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Combining ability over environments for shoot and fruit borer resistance and other quantitative traits in *Solanum melongena* L.

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Abstract

Ten parents and their 45 F_1's were evaluated for fruit yield and its component characters along with shoot and fruit borer infestation over four environments. Highly significant variation was observed due to genotypes and environments for all the twelve characters studied. Both gca and sca variances showed significant interactions. The genotypes ABV 1, PBR 129-5 and Aruna were found to be good general combiners and 15 crosses have been identified as good specific combiner for fruit yield and other related traits. The genotyps PBR 129-5 had shown highly significant negative gca effects for shoot and fruit borer infestation.

Key words : Brinjal, combining ability, gca x environment interaction, sca x environment interaction.

Introduction

Combining ability effects are considerably influenced by environments and for a more precise and valid conclusions, studies under different environments reveal the impact of genotype × environment interaction on the estimates. The preset investigation was carried out over four different environments to study the combining ability in ten genotypes for different quantitative characters along with two pest reaction characters in brinjal (*Solanum melongena* L.).

Materials and methods

Ten promising strains of brinjal were selected from germplasm maintained at Fruit Research Station, Himayat Bagh, Aurangabad, on the basis of genotypic differences. The parents and their 45 crosses (half diallel) were grown in randomised block design with two replications during summer/*kharif* 1999 at four locations. These four environments represent four growing conditions of the crop. Each entry was grown in two rows of 4.8 m long with a spacing of 75 × 60 cm for E_1 environment and 60 × 60 cm for E_2, E_3 and E_4 environments. Data were recorded for the characters viz., plant height (cm), number of secondary branches, days to 50 per cent flowering, node number of first flower cluster, average length of fruit (cm), average girth of fruit (cm), rind thickness (cm), number of fruits per plant, average weight of fruit (g) and fruit yield per plant (kg). Two characters viz., shoot borer infestation (%) and fruit borer infestation (%) were also studied for gene action. The statistical analysis for combining ability based on mean values was done as per method II Model I of Griffing [1]. The pooled analysis over environments was carried out by the method of Singh [2].

Results and discussion

Pooled analysis of variance revealed significant variation among parents for all the traits, indicating adequate genetic variability among the parental lines used in the present study (Table 1). The genotypes interacted significantly with the environments for all the traits.

Combining ability analysis revealed that gca and sca variances were highly significant for all the characters. Both gca and sca showed significant interaction with environments for all the traits. The significant gca × environment and sca × environment interactions indicated that the estimates of both additive and non-additive gene effects are prone to change with the environment. Similar results were also reported by Warade [3] and Barbind [4]. The ratio of additive variance to total genotypic variance revealed predominance of non-additive gene action for all the traits except for length of fruit and average weight of fruit.

GCA effects : The estimates of gca effects (Table 2) on the basis of pooled analysis revealed that the genotypes PBR 129-5, Round white and Muktakeshi were better general combiners for plant height, PBR 129-5, Round white and Muktakeshi for number of secondary branches, ABV 1, Anuradha, PBR 129-5, Muktakeshi and Round white for days to 50 per cent flowerung, PBR 129-5, ABV 1, Anuradha and Round White for node number of first flower cluster, PBR

Table 1. Pooled analysis of variance for combining ability for various characters over four environments

Source of variation	d.f.	Mean sum of squares						
		Plant height	No. of primary branches/plant	No. of secondary branches/Pant	Days to first flowering	Days to 50 % flowering	Node number of first flower cluster	Length of fruit
GCA	9	977.656**	0.724**	15.979**	83.731**	108.060**	2.815**	29.519**
SCA	45	309.834**	0.895**	12.848**	72.607**	74.382**	1.781**	1.722**
Environments	3	63.854**	0.391**	54.821**	0.188	2.042**	0.029**	0.380**
GCA × Env.	27	97.833**	0.161**	1.640**	1.637**	2.128**	0.37**	0.152**
SCA × Env.	135	42.149**	0.165**	1.808**	1.876**	2.559**	0.028**	0.131**
Error	216	7.248	0.015	0.515	0.722	0.192	0.004	0.0002
$\frac{2\sigma^2 gca}{2\sigma^2 gca + \sigma^2 sca}$		0.161	0.113	0.173	0.161	0.195	0.207	0.741
	df	Girth of trait (cm)	Rind thickness (cm)	No. of fruits/plots	Averagewt of fruit (g)	Yield/plant (cm)	Fruit bear infertile (%)	Shoot porer infestation (%)
GCA	9	54.509**	0.12500**	836.488**	1181.069**	0.556**	102.099**	300.776**
SCA	45	6.521**	0.06369**	134.081**	97.229**	0.159**	19.469**	44.390**
Environments	3	4.969**	0.00034**	174.563**	11.935**	0.349**	51.825**	2.173**
GCA × Env.	27	0.840**	0.00137**	5.459**	3.849**	0.006**	3.643**	10.549**
SCA × Env.	135	1.176**	0.00093**	6.937**	4.777**	0.013**	2.247**	8.144**
Error	216	0.018	0.00021	1.372	0.501	0.001	0.937	0.819
$\frac{2\sigma^2 gca}{2\sigma^2 gca + \sigma^2 sca}$		0.582	0.338	0.512	0.670	0.361	0.476	0.534

