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Short communication

Combining ability of quantitative characters in brinjal (*Solanum melongena* L.)

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Brinjal or eggplant (*Solanum melongena* L.) is one of the most common vegetable crop in India. Fruit yield of brinjal is a polygenic in nature and is influenced by environmental factors. Looking towards the great extent of diversity present in various quantitative traits among the genotypes of brinjal there is a tremendous scope for improvement in economic traits through conventional breeding. A knowledge of combining ability helps to make choice of the parents for hybrids and to know the nature of gene action as a basis of choosing an effective breeding methodology. Combining ability is a pre-requisite in any plant breeding programme either for varietal improvement or for evolving a hybrid. The general combining ability in respect of a character is the manifestation of additive gene action. Combining ability has been reported in brinjal by using line x tester analysis (Prakash *et al.*, 1994).

Brinjal, though it is a self pollinated crop yet cross pollination to the extent of 30-40% has also been reported in Bulgaria (Duskalov, 1957), this shows a tremendous potential for heterosis breeding, with increasing popularity of F_1 hybrid in brinjal, it is imperative to obtain such hybrids, as have excellent qualities coupled with high yields. The present investigation therefore was undertaken to identify potential parental combinations in order to have superior hybrids of excellent qualities coupled with high yields.

Ten parents of brinjal viz., RHRB-35(1), RHRB-36(2), RHRB-28(3), RHRB-14(4), RHRB-6(5), RHRB-11(6), RHRB-34(7), RHRB-12(8), RHRB-53(9) and RHRB-54(10) were crossed with all possible combinations excluding reciprocals. These (45 F_1s) were evaluated along with 10 parents under randomized block design with two replications at All India Coordinated Research Project on Vegetable Crops, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.) during 2008-09. The seeds were sown in nursery and the seedlings were transplanted at 75 x 75 cm spacing with a plot size of 2.25 x 4.50 m. All the cultural practices were followed to raise the good crop. Data were recorded on five randomly selected plants in each treatments over replications for 11 characters viz., days to 50 per cent flowering, plant height (cm), number of primary branches, fruit length (cm), fruit diameter (cm), average fruit weight (g), number of fruits per plant, yield (kg/plot), yield (q/ha), per cent fruit borer infestation (number basis) and per cent fruit borer infestation (weight basis). Combining ability variance and effects were worked out according to Griffing (1956).

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Table 1: Analysis of variance for combining ability in F_1 for 11 characters in brinjal

Sources of variation	Mean sum of square										
	Days to 50% flowering	Plant height (cm)	No. of primary branches	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	No. of fruits per plant	Yield (kg/plot)	Yield (q/ha)	FBI (NB)	FBI (WB)
GCA	21.47**	376.60**	66.88**	149.48**	43.05**	242.90**	89.60**	82.07**	11689.92**	26.56**	20.51*
SCA	25.74**	86.71**	56.11**	27.10**	16.37**	81.65**	50.71**	69.61**	9958.15**	11.28	9.93
Error	3.02	12.76	11.79	7.57	1.95	8.26	18.02	14.20	3146.49	8.55	8.19

*, ** Significant at 5%, 1% probability level

Table 2: Estimation of general combining ability effects of parents for various characters in brinjal

