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Heterosis in relation to multivariate genetic divergence in brinjal (*Solanum melongena*)

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ABSTRACT

The investigation was carried out during 2001–07 to examine the magnitude of heterosis in relation to genetic divergence among 9 parents in a 9 × 9 half-diallel cross of eggplant or brinjal *(Solanum melongena* L.). The 9 parents were grouped in 6 different clusters in the lot of 70 entries (10 elite varieties, 16 stable breeding lines and 44 indigenous cultivars of India and Bangladesh) based on multivariate analysis using Mahalanobis' D^2–statistic employing 18 growth, yield components, fruit yield and fruit quality traits from three years evaluation. Diversity of these 9 parental lines was again determined separately based on 4 important characters including fruit yield. The relationship between intra- and inter-cluster divergence, total divergence of the parents and both relative heterosis and heterobeltiosis of 36 crosses for 4 important characters, viz plant height, fruits/plant, fruit weight, and fruit yield/plant, was determined using correlations and linear regression. It demonstrated positive relationship between genetic distance of the parents and both relative heterosis and heterobeltiosis for fruit yield/plant, however, the relationship was not strong enough for regression of heterosis on genetic distance to confidently predict the level of heterosis based on a given value of genetic distance between the parents indicating that there might be optimum level of genetic divergence between parents to obtain heterosis in the F_1 generation. It is suggested that reliance should also be placed on the genetic distance apart from combining ability while selecting the parents for hybridization in order to realize high frequency of heterotic hybrids in brinjal.

Key words: Brinjal, D^2-statistic, Diallel crosses, Genetic diversity, Heterobeltiosis, Relative heterosis, *Solanum melongena*

Manifestation of heterosis is of direct relevance for developing hybrids in both self and cross-pollinated vegetable crops. Eggplant (*Solanum melongena* L.), the self-pollinated and most popular and widely cultivated vegetable crop in the central, southern and south-east Asia and in some African countries is a prominent vegetable for commercial exploitation of heterosis even by manual production of hybrid seeds because considerable number of hybrid seeds are gettable per cross-pollination. However, in pursuit of taking the programme of hybrid eggplant to logical ends, choice of suitable parents through careful and critical evaluation of the genetics in hand is of paramount importance. This is because *per se* performance of parents is not always a true indicator of its potential in hybrid combinations. There are several criteria by which a breeder can choose suitable parents for successful hybridization, of which the two important are: combining ability of the parents and genetic diversity between the parents. The great interest in genetic diversity arises from the possibility of demonstrating that phenotypic mean values express, in a larger or smaller degree, the genotypic value of an individual. Thus, while evaluating the divergence among populations, based on average phenotypic values, the divergence among genotypic values associated with gene frequency in different sample units (populations, varieties, clones, etc.) is also evaluated. Among the several techniques used to express divergence between samples genetic base, the Mahalanobis' generalized distance (D^2) stands out as one of the most robust (Rao 1952). The cluster analysis based on D^2 data is used for grouping samples in such a way that a high level of homogeneity within each

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group and high heterogeneity between groups is obtained (Johnson and Wichern 1982).

In spite of several genetic explanations for the phenomenon heterosis, it was conceived long before, particularly in corn that its manifestation depend on the genetic divergence of two parents (Hallauer and Miranda Filho 1981). According to Falconer and Mackay (1996), the magnitude of the heterosis manifested in a cross between two samples depend on the square of the gene frequency difference multiplied by the dominant deviation of the character under analysis. Several studies on wide array of crops, viz mungbean, triticale, rape, tomato, blackgram and sesame established close correspondence between the magnitude of genetic divergence and heterosis. However, heterosis does not always occur when divergent lines are crossed as found in alfalfa and sesame. Several research findings indicated that the magnitude of heterosis for yield and its components was found to be higher with restricted range of parental diversity than with extreme ones in different crops, like groundnut, maize, triticale and cowpea. Mohan Rao *et al.* 2004 reported that the estimates of better parent heterosis in sunflower significantly regressed towards the genetic distance of the parents but the relationship was not strong enough for regression of heterosis on genetic distance to confidently predict the level of heterosis based on a given value of genetic distance between the parents. With this background, the present investigation was designed to elucidate the kind of relationship that exists between parental diversity and heterosis over both mid-parent and better parent in brinjal.

