HYBRID VIGOUR FOR YIELD, ITS COMPONENTS AND MAJOR DISEASES IN PEARL MILLET [*Pennisetum glaucum* (L.) R. BR.]

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ABSTRACT

The present investigation in pearl millet [Pennisetum glaucum (L.) R. Br.]" was carried out at Pearl Millet Research Station, Junagadh Agricultural University, Jamnagar during Kharif 2015 with an objectives to generate information on heterosis through diallel analysis. The experimental material comprised of 8 parents and resultant 28 hybrids along with a standard check variety GHB 732 were conducted in a randomized block design with three replications. High heterosis was observed for plant height, number of effective tillers per plant, ear head length, fodder yield per plant, harvest index, whereas the magnitude of heterosis was moderate for days to 50 per cent flowering, days to maturity, blast score and low for downy mildew disease. The range of heterobeltiosis was from -31.43 to 140.75 per cent for grain yield per plant and the highest heterobeltiosis was registered by the cross $ICMB_1$ 94555 x $ICMB_4$ 05333 followed by $ICMB_4$ 10444 x $ICMB_4$ 05333 and $ICMB_1$ 94555 x $ICMB_4$ 10444, while the standard heterosis ranged from -50.90 to 51.24 % for grain yield per plant and the cross $ICMB_1$ 95444 x $JMSB_1$ 20102 showed the highest standard heterosis for this trait followed by $ICMB_1$ 95444 x $ICMB_4$ 05333, $ICMB_5$ 01777 x $ICMB_1$ 04999 and $JMSB_1$ 20102 x $JMSB_1$ 20064. These crosses also exhibited desirable heterosis for important yield attributes suggesting that the heterosis for grain yield per plant was associated with heterosis for component characters.

KEY WORDS: Heterosis, heterobeltiosis, pearl millet, standard heterosis

INTRODUCTION

Pearl millet is world's sixth important crop. In India, it is fourth most important food grain crop after rice, wheat and sorghum. Pearl millet [*Pennisetum glaucum* (L.) R. Br.] belongs to family *Poaceae* and genus *Pennisetum*. It is a highly cross-pollinated crop with protogynous flowering and wind borne pollination mechanism, which fulfils one of the essential biological requirements for hybrid development.

Pearl millet is an embodiment of unique features like allogamy, protogyny, male sterility, huge genetic variability and remarkable geographic diversity, but the breeding improvement work in earlier days was neglected because it was considered to be crop of low value. But now-a-days the grain and fodder are the main purposes of cultivation of pearl millet in India and other countries. Nutritionally, the pearl millet grains are rich source of protein (9-15%), fat

(5%), carbohydrates (67%), mineral matters (2-7%), high energy value (>360 Kcal/100g), high Fe, Zn and Ca compared to other cereals. Thus, it is the cheapest source not only energy and protein, but also for micronutrients such as Fe and Zn. It is rich in vitamin-A and B, thiamin and riboflavin content and imparts substantial energy to the body with easy digestibility (*Pal et al.*, 1996). Development of Tift-23-A male sterile source by Burton (1965) opened new vista for the exploitation of heterosis in pearl millet.

Though *per se* performance is taken as selection criterion, information on magnitude of heterosis, combining ability and gene action for grain yield and its components involved in inheritance is more helpful in selecting appropriate parents and desirable cross combinations for commercial exploitation of hybrid vigour. The present study was, therefore, undertaken to determine the extent of heterosis in pearl millet and to identify heterotic hybrids under rainfed condition.

MATERIAL AND METHODS

The eight diverse maintainer lines were crossed in all possible combinations, excluding reciprocals, to make a diallel set during summer-2015. Thus, the experimental materials for the present study consisted of the 28 crosses and their 8 parents along with hybrid GHB 732 as a standard check. This experiment was laid out at Pearl Millet Research Station, JAU, Jamnagar during kharif *2015*. Each entry was represented by a single row of 4.0 m length spaced at 60 x 10-12 cm. All the recommended cultural practices were followed for raising the good crop. The observations were recorded on five randomly selected competitive plants for each entry, in each replication for various characters *viz.*, days to 50 per cent flowering, days to maturity, plant height (cm), number of effective tillers per plant, ear head length (cm), grain yield per plant (g), downy mildew (%) and blast disease Score. The mean values were used in statistical analysis. Estimates of heterosis were calculated according to Fonseca and Patterson (1968). Heterobeltiosis was calculated as the deviation of F_1 from the better parent (Fonseca and Patterson, 1968) and standard Heterosis was calculated as the deviation of F_1 from the standard check and expressed as per cent basis. The significance of heterosis, was tested by using 't' test. The blast disease severity was recorded in score at the hard-dough stage using a 1-9 progressive scale developed at International Rice Research Institute (IRRI), Philippines for rice blast.

RESULTS AND DISCUSSION

The analysis of variance for the experimental design (Table 1) showed significant differences among the genotypes and hybrids for all the characters except for downy mildew, parents showed significant differences for all the characters. This indicated the presence of phenotypic variability in the material selected for the present investigation for grain yield and important yield attributes. The estimates of variance due to parents *vs.* hybrids were significant for all the traits except for downy mildew, which indicated the presence of high level of mean heterosis due to selection of female and male lines with diverse genetic origin.

