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Diallel analysis for study of Combining ability for Qualitative and Quantitative traits in brinjal (*Solanum melongena* L.)

Dhirendra Kumar*, R. K. Patel, Rupal Dhoot and Chandrabhan Ahirwar

Department of Genetics and Plant Breeding, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat (India)

*Corresponding Author E-mail: dhirendra346@gmail.com

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ABSTRACT

The present study was conducted to assess the general combining ability effects of parents and specific combining ability effects of hybrids for qualitative and quantitative traits and explore their use in hybrid development. 28 eggplant hybrids generated by 8 × 8 half diallel were evaluated along with their 8 parents and 2 checks. The ratio of $\sigma^2_{gca}/\ \sigma^2_{sca}$ *revealed that all characters except plant spread manifested less than unity which indicated that preponderance of non-additive genetic variance for inheritance of these characters. Among the parents, only GBL-1 was the good general combiner for fruit yield and was also found good general combiner for fruit length, fruit weight, total soluble solids and total sugar. Six high heterotic hybrids were found good in respect of sca effects for fruit yield per plant, which involved poor x average, average x good and average x average gca effects which have high potential for commercial exploitation.*

Key words: *Brinjal, half Diallel, qualitative and quantitative traits, general combining ability and specific combining ability*

INTRODUCTION

Brinjal (*Solanum melongena* L.) is very important and popular vegetable crop which is a self-pollinated, annual herbaceous versatile crop adapted to different agro-climatic regions and grown throughout the year. Brinjal originated in India and major brinjal growing states in India are Andhra Pradesh, Karnataka, Maharashtra, Orissa, Bihar, Uttar Pradesh, Gujarat and West Bengal. The fruits of brinjal are widely consumed in various culinary preparations and are rich source of protective nutrients (Hedges and Lister[8]). In the face of increasing population, there is a need for increased production and productivity levels of brinjal. In achieving the nutritional security through vegetables, brinjal crop also play a vital role. However, the present production and productivity of brinjal is not sufficient enough to meet the nutritional security of increasing population.

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The success of any breeding programme depends on the selection of parents together with information regarding nature of gene action controlling the various characters. Application of biometrical techniques like diallel analysis has appeared to be the immensely useful breeding tool, which gives generalized picture of genetics of the characters under study. Studies on combining ability help to identify the best parents and provide genetic information on the inheritance pattern of characters. The superiority of parents may not depend so much on their superior *per se* performance but in their ability to transmit desirable genes to their progenies. Therefore, combining ability analysis was a powerful tool to discriminate the good and poor combiners. This analysis also furnishes useful information on nature of gene action involved for the expression of various quantitative characters, which can be utilized for planning an effective breeding programme. The main objective of this part of study was to identify the parents with better potential to transmit the desirable characteristics to the progenies and to sort out the best specific hybrids for yield and its component characters.

MATERIALS AND METHODS

The experiment was carried out during rabi 2013-14 and late *kharif* 2014 at college farm, Navsari Agricultural University, Navsari (Gujarat) India. The experimental material consisted of eight parents namely, GJB-3, PLR-1, KS-224, Pant rituraj, GJB-2, GBL-1, Doli-5 and GOB-1 and their 28 hybrids derived from 8 x 8 diallel (excluding reciprocal) mating design. The hybrids and parents were evaluated along with the two checks namely, surati ravaiya and GBH-2 in a randomized block design with three replications. Each plot consisted of ten plants in a row at 90 x 60 cm^2 inter and intra row spacing. All the recommended package of practices were adopted for raising a healthy crop. Five randomly selected plants, excluding the border ones, from each plot of all the three replications were tagged and used for recording the observations and average values were computed. The data recorded for 14 biometrical traits namely, days to 50 % flowering, plant height(cm), primary branches per plant, secondary branches per plant, plant spread(cm^2), fruit length(cm), fruit girth(cm), fruit weight(g), fruits per plant, fruit yield per plant(g), Total soluble solids (°Bx), Total phenol (mg g-1), Fruit dry weight (mg/100mg) and Total sugar (%). Days to 50 per cent flowering noted by number of days from transplanting to first flowering in 50 % of plants in a entry. Observations on plant height, primary branches per plant, secondary branches per plant, plant spread were recorded at last picking and Plant spread obtained by multiplying both the directions (point of maximum spread in north - south and east - west) value. In contrast, data on fruit length, fruit girth, fruit weight, fruits per plant and fruit yield per plant was obtained for each picking and the total was computed. The observations on fruit dry matter, total sugars, Total soluble solids and total phenols were recorded on five random fresh fruits, taken from each genotype in each replication and the mean values were calculated. Estimates of total sugars and total phenols were obtained following the procedures outlined by Dubois *et al*[6] and Bray and Thorpe[3], respectively. However Total soluble solids recorded by Brix hand refractrometer (ERMA, Tokyo, Japan, Range 0-32%) and Fruit dry weight was determined by taking 5 g of green fruit sample and heating at 105 ^{0}C for five hours in oven. The estimates of combining ability variances and effects were obtained using Method 2 of Model - I (fixed effect), suggested by Griffings[7].

