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K Hussain
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

SH Khan
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Kouser Parveen
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

MI Mukhdoomi
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

B Afroza
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

ZA Dar
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

G Nazir
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

B Zehra
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Correspondence
K Hussain
Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India

Heterosis studies in brinjal (*Solanum melongena* L.)

K Hussain, SH Khan, Kouser Parveen, MI Mukhdoomi, B Afroza, ZA Dar, G Nazir and B Zehra

Abstract
The present investigation entitled "Studies in relation to commercial hybrid development in brinjal (*Solanum melongena* L.)" was carried out to generate information on nature and magnitude of heterosis. There was high heterosis response in most of the hybrids which supports the role of non-additive gene action. Significant positive better parent heterosis was observed in thirty one cross combinations viz., PPC x A.Nidhi, PPC x P. Kranti, PPC x SBPL-27, PPC x A.Kusumakar, PPC x SBW-11, PPC x GBL-1, PPC x GOB-1, PPC x PPL, PPC x L. Long, A.Nidhi x P. Kranti, A.Nidhi x SBPL-27, A. Nidhi x SBW-11, A.Nidhi x GOB-1, A.Nidhi x PPL, A.Nidhi x L. Long, P.Krati x A.Kusumakar, P.Kranti x PPL, SBPL-27 x SBW-11, SBPL-27 x GBL-1, SBPL-27 x GOB-1, SBPL-27 x PPL, SBPL-27 x L. Long, A.Kusumakar x L. Long, SBW-11 x GBL-1, SBW-11 x GOB-1, SBW-11 x PPL, SBW-11 x L. Long, GBL-1 x GOB-1, GBL-1 x PPL, GBL-1 x L. Long, GOB-1 x PPL (Table 9.3). Heterosis (%) over better parent ranged from -84.99 to 226.38 in SBPL-27 x A.Kusumakar and GBL-1 x PPL, respectively. Most superior cross combinations for better parent heterosis were GBL-1 x PPL, PPC x SBW-11, PPC x GBL-1, PPC x GOB-1 and A.Nidhi x P.Kranti exhibiting the heterosis (%) of 226.38, 82.03, 69.03, 67.36 and 64.54, respectively.

Keywords: *Solanum melongena* L., heterosis, gene action

Introduction
Brinjal (*Solanum melongena* L.) is one of the major and principle vegetable crops widely grown in both temperate and tropical regions of the globe. Brinjal has a huge genetic divergence in our country which offers much scope of improvement through heterosis breeding. The effort could enhance its quality and productivity without sacrificing the consumer's choice. The required goals of increasing productivity in the quickest possible time can be achieved only through heterosis breeding, which is feasible in this crop. The estimation of heterosis for yield and its component characters would therefore be useful to judge the best hybrid combination for exploitation of superior hybrids. Exploitation of hybrid vigour has become a potential tool for improvement in egg plant. The present investigation was therefore under taken with an objective to study the extent of heterosis in different crosses and their utilization in future crop improvement programmes. Moreover, the recent surge in widespread adoption of hybrids by farmers also necessitates the development of new and higher yielding hybrids which are able to realize the high degree of economic heterosis.

Materials and Methods
The present investigation was carried out to study general and specific combining ability of parents and crosses, respectively. The experimental materials for the present investigation consisted of ten diverse parental lines viz., Pusa Purple Cluster, Arka Nidhi, Pusa Kranti, SBPL-27, Arka Kusumakar, SBW-11, GBL-1, GOB-1, Pusa Purple Long and Local Long crossed in a diallel fashion during *Kharif* 2011 and 45 cross combinations were generated as per method II and Model-I (1,2). The parents and F_1 crosses were evaluated during *Kharif* 2012 in randomized complete block design with three replications at each of the three different locations viz., Vegetable Experimental Farm, Division of Vegetable Science, SKUAST-Kashmir, Shalimar (E_1), Regional Research Station and Faculty of Agriculture, Wadura (E_2) and Mountain Research Center for Field Crops, Khudwani, Anantnag (E_3). The observations were recorded on days to first flowering, days to first fruit set, days to first fruit picking, plant height (cm), plant spread (cm), number of branches plant^{-1}, fruit length (cm), fruit diameter (cm), number of pickings plant^{-1}, number of fruits plant^{-1}, average fruit weight (g), fruit yield plant^{-1} (kg), fruit yield (q ha^{-1}), dry matter (%), TSS (°Brix), vitamin C (mg 100g^{-1}), anthocyanin (mg 100 g^{-1}), total phenols (mg 100 g^{-1}). The data thus generated, was subjected to standard statistical procedures to generate the results.