Pearl millet is grown in erratic conditions of rainfall in marginal lands. Early flowering and maturity is desirable in pearl millet for escaping the drought conditions. Hence, negative heterosis is useful for days to 50 per cent flowering and days to maturity. In the present study, the degree of both the heterosis varied

from cross to cross for all the characters studied (Table 2). With respect to days to 50% flowering, 14 crosses showed significant and negative heterobeltiosis for earliness, there by suggesting the importance of dominance for earliness. The highest negative heterobeltiosis for days to 50 per cent flowering observed in cross combination $JMSB_1$ 20102 x $JMSB_1$ 20064 (-12.41 %) followed by $ICMB_5$ 01777 x $JMSB_1$ 20064 (-10.34 %). None of the crosses showed negative and significant heterosis over standard check. With respect to days to maturity, 14 hybrids showed significant negative heterobeltiosis and no cross showed significant desirable heterosis standard check for days to maturity. The highest significant and negative heterobeltiosis was observed in cross $ICMB_5$ 01777 x $ICMB_1$ 04999 (-6.38%) followed by $JMSB_1$ 20064 x $ICMB_1$ 04999 (-6.33 %). Similar results for days to flowering and maturity in pearl millet was also observed by Chaudhary *et al.* (2012) and Davda *et al.* (2012).

The plant height is regarded as a favourable character due to important role of stem as a source in supplementing assimilates during grain development. Nineteen crosses showed significant and positive heterobeltiosis, whereas four crosses showed significant and positive standard heterosis for this trait. The highest significant and positive heterobeltiosis was observed in cross $ICMB_1$ 94555 x $ICMB_4$10444 (44.96 %) followed by $ICMB_1$ 95444 x $ICMB_1$ 04999 (40.54%). The hybrid, $ICMB_5$ 01777 x $JMSB_1$ 20064 (23.84%) was superior for tallness over standard check followed by $ICMB_5$ 01777 x $JMSB_1$ 20102 (18.09%). These results are in confirmation to the findings Vaghasiya (2009) and Chaudhary *et al.* (2012).

As the number of tillers is a desirable character in pearl millet, the greater number of tillers is considered as a positive character. Five and four crosses displayed significant desirable (positive) heterobeltiosis and standard heterosis, respectively for this trait. The highest significant and positive heterobeltiosis was observed in cross $ICMB_5$ 01777 x $JMSB_1$ 20064 (41.76 %) followed by $JMSB_1$ 20064 x $ICMB_1$ 20064 (36.36%). The highest standard heterosis was registered in the cross $JMSB_1$ 20064 x $ICMB_1$ 04999 (51.52 %) followed by $ICMB_1$ 94555 x $ICMB_4$ 10444 (35.35 %). Bhadalia *et al.* (2011) have also reported the positive and significant heterosis for number of tillers per plant in pearl millet.

In case of ear head length, 14 and 3 hybrids manifested significant and positive heterosis over better parent and standard check, respectively. The highest heterobeltiosis was recorded by the cross $ICMB_5$ 01777 x $JMSB_1$ 20064 (50.99 %) followed by $ICMB_1$ 95444 x $ICMB_4$ 10444 (45.27 %), while, the cross $ICMB_5$ 01777 x $JMSB_1$ 20064 (25.17 %) showed the highest standard heterosis followed by $ICMB_1$ 95444 x $ICMB_4$ 10444 (19.44%). Heterosis for ear head length in pearl millet has also been reported by earlier workers Jethava *et al.* (2012).

In the present investigation, the degree of heterobeltiosis and standard heterosis varied considerably for grain yield and its components. Yield is a character of economic importance, for which considerable magnitude of heterosis was registered in a number of crosses. Out of 28 crosses, 14 and 9 crosses manifested significant and positive heterobeltiosis and standard heterosis, respectively for grain yield per plant. The highest heterobeltiosis was registered by the cross $ICMB_1$

94555 x $ICMB_4$ 05333 (140.75%) followed by $ICMB_4$ 10444 x $ICMB_4$ 05333 (132.60 %). The cross $ICMB_1$ 95444 x $JMSB_1$ 20102 (51.24 %) showed the highest standard heterosis for this trait followed by $ICMB_1$ 95444 x $ICMB_4$ 05333 (40.93 %), (Table 2). The manifestation of heterosis for grain yield per plant in pearl millet has been reported by Jethava *et al.* (2012) and Bhadalia *et al.* (2013).

In the present investigation, out of 28 crosses 07 crosses showed significant and negative heterosis over better parent for downy mildew but none of cross showed significant and negative heterosis over standard check. The highest heterobeltiosis was recorded by the cross $JMSB_1$ 20102 x $ICMB_4$ 10444 (-49.38%) followed by $JMSB_1$ 20102 x $JMSB_1$ 20064 (49.38%). Heterosis for downy mildew in pearl millet has also been reported by earlier worker like Maryam (2015). In case of blast disease, out of 28 crosses 10 crosses showed significant and negative heterosis over better parent for blast but none of crosses showed significant and negative heterosis over standard check. The highest heterobeltiosis was recorded by the cross $ICMB_4$ 10444 x $ICMB_4$ 05333 (-42.17 %) followed by $ICMB_1$ 94555 x $ICMB_5$ 01777 (-38.50 %). Heterosis for blast content in pearl millet has also been reported by earlier worker like Zhang *et al.* (2000).