RESULTS AND DISCUSSION

The analysis of variance for combining ability of each character is presented in **Table 1**. It was observed that gca and sca variances were highly significant for almost all the characters studied indicating that both additive as well as non-additive types of gene action were involved in the inheritance of these traits. Importance of additive and non-additive genetic components in the expression of

different characters in brinjal has been also reported by several workers *viz.*, Umaretiya *et al*[22]; Prasad *et al*[13]; Ramireddy *et al*[14]; Thangavel *et al*[21]; Bhushan *et al*[2]; Khapte *et al*[9]; Mishra *et al*[11]; Patel *et al*[12]; Shafeeq *et al*[18]; Singh *et al*[20]; Ansari and Singh[1]; Choudhary and Didel[4] and Venkata *et al*[23]. The ratio of $\sigma^2_{gca}/\sigma^2_{sca}$ revealed that all characters except plant spread manifested less than unity which indicated that preponderance of non-additive genetic variance for inheritance of these characters. Several workers *viz.,* Sao and Mehta[17]; Sane *et al*[16]; Shinde *et al*[19]; Bhushan *et al*[2]; Khapte *et al*[9]; Mishra *et al*[11]; Deshmukh *et al*[5]; Reddy and Patel[15] and Venkata *et al*[23] also found preponderance of non-additive genetic variance for inheritance of these characters. Plant spread manifested more than unity which indicated that preponderance of additive genetic variance for inheritance of this character. This result is in parallel with the findings of Bhushan *et al*[2] and Singh *et al*[20]. The estimates of general combining ability effects and specific combining effects for 8 parents for 14 characters **(Table 2 and 3)** indicated that best combiners were GJB-2, Doli-5 for days to 50 % flowering, GJB-3, Pant rituraj, Doli-5, GOB-1for plant height, GJB-2, Doli-5 for primary branches per plant, Doli-5 for secondary branches per plant, Pant rituraj, GJB-2, Doli-5 for plant spread, GBL-1, Doli-5 for fruit length, GJB-3, GOB-1for fruit girth, GJB-3, GBL-1, Doli-5 for fruit weight, PLR-1, KS-224, Pant rituraj for fruits per plant, GBL-1 for fruit yield per plant, GBL-1, Doli-5, GOB-1 for total soluble solids, GJB-3, KS-224, Pant rituraj, GJB-2 for total phenol, GJB-2 for fruit dry weight and GBL-1, GOB-1 for total sugar . For many of the characters studied, the parents GBL-1 and Doli-5 were found as good general combiners for most of the charecters. Therefore, these parents may be exploited to develop productive new recombinations for optimum yield and desirable quality parameter. High GCA effects also cited by Kumar *et al*[12] and Choudhary and Didel[4].Based on estimation of sca effects the hybrids *viz.*, GJB-3 x GOB-1, PLR-1 x GOB-1, KS-224 x GJB-2, KS-224 x GBL-1, Pant rituraj x Doli-5, Pant rituraj x GOB-1 registered high and significant sca effects for fruit yield per plant and also possessed high sca effects for at least one yield contributing component. Such combination may be useful for isolating desirable transgressive segregants. By studying the best parents, best general combiners and best specific cross combinations it was revealed that poor x average, average x good and average x average combinations produced high fruit yielding hybrids described in **Table 4** and could be exploited for practical breeding which was expected to throw stable performing transgressive segregants carrying fixable genes.