Sr. No.	Parents	Days to 50% flowering	Plant height (cm)	No. of primary branches	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	No. of fruits per plant	Yield (kg/plot)	Yield (q/ha)	FBI (NB)	FBI (WB)
1	RHRB-35	0.673	-4.087**	-1.267	6.315**	0.928*	2.138**	0.713	3.767**	48.631**	-1.266	-0.207
2	RHRB-36	0.432	-6.758**	1.358	0.719	0.403	-1.116	-2.146	-2.529*	-25.944	-2.500**	-2.511**
3	RHRB-28	-1.381**	9.793**	-1.308	-0.498	1.303**	5.247**	0.276	4.229**	54.182**	1.418	0.565
4	RHRB-14	2.115**	3.693**	-2.183*	-1.806*	2.740**	3.584**	-3.571**	-0.946	-9.916	0.415	0.580
5	RHRB-6	-0.014	-1.528	-1.350	1.644*	-1.514**	-5.358**	5.006**	0.629	-5.006	0.168	0.285
6	RHRB-11	-1.214*	3.297**	0.192	-0.556	0.636	1.390	3.268**	0.505	-8.811	1.171	1.200
7	RHRB-34	-0.010	6.372**	-0.392	0.461	1.540**	3.445*	-2.602*	-2.379*	-24.594	0.777	0.405
8	RHRB-12	-2.273**	-3.008**	5.817**	-7.110**	-2.835**	-7.108**	-1.587	-3.663**	-39.780*	-0.262	0.008
9	RHRB-53	0.111	-6.845**	0.983	3.069**	-0.214	3.888**	-1.097	-0.900	-7.464	-1.937*	-1.985*
10	RHRB-54	1.561**	-0.928	-1.850	-2.239**	-2.985**	-5.612**	1.740	1.288	18.701	2.016*	1.661*
	S.E. (gi)±	0.476	0.978	0.940	0.753	0.383	0.787	1.162	1.032	15.361	0.801	0.783
	S.E. (gi-gj)±	0.710	1.458	1.402	1.123	0.571	1.173	1.733	1.538	22.900	1.194	1.168

*, ** Significant at 5%, 1% probability level.

Analysis of variance (Table 1) revealed significant differences among the parents for all the characters studied. Upon partitioning, it was further revealed that variance due to the parents and hybrids were also significant for all the characters except per cent fruit borer infestation both number and weight basis. Similarly, variance due to cross and its components, parents vs hybrids were found highly significant for all the characters except number of primary branches, fruit length and per cent fruit borer infestation both at number and weight basis. Combining ability analysis indicated significant variance due to parents and hybrids. The variance due to interaction between parents and hybrids was found highly significant for all the characters revealed the importance of additive components of genetic variance in the inheritance of these traits on the other hand, variance due to sca were significant for all the characters except per cent fruit borer infestation at number and weight basis. The gca/sca variance ratio being less than unity for most of the characters revealed predominance of non-additive components of variance (Table 2). The importance of both additive as well as non-additive components for number of fruits per plant, branches per plant, plant height and yield (kg/plot and q/ha) in brinjal was reported by Ramesh *et al.* (1996).

The general combining ability (gca) effects revealed that the parents used were found good general combiner for most of the characters. However, among parents RHRB-35, RHRB-28, RHRB-14, RHRB-34, RHRB-12 and RHRB-53 were good general combiner for as many as five to eight characters on the strength of the magnitude of gca effects for various traits (Table 3). The parents 1, 2, 8 and 9 were recorded negative significant gca effects for per cent fruit borer infestation both at number and weight basis indicating that these parents should be further exploited for hybridization programme for tolerance to this character. The results are in close conformity with those reported by Ramesh *et al.* (1996) and Padmanabhan and Jagdish (1996).

The sca effects for hybrids pertaining to different characters are given in Table 3. As regard specific combining ability effects of the crosses viz., 2 x 3, 6 x 7, 7 x 8, 1 x 4, 2 x 6, 1 x 9, 1 x 6, 2 x 9, 3 x 5 significantly scored for yield (q/ha), yield (kg/plot), number of fruits per plant, fruit weight, fruit diameter, fruit length, plant height and days to 50 per cent flowering. Most of the other cross combinations were also significant for yield and most of yield related traits. These crosses exhibited significant sca effects indicating the presence of dominance and epistatic (non-additive)

Table 3: Estimation of specific combining ability effects of crosses for various traits in brinjal

