

Combining ability analysis for growth and yield components in brinjal (*Solanum melongena* L.)

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Combining ability studies on growth and yield components were conducted from 10 × 10 half diallel cross of brinjal. The analysis of variance for combining ability selected revealed that mean squares due to GCA and SCA variance were significant for all the characters which indicated that all the characters were controlled by both additive and non-additive gene effects. However, the $\sigma_{gca}^2 / \sigma_{sca}^2$ ratio being less than unity for all the characters except fruit diameter and plant height indicating that the non-additive gene action was more important in the inheritance. Among the parents, based on fruit yield DBSR-91, followed by DBR-31 were found to be best general combiners, DBSR-91 was found to be best general combiner over all the characters. DBR-31 was found to have desirable GCA effects only for plant height, crude protein content besides fruit yield. Pusa Purple Round × Pusa Kranti followed by DBR-31 × Pusa Kranti, HLB-12 × DBR-31, Hisar Shyamal × Pusa Purple Round and HLB-25 × DBSR-91 were the best crosses based on SCA effects of fruit yield.

Key words : Brinjal, Combining ability, Gene effects

How to cite this paper : Choudhary, Santosh and Didel, R.P. (2014). Combining ability analysis for growth and yield components in brinjal (*Solanum melongena* L.). *Asian J. Bio. Sci.*, 9 (1) : 88-92.

INTRODUCTION

Brinjal (*Solanum melongena* L.) is a major vegetable crop of India after potato. The study on the nature of gene action for yield and yield contributing traits is a pre-requisite for initiating breeding programme on any crop. The diallel cross technique provides a systematic approach to study the genetics of quantitative characters. The combining ability is useful to assess the nicking ability of parents and at the same time it elucidates the nature and magnitude of different types of genes actions involved. Nature and magnitude of combining ability effects provide an idea about the relative role of fixable and non-fixable gene effects in the inheritance of different characters. Joshi and Dhawan (1966) and Dhariwal and Singh (1970) discussed the importance of combining ability analysis in selection of parental lines in self-pollinated crops where GCA effects are more pronounced. The present investigation was planned to obtain the information on combining ability variances and effects from a 10 × 10 half diallel crosses.

RESEARCH METHODOLOGY

Ten diverse brinjal parents namely HLB-25, Hisar Pragati,

BR-112, Hisar Shyamal, HLB-12, DBR-31, DBSR-91, Pant Rituraj, Pusa Kranti and Pusa Purple Round were used in the study. The parents along with their F_1 s without reciprocals were grown in a randomized block design with three replications. In each replication and each of the generation *i.e.* parents and F_1 s were transplanted in a plot of size 3.0 m × 1.2 m accommodating 2 rows spaced at 60 cm. All the agronomical practices were adopted as per recommendations to raise a good crop. Following observations were recorded on five randomly selected plants from each replication *viz.*, days to first flowering, plant height (cm), plant spread (cm²), branches per plant, number of fruits per plant, fruit length (cm), fruit diameter (cm), average fruit weight (g), fruit yield per plant (kg), crude protein content in fruit (%).

RESEARCH FINDINGS AND ANALYSIS

The results are present in Table 1-4. Among the parents, based on fruit yield, DBSR-91, followed by DBR-31 were found to be best general combiners. DBSR-91 was also found to be a general combiner for average fruit weight, number of fruits, fruit diameter and crude protein content also. Thus this parent was found to be best general combiner over all the characters.

DBR-31 was found to have desirable GCA effects only for plant height and crude protein content besides fruit yield. Hisar Pragati followed by HLB-25 on the other hand was found to be poor general combiner among all the parents for fruit yield. Hisar Pragati was also found to be poor general combiner for plant height, number of branches per plant, average fruit weight, fruit diameter, plant spread as well as crude protein content among all the parents. HLB-25 was found to be poor general combiner for fruit diameter, average fruit weight, crude protein content, besides fruit yield, although it was found to be best general combiner for plant spread, number of branches per plant and fruit length among all the parents. Based upon over all ranking DBSR-91 was the best general combiner, followed by Pusa Kranti. The parent Pusa Kranti exhibited desirable GCA effects for crude protein content and plant spread Hisar Pragati and Pusa Purple Round were the parents with poor GCA effects among all the parents.