**Significant at P = 0.01

Table 2. Pooled estimates of general combining ability effects for various characters over different environments

Parents	Plant height (cm)	No. of primary branches/ plant	No. of secondary branches/ plant	Days to first flowering	Days to 50% flowering	Node number of first flower cluster	Length of fruit (cm)	Girth of fruit (cm)	Rind thickness (cm)	No. of fruits/ plant	Average weight of fruit (g)	Yield/ plant (kg)	Reaction to fruit borer	Reaction to shoot borer
PBR 129-5	10.767**	0.236**	0.844**	–0.315**	–0.350**	–0.017*	2.120**	–2.586**	–0.086**	5.919**	–6.073**	0.163**	–4.022**	–6.813**
ABV-1	–2.745**	–0.042*	–0.681**	–2.846**	–3.402**	–0.442**	–0.240**	0.495**	0.007**	5.297**	–0.354**	0.175**	0.734**	0.572**
Aruna	–1.394**	–0.114**	–0.803**	0.248**	0.317**	0.121**	–0.350**	–0.484**	0.046**	5.700**	–6.303**	0.100**	0.820**	0.844**
Anuradha	–4.489**	–0.214**	–0.083	–0.596**	–0.683**	–0.381**	–0.785**	–0.176**	–0.014**	–0.852**	–4.002**	–0.083**	0.168	2.056**
Vaishali	0.368	–0.056**	–0.209*	0.925**	1.619**	0.169**	–0.319**	–0.224**	–0.043**	0.307	–3.328**	–0.054**	0.180	1.039**
Harsool local	–3.146**	0.053**	0.267**	0.894**	0.744**	0.134**	–0.255**	–0.282**	–0.051**	–3.072**	1.659**	–0.087**	1.131**	0.434**
Early round market	–0.765*	0.066**	–0.104	0.175	–0.079	0.046**	0.084**	1.233**	0.007**	–3.196**	7.467**	–0.029**	0.506**	0.378*
Muktakeshi	1.646**	0.94**	0.372**	–0.169	–0.173**	0.082**	0.096**	0.707**	0.065**	–4.122**	7.228**	–0.063**	0.181	–0.267*
Round white	3.372**	0.001	0.841**	–0.565**	–0.173**	–0.051**	–0.144**	0.681**	0.071**	–1.271**	1.809**	0.001	0.347**	–0.041
S-5	–3.614**	–0.024	–0.446**	2.248**	2.181**	0.339**	–0.206**	0.636**	–0.003**	–4.710**	1.897**	–0.123**	–0.046	1.798**
S.E. (gi) ±	0.368	0.017	0.098	0.116	0.060	0.008	0.006	0.018	0.001	0.160	0.097	0.005	0.132	0.123

*Significant at 1%; *Significant at 5%

129-5, Early round market and Muktakeshi for length of fruit, Early Round market, Muktakeshi and Round white for girth of fruit, Round white, Muktakeshi and Aruna for rind thickness, PBR 129-5, Aruna and ABV 1 for number of fruits per plant, Early round market, Muktakeshi, Round white and S 5 for average weight of fruit and PBR 129-5, ABV 1 and Aruna for yield per plant.

The parent PBR 129-5 had shown highly significant negative gca effect for both shoot and fruit borer infestation.

Present findings revealed that the parents viz., ABV 1, PBR 129-5 and Aruna offered the best possibilities of exploitation for the development of improved high yielding lines of brinjal.

SCA effects : The 15 crosses which showed highest significant positive sca effects for fruit yield are presented in Table 3. The crosses ABV 1 × Anuradha and ABV 1 × Vaishali exhibited significant sca effects for number of fruits per plant and desirable negative significant sca effects for days to 50 per cent flowering

and node number of first flower cluster. The cross PBR 129-5 × Round white exhibited positive and significant sca effect for plant height, average length of fruit, number of fruit per plant, average of fruit and negative significant sca effect for days to 50 per cent flowering and node number of first flower cluster. The cross Round white × S 5 showed significant sca effects for the character number of fruits/plant and average weight of fruit. For the character number of secondary branches per plant the crosses viz., Anuradha × Early round market, Early round market x Muktakeshi and PBR 129-5 x Early round market exhibited positive significant sca effect. Most of the hybrids were early in flowering as indicated by negative sca effects for days to 50 per cent flowering.

The parental lines in this study were having diverse genetic background of the source populations and hence these crosses exhibited high sca effects. The hybrids which involved PBR 129-5 (shoot and fruit borer tolerant) as one of the parent were found to be having less infestation of shoot and fruit borer indicating dominance of tolerance over susceptibility. The tolerance of PBR 129-5 for shoot and fruit borer has also been reported by Patil and Ajri [5]. The cross combinations PBR 129-5 × Round white, Round white × S 5, PBR 129-5 × ABV 1, Harsool local × S 5, PBR 129 5 × Harsool local and PBR 129-5 × Aruna exhibited negative significant sca effects for fruit borer infestation and are desirable due to their low infestation.

