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Research Note

Heterosis for yield and morpho-nutritional traits in pearl millet [*Pennisetum glaucum* (l.) R. Br.]

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Abstract
A line x tester analysis was carried out with four male sterile lines and twelve testers. These sixteen parents and forty eight crosses were used to estimate the heterosis for ten morpho-nutritional traits *viz*, plant height, number of effective tillers per plant, ear head length, ear head girth, number of grains per cm^2, 1000-grain weight, fodder yield per plant, grain Fe content, grain Zn content and grain yield per plant. The study revealed that the hybrids DHLB-18A x K-13/1005, DHLB-17A x K-13/1005 and DHLB-18A x K-13/1017 were superior hybrids for exploitation of grain yield and other morpho-nutritional characters.

Key words
Pearl millet, heterobeltiosis, standard Heterosis, grain, Fe content

Pearl millet [*Pennisetum glaucum* (L.) R. Br.)] is the most important drought tolerant warm-season cereal crop predominantly grown as a staple food grain and source of feed and fodder. Pearl millet has balanced genetic load and show considerable inbreeding depression Harinarayana(1980). Therefore, the varieties aimed to be developed in pearl millet should have heterozygous nature to be heterotic and at the same time homogenous constitution to be synchronous and uniformly productive. The male sterile lines have been extensively used in India for development of desirable hybrids. Therefore, breeding efforts are directed towards developing hybrids. The quantum jump (from 303 kg to 1250 kg/ ha) in the productivity of pearl millet was possible mainly through development of hybrids by the utilization of cytoplasmic genetic male sterility system. Now a days heterosis breeding has been recognized as the most suitable breeding tool for boosting up grain yield. It requires evaluation of inbred in terms of their genetic value and the selection of suitable parents for breeding programme. Therefore, the present study was undertaken to identify heterotic crosses for grain yield and morho-nutritional traits in pearl millet.

The present investigation on pearl millet [*P,glaucum* (L.) R. Br.)] was conducted at the Botany Section Farm, College of Agriculture, Dhule during *summer* and *kharif* 2014. Four male sterile lines *viz.*, DHLB - 15A, DHLB-16A, DHLB-17A, DHLB-18A and twelve testers *viz.* K-13/973, K-13/991, K-13/995, K-13/996, K-13/999, K-13/1005, K-13/1007, K-13/1008, K-13/1009, K-13/1011, K-13/1016 and K-13/1017, with varying morho-nutritional characteristics were selected. The four lines and twelve testers were crossed in Line X Tester manner from January 2014 to April 2014 resulting in forty eight hybrids. The resulting hybrids along with the parents were raised in a randomized block design, replicated two times, during July 2014. Observation were made on parents and hybrids for plant height, number of effective tillers per plant, ear head length, ear head girth, number of grains per cm^2, 1000-grain weight, fodder yield per plant, grain Fe content, grain Zn content and grain yield per plant.
The mean values were used for the estimation of relative heterosis (di) (deviation of hybrid from mid parent), heterobeltiosis (dii) (deviation of hybrid from better parent) and standard heterosis (diii) (deviation of hybrid from standard parent) using Shraddha as hybrid check. Significance for heterosis was tested using "t" test Wynne *et al.(*1970).

Heterosis was calculated as percent increase over mid-parent, corresponding better parent and standard parent. The range of heterosis and number of crosses showing a desirable heterotic response for the different morpho-nutritional traits are presented in Table 1. A greater magnitude of standard heterosis more than 30% was noticed in many of the crosses for grain yield per plant, number of effective tillers per plant, ear length and fodder yield per plant. A large number of crosses exhibited standard heterosis in desirable direction for different morho-nutritional traits under study. Table 2 shows the hybrids with highest relative heterosis, heterobeltiosis and standard heterosis for all the morho-nutritional characters. The hybrid DHLB-18A x K-13/1005 exhibited maximum positive and significant standard heterosis for the traits number of effective tillers per plant, grain yield per plant and fodder yield per plant The hybrid DHLB-15A x K-13/1009 showed maximum significant positive and negative standard heterosis for ear head length and plant height, respectively while the hybrid DHLB-17A x K-13/1009 showed maximum positive and significant standard heterosis for ear head girth. The desirable standard heterosis for 1000 grain weight was exhibited by the hybrid DHLB-16A x K-13/1009. The standard heterosis was maximum, positive and significant in DHLB-16A x K-13/1011 for number of grains per cm^2. The hybrids DHLB-18A x K-13/1017 and DHLB-17A x K-13/999 showed standard heterosis for micronutrient grain Fe and Zn content, respectively in desirable direction. Positive and significant standard heterosis for grain yield per plant was already reported by Vagadiya *et al*. (2010).