For identifying most desirable parents based on *per se* performances as well as GCA effects five best parents were considered for each trait separately (Table 4). Taking the above parameters into consideration the parents Pant Rituraj, HLB-25, Hisar Pragati, Pusa Kranti and BR-112 were the most

desirable for days to first flowering; BR-112, Hisar Shyamal, DBSR-91, DBR-31 and Pant Rituraj were most desirable for fruit diameter; HLB-25, HLB-12, Hisar Pragati, Pusa Kranti were most desirable for fruit length; Hisar Shyamal, DBSR-91, DBR-31, Pusa Purple Round BR-112 and Pusa Kranti were most desirable for average fruit weight; DBR-31, Pusa Purple Round, Pant Rituraj, DBSR-91 and Pusa Kranti were most desirable for plant height; DBSR-91, HLB-12, Hisar Pragati and HLB-25 were most desirable for number of fruits per plant; HLB-25, HLB-12, Pant Rituraj, BR-112 and Pusa Purple Round were most desirable for number of branches per plant; HLB-25, Pusa Kranti, Hisar Shyamal, BR-112, DBSR-91 and Pant Rituraj were most desirable for plant spread; Pusa Kranti, DBR-31, DBSR-91 and Hisar Shyamal were most desirable for crude protein content; DBSR-91 and DBR-31 were most desirable for yield per plant. The high general combining ability effects observed were primarily due to additive and additive x additive gene effects (Griffing, 1956). However, overall best general combiner on the basis of above two criteria was DBSR-91 followed by Pusa Kranti, DBR-31 and Pant Rituraj.

In general the parents, which gave the best *per se* performance were also the best general combiners indicating

Table 1 : Analysis of variance for combining ability of different characters

Source of variation	d.f.	Days to 1 st flowering	Plant height (cm)	Plant spread (cm ²)	Number of branches per plant	Number of fruits per plant	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)	Yield per plant (kg)	Crude protein (%)
GCA	9	55.87**	503.08**	352439.2**	4.28**	116.26**	30.73**	8.04**	631.81**	0.34**	5.47**
SCA	45	9.90**	35.24**	427104**	1.41**	21.84**	2.43**	0.60**	85.50**	0.04**	0.63**
Error	108	1.85	1.69	1616.05	0.31	0.88	0.05	0.02	1.64	0.0007	0.02
σ_g^2		3.83	38.99	-6222.07	0.24	7.87	2.36	0.62	45.53	0.03	0.40
σ_s^2		8.05	33.55	425487.95	1.10	20.96	2.38	0.58	83.86	0.04	0.61
σ_g^2/σ_s^2		0.48	1.16	-0.015	0.22	0.38	0.99	1.07	0.54	0.75	0.66

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 2 : Estimates of general combining ability effects of parents for different characters in a 10x10 diallel cross of brinjal

Progenies	Days to 1 st flowering	Plant height (cm)	Plant spread (cm ²)	Number of branches per plant	Number of fruits per plant	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)	Yield per plant (kg)	Crude protein (%)
HLB-25	-3.24**	-5.41**	197.64**	1.27**	1.48**	2.26**	-1.24**	-9.95**	-0.14**	-0.81**
Hisar pragati	-2.27**	-8.26**	-64.81**	-0.58**	1.73**	2.02**	-0.87**	-10.35**	-0.16**	-0.45**
BR-112	0.64**	-6.90**	90.35**	0.23**	-3.34**	-1.28**	0.92**	2.44**	-0.10**	0.005
Hisar shyamal	2.06**	-5.91**	99.51**	-0.36**	-4.70**	-1.39**	0.84**	9.42**	-0.04**	0.18**
HLB-12	0.66**	-1.32**	-9.47	0.44**	4.28**	2.16**	-1.05**	-9.09**	-0.04**	-0.22**
DBR-31	1.84**	8.73**	-229.54**	-0.48**	-0.16	-0.36**	0.44**	2.27**	0.04**	0.84**
DBSR-91	2.03**	4.43**	41.08**	-0.71**	4.66**	-1.27**	0.80**	7.11**	0.44**	0.56**
Pant rituraj	-3.33**	5.26**	35.93**	0.25**	-0.17	-0.35**	0.40**	0.50*	0.018	-0.46**
Pusa kranti	0.02	0.95**	178.82**	-0.24**	-1.02**	0.16**	-0.26**	2.25**	0.003	1.15**
Pusa purple round	1.60**	8.43**	-339.51**	0.18	-2.76**	-1.93**	0.01	5.42**	-0.03**	-0.77**
SE	0.22	0.21	6.64	0.09	0.15	0.04	0.0245	0.2117	0.004	0.020

