Electronic Journal of Plant Breeding, 7(3): 758-760 (September 2016)
ISSN 0975-928X
DOI: 10.5958/0975-928X.2016.00099.5

Research Note

Estimation of heterosis in pearl millet [*Pennisetum glaucum* (L.)] for yield and quality traits

K.U. Nandaniya. K.D. Mungra* and J.S. Sorathiya*
*Pearl millet Research Center, Junagadh Agricultural University, Jamnagar. (Gujarat)
Email: nandaniyakishor1992@gmail.com

(Received:30 Jul 2015; Accepted:17 Jun 2016)

Abstract
Five CMS lines were crossed with nine testers in a line x tester design to study the extent of heterosis in pearl millet for yield and quality traits. Heterosis was observed in both directions for most of the characters. High magnitude of heterosis was observed for plant height, ear head girth, ear head weight, grain yield per plant and harvest index. The heterosis was moderate for Fe content, Zn content and test weight. The heterobeltiosis for grain yield per plant ranged from -26.50 to 200.00 per cent, while the standard heterosis ranged from -53.38 to 37.79 per cent. The highest heterobeltiosis was recorded by cross $JMSA_1$ 20141 x 149-SB-14 and $JMSA_5$ 20142 x J-2340 followed by $JMSA_1$ 20141 x 81-SB-14, $ICMA_4$ 10444 x 149-SB-14. The cross $JMSA_5$ 20142 x J-2340, $ICMA_4$ 10444 x J-2340 and $ICMA_4$ 10444 x 149-SB-14 recorded the highest standard heterosis for grain yield per plant. 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 character. Thus, these hybrids can be commercially exploited through heterosis breeding programme after testing in multilocational trial to work out its stability and in diseases screening trial to find out its resistance capacity against major pearl millet diseases in order to achieve hybrids with high grain yield in pearl millet.

Keywords
Grain yield, heterosis, *Pennisetum glaucum*, line x tester

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is predominantly grown as the dual purpose crop, grain as well as fodder in marginal lands under erratic and poor rainfed conditions, and is amazingly tolerant to adverse environmental conditions. Pearl millet is a highly cross-pollinated (allogamous) crop. The availability of cytoplasmic genetic male sterile lines in this crop is made feasible to exploit heterosis commercially and hybrid seed production on large scale. The exploitation of heterosis on commercial scale in pearl millet is regarded as one of the major breakthroughs in the improvement of its productivity. Heterosis breeding is an important one, among conventional breeding programme to identify the best hybrids which are promising. With this view the work was undertaken to investigate the heterobeltiosis and standard heterosis for quantifying the extent of heterosis for grain yield and its component characters in pearl millet.

Five male sterile lines *viz.*, $ICMA_1$ 98222, $ICMA_1$ 09555, $ICMA_4$ 10444, $JMSA_1$ 20141 and $JMSA_5$ 20142 were crossed with nine diverse restorer lines *viz.*, 149-SB-14, 150-SB-14, 158-SB-14, J-2340, J-2540, J-2552, J-2555, 81-SB-14 and 85-SB-14 in a line x tester mating design during summer 2014. The resultant 45 cross combinations along with fertile counter parts of five male sterile lines, nine pollinators and the standard check, GHB 558 were grown in a randomized block design with three replications during *Kharif* 2014 at Pearl Millet Research Station, Junagadh Agricultural University, Jamnagar (Gujarat), India. Each entry was represented by a single row of 5.0 m length spaced at 60 x 15 cm. Recommended agronomic practices and plant protection measures were adopted to raise healthy crop. Observations were recorded on five randomly selected plants for each entry, in each replication for various characters. The extent of heterosis over better parent (heterobeltiosis as per Fonseca and Patterson, 1968) and the standard check, GHB 558 (standard heterosis) was worked out for each character.

The analysis of variance for the experimental design showed significant differences among the genotypes, parents and hybrids 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 Zn content, which indicated the presence of high level of mean heterosis due to selection of female and male lines with diverse genetic origin.

The measure of heterosis over mid parental value has relatively limited scope and is of more academic interest than of practical utility. Thus, the heterosis measured in terms of superiority over the better parent and over the standard check hybrid is more valuable. The range of heterosis and number of significant crosses for all the characters are present in Table 1.