MATERIALS AND METHODS

Materials for the commencement of the investigation comprised 70 entries of eggplant consisting of 10 elite varieties of India, 16 stable breeding lines developed at different agricultural universities and research institutes of India and 44 indigenous cultivars collected from the farmers of eastern and north-eastern part of India and Bangladesh conserved at the Department of Vegetable Crops, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India. These entries were evaluated in three consecutive years (2000–03) following randomized block design with 3 replications at Central Research Station, Bidhan Chandra Krishi Viswavidyalaya lying at 23°N latitude, 89°E longitude and at 9.75 m elevation above mean sea level during autumn-winter season (September to March) under the average day and night temperature ranging between 24.8 to 33.4°C and 10.2 to 25.1°C for 18 growth, yield components, fruit yield and fruit quality traits, viz plant height (cm), primary branches/plant, terminal shoots/plant, thickness of terminal shoot (cm), leaves/plant, mean leaf area (cm^2), leaf area/plant (m^2), calyx length, calyx diameter (cm), fruit length (cm), fruit girth (cm), fruits/plant, fruit weight (g), fruit yield/plant (kg), moisture (%), crude protein (g/100 g fresh), total phenol

Table 1 Clustering pattern of 70 entries of brinjal based on pooled data for 18 characters

Cluster	Brinjal entries under the cluster
1	'Bhagyamati' (Hyderabad), 'CH 309' (Ranchi), 'Astrang Local' (Orissa, LC), 'Kanta Makra' (West Bengal, LC), 'Mukta' (Orissa, LC), 'BR 112' (Hisar), 'Malapur Local' (Karnataka, LC), 'BB 40' (Orissa), 'Nilgiri Local' (Orissa, LC), 'CH 166' (Ranchi), 'Coochbehar Local' (West Bengal, LC), 'China' (Bangladesh, LC), 'CO–2' (Tamil Nadu), 'Jafar's Black' (Bangladesh, LC), 'Jessore Local' (Bangladseh, LC), 'Makra' (West Bengal, LC), 'Hisar Pragati' (Haryana), 'CH 243' (Ranchi), 'SM 59' (Hyderabad), 'CH 671' (Ranchi), 'CH 165' (Ranchi), 'CH 668' (Ranchi), 'Orissa Muktakeshi' (Orissa, LC), 'Muktakeshi ' (West Bengal, LC), 'Makra Long' (West Bengal, LC), 'Pusa Purple Long' (New Delhi), 'Duli' (West Bengal, LC), 'Orissa Local' (Orissa, LC), 'Hisar Shyamal' (Haryana), 'Makra Round' (West Bengal, LC), 'Orissa Green' (Orissa, LC), 'BB 14 ' (Orissa), 'Chakdah Local' (West Bengal, LC), 'CH 156' (Ranchi), 'Guli' (West Bengal, LC), 'HLB 25' (Haryana), 'Bholanath' (Tripura, LC), 'Bhangar' (West Bengal, LC)
2	'Haringhata Local' (West Bengal, LC), 'Orissa Local' (Orissa, LC), 'Puri Local ' (Orissa, LC), 'CH 225' (Ranchi), 'CH 207' (Ranchi), 'Hisar Jamuni' (Haryana), 'KS 352' (Kalyanpur), 'NDBS–26–1' (Faizabad), 'NDBS–28–2' (Faizabad), P'LR 1 ' (Tamil Nadu), 'KS 331' (Kalyanpur), 'Utkal Madhu' (Orissa), 'Green Rocket' (Orissa), 'DLB 11' (New Delhi), 'Tufanganj Local' (West Bengal, LC), 'Nadia Local' (West Bengal, LC), 'Sel 4' (Varanasi), 'Falakata Local' (West Bengal, LC), 'Islampuri' (West Bengal, LC), 'Uttara' (Bangladesh), 'Melwanki Local' (Karnataka, LC)
3	'Pusa Purple Cluster' (New Delhi), 'CH 204' (Ranchi), 'Pusa Anupam' (New Delhi), 'Orissa Green ' (Orissa, LC), 'HE 12' (Punjab)
4	'Nawabganj Local' (West Bengal, LC), 'Singhnath Local' (Tripura, LC)
5	'Shyamala' (Hyderabad)
6	'Singnath 666' (Bangladesh)

Note: 1. Place of collection/development of the genotype in parenthesis; 2. LC denotes local cultivar; 3. Other entries are either improved varieties or breeding lines.