Table 1: Analysis of variance for combining ability in brinjal

Characters	Days to 50 % flowering	Plant height (cm)	Primary branches per plant	Secondary branches per plant	Plant spread (cm^2)	Fruit length (cm)	Fruit girth (cm)
gca (7 d.f.)	6.40**	123.84**	0.76**	3.15**	10937.15**	6.68**	14.07**
sca (27 d.f.)	2.88**	95.83**	0.38**	2.09**	2069.62	2.77**	9.13**
Error (70 d.f.)	0.72	2.10	0.10	0.39	1274.87	0.41	1.74
σ^2 gca	0.66	2.80	0.07	0.28	966.22	0.63	1.23
σ^2 sca	4.68	93.73	0.29	1.70	794.74	2.37	7.40
σ^2 gca /σ^2 sca	0.14	0.03	0.24	0.16	1.22	0.27	0.17
Characters	**Fruit weight (g)**	**Fruits per plant**	**Fruit yield per plant (g)**	**Total soluble solids (°Bx)**	**Total phenol (mg g^{-1})**	**Fruit dry weight (mg/100mg)**	**Total sugar (%)**
gca (7 d.f.)	223.84**	45.17**	1173.11**	0.24**	265.96**	0.29**	0.20**
sca (27 d.f.)	192.87**	19.24**	1612.17**	0.18**	180.22**	0.85**	0.18**
Error (70 d.f.)	3.58	1.05	187.76	0.01	7.70	0.07	0.01
σ^2 gca	1.38	2.59	-19.51	0.02	25.82	0.02	0.02
σ^2 sca	82.14	18.19	528.76	0.17	172.51	0.79	0.18
σ^2 gca /σ^2 sca	0.02	0.14	-0.04	0.12	0.15	0.03	0.11

Table 2: Estimation of general combining ability (gca) effects of parentss for various characters in brinjal

Parents /Characters	Days to 50 % flowering	Plant height (cm)	Primary branches per plant	Secondary branches per plant	Plant spread (cm^2)	Fruit length (cm)	Fruit girth (cm)
GJB-3	0.26	2.23**	-0.04	-0.10	-14.00	-0.21	1.15**
PLR-1	1.24**	1.25**	-0.23*	-0.36	-28.13**	-0.23	-2.06**
KS-224	0.95**	-8.04**	0.09	-0.20	-12.08	-0.81**	0.32
Pant rituraj	-0.29	1.34**	-0.46**	-0.36	26.74*	-0.42*	0.47
GJB-2	-0.91**	-1.73**	0.40**	0.63**	41.97**	0.33	0.56
GBL-1	-0.29	0.74	0.03	0.09	-11.71	0.86**	-0.32
Doli-5	-0.99**	1.26**	0.29**	1.00**	42.78**	1.41**	-1.38**
GOB-1	0.04	2.93**	-0.08	-0.70**	-45.57 **	-0.94**	1.26**
Parents /Characters	**Fruit weight (g)**	**Fruits per plant**	**Fruit yield per plant (g)**	**Total soluble solids (°Bx)**	**Total phenol (mg g^{-1})**	**Fruit dry weight (mg/100mg)**	**Total sugar (%)**
GJB-3	4.64**	-1.67**	-133.29*	-0.01	-6.19**	-0.25**	0.05
PLR-1	-4.70**	3.14**	-99.95	-0.11**	7.80**	0.10	-0.14**
KS-224	-5.90**	2.14**	93.18	-0.27**	-3.19**	0.09	-0.22**
Pant rituraj	1.31	0.97**	60.62	-0.05	-3.79**	0.00	-0.07**
GJB-2	-3.15**	-0.56	-89.70	0.01	-4.45**	0.26**	0.03
GBL-1	5.07**	-0.30	183.65**	0.16**	4.34**	0.07	0.11**
Doli-5	5.69**	-3.61**	-15.27	0.07*	0.68	-0.20**	0.01
GOB-1	-2.94**	0.11	0.75	0.21**	4.80**	-0.07	0.23**

Table 3: Estimation of specific combining ability (sca) effects of hybrids for various characters in brinjal