Results and Discussion

In the present study, the heterosis was computed over better parent (heterobeltiosis) for each trait from the data pooled over environments and expressed as per cent. The results (Table 1) revealed the wide range of heterotic patterns for different traits.

In addition to cross pollinated species, the phenomenon of heterosis has also been commercially exploited in self and often-cross-pollinated species wherever it was technically feasible because of manifestation of heterosis for different traits. In the present study, heterosis was computed over better parent (heterobeltiosis) for each trait from the data pooled over environments. The results revealed a wide range of heterotic patterns for different traits. Significant and desirable heterosis over better parent was observed in SBPL-27 x GOB-1, A.Kusumakar x GOB-1, A.Kusumakar x L.Long, SBW-11 x GOB-1, SBW-11 x PPL, GBL-1 x L.Long and GOB-1 x L. Long for days to first flowering; PPC x A.Kusumakar, PPC x GBL-1, PPC x L. Long, SBPL-27 x GOB-1, SBPL-27 x PPL, A.Kusumakar x GOB-1, A.Kusumakar x L Long, SBW-11 x GOB-1, SBW-11 x PPL, GBL-1 x GOB-1, GBL-1 x L.Long and GOB-1 x L. Long for days to first fruit set and PPC x A.Kusumakar, PPC x GBL-1, PPC x L. Long, SBPL-27 x GBL-1, SBPL-27 x GOB-1, SBPL-27 x PPL, A.Kusumakar x GBL-1, A.Kusumakar x GOB-1, A.Kusumakar x L.Long, SBW-11 x GOB-1, SBW-11 x L. Long, GBL-1 x GOB-1, GBL-1 x PPl and GOB-1 x PPL for days to first fruit picking, PPC x A.Nidhi, PPC x SBW-11, PPC x GBL-1, A.Nidhi x P.Kranti, A.Nidhi x A.Kusumakar, A.Nidhi x GBL-1, A.Nidhi x GOB-1, A.Nidhi x PPL, A.Nidhi x L.Long, P.Kranti x A.Kusumakar, P.Kranti x SBW-11, P.Kranti x GBL-1, P.Kranti x PPL, A.Kusumakar x PPL and GBL-1 x GOB-1 for plant height, PPC x P.Kranti, PPC x SBW-11, PPC x PPL, A. Nidhi x L. Long, P. Kranti x SBW-11, P.Kranti x L. Long, SBPL-27 x PPL, A.Kusumakar x L. Long, SBW-11 x L. Long, GBL-1 x GOB-1 and GOB-1 x L. Long for plant spread, PPC x P. Kranti, PPC x A. Kusumakar, PPC x GBL-1, A.Nidhi x P. Kranti, A. Nidhi x A. Kusumakar, A.Nidhi x SBW-11, A.Nidhi x GBL-1, A.Nidhi x PPL, P.Kranti x SBPL-27, P.Kranti x A.Kusumakar, P.Kranti x GBL-1, P.Kranti x GOB-1, P. Kranti x PPL, P. Kranti x L. Long, SBPL-27 x SBW-11, SBPL-27 x GOB-1, SBPL-27 x PPL, A.Kusumakar x GOB-1, A.Kusumakar x PPL, SBW-11 x GBL-1, SBW-11 x L. Long, GBL-1 x GOB-1, GBL-1 x PPL, GBL-1 x L. Long, GOB-1 x L. Long and PPL x L. Long for number of branches plant^{-1}, PPC x P. Kranti, PPC x SBPL-27, PPC x GBL-1, A.Nidhi x A.Kusumakar, A.Kusumakar x SBW-11, SBW-11 x GBL-1 and GBL-1 x PPL for fruit length, PPC x A.Nidhi, PPC x SBPL-27, PPC x PPL, A.Nidhi x PPL, P.Kranti x SBPL-27, P.Kranti x SBW-11, P.Kranti x GBL-1, and SBPL-27 x A. Kusmakar. For fruit diameter, PPC x A.Nidhi, PPC x SBW-11, PPC x GBL-1, PPC x GOB-1, PPC x PPL, A.Nidhi x A.Kusumakar, A.Nidhi x GBL-1, A.Nidhi x GOB-1, SBPL-27 x SBW-11, A. Kusmakar x GBL-1, SBW-11 x GBL-1, SBW-11 x GOB-1, GBL-1 x GOB-1, GBL-1 