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 3 : Estimates of specific combining ability effects of parents for different characters in a 10×10 diallel cross of brinjal

Progenies	Days to 1 st flowering	Plant height (cm)	Plant spread (cm ²)	Number of branches per plant	Number of fruits per plant	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)	Yield per plant (kg)	Crude protein (%)
HLB-25 × Hisar Pragati	-9.35	3.47**	-996.19	-1.36	-4.90	-0.24	1.11**	9.19**	0.03**	-0.43
HLB-25 × BR-112	-0.25	2.62**	320.91**	0.97**	4.44**	1.26**	-1.39	-1.93	0.11**	0.41**
HLB-25 × Hisar Shyamal	0.66	5.22**	750.02**	2.68**	-5.20	1.23**	-1.44	15.35**	-0.02	0.39**
HLB-25 × HLB-12	-1.68	2.91**	286.47**	-2.18	0.09	2.59**	0.89**	0.88	0.004	0.54**
HLB-25 × DBR-31	2.35**	-1.81	-680.19	-1.39	3.79**	-1.04	-0.25	-6.77	0.02	1.10**
HLB-25 × DBSR-91	2.36**	-1.78	782.92**	0.17	5.97**	-0.05	-0.16	-2.23	0.23**	-0.16
HLB-25 × Pant Rituraj	-6.69	0.59	-474.40	0.28	1.60**	0.90**	-0.29	0.16	0.08**	-0.28
HLB-25 × Pusa Kranti	3.57**	-2.66	-45.42	0.37	0.12	-0.32	0.001	-5.92	-0.12	1.20**
HLB-25 × Pusa Purple Round	2.58**	-2.21	737.97**	1.42**	-2.21	-0.79	0.25**	-3.69	-0.11	-1.74
Hisar Pragati × BR-112	-3.36	6.57**	842.57**	-0.52	2.12**	-0.28	-0.62	4.16**	0.22**	-0.93
Hisar Pragati × Hisar Shyamal	0.15	3.74**	-361.19	-1.87	-1.45	-2.20	-0.84	-4.75	0.14	0.20**
Hisar Pragati × HLB-12	1.22	-2.61	624.06**	-0.86	-8.63	-5.51	0.32**	7.26**	-0.21	0.91**
Hisar Pragati × DBR-31	-0.16	-4.23	915.53**	1.59**	6.34**	2.20**	-0.25	-11.74	-0.09	1.81**
Hisar Pragati × DBSR-91	2.78**	-2.03	-1335.49	2.02**	2.92**	0.32**	-0.16	0.35	0.21**	-0.10
Hisar Pragati × Pant Rituraj	0.74	-1.36	527.79**	-0.61	3.28**	2.63**	-0.75	-5.64	-0.10	-0.89
Hisar Pragati × Pusa Kranti	2.82**	-2.88	477.23**	-0.44	3.34**	0.50**	-0.54	-5.27	0.01	0.71**
Hisar Pragati × Pusa Purple Round	4.88**	3.38**	425.03**	0.27	-0.73	1.71**	0.34**	5.62**	0.21**	0.19**
BR-112 × Hisar Shyamal	-1.56	1.48**	-182.62	0.19	6.42**	0.79**	0.65**	-13.60	0.02	0.29**
BR-112 × HLB-12	0.37	2.13**	801.43**	0.00	-6.56	-1.29	0.53**	18.70**	0.09**	0.21**
BR-112 × DBR-31	0.60	-4.72	-646.96	0.86**	-5.39	-0.69	0.77**	12.59**	-0.10	-0.58
BR-112 × DBSR-91	0.94	0.24	113.15**	-0.26	2.46**	-0.17	-0.99	-2.87	0.10**	0.95**