(mg/100 g fresh) and total sugar (%) contents of fruits of marketable maturity.Each entry was grown in 2 rows of 6.0 m long with a spacing of 70 cm × 70 cm following all recommended agronomic practices for raising a healthy crop and observations on 18 characters were recorded on 5 randomly selected plants of each entry in a replication. Different biochemical compositions of fresh fruits of marketable maturity (15–25 days after anthesis depending on the genotype) were estimated from the sampled fruits of all the entries following standard methods: total sugars by anthrone method (Dubois *et al*. 1951), crude protein through estimation of nitrogen by micro-kjeldahl method (Sadasivam and Manickam 1996) and total phenols by folin-ciocalteau reagent method (Bray and Thrope 1954) and expressed on fresh weight basis.

Genetic divergence among the entries was estimated by the Mahalanobis' generalized distance ((Mahalanobis 1936) as per Rao (1952) which is defined as: $D^2 = d'W{-}1d$, where d' is transpose of the vector of difference among means of accesses for all p characters, W is the p × p matrix of residual variances and covariances and d is the vector of differences among means of accesses for all p characters. The Tocher method (Rao 1952) was used to define similarity groups. Estimation of inter and intra-cluster distance averages was performed according to Singh and Chaudary (1979). Based on the divergence, as measured by Mahalanobis' D^2 statistic employing pooled data over 3 years for the 18 characters the 70 entries could be grouped into 6 distinct clusters using Tocher's method as described by Rao (1952). Diversity of selected 9 parental lines was again determined separately based on 4 important characters, viz plant height, fruits/plant, fruit weight and fruit yield/plant. The 9 parents selected from the lot of 70 from the 6 clusters ('Muktakeshi': cluster 1; 'Nadia Local' and 'Uttara': cluster 2; 'Pusa Purple Cluster', 'Pusa Anupam' and 'HE 12': cluster 3; 'Nawabganj Local': cluster 4, 'Shyamala': cluster 5 and Singnath 666: cluster 6) were crossed in 9 × 9 diallel mating design excluding the reciprocals.

The 36 hybrids along with their 9 parents were evaluated during autumn-winter season, 2006–07 following randomized block design with 3 replications at Central Research Station, Bidhan Chandra Krishi Viswavidyalaya for 4 quantitative traits, viz plant height (cm), fruits/plant, fruit weight (g) and fruit yield (kg). Each hybrid and parental line was grown in 2 rows of 6.0 m long with a spacing of 70 cm × 70 cm. All the recommended agronomic practices were followed for raising a healthy crop. The observations were recorded on 5 randomly selected plants of each genotype. Ten fruits of marketable maturity (well developed but soft, tender and lustrous) from the 5 selected plants per replication were used to take fruit weight. The mean values computed over 3 replications were used for the estimation of relative heterosis over mid-parent (H1) and heterobeltiosis over better parent (H2). To assess the existence of relationship, if any, between the estimates of both relative heterosis (H1) and heterobeltiosis (H2) of the crosses and genetic divergence of their respective parents as measured by intra and inter-cluster D^2 values based on 18 characters (D^2 1) and total D^2 values of 2 parents based on 4 characters (D^2 2), correlation and regression analysis between heterosis and parental divergence for the selected characters were estimated.

RESULTS AND DISCUSSION

Divergence in parental lines

The analysis of variance revealed significant differences among the 70 entries in respect of all the 18 characters. Based

Table 2 Cluster-wise mean values for 18 characters

Cluster	Plant height (cm)	Primary branches/ plant	Terminal shoots/ plant	Thickness of terminal shoot (mm)	Leaves/ plant	Mean leaf area (cm^2)	Leaf area/ plant (m^2)	Calyx length (cm)	Calyx diameter (cm)
1	72.25	13.65	36.25	3.85	248.06	128.31	3.27	2.93	3.30
2	73.02	13.71	42.68	3.66	261.10	124.73	2.96	2.55	2.75
3	65.67	13.62	40.81	3.27	285.09	107.29	3.07	2.10	2.06
4	58.36	8.00	11.97	4.25	68.71	226.28	4.99	3.24	3.47
5	67.67	16.90	86.20	2.50	330.33	58.43	1.95	1.43	1.45
6	98.47	14.00	27.83	3.23	201.83	152.20	3.01	4.05	1.76

