (2007), Davda *et al.,* (2008), Vetriventhan *et al.,* (2008), Bidinger and Yadav (2009), Chotaliya *et al.,* (2009), Chauhan *et al.,* (2010), Vagadiya *et al.,* (2010), Jethva *et al.,* (2012) and Bhadalia *et al.,* (2013).

The general expectation of the pearl millet farmers is mainly focused on level of superiority of newly released hybrids, synthetic/composite and multiline variety than the local standard hybrids or variety, which is grown widely. So there is a compulsory need for the breeder to evaluate the newly developed hybrids, synthetic/composite and multiline variety with such popular check for yield or any other desirable characters.

The hybrids exhibited heterobeltiosis were found to be most promising for grain yield and other desirable traits, hence could be further evaluated to exploit the heterosis or utilized in future breeding programme to obtain desirable segregants for the development of superior inbred lines, multiline and synthetic/ composite variety.

The present study reveals ample variability among the parents and high scope for exploitation of heterosis for advancement of grain yield in pearl millet. The crosses exhibited positively significant heterobeltiosis in all the three environments were 26-30 x 31-40, 26-30 x 71-75, 26-30 x RIB-135-144, 31-40 x RIB-20, 31-40 x 71-75, 31-40 x RIB-135-144, 31-40 x 101-105, 41-50 x RIB-20, RIB-20 x 71-75, RIB-20 x RIB-135-144, 61-70 x 71-75, 61-70 x 101-105, 71-75 x 51-60, 71-75 x 101-105 and RIB-135-144 x 101-105. These crosses were recognized as the best heterotic crosses for grain yield and these crosses can be further evaluated and used in hybrid breeding programme to boost up the grain yield.

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Table 1

Range of heterobeltiosis (as percent) for different characters in E_1, E_2 and E_3 environments.

S.N.	Characters	Range E_1	Range E_2	Range E_3	S.N	Characters	Range E_1	Range E_2	Range E_3
1	Days to 50% flowering	-32.79 to 14.88	-17.54 to 7.83	-17.06 to 8.67	7	Biological yield per plant	-35.43 to 277.21	-31.11 to 110.48	-27.34 to 71.26
2	Days to maturity	-21.15 to 5.75	-18.25 to 10.29	-12.94 to 5.93	8	Dry fodder yield per plant	-41.17 to 333.93	-39.69 to 145.98	-33.61 to 100.45
3	Productive tillers per plant	-60.67 to 121.43	-55.88 to 59.09	-21.05 to 46.67	9	Grain yield per plant	-2.28 to 101.78	-31.57 to 82.41	-36.66 to 113.85
4	Plant height	-16.35 to 69.95	-32.71 to 45.69	-24.03 to 59.00	10	Harvest index	-65.67 to 71.75	-35.11 to 90.39	-45.89 to 76.26
5	Panicle length	-16.18 to 59.30	-41.91 to 77.32	-39.16 to 49.24	11	Test weight	-37.48 to 56.13	-26.94 to 87.87	-35.53 to 96.70
6	Panicle girth	-40.47 to 93.18	-53.95 to 80.05	-54.38 to 46.30	12	Protein content	-32.29 to 23.31	-32.79 to 15.74	-33.62 to 28.73

Table 2

Magnitude of heterobeltiosis (HB) for grain yield per plant in E_1, E_2 and E_3 environments