x PPL and GOB-1 x PPL. For average fruit weight, PPC x P.Kranti, PPC x SBPL-27, PPC x A.Kusumakar, PPC x SBW-11, PPC x GOB-1, PPC x PPL, PPC x L. Long, P.Kranti x SBW-11, P. Kranti x GOB-1, P.Kranti x L. Long, SBPL-27 x A.Kusumakar, SBPL-27 x GBL-1, SBPL-27 x PPL, SBW-11 x PPL, SBW-11 x L.Long, GBL-1 x PPL, GOB-1 x L.Long and PPL x L.Long for number of fruits plant^{-1}, PPC x A.Nidhi, PPC x A.Kusumakar, PPC x L. Long, A.Nidhi x GOB-1, P.Kranti x SBPL-27, P.Kranti x PPL, SBPL-27 x GOB-1, SBPL-27 x L. Long, GBL-1 x PPL, GOB-1 x L. Long and PPL x L. Long for number of pickings plant^{-1}, PPC x A.Nidhi, PPC x P. Kranti, PPC x SBPL-27, PPC x A.Kusumakar, PPC x SBW-11, PPC x GBL-1, PPC x GOB-1, PPC x PPL, PPC x L. Long, A.Nidhi x P. Kranti, A.Nidhi x SBPL-27, A. Nidhi x SBW-11, A.Nidhi x GOB-1, A.Nidhi x PPL, A.Nidhi x L. Long, P.Krati x A.Kusumakar, P.Kranti x PPL, SBPL-27 x SBW-11, SBPL-27 x GBL-1, SBPL-27 x GOB-1, SBPL-27 x PPL, SBPL-27 x L. Long, A.Kusumakar x SBW-11, A.Kusumakar x PPL, A.Kusumakar x L. Long, SBW-11 x GBL-1, SBW-11 x GOB-1, SBW-11 x PPL, SBW-11 x L. Long, GBL-1 x GOB-1, GBL-1 x PPL, GBL-1 x L. Long and GOB-1 x PPL for fruit yield, PPC x SBPL-27, PPC x A.Kusumakar, PPC x GBL-1, PPC x L. Long, A.Nidhi x P.Kranti, A.Nidhi x A.Kusumakar, A.Nidhi x GBL-1, P.Kranti x A.Kusumakar, P.Kranti x GBL-1, P.Kranti x A.Kusumakar, P.Kranti x GBL-1, P.Kranti x GOB-1, SBPL-27 x GOB-1, SBPL-27 x PPL, A.Kusumakar x GOB-1, GBL-1 x GOB-1 and GOB-1 x PPL for dry matter, P.Kranti x A.Kusumakar (34.93), A.Kusumakar x GBL-1 (32.76), SBPL-27 x L.Long (25.73) and A.Nidhi x GOB-1 (23.35) for TSS, A.Nidhi x P.Kranti, A.Nidhi x GBL-1, A.Nidhi x GOB-1, P.Kranti x SBPL-27, P.Kranti x SBW-11, P.Kranti x L.Long, SBPL-27 x GBL-1, A.Kusumakar x L.Long, GBL-1 x PPL and GBL-1 x L.Long for vitamin C, PPC x GOB-1, A.Nidhi x P.Kranti, A.Nidhi x SBW-11, A.Nidhi x GOB-1, A.Nidhi x PPL, A.Nidhi x L. Long, P.Kranti x SBPL-27, P.Kranti x A.Kusumakar, P.Kranti x SBW-11, P.Kranti x GBL-1, P.Kranti x GOB-1, P.Kranti x L.Long, SBPL-27 x GBL-1, A.Kusumakar x GBL-1, A.Kusumakar x PPL, A.Kusumakar x L. Long, SBW-11 x GBL-1, SBW-11 x GOB-1, SBW-11 x PPL, SBW-11 x L. Long, GBL-1 x GOB-1, GBL-1 x PPL, GOB-1 x PPL and PPL x L. Long for anthocyanin and PPC x A.Nidhi, PPC x P.Kranti, PPC x GBL-1, PPC x GOB-1, PPC x PPL, PPC x L. Long, A.Nidhi x P. Kranti, A.Nidhi x A.Kusumakar, A.Nidhi x SBW-11, A.Nidhi x GBL-1, A.Nidhi x PPL, A.Nidhi x L. Long, P.Kranti x SBPL-27, P.Kranti x A.Kusumakar, P.Kranti x SBW-11, P.Kranti x GBL-1, P.Kranti x GOB-1, P.Kranti x PPL, P.Kranti x L. Long, SBPL-27 x A.Kusumakar, SBPL-27 x SBW-11, SBPL-27 x GBL-1, SBPL-27 x GOB-1, SBPL-27 x PPL, SBPL-27 x L. Long, A.Kusumakar x SBW-11, A.Kusumakar x GBL-1, A.Kusumakar x GOB-1, A.Kusumakar x PPL, A.Kusumakar x L. Long, SBW-11 x GBL-1, SBW-11 x GOB-1, SBW-11 x PPL, SBW-11 x L. Long, GBL-1 x GOB-1, GBL-1 x PPL, GBL-1 x L. Long, GOB-1 x PPL, GOB-1 x L. Long and PPL x L. Long for total phenols.