CONCLUSION

The magnitude of heterosis varied from cross to cross for all the characters studied. The conspicuous heterotic response in certain crosses and low in others, revealed the nature of gene actions, which varied according to the genetic makeup of the parents. Significant level of positive and negative heterobeltiosis and standard heterosis in several crosses for most of the traits also indicated genetic diversity of parents used in present investigation. The cross $ICMB_1$ 95444 x $JMSB_1$ 20102 (51.24 %) showed the highest standard heterosis for grain yield per plant followed by $ICMB_1$ 95444 x $ICMB_4$ 05333 (40.93 %) could be exploited for the development of hybrids by the use of male sterile counterpart of B lines used in these crosses.

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Table 1: Analysis of variance for experimental design for different characters in pearl millet

Source	d.f.	Days to 50% Flowering	Days to Maturity	Plant Height (cm)	No. of Effective Tillers per Plant	Ear Head Length (cm)	Grain Yield per Plant	Downy Mildew Disease	Blast Disease
Replications	2	1.676	1.750	51.420	0.435	0.007	4.825*	1.064	0.159
Genotypes	35	8.881**	10.086**	2446.679**	0.810**	53.073**	544.042**	1.064	0.247**
Parents	7	0.423**	12.000**	1056.313**	0.431**	22.316**	193.070**	4.788**	0.395**
Hybrids	27	8.026**	9.272**	2383.878**	0.877**	49.700**	486.617**	0.000	0.199**
P. *vs.* H.	1	21.191**	18.667**	13874.860**	1.647**	359.453**	4551.321**	3.724	0.515**
Error	70	2.209	2.445	19.276	0.142	4.096	23.205	1.064	0.064

, ** Significant at 5% and 1% levels, respectively

Table 2: Best crosses on the basis of heterobeltiosis and standard heterosis for various characters in pearl millet

Sr. No.	Characters	Best Crosses	
		Heterobeltiosis	**Standard heterosis**
1	Days to 50% Flowering	$JMSB_1$ 20102 x $JMSB_1$ 20064	-
		$ICMB_5$ 01777 x $JMSB_1$ 20064	-
		$ICMB_1$ 95444 x $JMSB_1$ 20064	-
2	Days to Maturity	$ICMB_5$ 01777 x $ICMB_1$ 04999	-
		$JMSB_1$ 20064 x $ICMB_1$ 04999	-
		$JMSB_1$ 20102 x $ICMB_1$ 04999	-
3	Plant Height (cm)	$ICMB_1$ 94555 x $ICMB_4$ 10444	$ICMB_5$ 01777 x $JMSB_1$ 20064
		$ICMB_1$ 95444 x $ICMB_1$ 04999	ICMB5 01777 x $JMSB_1$ 20102
		ICMB5 01777 x $JMSB_1$ 20064	$ICMB_5$ 01777 x $ICMB_4$ 05333
4	No. of Effective Tillers per Plant	$ICMB_5$ 01777 x $JMSB_1$ 20064	$JMSB_1$ 20064 x $ICMB_1$ 04999
		$JMSB_1$ 20064 x $ICMB_1$ 04999	ICMB1 94555 x $ICMB_4$10444
		$ICMB_1$ 95444 x $JMSB_1$ 20064	$ICMB_5$ 01777 x $JMSB_1$ 20064
5	Ear Head Length	$ICMB_5$ 01777 x $JMSB_1$ 20064	$ICMB_5$ 01777 x $JMSB_1$ 20064
		$ICMB_1$ 95444 x $ICMB_4$ 10444	$ICMB_1$ 95444 x $ICMB_4$ 10444
		$JMSB_1$ 20102 x $JMSB_1$ 20064	$JMSB_1$ 20064 x $ICMB_4$ 05333
6	Grain Yield per Plant	$ICMB_1$ 94555 x $ICMB_4$ 05333	$ICMB_1$ 95444 x $JMSB_1$ 20102
		$ICMB_4$ 10444 x $ICMB_4$ 05333	$ICMB_1$ 95444 x $ICMB_4$ 05333
		$ICMB_1$ 94555 x $ICMB_4$ 10444	$ICMB_5$ 01777 x $ICMB_1$ 04999
7	Downy Mildew Disease	$JMSB_1$ 20102 x $ICMB_4$ 10444	-
		$JMSB_1$ 20102 x $JMSB_1$ 20064	-
		$JMSB_1$ 20102 x $ICMB_1$ 04999	-
8	Blast Disease	$ICMB_4$ 10444 x $ICMB_4$ 05333	$ICMB_4$ 10444 x $ICMB_4$ 05333
		$ICMB_1$ 94555 x $ICMB_5$ 01777	-
		$ICMB_4$ 10444 x $JMSB_1$ 20064	-

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