S. N.	Crosses	E_1 HB	E_2 HB	E_3 HB	S. No.	Crosses	E_1 HB	E_2 HB	E_3 HB
1	26-30 X 31-40	56.95 **	42.13 **	53.13 **	24	41-50 X 101-105	23.97 **	31.10 **	8.45
2	26-30 X 41-50	71.65 **	52.44 **	0	25	RIB-20 X 61-70	101.78 **	11.8	47.46 **
3	26-30 X RIB-20	81.81 **	49.91 **	34.9	26	RIB-20 X 71-75	86.58 **	76.24 **	46.62 **
4	26-30 X 61-70	60.85 **	12.81	41.68 **	27	RIB-20 X 76-80	3.89	1.26	-0.52
5	26-30 X 71-75	61.67 **	49.83 **	45.04 **	28	RIB-20 X 51-60	16.4	59.32 **	-0.93
6	26-30 X 76-80	12.22	-31.57 **	-20.57 *	29	RIB-20 X RIB-135-144	34.01**	53.75 **	36.92*
7	26-30 X 51-60	29.95 **	28.63 **	12.07	30	RIB-20 X 101-105	21.7*	-1.08	-3.28
8	26-30 X RIB-135-144	63.84 **	82.41 **	113.85 **	31	61-70 X 71-75	76.87**	66.67 **	38.35**
9	26-30 X 101-105	35.86 **	5.74	-11.89	32	61-70 X 76-80	3.93	-11.14	-33.33**
10	31-40 X 41-50	5.26	-21.09 *	-28.38 *	33	61-70 X 51-60	16.77	18.33 *	-13.62
11	31-40 X RIB-20	48.60 **	75.51 **	79.87 **	34	61-70 X RIB-135-144	17.91	-9.55	15.65
12	31-40 X 61-70	12.86	15.95 *	12.35	35	61-70 X 101-105	84.85**	18.92 *	59.84**
13	31-40 X 71-75	31.47 **	43.89 **	28.20 *	36	71-75 X 76-80	38.72**	4.25	-13.80
14	31-40 X 76-80	37.97 **	3.79	15.63	37	71-75 X 51-60	42.09**	30.92 **	24.15*
15	31-40 X 51-60	29.21 **	19.49 *	-4.64	38	71-75 X RIB-135-144	32.94**	32.01 **	18.80
16	31-40 X RIB-135-144	51.36 **	63.52 **	108.72 **	39	71-75 X 101-105	36.65**	44.22 **	32.71*
17	31-40 X 101-105	86.21 **	56.01 **	77.46 **	40	76-80 X 51-60	52.88**	-7.46	-18.75*
18	41-50 X RIB-20	59.28 **	42.05 **	45.95 **	41	76-80 X RIB-135-144	-2.28	-4.94	-18.75
19	41-50 X 61-70	79.12 **	18.62 *	3.04	42	76-80 X 101-105	3.93	-26.75 **	-20.30*
20	41-50 X 71-75	67.77 **	-8.01	-8.78	43	51-60 X RIB-135-144	8.47	29.29 **	-16.10
21	41-50 X 76-80	18.67 **	-9.53	-6.51	44	51-60 X 101-105	33.86**	0.56	-36.66**
22	41-50 X 51-60	18.97 *	0.75	-17.96	45	RIB-135-144 X 101-105	27.12**	52.70 **	71.31**
23	41-50 X RIB-135-144	80.41 **	19.40 *	17.91		SE_D	1.124	0.874	1.186

*and**significant at 5% and 1% level of significance, respectively

Table 3
Top three promising crosses for different characters in E_1, E_2 and E_3 environments

S.N.	Characters	E1	E2	E3	S.N.	Characters	E1	E2	E3
1	Days to 50% flowering	26-30 x RIB-20 41-50 x 71-75	71-75 x 51-60 51-60 x RIB-135-144	76-80 x RIB -135-144 61-70 x 51-60	7	Biological yield per plant	41-50 x 71-75 41-50 x 61-70	26-30 x RIB-20 26-30 x 41-50	26-30 x 41-50 31-40 x 61-70
		26-30 x 71-75	61-70 x 51-60	26-30 x 51-60			41-50 x 76-80	26-30 x RIB-135-144	61-70 x RIB-135-144
2	Days to maturity	26-30 x RIB-20	RIB-20 x 51-60	41-50 x 71-75	8	Dry fodder yield	41-50 x 61-70	26-30 x RIB-20	26-30 x 41-50
		RIB-20 x 51-60	61-70 x 51-60	76-80 x RIB-135-144		per plant	31-40 x 51-60	26-30 x 41-50	31-40 x 41-50
		76-80 x RIB-135-144	RIB-20 x RIB-135-144	RIB-20 x 51-60			41-50 x 76-80	26-30 x RIB-135-144	76-80 x 51-60
3	Productive tillers per plant	26-30 x 41-50 41-50 x 51-60	26-30 x 41-50 26-30 x RIB-135-144	26-30 x 41-50	9	Harvest index	26-30 x 71-75 26-30 x RIB-20	26-30 x 71-75 26-30 x 51-60	31-40 x 101-105 RIB-20 x 71-75
		41-50 x 76-80	41-50 x 76-80				31-40 x RIB-135-144	RIB-20 x 51-60	31-40 x RIB-135-144
4	Plant height	61-70 x RIB-135-144	26-30 x 61-70	71-75 x 51-60	10	Test weight	26-30 x 31-40	26-30 x RIB-135-144	26-30 x RIB-135-144
		71-75 x RIB-135-144	26-30 x 71-75	71-75 x RIB-135-144			26-30 x 41-50	26-30 x 41-50	26-30 x 61-70
		76-80 x RIB-135-144	61-70 x 51-60	RIB-20 x 101-105			26-30 x RIB-135-144	26-30 x 51-60	26-30 x 51-60
5	Panicle length	71-75 x 101-105	26-30 x 31-40	26-30 x 31-40	11	Protein content	RIB-20 x 76-80	31-40 x RIB-20	31-40 x 61-70
		76-80 x 51-60	26-30 x 41-50	26-30 x RIB-135-144			76-80 x 101-105	76-80 x 101-105	31-40 x 76-80
		61-70 x 71-75	26-30 x RIB-20	31-40 x 61-70			31-40 x 76-80	31-40 x 61-70	51-60 x RIB-135-144
6	Panicle girth	41-50 x 71-75	26-30 x RIB-20	41-50 x RIB-135-144					
		41-50 x 76-80	26-30 x 71-75	61-70 x RIB-135-144					
		71-75 x RIB-135-144	RIB-20 x 71-75	26-30 x 31-40					

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