Grain yield per plant in pearl millet is the character of economic importance for which 27 hybrids over better parent and 10 hybrids over standard check exhibited significant and positive heterosis. Several hybrids exhibited significant and desirable direction of heterobeltiosis and standard heterosis for various characters such as plant height (38 & 24 hybrids); ear head weight (29 & 15 hybrids); ear head girth (13 & 04 hybrids); test weight (11 & 16 hybrids), harvest index (23 & 5 hybrids); Fe content (05 & 09 hybrids) and Zn content (02 & 02 hybrids) respectively.

In general, high magnitude of heterosis was observed for plant height, ear head girth, ear head weight, grain yield per plant and harvest index and the heterosis was moderate for Fe content, Zn content and test weight.

The hybrid, $JMSA_1$ 20141 x 149-SB-14 for plant height, $JMSA_1$ 20141 x 81-SB-14 for ear head weight, $JMSA_1$ 20141 x 81-SB-14 for ear head girth, $ICMA_1$ 98222 x 150-SB-14 for test weight, $JMSA_1$ 20141 x 149-SB-14 for grain yield per plant, $JMSA_5$ 20142 x J-2340 for harvest index, $ICMA_1$ 98222 x 150-SB-14 for Fe content and $ICMA_1$ 98222 x 85-SB-14 for Zn content showed significant and maximum heterosis over better parent.

The hybrid, $JMSA_1$ 20141 x 149-SB-14 for plant height, $ICMA_4$ 10444 x 85-SB-14 for ear head weight, $ICMA_4$ 10444 x J-2555 for ear head girth, $ICMA_1$ 09555 x J-2540 for test weight, $JMSA_5$ 20142 x J-2340 for grain yield per plant, $JMSA_1$ 20141 x 149-SB-14 for harvest index, $ICMA_1$ 98222 x 150-SB-14 for Fe content and $ICMA_4$ 10444 x J-2555 for Zn content showed significant and maximum heterosis over standard check.

The crosses which showed heterosis for grain yield per plant also showed heterosis for yield attributing components like ear head girth, ear head weight, harvest index and test weight (Table 2).This revealed that the heterosis for grain yield per plant was associated with the heterosis expressed by its component traits. Such a situation of combinational heterosis in pearl millet has also been reported by Ansodariya (2004), Dhuppe *et al.* (2005), Bhanderi *et al.* (2007), Chotaliya *et al.* (2009), Chaudhary *et al.* (2012) and Bhadalia *et al.* (2013). The crosses showing combinational heterosis favour the idea of heterosis breeding for their efficient utilization in future breeding programme. Considerable amount of high heterosis in certain crosses and low in other crosses revealed that nature of gene action varied with the genetic makeup of the parents involved in crosses. As such, nature and magnitude of heterosis helps in identifying superior cross combinations to obtain better transgressive segregants. In view of the variation observed for hybrid vigour, it would be worthwhile to find out suitable combinations, where maximum heterosis can be exploited.

A comparative study of top five crosses for grain yield *per se* (Table 2) indicated that none of the cross combinations depicted desired heterobeltiosis and standard heterosis for all the characters studied. The cross combination $JMSA_1$ 20141 x 149-SB-14 exhibited significant and desired heterosis over better parent and standard hybrid for grain yield per plant also showed significant and desirable heterobeltiosis and standard heterosis for ear head weight and plant height. The hybrid $JMSA_1$ 20141 x 81-SB-14 expressed desirable heterobeltiosis for plant height, ear head girth, ear head weight, test weight and desirable standard heterosis for ear head girth, ear head weight and test weight. These two superior hybrids may be exploited commercially for getting benefits of heterosis for grain yield and its component traits in pearl millet.

References

Ali Ansodariya, V.V. 2004. Genetic studies on yield and its components in pearl millet (*Pennisetum glaucum* (L.) R. Br.). M.Sc. (Agri.) Thesis (Unpublished), J.A.U., Junagadh.

Bhadalia, A.S.; Dhedhi, K.K. and Joshi, H.J. 2013. Heterosis studies in diallel crosses of pearl millet. *J. Agric. Res. Tech..*, **38**(3): 360-365.