The heterosis over better parent ranged from -30.13 to 38.94 per cent in days to first flowering, -25.11 to 32.72 per cent in days to first fruit set, -18.72 to 23.20 per cent in days to first fruit picking, -65.94 to 51.27 per cent in plant height, -40.80 to 47.96 per cent in plant spread, -25.06 to 35.02 per cent in number of branches plant^{-1}, -58.62 to 8.88 per cent in fruit length, -33.75 to 45.38 per cent in fruit diameter, -88.01 to 108.36 in average fruit weight, -59.35 to 95.18 per cent in number of fruits plant^{-1}, -18.14 to 9.57 per cent in number of pickings plant^{-1}, -85.09 to 232.50 per cent in fruit yield, -42.31 to 37.02 per cent in dry matter, -48.64 to 34.93 per cent in TSS, -26.13 to 29.20 per cent in vitamin C and -56.00 to 350.81 per cent in anthocyanins and -16.13 to 55.26 in total phenols. These results are in conformity for various characters studied to those of early workers (3- 16).

Table 1: Estimation of heterosis for maturity and yield attributing traits in brinjal (*Solanum melongena* L.) (pooled data)

Crosses	Days to first flowering	Days to first fruit set	Days to first fruit picking	Plant height (cm)	Plant spread	Number of branches plant^{-1}	Fruit length	Fruit diameter
PPC x A.Nidhi	8.10**	2.62	2.04	32.97**	-15.43**	4.12	-34.95**	45.38**
PPC x P. Kranti	16.82**	15.40**	10.85**	-19.59**	7.83**	29.22**	7.74**	-18.96**
PPC x SBPL-27	29.89**	8.72**	6.20**	-10.33**	-27.53**	5.39	6.74**	15.17*
PPC x A.Kusumakar	6.53*	-19.31**	-9.22**	-34.98**	-26.01**	15.34**	-16.06**	-1.06
PPC x SBW-11	2.16	0.53	0.56	15.91**	47.96**	-16.94**	1.39	-2.21
PPC x GBL-1	12.76**	-12.24**	-3.58**	6.77**	-4.82**	17.86**	5.27*	-15.10**
PPC x GOB-1	29.89**	-0.87	5.47**	-7.58**	-11.76**	-18.97**	-4.79	-11.85**
PPC x PPL	38.94**	23.30**	17.01**	-9.06**	4.71**	-0.39	-53.16**	24.02**
PPC x L. Long	7.77**	-16.96**	-7.51**	-13.16**	-11.12**	-25.06**	-22.74**	-30.22**
A.Nidhi x P. Kranti	13.06**	14.33**	9.89**	13.80**	-26.48**	15.07**	-17.31**	-36.82**
A.Nidhi x SBPL-27	2.30	5.79**	4.27**	-23.95**	-35.43**	-8.40*	-4.73	-0.50
A.Nidhi x A.Kusumakar	28.16**	30.19**	21.40**	17.07**	-19.80**	9.96**	8.88**	-0.89
A.Nidhi x SBW-11	3.83	5.58**	3.58**	2.62	-10.59**	18.04**	-27.59**	-8.54
A.Nidhi x GBL-1	1.14	2.62	2.04*	31.25**	-12.80**	-5.42	3.16	-26.66**
A.Nidhi x GOB-1	-2.02	1.06	0.92	16.55**	-9.59**	15.56**	-3.92	2.45
A.Nidhi x PPL	27.26**	25.21**	17.31**	3.29*	-2.17*	10.38**	-41.79**	37.18**