Cluster	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Fruits/ plant	Moisture (%)	Crude protein (g/100 g fresh weight)	Total sugar (%)	Phenol (mg/100 g fresh fruit)	Fruit yield/ plant (kg)
1	9.98	6.02	128.95	19.84	92.51	1.68	3.65	0.09	2.33
2	10.82	5.14	100.61	35.41	91.32	1.49	2.66	0.13	2.93
3	10.52	4.04	51.50	77.81	89.06	1.23	1.69	0.21	3.75
4	14.03	7.91	302.95	3.73	92.48	1.77	3.86	0.08	1.11
5	11.80	2.20	27.27	55.33	89.27	1.29	1.84	0.19	1.54
6	20.43	2.27	53.13	40.50	90.08	1.41	2.49	0.14	2.77

on the divergence between the entries, as measured by the D^2 statistic, the 70 entries were grouped into 6 distinct clusters (Table 1). It revealed lack of correspondence between geographical origin and genetic divergence of the entries. Despite considering as many as 18 wide arrays of characters, grouping of the entries in relatively lesser number of clusters indicated that either common character constellation was manifested simultaneously in the genotypes or mutual balancing in character expression was operative in the genotypes of brinjal, although no character contributed overwhelmingly towards divergence of the genotypes, the highest and lowest being 7.03 and 1.39% by fruit weight and total sugar content of fresh fruit, respectively. However, the estimated genetic divergence among the entries is related only to the variability existing in the characteristics used for their estimation, not allowing extrapolations to other non-analyzed characters. Although cluster-wise mean values for 18 characters showed appreciable variability (Table 2) divergence of the selected 9 parents, as measured by D^2 statistic, were also determined separately employing fruit yield and 3 other important yield components. Hence, both intra- and inter-cluster D^2 values based on 18 characters ($D^2 1$) and total divergence based on 4 characters ($D^2 2$) were utilized to express parental divergence.

Heterosis

Selection of 9 parental lines from all the 6 different clusters was considered relevant in theoretical consideration that not only pure dominance and its interactions but additive × additive epistasis also can cause heterosis and it is likely that very low parental divergence fail to result heterosis. In the 36 cross combinations, the range of relative heterosis (heterosis over mid-parent), H1 and heterobeltiosis (heterosis over better parent), H2 (H1: 0.47 to 52.45%, H2: – 12.12 to 35.58% for plant height; H1: –72.71 to 38.06%, H2: – 85.65 to 11.52% for fruits/plant; H1: –36.76 to 40.42%, H2: – 65.73 to 41.03% for fruit weight and H1: –24.87 to 107.35%, H2: – 37.48 to 83.08% for fruit yield/plant) was very wide revealing considerable variation in manifestation of heterosis in the hybrids for these characters (Table 3). Dominance of small fruitedness and internal balancing between fruit number and fruit weight might have caused marked negative heterosis in about one-third of the hybrids for both fruit number/plant and fruit weight. Although, significant positive heterosis in fruit yield/plant over both mid-parent and better parent was manifested in most of the hybrids but it was not always associated with heterosis in fruits/plant and fruit weight. Six hybrids could be identified as most promising (‘Uttara’ × ‘Pusa Anupam’, ‘Uttara’ × ‘Nawabganj Local’, ‘Pusa Purple Cluster’ × ‘Pusa Anupam’, ‘Pusa Purple Cluster’ × ‘Nawabganj Local’, ‘Pusa Anupam’ × ‘Nawabganj Local’ and ‘Muktakeshi’ × ‘Nawabganj Local’) which manifested commercially exploitable range of 40 to 80% heterosis over better parent (Table 3).