Bhanderi, S.H., Dangaria, C.J. and Dhedhi, K.K. 2007. Heterosis studies in newly developed restorers of pearl millet. *Int. J. Bio. sci. Repo.*, **5**(2): 563-569.

Chaudhary, V.B., Dhedhi, K.K., Joshi, H.J. and Sorathiya, J.S. 2012. Genetic variability for grain iron, zinc, protein, yield and yield attributes in pearl millet (*Pennisetum glaucum* (L) R. Br.). *Madras Agric. J.*, **99**(7-9): 465-468.

Chotaliya, J.M., Dangaria, C.J. and Dhedhi, K.K. 2009. Exploitation of heterosis and selection of superior inbreds in pearl millet. *Int. J. Agric. Sci.*, **5**(2): 531-535.

Dhuppe, M.V., Chavan, A.A., More, A.W., More, S.S. and Choudhary, L.M. 2005. Heterosis in pearl millet. *J. Soils and Crops*, **15**(2): 343-351.

Fonseca, S. and Patterson, F.L. 1968. Hybrid vigour in a seven parent diallel cross in common winter wheat (*Triticum aestivum* L.). *Crop Sci.*, **8**: 85-88.

Table 1. Range of heterosis and crosses with significant heterotic effects for various characters in pearl millet

Sr. No.	Characters	Range of heterosis (%)						Number of crosses with significant heterosis			
		Heterobeltiosis (%)			Standard heterosis (%)			H_1 (%)		H_2 (%)	
								+Ve	-Ve	+Ve	-Ve
1.	Plant height	-4.74	to	87.94	-19.31	to	35.28	38	01	24	07
2.	Ear head weight	-17.30	to	165.98	-39.90	to	32.02	29	01	15	09
3.	Ear head girth	-15.37	to	41.22	-25.78	to	36.10	13	08	04	17
4.	Test weight	-28.48	to	31.01	-28.81	to	22.03	11	29	16	25
5.	Grain yield per plant	-26.50	to	200.00	-53.38	to	37.59	27	01	10	09
6.	Harvest index	-25.51	to	91.45	-29.98	to	22.14	13	02	01	05
7.	Fe content	-37.56	to	18.69	-31.79	to	30.26	05	36	09	17
8.	Zn content	-34.06	to	23.64	-26.67	to	24.17	02	20	02	07

Table 2. Heterosis and *per se* performance of top time hybrids

Sr. No.	Crosses	Grain yield per plant	Plant height	Ear head girth	Ear head weight	Test weight	Harvest index	*Per se* for grain yield per plant
	Heterobeltiosis							
1.	$JMSA_1$ 20141 x 149-SB-14	200.00**	87.91**	23.61**	142.27**	17.56**	16.23	61.00
2.	$JMSA_5$ 20142 x J-2340	200.00**	16.50**	1.65	103.31**	-17.33**	91.45**	59.00
3.	$JMSA_1$ 20141 x 81-SB-14	193.44**	35.99**	41.22**	165.98**	19.08**	7.83	59.67
4.	$ICMA_4$ 10444 x J-2340	190.48**	16.21**	5.43	108.85**	24.55**	54.73**	61.00
5.	$ICMA_4$ 10444 x 149-SB-14	190.48**	60.33**	13.33**	136.11**	-28.81**	18.96	61.00
	Standard heterosis							
1.	$JMSA_5$ 20142 x J-2340	37.59**	4.26	--3.59	21.18**	-15.93**	17.25	59.00
2.	$ICMA_4$ 10444 x J-2340	37.59**	-6.06**	-4.26	16.26**	16.95**	16.72	61.00
3.	$ICMA_4$ 10444 x 149-SB-14	37.59**	2.36	2.91	25.62**	-37.50**	11.93	61.00
4.	$JMSA_1$ 20141 x 81-SB-14	34.59**	4.44	19.06**	27..09**	14.24**	13.32	59.67
5.	$JMSA_1$ 20141 x 149-SB-14	33.08**	35.28**	-0.22	15.76	-6.10**	22.14*	61.00

*, ** significant at 5 and 1 per cent level.