The crosses with significant positive sca effects for fruit yield involved parent with low × low or low × high gca effects indicating the presence of non-allelic interactions and also manifested heterosis of higher

Table 3. Estimates of specific combining ability effects of the best fifteen specific crosses over four environments

Name of the cross	Plant height (cm)	No. of secondary branches/plant	Days to 50% flowering	Node no. of first flower-cluster	Average length of fruit (cm)	Average girth of fruit (cm)	GCA status
ABV-1 × Anuradha	0.370	0.644	−2.035**	−0.140**	−0.471**	−1.120**	
ABV-1 × Vaishali	0.726	−0.530	−6.712**	−0.927**	−0.099**	−0.997**	
PBR 129-5 × Round white	4.372**	−0.579	−5.223**	−0.907**	1.054**	−0.358**	
Round white × S-5	−1.759	2.673	0.496**	0.112**	−0.033	−0.531**	
PBR 129-5 × ABV 1	−0.373	0.643	−1.118**	−0.192**	0.400**	−0.272**	
Round white × Early round market	10.077**	2.680**	0.142	−0.177**	−0.495*	−0.771**	
Harsool lacol × S-5	7.133**	0.072	−0.045	0.252**	−0.571**	−1.580**	
Anuradha × Muktakeshi	−1.945	−0.559	0.611**	−0.076*	0.431**	1.643**	
PBR 129-5 × Harsool local	1.240	−0.280	−0.889**	0.132**	0.453**	−0.195**	
Early round market × Muktakeshi	6.730**	1.925**	4.007**	0.497**	−0.350**	−1.579**	
PBR 129-5 × Early round market	2.696*	3.053**	−0.692**	0.258**	1.263**	−0.011	
Muktakeshi × S-5	3.379**	0.342	−2.004**	−0.021	0.003	−2.157**	
Harsool local × Round white	6.448**	0.498	0.809**	0.917**	0.241**	1.750**	
Harsool local × Muktakeshi	8.849**	0.592	−0.691**	0.171**	1.027**	1.111**	
S.E. (s^{ij}) ±	1.240	0.330	0.202	0.029	0.021	0.062	
ABV-1 × Anuradha	−0.055**	15.494**	−1.169**	0.534**	0.161	−0.050	HXL
ABV-1 × Vaishali	−0.073**	14.084**	−3.968**	0.357**	0.547	0.466	HXL
PBR 129-5 × Round white	−0.126**	8.666**	1.989**	0.280**	−1.082*	−0.345	HXL
Round white × S-5	0.014*	3.432**	5.894**	0.211*	−1.918**	−1.704**	LXL
PBR 129-5 × ABV 1	0.072**	7.098**	−0.573	0.206**	−1.961**	−1.137**	HXH
Round white × Early round market	0.081**	5.112**	−1.990**	0.195**	−0.623	0.223	LXL
Harsool local × S-5	−0.006	3.358**	6.294**	0.186**	−3.478**	2.596**	HXL
Anuradha × Muktakeshi	0.252**	5.038**	−2.501**	0.171	0.379	−0.163	HXL
PBR 129-5 × Harsool local	0.022**	2.592**	4.264**	0.167**	−1.287**	0.857**	HXL
Early round market × Muktakeshi	0.006	0.519	9.280**	0.154**	−0.537	−1.572**	HXL
PBR 129-5 × Early round market	0.044**	3.716**	0.331	0.143**	−0.472	−3.338**	LXL
Muktakeshi × S-5	0.078**	3.258**	0.350	0.140**	0.158	−3.184**	HXL
Harsool local × Round white	0.127**	3.031**	−0.119	0.138**	3.537**	2.018**	LXL
Harsool local × Muktakeshi	0.104**	4.007**	−2.287**	0.110**	0.590	1.054*	LXL
S.E. (s^{ij}) ±	0.006	0.539	0.326	0.018	0.445	0.417	LXL

*Significant at P = 00 and ** Significant at P = 0.01; L = Low and H = High

magnitude. Both parents with high gca effects when crossed had probably low magnitude of non-additive gene effects resulting in the small degree of sca effects and heterosis. The present findings are in agreement with the earlier results [3, 5-11]. Therefore, recurrent selection for specific combining ability could be followed in the segregating generations of the crosses ABV 1 × Anuradha, ABV 1 × Vaishali, PBR 129-5 × Round white, Harsool local × S 5, Anuradha × Maktakeshi, PBR 129-5 × Harsool local, PBR 129-5 × Aruna and PBR 129-5 × Early round market, as this type of selection was proposed on the assumption that an important part of heterosis results from the non-linear interaction of genes at different loci, from interaction between alleles at the same locus or from both causes in combination. It is possible to obtain substantial improvement with regard to fruit yield in addition to other desirable traits like earliness, more number of fruits per plant and rind thickness. Hetersis breeding could be suggested for hybrid development by manual hand emasculation and pollination as genetic and functional male sterility sources though reported but are not being utilized so far in brinjal for commercial exploitation of heterosis.

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