The hybrid DHLB-18A x K-13/1007 recorded maximum positive and significant heterobeltiosis for grain yield per plant. While, the hybrid DHLB-15A x K-13/999 showed maximum positive and significant heterobeltiosis for number of effective tillers per plant, the hybrid DHLB-16A x K-13/995 registered maximum, positive and significant heterobeltiosis for ear head length. For the trait 1000 grain weight, the hybrid DHLB-17A x K-13/995 showed positive and significant heterobeltiosis. For ear head girth, the maximum positive and significant heterobeltiosis was recorded by the hybrid DHLB-18A x K-13/995. The hybrid DHLB-16A x K-13/1008 registered maximum positive and significant heterobeltiosis for fodder yield per plant as well as for Fe content in grain. For plant height, DHLB-15A x K-13/996 recorded maximum, negative and significant heterobeltiosis. Significant, positive and maximum heterobeltiosis was exhibited by hybrid DHLB-16A x K-13/1011 for number of grains per plant. None of the hybrid showed heterobeltiosis in desirable direction for grain Zn content. Positive and significant heterobeltiosis for grain yield and other morpho-nutritional characters were also reported by Ramamoorthi *et al*., (2000) and Jethva *et al*. (2012). While, previously, Velu *et al*., (2011) and Govindraj *et al*. (2013) was noted negative heterobeltiosis for micronutrient traits, grain Fe and Zn content in pearl millet. Rai *et al*., (2006) also observed none of the hybrids could not even match the level of Zn content as detected in their parents.

From the foregoing discussion, it may be concluded that the hybrids DHLB-18A x K-13/1005 can be rated as the best hybrids based on standard heterosis. It recorded significant and positive standard heterosis for grain yield, number of tillers per plant as well as fodder yield. Thus, the above cross can be exploited in subsequent generations to isolate desirable segregants for developing pearl millet hybrids, as a better response to selection is expected.

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Table 1. Number of crosses showing a desirable heterotic performance and range of heterosis for yield and morpho-nutritional components.

No. of crosses with:	Plant height	Number of effective tillers per plant	Ear head length	Ear head girth	Number of grains per cm^2	1000 grain weight	Fodder yield per plant	Fe content	Zn content	Grain yield per plant
Desirable relative heterosis	0	32	41	23	5	28	47	9	5	48
Heterobeltiosis	7	28	22	9	1	8	47	1	0	47
Standard heterosis	36	20	28	11	36	3	40	9	12	32
Range of relative heterosis (%)	7.37 to 37.66	-1.91 to 65.93	-9.69 to 43.60	-3.13 to 20.99	-22.26 to 22.24	-17.80 to 43.51	24.85 to 189.70	-32.20 to 21.74	-20.40 to 13.99	35.15 to 151.48
Range of heterobeltiosis (%)	-3.29 to 29.93	-12.20 to 64.13	-24.63 to 34.00	-5.63 to 20.69	-33.07 to 12.10	-22.09 to 37.02	16.41 to 167.16	-38.46 to 13.21	-36.51 to 7.84	24.31 to 166.08
Range of standard heterosis (%)	-21.90 to 7.65	-10.48 to 52.38	-14.04 to 31.91	-6.98 to 14.88	-0.98 to 67.42	-28.17 to 20.63	-11.62 to 119.95	-31.03 to 24.14	-18.37 to 22.45	-16.92 to 107.70

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Table 2. Best crosses showing high heterotic vigour for yield and morpho-nutritional components.

Characters	Hybrids with desirable heterosis		
	di	dii	diii
Plant height	-	DHLB-15A x K-13/996	DHLB-15A x K-13/1009
	-	DHLB-17A x K-13/1007	DHLB-16A x K-13/991
Number of effective tillers per plant	DHLB-15A x K-13/999	DHLB-15A x K-13/999	DHLB-18A x K-13/1005
	DHLB-17A x K-13/1007	DHLB-18A x K-13/1005	DHLB-15A x K-13/999
Ear head length	DHLB-17A x K-13/1009	DHLB-16A x K-13/995	DHLB-15A x K-13/1009
	DHLB-16A x K-13/1009	DHLB-17A x K-13/1017	DHLB-17A x K-13/1009
Ear head girth	DHLB-18A x K-13/995	DHLB-18A x K-13/995	DHLB-17A x K-13/1009
	DHLB-17A x K-13/1009	DHLB-17A x K-13/1009	DHLB-17A x K-13/1005
Number of grains per cm^2	DHLB-16A x K-13/1011	DHLB-16A x K-13/1011	DHLB-16A x K-13/1011
	DHLB-17A x K-13/1016	-	DHLB-17A x K-13/1011
1000 grain weight	DHLB-18A x K-13/995	DHLB-17A x K-13/995	DHLB-16A x K-13/1009
	DHLB-16A x K-13/1009	DHLB-18A x K-13/995	DHLB-18A x K-13/1009
Fodder yield per plant	DHLB-15A x K-13/1017	DHLB-16A x K-13/1008	DHLB-18A x K-13/1005
	DHLB-16A x K-13/1008	DHLB-15A x K-13/1009	DHLB-17A x K-13/1005
Grain Fe content	DHLB-18A x K-13/1005	DHLB-16A x K-13/1008	DHLB-18A x K-13/1017
	DHLB-15A x K-13/973	-	DHLB-18A x K-13/973
Grain Zn content	DHLB-16A x K-13/1008	-	DHLB-17A x K-13/999
	DHLB-17A x K-13/1005	-	DHLB-18A x K-13/999
Grain yield per plant	DHLB-15A x K-13/1017	DHLB-18A x K-13/1007	DHLB-18A x K-13/1005
	DHLB-16A x K-13/1007	DHLB-17A x K-13/1007	DHLB-17A x K-13/1005