Divergence and heterosis

The genetic divergence of the parents ($D^2 1$, $D^2 2$) and heterosis (both relative heterosis and heterobeltiosis) did not exhibit any definite relationship for fruit yield/plant. For example, of the 6 promising hybrids manifesting high range of heterobeltiosis for fruit yield/plant, one each had low (‘Pusa Purple Cluster’ × ‘Pusa Anupam’: $D^2 1$= 19.93, $D^2 2$ = 63.07) and medium (‘Uttara’ × ‘Pusa Anupam’: $D^2 1$= 43.25, $D^2 2$ = 118.41) parental divergence; one had high (‘Muktakeshi’ × ‘Nawabganj Local’: $D^2 1$= 33.44, $D^2 2$ = 2569.15) and the other three had very high (‘Uttara’ × ‘Nawabganj Local’: $D^2 1$= 61.66, $D^2 2$ = 4630.57, ‘Pusa Purple Cluster’ × ‘Nawabganj Local’: $D^2 1$= 95.44, $D^2 2$ = 5083.65 and ‘Pusa Anupam’ × ‘Nawabganj Local’: $D^2 1$= 95.44, $D^2 2$ = 5922.26) parental divergence. There are few examples where hybrids having low parental divergence (Uttara × Pusa Purple Cluster: $D^2 1$= 43.25, $D^2 2$ = 16.71; HE12 × Nadia Local: $D^2 1$= 43.25, $D^2 2$ = 22.21) manifested considerable heterobeltiosis for fruit yield/plant and on the contrary hybrids having very high parental divergence (‘Nawabganj Local’ × ‘Shyamala’: $D^2 1$= 104.70, $D^2 2$ = 5719.75 and ‘Nawabganj Local’ × ‘Singnath 666’: $D^2 1$= 70.74, $D^2 2$ = 5025.89) registered significant negative heterosis over both mid and better parent (Table 3). Considering the manifestation of medium range of positive relative heterosis (26.79 to 43.69%) and heterobeltiosis (12.17 to 37.82%) in 7 hybrids having low to medium parental divergence, some level of correspondence between parental divergence and heterosis for fruit yield/plant could be indicated.

Correlations between relative heterosis and heterobeltiosis and parental divergence based on both $D^2 1$ and $D^2 2$ for 4 characters registered somewhat consistent associationships (Table 4). Although the association between parental divergence and heterosis for fruit yield/plant was positive in 3 comparisons, in one case only ($D^2 2$ *vs* relative heterosis), the correlation co-efficient (r = 0.371*) was significant (Table 4). Although the estimates of heterosis for fruit yield/plant regressed towards the genetic distance of the parents, it was only significant for relative heterosis regressing towards $D^2 2$ (Table 4) which was not enough for confident prediction of heterosis. Dominance of small fruitedness, internal balancing between fruit number and fruit weight and internal cancellation of components of heterosis as recorded for the expression of negative heterosis for fruit weight and fruit number in about one-third of the hybrids (Table 3) coupled with varied response of multiple characters, presence of linkage, epistasis, etc. might bring about relatively weak association between parental diversity and heterosis. Divergence of parents with respect to some characters not included in the present study might be responsible for manifestation of higher heterosis in certain crosses involving parents having lower parental divergence or parents grouped in the same cluster.

Table 3 Parental divergences of 36 cross combinations (D^2 1 and D^2 2) and percentage relative heterosis (H1) and heterobeltiosis (H2)