Name of crosses	Days to 50% flowering	Plant height (cm)	No. of primary branches	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	No. of fruits per plant	Yield (kg/plot)	Yield (q/ha)	FBI (NB)	FBI (WB)
1 x 2	-3.330**	0.713	-1.928	11.450**	3.927**	13.047**	4.721**	3.201**	33.418**	2.535*	0.638
1 x 3	3.133**	6.813**	3.239**	-0.033	-1.073	1.734	4.998**	3.188**	33.267**	-1.532	1.758
1 x 4	-3.913**	-2.337*	-0.386	2.475*	-0.910	-7.253**	10.250**	10.208**	119.200**	3.406**	-0.833
1 x 5	-5.034**	2.534*	4.780**	2.525	1.944	5.788**	4.703**	10.617**	137.830**	1.627	0.187
1 x 6	-5.184**	9.959**	-2.761**	0.225	1.944*	-1.885	3.442**	4.311**	74.681**	0.844	0.373
1 x 7	3.612**	-10.216**	6.322**	1.709	3.690**	10.161**	-5.488**	-2.914**	-38.597**	2.074*	3.777**
1 x 8	0.875	8.463**	4.114**	-4.470**	-1.935	-3.112**	9.397**	5.964**	66.449**	-3.212**	-2.530*
1 x 9	-6.459**	-0.399	-3.553**	4.000**	1.444	11.192**	-3.624**	-1.263	-18.662**	1.233	1.163
1 x 10	-3.459**	-0.416	-2.220*	-2.591*	-1.285	-6.558**	2.469*	4.599**	50.618**	-0.600	-2.569*
2 x 3	5.725**	7.834**	3.614**	1.663	-1.248	-5.412**	16.092**	14.624**	168.366**	1.361	2.936**
2 x 4	-9.321**	2.684**	0.989	-5.929**	-6.085**	-12.249**	-4.396**	-4.106**	-48.716**	-2.196*	-1.129
2 x 5	-3.792**	0.705	-5.845**	-8.379**	-2.031*	-2.908**	2.892**	1.948	35.024**	-2.659**	2.371**
2 x 6	-1.892	-2.870**	-4.386**	-2.179*	-1.981*	-3.805**	10.101**	6.677**	93.410**	-4.747**	-2.799**
2 x 7	-2.596**	6.005**	-6.303**	2.305	3.815**	0.740	2.901**	0.437	9.697**	-0.918	-1.710
2 x 8	4.216**	-4.366**	5.989**	-1.425	-0.210	-2.208*	-1.974*	-2.175*	-29.937**	2.087*	-2.842**
2 x 9	5.233**	-8.478**	1.322	2.696**	1.469	1.797	3.165**	6.937**	78.512**	-0.328	-0.234
2 x 10	-1.767	7.205**	-1.345	-3.295**	5.140**	0.197	-6.372**	-2.815**	-37.308**	5.369**	-2.285*
3 x 4	-0.409	2.084*	-5.345**	-7.412**	-4.085**	-13.162**	-0.148	3.256**	11.723**	-1.828	-5.690**
3 x 5	-4.430**	14.505**	-1.178	6.838**	2.769**	0.330	1.075	2.300*	74.719**	1.118	0.655
3 x 6	-4.530**	7.880**	3.780**	-4.962**	-4.881**	-12.018**	-0.757	1.969*	37.579**	2.460*	4.496**
3 x 7	0.716	4.405**	-0.136	-10.479**	-5.785**	-10.472**	1.913	2.729**	28.176**	-4.101**	-2.495*
3 x 8	-3.621**	6.884**	-9.345**	2.092*	1.390	-6.470**	1.133	1.107	8.933**	3.034**	0.483
3 x 9	-2.905**	2.022*	-11.511**	-7.487**	-2.031*	-11.866**	9.243**	10.269**	117.951**	-2.221*	-0.984
3 x 10	-2.455**	-8.095**	-0.678	-0.179	2.840**	-5.616**	-1.729	-3.683**	-47.648**	1.471	-1.911
4 x 5	-7.825**	3.205**	-8.303**	-7.154**	-4.869**	-6.308**	-0.143	-0.845	4.656**	1.296	0.120
4 x 6	-2.575**	-4.370**	-4.345**	6.846**	2.881**	8.695**	-10.075**	-5.696**	-50.503**	-0.492	-0.725
4 x 7	3.670**	3.105**	8.239**	-4.170**	-2.323*	-5.110**	-3.240**	-2.071*	-25.946**	-3.163**	-0.580
4 x 8	6.433**	6.334**	3.530**	4.900**	-1.248	-1.108	6.015**	3.877**	44.531**	4.297**	5.898**
4 x 9	-4.000**	-3.478**	5.364**	-1.779	-1.969*	-8.703**	2.155*	4.974**	58.059**	1.417	-0.345
4 x 10	0.150	5.605**	-9.803**	4.030**	0.252	-0.703	4.123**	5.162**	59.944**	3.364**	4.794**
5 x 6	2.504**	-9.799**	16.322**	2.896**	-0.864	3.286**	1.713	7.444**	-106.013**	2.375*	3.115**
5 x 7	1.850	-8.974**	-1.095	1.880	0.731	-0.618	0.718	0.828	22.029**	1.724	0.260
5 x 8	0.512	-7.395**	1.697	1.950	2.606*	4.034**	-1.897	0.787	24.031**	-3.131**	-2.193*
5 x 9	-4.771**	-1.758	12.530**	2.771**	1.486	-6.112**	3.413**	3.639**	55.894**	0.269	-2.725**
5 x 10	-3.321**	-2.874**	-16.636**	-5.220**	5.256**	2.838**	-2.424*	1.442	29.335**	-9.374*	-9.851**
6 x 7	1.500	11.301**	5.364**	-3.120**	-3.119**	-1.016	3.957**	10.077**	134.130**	-1.759	0.470
6 x 8	3.312**	8.280**	1.655*	1.150	2.256*	5.286**	0.077	2.601*	45.496**	-1.054	-1.722
6 x 9	-0.121	11.067**	-5.011**	4.471**	1.536	1.590	-2.284*	0.648	22.530**	6.241**	0.821
6 x 10	-3.121**	19.201**	17.822**	1.080	4.906**	2.290*	11.514**	6.335**	89.945**	1.108	1.799
7 x 8	-3.492**	0.305	0.239	3.534**	1.502	5.832**	9.012**	11.280**	129.964**	-0.190	2.352**
7 x 9	-2.325*	-8.758**	-9.428**	4.955**	5.131**	11.836**	-5.844**	-2.393*	-31.658**	3.610**	2.100*
7 x 10	-0.225	2.476*	2.905**	5.763**	2.702**	1.286**	5.249**	6.155**	69.402**	-3.828**	-4.502**
8 x 9	-0.113	11.222**	-7.136**	-2.975**	0.606	0.688	-3.859**	0.841	6.638**	1.394	1.663
8 x 10	-2.463*	0.405	-1.803	5.334**	2.777**	5.688**	-6.496**	-1.191	-14.726**	-0.873	-0.449
9 x 10	0.654	-0.558	-0.970	1.655	1.156	0.192	-4.886**	-2.309*	-30.508**	4.127**	4.889**
S.E. (gi)±	2.35	4.83	4.65	3.72	1.89	3.89	5.74	5.10	75.95	3.96	3.87
S.E. (gi-gj)±	2.24	4.61	4.43	3.55	1.80	3.71	5.48	4.86	72.41	3.77	3.69