Hybrids/ Characters	Days to 50 % flowering	Plant height (cm)	Primary branches per plant	Secondary branches per plant	Plant spread (cm^2)	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Fruits per plant	Fruit yield per plant (g)	Total soluble solids (°Bx)	Total phenol (mg g^{-1})	Fruit dry weight (mg/100mg)	Total sugar (%)
GJB-3 x PLR-1	-0.47	-20.69**	-0.32	-0.55	15.12	-0.22	0.24	-27.00**	4.31**	-262.94	-0.06	6.54	0.62	-0.12
GJB-3 x KS-224	-0.58	-8.01**	0.06	0.55	6.66	2.05	1.67	6.42*	-0.52	155.93	-0.19	-3.79	-1.15	-0.25
GJB-3 x Pant rituraj	-2.11**	-3.52**	0.09	-0.21	-6.18	-1.16	1.82	-0.03	-0.32	-23.72	0.16	-5.19	-0.68	0.06
GJB-3 x GJB-2	1.94**	6.57**	-0.27	0.99	34.00	-0.58	-1.67	13.91**	-5.01**	-146.21	-0.33	5.81	0.49	-0.40
GJB-3 x GBL-1	-0.50	18.3**	0.70	1.29	-33.10	2.79	2.62	3.89	0.76	72.33	-0.39	3.01	1.02	-0.40
GJB-3 x Doli -5	-0.50	17.10**	-0.44	-1.16	-17.16	-0.78	0.79	-0.48	-3.30**	-50.30	0.21	-3.33	0.90	0.11
GJB-3 x GOB-1	0.41	12.91**	2.85*	1.06	26.53	1.72	2.11	12.45**	1.71	322.13**	0.13	-14.13	-0.39	0.93
PLR-1 x KS-224	0.23	8.22**	-0.19	0.01	4.27	0.88	6.30**	25.05**	-7.44**	69.46	-0.04	0.21	0.66	-0.04
PLR-1 x Pant rituraj	-0.21	11.81**	0.59	1.59	27.15	-2.17	-1.75	14.45**	-6.89**	-145.48	0.24	-12.86	-0.04	0.22
PLR-1 x GJB-2	-4.56**	10.60**	0.36	3.94*	70.08	-1.39	-1.77	26.82**	-5.48**	124.34	-0.37	0.47	0.13	-0.32
PLR-1 x GBL-1	2.12**	5.63**	-0.23	-0.46	-21.08	0.42	2.36	6.24*	-4.19**	168.92	0.12	-10.99	0.07	0.11
PLR-1 x Doli-5	3.22**	2.83*	0.12	-0.26	120.22*	0.88	-2.12	-10.73**	3.35**	100.13	0.31	21.01	0.61	0.28
PLR-1 x GOB-1	1.21*	-2.66*	0.53	1.49	18.75	1.03	2.75	-1.08	5.88**	382.85**	-0.80	28.54	-0.98	-0.70
KS-224 x Pant rituraj	-2.51**	4.59**	-0.47	1.12	26.57	2.79	2.67	1.19	4.48**	277.02	-0.36	26.14	1.15	-0.29
KS-224 x GJB-2	-0.28	8.08**	-0.10	-3.20	-115.90	2.31	4.95**	9.29**	6.69**	672.71**	0.57	6.81	-0.07	0.77
KS-224 x GBL-1	0.19	-6.69**	1.03	6.80**	146.53**	1.80	1.43	9.24**	1.05	303.35*	0.42	-7.99	-0.86	0.31
KS-224 x Doli-5	1.28*	3.40*	0.92	1.58	9.00	-1.61	2.22	6.03*	2.73**	55.52	0.37	3.67	-2.03	0.30
KS-224 x GOB-1	1.47*	-4.58**	-0.29	-2.57	-27.42	-3.57	-2.15	-9.06**	-4.12**	-303.02*	0.33	-5.46	0.05	0.16
Pant rituraj x GJB-2	2.20**	5.57**	-0.16	0.52	-18.79	-2.32	0.30	4.23	-1.98*	-18.74	0.33	-10.93	-0.43	0.22
Pant rituraj x GBL-1	1.21*	-2.40	-0.18	-0.76	-25.51	-1.12	2.23	0.36	-0.49	200.95	0.36	16.61	-0.77	0.28
Pant rituraj x Doli-5	1.58**	3.90**	0.19	0.48	-15.91	-0.11	4.14*	8.21**	1.35	473.27**	-0.48	4.94	0.25	-0.35
Pant rituraj x GOB-1	0.66	-7.09**	0.24	-0.41	16.50	-1.52	2.61	2.30	7.88**	284.19*	0.03	-26.19	-1.71	0.06
GJB-2 x GBL-1	-0.58	-0.21	1.13	1.54	-7.40	1.56	-2.88	-2.88	3.21**	185.24	0.93	-7.73	-1.07	0.98
GJB-2 x Doli-5	1.25*	2.09	0.85	0.40	2.59	-2.22	-1.49	6.72*	-2.07*	-255.10	-0.01	6.61	-0.01	-0.04
GJB-2 x GOB-1	-0.76	-6.60**	-0.45	-0.10	-11.70	-0.03	0.56	-22.20**	1.21	44.35	0.09	0.81	1.11	-0.07
GBL-1 x Doli -5	-2.29**	-4.38**	-0.40	-1.16	-8.97	-2.65	-0.94	-9.33**	3.34**	-270.33	0.07	-5.86	-0.25	0.06
GBL-1 x GOB-1	-0.65	3.73**	-0.52	-0.35	0.15	-0.99	-1.22	-2.03	-2.93**	-121.25	0.15	14.01	-0.36	0.02
Doli-5 x GOB-1	-1.38*	1.03	-0.49	-0.71	-20.48	0.81	-0.19	5.28*	2.04*	-13.85	-0.16	-18.66	0.29	-0.19
S.E(Sij)±	2.32	6.31	0.29	0.57	32.38	0.58	1.20	6.11	1.54	124.54	0.09	2.52	0.23	0.08
S.E(Sij—Sik) ±	3.43	9.34	0.43	0.84	47.9	0.86	1.77	9.05	2.28	180.38	0.13	3.73	0.34	0.11
S.E(Sij—Skl) ±	3.23	8.81	0.40	0.79	45.16	0.81	1.67	8.53	2.15	154.68	0.12	3.51	0.32	0.11