BR-112 × Pant Rituraj	3.36**	-2.19	237.23**	-0.88	-1.98	0.03	1.76**	-5.20	-0.17	0.20**
BR-112 × Pusa Kranti	-0.85	0.96	484.67**	-0.25	-0.39	0.01	-0.87	4.91**	0.06**	-0.56
BR-112 × Pusa Purple Round	-2.70	-0.65	521.33**	-1.34	1.55**	-0.60	-0.50	2.16**	0.17**	0.09
Hisar Shyamal × HLB-12	-2.32	0.07	-716.80	-0.55	0.40	-1.81	-0.69	4.04**	0.18**	0.85**
Hisar Shyamal × DBR-31	-3.16	1.12	28.28	0.84**	1.57**	0.45**	-1.01	-2.51	0.01	0.30**
Hisar Shyamal × DBSR-91	0.65	3.82**	-980.81	-0.27	0.28	1.17**	1.57**	5.18**	0.05**	0.58**
Hisar Shyamal × Pant Rituraj	3.94**	3.35**	683.14**	-0.09	1.77**	-1.88	-0.59	6.92**	0.22**	0.58**
Hisar Shyamal × Pusa Kranti	-1.21	1.97**	-629.22	-0.53	-0.70	0.46**	-0.66	10.09**	0.04**	-0.53
Hisar Shyamal × Pusa purple round	-5.32	-2.95	177.84	0.58	3.77**	0.14	0.60**	3.13**	0.29**	-1.23
HLB-12 × DBR-31	-0.63	3.46**	72.53**	-1.22	2.46**	0.58**	0.24**	6.31**	0.30**	-0.65
HLB-12 × DBSR-91	-1.22	6.36**	230.30**	1.20**	4.57**	0.20	-0.64	-3.05	0.10**	-1.32
HLB-12 × Pant Rituraj	-2.33	2.87**	-195.68	0.71**	6.60**	3.16**	-0.65	-8.34	0.04**	0.19**
HLB-12 × Pusa Kranti	2.66**	-2.45	-49.24	0.47	5.12**	1.00**	-0.22	-6.77	0.03**	-0.15
HLB-12 × Pusa Purple Round	0.01	2.77**	-521.45	0.05	11.26**	2.30**	-0.21	-16.34	0.21**	-0.19
DBR-31 × DBSR-91	-4.39	5.11**	285.24**	1.32**	2.07**	-0.17	-0.47	-3.92	0.01	-0.77
DBR-31 × Pant Rituraj	-2.77	8.31**	-27.41	-0.10	-0.10	-0.55	-0.26	-10.98	-0.20	-1.64
DBR-31 × Pusa Kranti	0.28	4.56**	346.76**	1.19**	0.22	-0.03	0.12	10.91**	0.35**	0.14**
DBR-31 × Pusa Purple Round	-0.37	9.52**	154.36**	-0.76	-3.84	-0.09	0.20**	8.70**	0.03**	0.62**
DBSR-91 × Pant Rituraj	-2.89	0.15	671.30**	1.39**	-6.45	-1.12	-0.29	17.12**	0.07**	-0.03
DBSR-91 × Pusa Kranti	-1.24	3.20**	40.34	0.62**	-6.13	-0.02	-0.59	17.34**	-0.02	0.31**
DBSR-91 × Pusa Purple Round	-2.09	4.92**	-859.00	-0.34	4.21**	-0.28	-0.13	-12.34	0.10**	0.65**
Pant Rituraj × Pusa Kranti	-2.35	6.40**	758.56**	1.19**	5.56**	1.20**	0.30**	-3.51	0.43**	0.74**
Pant Rituraj × Pusa Purple Round	3.40**	9.45**	-131.58	0.71**	-7.16	-0.67	-0.07	7.08**	-0.26	0.84**
Pusa Kranti × Pusa Purple Round	-1.75	5.87**	245.93**	-0.27	-3.31	1.04**	0.56**	8.24**	0.07**	0.04
SE	0.72	0.69	21.38	0.29	0.50	0.12	0.08	0.68	0.01	0.07