Hybrid	D^2 1	D^2 2	Plant height		Fruits/plant		Fruit weight		Fruit yield/plant	
			H1	H2	H1	H2	H1	H2	H1	H2
'Uttara' × 'Pusa Purple Cluster'	43.25	16.71	37.22**	29.31**	13.56**	6.06	16.22**	3.81	43.69**	37.82**
'Uttara' × 'Pusa Anupam'	43.25	118.41	35.2**	32.42**	38.06**	11.52**	28.58**	–2.72	92.07**	83.08**
'Uttara' × 'HE 12'	43.25	180.98	9.83**	4.26	28.13**	–1.75	23.18**	1.86	36.76**	19.74**
'Uttara' × 'Nadia Local'	22.16	96.94	43.94**	27.8**	1.76	–18.55**	22.58**	9.99	41.62**	31.61**
'Uttara' × 'Muktakeshi'	42.86	353.65	21.65**	15.87**	29.62**	–15.92**	–14.68**	–36.18**	24.31**	7.02**
'Uttara' × 'Nawabganj Local'	61.66	4630.57	52.45**	35.58**	9.06**	–42.44**	–26.19**	–56.36**	107.35**	49.86**
'Uttara' × 'Shyamala'	50.73	130.15	7.72*	1.05	3.53	–0.01	2.1	–30.8**	8.19**	–22.68**
'Uttara' × 'Singnath 666'	39.41	50.32	9.81**	–1.42	22.83**	8.80*	–2.36	–17.36**	13.86**	0.18
'Pusa Purple Cluster' × 'Pusa Anupam'	19.93	63.07	48.83**	37.55**	0.27	–14.3**	40.42**	16.02**	50.47**	49.51**
'Pusa Purple Cluster' × 'HE 12'	19.93	122.57	22.39**	21.47**	20.93**	–2.37	25.49**	14.92*	47.98**	25.02**
'Pusa Purple Cluster' × 'Nadia Local'	43.25	53.22	25.79**	18.04**	–12.81**	–26.23**	8.11	7.56	0.52**	–10.12**
'Pusa Purple Cluster' × 'Muktakeshi'	77.74	499.18	14.56**	3.14	6.31	–33.13**	–13.08**	–39.59**	17.89**	5.29**
'Pusa Purple Cluster' × 'Nawabganj Local'	95.44	5083.65	39.05**	30.72**	–4.05	–49.71**	–30.5**	–60.27**	92.87**	43.24**
'Pusa Purple Cluster' × 'Shyamala'	32.43	73.33	4.35	3.84	–4.97	–8.21*	6.12	–22.95**	2.74**	–24.61**
'Pusa Purple Cluster' × 'Singnath 666'	59.07	61.46	5.67	–9.98**	6.63*	–10.98**	3.36	–2.79	0.11	–8.53**
'Pusa Anupam' × 'HE 12'	19.93	55.54	10.72**	3.05	–0.91	–7.52*	32.68**	18.4**	33.47**	12.17**
'Pusa Anupam' × 'Nadia Local'	43.25	49.72	34.76**	17.5**	5.88	4.6	31.43**	7.81	38.37**	23.03**
'Pusa Anupam' × 'Muktakeshi'	77.74	827.12	7.59*	4.57	–8.51**	–45.88**	–11.11*	–44.25**	24.27**	11.62**
'Pusa Anupam' × 'Nawabganj Local'	95.44	5922.26	17.88**	2.95	–18.21**	–57.7**	–37.33**	–65.73**	90.55**	42.11**
'Pusa Anupam' × 'Shyamala'	32.43	93.31	8.82**	0.12	–11.16**	–26.23**	23.72**	4.71	–3.1**	–28.6**
'Pusa Anupam' × 'Singnath 666'	50.07	131.09	6.79*	–2.31	–12.59**	–35.54**	6.75	–7.09	–4.59**	–12.31**
'HE 12' × 'Nadia Local'	43.25	22.21	35.09**	25.87**	10.77**	4.57	6.07	–3.32	26.79**	18.86**
'HE 12' × 'Muktakeshi'	77.74	980.33	6.89*	–3.11	–7.26*	–46.27**	–9.21*	–39.89**	24.86***	–3.72**
'HE 12' × 'Nawabganj Local'	95.44	6063.06	25.58**	17.22**	–24.22**	–60.98**	–30.61**	–61.17**	78.52**	19.13**
'HE 12' × 'Shyamala'	32.43	253.22	9.91**	8.55*	–23.65**	–39.96**	28.32**	–0.96	–17.28**	–45.3**
'HE 12' × 'Singnath 666'	50.07	283.19	2.51	–12.12**	38.65**	–2.14	45.1**	41.03**	49.98**	17.78**
'Nadia Local' × 'Muktakeshi'	42.86	756.39	0.47	–14.5**	–24.02**	–55.22**	–11.13*	–38.05**	8.87**	–11.82**
'Nadia Local' × 'Nawabganj Local'	61.66	5524.57	16.49**	16.27**	–35.78**	–66.82**	–36.05**	–63.39**	30.91**	–9.51**
'Nadia Local' × 'Shyamala'	50.73	176.64	13.91**	7.38*	–14.64**	–29.79**	16.19*	–15.91**	–8.64**	–37.48**
'Nadia Local' × 'Singnath 666'	39.41	204.31	18.94**	–3.84	30.33**	–4.63	16.21**	8.77	43.12**	18.24**
'Muktakeshi' × 'Nawabganj Local'	33.44	2569.15	15.86**	–1.25	175.7**	63.63**	–36.76**	–56.75**	90.13**	53.74**
'Muktakeshi' × 'Shyamala'	83.33	697.68	8.21*	–2.99	–8.73**	–41.72**	–4.84	–44.03**	28.85**	2.74**
'Muktakeshi' × 'Singnath 666'	56.93	424.51	3.59	–2.68	1.26	–29.86**	–7.42	–37.8**	–4.86**	–7.23**
'Nawabganj Local' × 'Shyamala'	104.70	5719.75	18.31**	11.73**	–72.71**	–85.65**	–19.4**	–57.09**	–5.56**	–7.27**
'Nawabganj Local' × 'Singnath 666'	70.74	5025.89	9.53**	–11.31**	–58.24**	–77.62**	–18.7**	–54.21**	–24.87**	–40.4**
'Shyamala' × 'Singnath 666'	55.82	81.13	9.89**	–6.77*	22.69**	5.44	14.64**	–13.27*	6.89**	–16.35**
SE±			3.25	3.54	3.18	3.74	4.55	5.97	0.19	0.22