A.Nidhi x L. Long	28.73**	30.71**	22.52**	34.51**	6.95**	5.43	-8.24**	-30.90**
P.Kranti x SBPL-27	21.07**	23.79**	15.79**	-18.07**	-26.53**	21.50**	-35.64**	25.44**
P.Kranti x A.Kusumakar	4.46	4.06*	3.42**	8.40**	-25.64**	9.97**	-4.17	-19.00*
P.Kranti x SBW-11	22.28**	24.86**	17.51**	6.64**	3.88**	0.24	-8.40**	12.28*
P.Kranti x GBL-1	14.85**	21.36**	15.40**	9.29**	-27.68**	27.93**	-17.17**	23.89**
P.Kranti x GOB-1	21.07**	26.49**	18.45**	-4.84**	-8.40**	24.03**	-18.50**	-2.72
P.Kranti x PPL	1.50	2.16	1.52	3.76*	10.38**	23.42**	-38.54**	-19.44**
P.Kranti x L. Long	30.88**	32.72**	23.20**	-1.54	5.76**	23.88**	0.78	4.94
SBPL-27 x A.Kusumakar	0.79	0.70	0.001	-5.78**	-23.56**	11.54**	-58.62**	23.62**
SBPL-27 x SBW-11	32.24**	31.12**	22.03**	-8.06**	-25.06**	-11.62**	-3.45	4.61
SBPL-27 x GBL-1	0.00	-8.49**	-6.38**	-18.36**	-11.76**	-5.40	1.29	-31.14**
SBPL-27 x GOB-1	-10.71**	-12.27**	-9.29**	-25.37**	-41.46**	17.71**	4.73	-26.06**
SBPL-27 x PPL	-0.29	-3.66*	-2.31*	-65.94**	16.13**	18.24**	-39.35**	-7.83
SBPL-27 x L. Long	14.44**	8.49**	6.20**	-14.06**	-40.43**	-17.08**	-20.44**	-31.53**
A.Kusumakar x SBW-11	1.17	1.58	1.69	-20.10**	-25.62**	5.00	5.15*	-25.88**
A.Kusumakar x GBL-1	5.47**	-12.83**	-9.94**	0.90	-12.45**	-0.37	-0.06	-33.75
A.Kusumakar x GOB-1	-13.08**	-9.34**	-6.30**	-3.10*	-11.26**	11.17**	-34.02**	-31.96**
A.Kusumakar x PPL	29.30**	19.85**	14.19**	21.84**	-10.62**	12.20**	-25.52**	-0.94
A.Kusumakar x L. Long	-11.76**	-25.11**	-18.72**	-4.99**	44.80**	2.54	1.25	-19.58**
SBW-11 x GBL-1	0.29	26.85**	19.20**	-6.15**	0.74	17.65**	5.16*	-33.56**
SBW-11 x GOB-1	-6.82**	-5.60**	-4.14**	-18.99**	-22.23**	-19.31**	-1.22	-13.75**
SBW-11 x PPL	-6.52**	-6.13**	-3.95**	-40.22**	-16.49**	5.80	-52.49**	-13.40*
SBW-11 x L. Long	6.20**	6.10**	4.53**	--11.14**	9.70**	20.81**	-29.77**	-0.46
GBL-1 x GOB-1	-2.31	-19.87**	-14.90**	51.27**	4.19**	24.24**	-0.69	-31.09**
GBL-1 x PPL	13.93**	0.00	0.35	-20.75**	-9.12**	35.02**	5.22**	-20.80**
GBL-1 x L. Long	-4.05*	-20.52**	-15.38**	-1.66	1.90	11.96**	-3.45	7.40
GOB-1 x PPL	-30.13**	-4.90**	-3.56**	0.69	3.65**	0.25	-46.17**	-24.86**
GOB-1 x L. Long	14.34**	20.85**	-0.31	-31.63**	-2.34*	11.82**	-35.73**	-22.67**
PPL x L. Long	37.68**	16.68**	11.87**	-1.59	-20.53**	13.47**	-38.17**	-4.84
Range	-30.13-38.94	-25.11-32.72	-18.72-23.20	-65.94-51.27	-40.80-44.80	-25.06-35.02	-58.62-8.88	-33.75-45.38