Table 4: A summary table showing the best *per se* performance along with specific combining ability and general combining ability effects of the parents involved in the combination for different characters in brinjal

Characters	Best specific combination	*Per se* performance	sca	gca effects of the parents involved
Days to 50 % flowering	PLR-1 x GJB-2	59.00	-4.56	P x G
	KS-224 x Pant rituraj	62.50	-2.51	P x A
	GBL-1 x Doli -5	61.00	-2.29	A x G
Plant height	GJB-3 x GBL-1	94.90	18.30	P x A
	GJB-3 x Doli -5	100.00	17.10	P x G
	GJB-3 x GOB-1	97.50	12.91	G x G
Primary branches per plant	GJB-3 x GOB-1	7.40	2.85	A x A
	GJB-2 x GBL-1	6.70	1.13	G x A
	KS-224 x GBL-1	6.30	1.03	A x A
Secondary branches per plant	KS-224 x GBL-1	11.80	6.80	A x A
	PLR-1 x GJB-2	11.30	3.94	A x P
	PLR-1 x Pant rituraj	10.90	1.59	A x A
Plant spread	KS-224 x GBL-1	5832.50	146.53	A x A
	PLR-1 x Doli-5	5653.70	120.22	P x G
	PLR-1 x GJB-2	4644.20	70.08	P x G
Fruit length	KS-224 x Pant rituraj	11.11	2.79	P x P
	GJB-3 x GBL-1	12.99	2.79	A x G
	KS-224 x GJB-2	11.38	2.31	P x A
Fruit girth	PLR-1 x KS-224	22.51	6.30	P x A
	KS-224 x GJB-2	23.12	4.95	A x A
	Pant rituraj x Doli-5	21.18	4.14	A x P
Fruit weight	PLR-1 x GJB-2	75.05	26.82	P x P
	PLR-1 x KS-224	72.12	25.05	P x P
	PLR-1 x Pant rituraj	85.08	14.45	P x A
Fruits per plant	Pant rituraj x GOB-1	31.67	7.88	G x A
	KS-224 x GJB-2	27.25	6.69	G x A
	PLR-1 x GOB-1	34.50	5.88	G x A
Fruit yield per plant	KS-224 x GJB-2	2182.02	672.71	A x A
	Pant rituraj x Doli-5	2230.20	473.27	A x A
	PLR-1 x GOB-1	2436.23	382.85	A x A
Total soluble sugar	GJB-2 x GBL-1	4.86	0.93	A x G
	KS-224 x GJB-2	4.07	0.57	P x A
	KS-224 x GBL-1	4.07	0.42	P x G
Total phenol	Pant rituraj x GOB-1	0.57	-26.19	G x P
	Doli-5 x GOB-1	0.69	-18.66	A x P
	GJB-3 x GOB-1	0.67	-14.13	G x P
Fruit dry weight	KS-224 x Pant rituraj	10.07	1.15	A x A
	GJB-2 x GOB-1	10.13	1.11	G x A
	GJB-3 x GBL-1	9.65	1.02	P x A
Total sugar	GJB-2 x GBL-1	3.54	0.98	A x G
	GJB-3 x GOB-1	3.63	0.93	A x G
	KS-224 x GJB-2	3.00	0.77	P x A

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