This study demonstrated positive relationship between genetic distance of the parents and both relative heterosis and heterobeltiosis for fruit yield/plant which would be of interest to check the efficiency of selection of parents based on genetic divergence as envisaged here and in other studies with different crops as well. However, the relationship was not strong enough for regression of heterosis on genetic distance to confidently predict the level of heterosis based on a given value of genetic distance between the parents which also indicated that there was an optimum level of

Table 4. Regression and correlation (r) between parental divergence and heterosis (Relative heterosis and Heterobeltiosis) for four characters

Parental divergence	Relative heterosis	Heterobeltiosis
	Plant height	
$D^2$1	Regression equation=21.706 – 0.0631D^2 (5.9887, 0.1032), r = – 0.104	Regresseion equation =12.8741– 0.0829 D^2 (6.2004, 0.1068), r = – 0.132
$D^2$2	Regresseion equation = 16.742 + 0.0012 D^2 (2.7431, 0.0011), r = 0.183	Regresseion equation =7.201 + 0.0009D^2 (2.507, 0.808), r = 0.137
	Fruits/plant	
$D^2$1	Regresseion equation = 38.497 – 0.6569 D^2 (15.1194, 0.2606), r = – 0.396*	Regresseion equation =21.5748 – 0.8373 D^2 (9.9242, 0.1711), r = – 0.642**
$D^2$2	Regresseion equation = 10.658 – 0.0055 D^2 (7.2732, 0.0029), r = – 0.303	Regresseion equation = –11.5462 – 0.0088 D^2 (4.7211, 0.0019), r = – 0.617**
	Fruit weight	
$D^2$1	Regresseion equation = 38.477 – 0.6753 D^2 (7.3842, 0.1272), r = – 0.673**	Regresseion equation = 28.5487 – 0.9183 D^2 (8.6154, 0.1485), r = – 0.727**
$D^2$2	Regresseion equation = 13.362 – 0.0083 D^2 (3.0216, 0.0012), r = – 0.757**	Regresseion equation = –6.6824 – 0.0105D^2 (3.7863, 0.0015), r = – 0.759**
	Fruit yield/plant	
$D^2$1	Regresseion equation = 21.108 + 0.1703D^2 (14.7185, 0.253), r = 0.114	Regresseion equation = 10.6067 – 0.0499 D^2 (12.591, 0.2171), r = – 0.039
$D^2$2	Regresseion equation = 22.261 + 0.006D^2 (6.377, 0.0025 D^2), r = 0.371*	Regresseion equation = 5.514034 + 0.00184 D^2 (5.7876, 0.0023), r = 0.133

**P* = 0.05, ***P* = 0.01

Standard error of the regression equations in the parenthesis

genetic divergence between parents to obtain heterosis in the F_1 generation. It is suggested that reliance should also be placed on the genetic distance apart from combining ability while selecting the parents for hybridization to realize high frequency of heterotic hybrids in brinjal.

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