*, ** Significant at 5 and 1 per cent levels, respectively

Table 1: Estimation of heterosis for maturity and yield attributing traits in brinjal (*Solanum melongena* L.) (pooled data)

Crosses	Average fruit weight	Number of fruits plant^{-1}	Number of pickings plant^{-1}	Fruit yield plant^{-1}	Fruit yield ha^{-1}	Dry matter	T.S.S	Vitamin C	Anthocyanin	Total phenols
PPC x A.Nidhi	80.41**	-11.89**	4.71**	30.33**	67.77**	2.60	-27.56**	-5.64	-5.00	11.47**
PPC x P. Kranti	-6.22**	19.60**	-18.14**	53.41**	53.54**	1.43	-5.78	6.51	-37.67**	9.58**
PPC x SBPL-27	2.28	31.62**	-4.71**	38.73**	39.04**	9.53**	-21.67**	-3.68	-40.00**	-7.47**
PPC x A.Kusumakar	-3.48*	42.83**	9.14**	37.94**	38.25**	19.42**	-21.11**	-26.13**	5.00	-16.13**
PPC x SBW-11	5.78**	28.38**	-4.43**	76.33**	82.03**	-5.90**	-8.72	-1.93	6.00	-0.73
PPC x GBL-1	108.36**	-18.83**	-4.43**	68.71**	69.03**	16.29**	-16.33*	-13.64**	4.33	12.24**
PPC x GOB-1	20.70**	26.13**	-9.00**	67.45**	67.36**	-42.31**	-12.56	1.27	78.33**	9.68**
PPC x PPL	11.61**	21.40**	-9.00**	48.44**	48.14**	2.73	-43.10**	-6.09	6.33	33.72**
PPC x L. Long	-27.68**	28.93**	4.71**	25.12**	24.99**	6.56**	-38.50**	-1.09	-43.33**	11.52**
A.Nidhi x P. Kranti	-2.86**	-7.10**	-18.14**	64.09**	64.54**	37.02**	-16.14	29.20**	29.33**	17.19**
A.Nidhi x SBPL-27	2.60	-4.55**	-4.71**	34.60**	34.59**	-2.78	-22.75**	-3.27	-4.00	-4.84**
A.Nidhi x A.Kusumakar	33.97**	-59.35**	-13.64**	-38.21**	-38.05**	23.49**	-14.96	6.17	-49.67**	5.19**