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 4 : Top five parents and five crosses based on per se performance and combining ability for yield and associated characters

per se performance		GCA effects	SCA effects
Parents	Crosses		
Days to flowering			
Hisar Pragati	HLB-25 × Hisar Pragati	Pant Rituraj	HLB-25 × Hisar Pragati
Pant Rituraj	HLB-25 × Pant Rituraj	HLB-25	HLB-25 × Pant Rituraj
HLB-25	Pant Rituraj × Pusa Kranti	Hisar Pragati	Hisar Shyamal × Pusa Purple Round
Pusa Kranti	Hisar Pragati × BR-112	Pusa Kranti	DBR-31 × DBSR-91
BR-112	HLB-12 × DBSR-91	BR-112	Hisar Pragati × BR-112
Plant height			
DBR-31	DBR-31 × Pusa Purple Round	DBR-31	DBR-31 × Pusa Purple Round
Pusa Purple Round	Pant Rituraj × Pusa Purple Round	Pusa Purple Round	Pant Rituraj × Pusa Purple Round
DBSR-91	DBR-31 × Pant Rituraj	Pant Rituraj	DBR-31 × Pant Rituraj
Pant Rituraj	DBR-31 × DBSR-91	DBSR-91	Hisar Pragati × BR-112
Pusa Kranti	DBSR-91 × Pusa Purple Round	Pusa Kranti	Pant Rituraj × Pusa Kranti
Plant spread			
Hisar Shyamal	HLB-25 × Hisar Shyamal	HLB-25	Hisar Pragati × DBR-31
DBSR-91	HLB-25 × DBSR-91	Pusa Kranti	Hisar Pragati × BR-112
HLB-25	Pant Rituraj × Pusa Kranti	Hisar Shyamal	BR-112 × HLB-12
HLB-12	BR-112 × HLB-12	BR-112	HLB-25 × DBSR-91
Pusa Kranti	Hisar Pragati × BR-12	DBSR-91	Pant Rituraj × Pusa Kranti
Number of branches			
HLB-12	HLB-25 × Hisar Shyamal	HLB-25	HLB-25 × Hisar Shyamal
HLB-25	HLB-25 × Pusa Purple Round	HLB-12	Hisar Pragati × DBSR-91
BR-112	HLB-25 × BR-112	Pant Rituraj	Hisar Pragati × DBR-31
Pusa Purple Round	HLB-25 × Pant Rituraj	BR-112	HLB-25 × Pusa Purple Round
Hisar Pragati	HLB-25 × Pusa Kranti	Pusa Purple Round	DBSR-91 × Pant Rituraj
	HLB-12 × Pant Rituraj		
Number of fruits			
DBSR-91	HLB-12 × DBSR-91	DBSR-91	HLB-12 × Pusa Purple Round
Hisar Pragati	HLB-12 × Pusa Purple Round	HLB-12	HLB-12 × Pant Rituraj
HLB-25	HLB-25 × DBSR-91	Hisar Pragati	BR-112 × Hisar Shyamal
HLB-12	HLB-12 × Pant Rituraj	HLB-25	Hisar Pragati × DBR-31
Pant Rituraj	Hisar Pragati × DBSR-91	DBR-31	HLB-25 × DBSR-91
Fruit length			
Hisar Pragati	HLB-25 × HLB-12	HLB-25	HLB-12 × Pant Rituraj
HLB-12	HLB-12 × Pant Rituraj	HLB-12	Hisar Pragati × Pant Rituraj
HLB-25	Hisar Pragati × Pant Rituraj	Hisar Pragati	HLB-25 × HLB-12
DBR-31	HLB-25 × Hisar Pragati	Pusa Kranti	HLB-12 × Pusa Purple Round
Pusa Kranti	Hisar Pragati × DBR-31	Pant Rituraj	Hisar Pragati × DBR-31
Fruit diameter			
Hisar Shyamal	Hisar Shyamal × DBSR-91	BR-112	BR-112 × Pant Rituraj
DBSR-91	BR-112 × Pant Rituraj	Hisar Shyamal	Hisar Shyamal × DBSR-91
BR-112	BR-112 × Hisar Shyamal	DBSR-91	HLB-25 × Hisar Pragati
DBR-31	BR-112 × DBR-31	DBR-31	HLB-25 × HLB-12
Pant Rituraj	Hisar Shyamal × Pusa Purple Round	Pant Rituraj	BR-112 × DBR-31
Average fruit weight			
HLB-12	HLB-25 × Hisar Shyamal	Hisar Shyamal	BR-12 × HLB-112
Hisar Pragati	HLB-25 × HLB-12	DBSR-91	DBSR-91 × Pusa Kranti
HLB-25	HLB-25 × BR-112	Pusa Purple Round	DBSR-91 × Pant Rituraj
Pusa Kranti	Hisar Pragati × Pusa Kranti	BR-112	HLB-25 × Hisar Shyamal
DBR-31	HLB-12 × Pusa Kranti	DBR-31	BR-112 × DBR-31
Yield Per plant			
DBSR-91	HLB-25 × DBSR-91	DBSR-91	Pant Rituraj × Pusa Kranti
Pant Rituraj	DBSR-91 × Pant Rituraj	DBR-31	DBR-31 × Pusa Kranti
DBR-31	DBSR-91 × Pusa Purple Round	Pant Rituraj	HLB-12 × DBR-31
Hisar Pragati	HLB-12 × DBSR-91	Pusa Kranti	Hisar Shyamal × Pusa Purple Round
Hisar Shyamal	Hisar Pragati × DBSR-91	Pusa Purple Round	HLB-25 × DBSR-91
Crude protein content			
DBR-31	Hisar Pragati × DBR-31	Pusa Kranti	Hisar Pragati × DBR-31
Pusa Kranti	DBR-31 × Pusa Kranti	DBR-31	HLB-25 × Pusa Kranti
DBSR-91	DBSR-91 × Pusa Kranti	DBSR-91	HLB-25 × DBR-31
BR-112	HLB-25 × Pusa Kranti	Hisar Shyamal	BR-112 × DBSR-91
Hisar Shyamal	BR-112 × DBSR-91	BR-112	Hisar Pragati × HLB-12