*, ** Significant at 5%, 1% probability level.

type of gene action (Table 4). In general, the cross exhibiting best sca effects for earliness were 1 x 9, for plant height and number of primary branches 6 x 10, for fruit length 1 x 2, for fruit diameter 5 x 10, for fruit weight 1 x 2, for number of fruits per plant 2 x 3, for yield kg/plot and yield q/ha 1 x 6, 1 x 9, 1 x 4 and 7 x 8, for per cent fruit borer infestation 1 x 8, 2 x 6, 5 x 8, recorded negative significant sca effects. Similar results were also reported by Kale *et al.* (1992) and Dahiya *et al.* (1985).

High general combining ability of the parents, therefore seems to be reliable criterian for the prediction of specific combining ability. Heterosis in the cross involving low x high combiners might be due to dominant x additive type of interaction which is partially fixable and the crosses involving both the poor combining parents showing high sca must be due to intra and inter allelic interactions. Generally the crosses 2 x 3, 6 x 7, 7 x 8, 1 x 4, 2 x 6, 1 x 9, 1 x 6, 2 x 9 and 3 x 5 showing high sca for yield and also exhibited high or average sca effects for yield component traits. Similar results have been reported by Singh and Kumar (1998) and Ramesh *et al.* (1996). From this study, it can be concluded that the crosses 1 x 6, 1 x 9, 1 x 2, 2 x 3, 3 x 5, 5 x 10, 6 x 7, 7 x 8 could be exploited for hybrid vigour and yield and other economic traits in brinjal. However, it needs further testing before recommending these combinations for exploitation on large scale.

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