A.Nidhi x SBW-11	-10.73**	-12.48**	-8.74**	35.00**	39.46**	-18.91**	-15.86	1.14	68.67**	3.98**
A.Nidhi x GBL-1	10.06**	-30.83**	-8.74**	-24.23**	-24.20**	18.01**	-8.92	30.62**	-13.33*	24.88**
A.Nidhi x GOB-1	34.02**	-22.42**	4.64**	52.20**	52.35**	-8.16**	23.35*	27.45**	72.67**	-11.77**
A.Nidhi x PPL	-2.77*	-12.40**	-4.50**	24.38**	24.39**	-14.31**	-34.75**	3.67	132.67**	31.61**
A.Nidhi x L. Long	-16.23**	-13.22**	-4.71**	30.33**	30.16**	-23.77**	-19.26*	4.74	74.00**	33.51**
P.Kranti x SBPL-27	-47.97**	-3.05	4.71**	-28.89**	-33.42**	-4.17	-8.56	9.61**	43.33**	26.80**
P.Kranti x A.Kusumakar	-10.60**	-3.53**	0.00	26.56**	26.33**	27.35**	34.93**	0.00	39.67**	23.69**
P.Kranti x SBW-11	-51.44**	30.79**	-4.43**	-27.33**	-35.06**	-32.92**	5.07	12.89**	31.67**	20.01**
P.Kranti x GBL-1	-34.45**	-32.82**	0.00	-10.74**	-13.45**	6.38*	-32.40**	2.22	75.67**	22.79**
P.Kranti x GOB-1	-37.37**	10.70**	0.00	-14.66**	-14.77**	15.90**	-30.27**	-0.27	51.00**	26.35**
P.Kranti x PPL	-15.65**	1.24	4.64**	11.88**	6.44**	-13.54**	-38.21**	-1.24	-52.00**	43.71**
P.Kranti x L. Long	-56.08**	28.35**	0.00	-43.60**	-43.85**	-23.48**	-24.20**	16.00**	80.67**	51.56**
SBPL-27 x A.Kusumakar	-88.01**	18.30**	0.00	-85.09**	-84.99**	-0.69	-5.40	-1.82	-49.67**	20.64**
SBPL-27 x SBW-11	29.66**	-22.38**	-2.96**	30.67**	24.63**	-30.78**	-26.40**	-2.38	-56.00**	15.03**
SBPL-27 x GBL-1	-14.12**	16.92**	0.00	42.33**	42.57**	0.16	-12.40	12.58**	71.67**	36.10**
SBPL-27 x GOB-1	41.18**	-26.07**	4.64**	14.66**	14.80**	6.65*	-13.13	4.22	-17.33**	42.19**
SBPL-27 x PPL	41.99**	3.93*	0.00	60.62**	60.80**	15.82**	-40.52**	-7.09*	-27.33**	47.67**
SBPL-27 x L. Long	-14.95**	-0.36	9.57**	13.98**	13.99**	2.20	25.73**	2.36	-15.00*	49.25**
A.Kusumakar x SBW-11	-11.01**	-17.09**	0.00	14.67**	-6.73**	-8.59**	-9.38	-5.21	4.62	15.98**
A.Kusumakar x GBL-1	36.78**	-49.63**	-4.43**	-4.60**	-15.67**	2.02	32.76**	4.95	22.68*	34.31**
A.Kusumakar x GOB-1	-15.96**	-49.69**	9.14**	-44.57**	-48.48**	6.75*	5.86	5.24	19.50	33.64**
A.Kusumakar x PPL	-12.34**	-10.33**	-9.00	3.12**	-10.50**	-0.77	-45.41**	2.71	181.82**	41.90**
A.Kusumakar x L. Long	-9.63**	-6.61**	4.71**	36.49**	36.40**	-0.53	-21.01*	12.14**	100.81**	42.85**
SBW-11 x GBL-1	6.91**	-35.01**	-8.38**	19.94**	20.09**	-32.00**	-3.80	-6.42	66.49**	2.69**
SBW-11 x GOB-1	27.19**	2.75	-16.63**	37.24**	37.06**	-29.89**	-11.13	-14.84**	93.08**	21.01**
SBW-11 x PPL	0.23	6.18**	-8.38**	19.37**	19.17**	-15.30**	-48.64**	-6.31	181.06**	27.37**
SBW-11 x L. Long	-7.93**	19.61**	-16.63**	9.48**	9.52**	-31.37**	-9.60	-7.71*	148.39**	30.74**
GBL-1 x GOB-1	38.79**	-43.18**	-16.63**	28.15**	27.86**	17.92**	2.22	6.72	70.67**	42.78**
GBL-1 x PPL	5.90**	95.18**	8.38**	232.50**	226.38**	2.69	-33.69**	19.44**	67.00**	12.33**
GBL-1 x L. Long	-24.08**	-11.86**	0.00	32.46**	32.27**	0.82	4.03	11.11**	8.00	27.36**
GOB-1 x PPL	39.51**	5.40**	-9.00**	60.62**	50.70**	15.04**	-29.58**	-0.95	32.67**	19.14**
GOB-1 x L. Long	-57.46**	3.40*	4.71**	-44.79**	-44.82**	-19.69**	-12.95	-3.67	10.00	39.50**
PPL x L. Long	-52.46**	7.71**	4.71**	-35.55**	-35.69**	-21.69**	-31.14	6.95	350.81**	55.26**
Range	-88.01-108.36	-59.35-95.18	-18.14-9.57	-85.09-232.50	-84.99-226.38	-42.31-37.02	-48.64-34.93	-26.13-30.62	-56.00-350.81	-16.13-55.26

*, ** Significant at 5 and 1 per cent levels, respectively

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