a positive association between the two parameters. The rank correlations between GCA effects and *per se* performance was 0.357. This result suggested that selection of parents to be included in hybridization could also be judged on *per se* performance, besides, general combining ability effects. Similar associations between these two parameters was also observed by Singh *et al.* (1978), Bhutani *et al.* (1980), Singh and Hazarika (1982) and Kumar and Ram (1987).

A perusal of *per se* performance of the crosses for various characters suggested that in most of the cases, in general, the SCA effects of the cross combinations did not appear to be directly related to their *per se* performance. However, in some characters the *per se* performance and SCA effects were related. Rank correlation between the *per se* performance and SCA effects was very high for plant spread (0.926), followed by number of branches (0.817) and number of fruits (0.783). It was negative in case of average fruit weight. For fruit yield the correlation was 0.663. This may be attributed to the fact

that *per se* performance is a realized value whereas SCA effect is an estimate obtained on deviation of F_1 performance over the parental one. Therefore, *per se* performance with the SCA effects should be considered for evaluating the superiority of a cross although, the former may be more important where development of F_1 hybrid will be ultimate objective.

Pusa Purple Round \times Pusa Kranti followed by DBR-31 \times Pusa Kranti, HLB-12 \times DBR-31, Hisar Shyamal \times Pusa Purple Round and HLB-25 \times DBSR-91 were the best crosses based on SCA effects for fruit yield. Pusa Purple Round \times Pusa Kranti was also found to be best among all the crosses based on all characters, this was followed by DBR-31 \times Pusa Kranti. Pant Rituraj \times Pusa Purple Round followed by Hisar Pragati \times HLB-12, DBR-31 \times Pant Rituraj, BR-112 \times Pant Rituraj and HLB-25 \times Pusa Kranti were found to be undesirable based on SCA effects of fruit yield per plant. Over all the characters, HLB-25 \times Pusa Kranti was also found to be undesirable cross based on SCA effects.

LITERATURE CITED

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