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Diallel analysis for economic traits in brinjal over environment

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ABSTRACT

An experiment was conducted on 49 genotypes (42 hybrids + 7 parents) obtained through 7× 7 full diallel mating design during Rabi-2020-21 and evaluated in Kharif-2021-22 in three environments created by different dose of fertilizer in RBD with three replications in brinjal at JAU, Junagadh to find out combining ability over environment. The GCA, SCA and RCA and their interaction with environments found significant and non-additive gene action was predominant for most of traits. The reciprocal difference observed for many traits. The parents JBCL-10-12, GJB-2 and JBCL-16-12 observed good general combiner and crosses 16-12 × Swarnamani Black (SB), JBCL-10-12 × JBCL-16-12, GRB-5 × GJB-2, JBCL-17-01 × GJB-2 and JBCL-10-12 × GJB-3 found specific combiner for fruit yield plant^{-1}. The significant correlation between per se performance and gca effect and sca effect obtained for many traits. The superior crosses can use as hybrid or as breeding material in future breeding programme.

Keywords: Brinjal (*Solanum melongena* L.), Diallel, General combining ability, Specific combining ability

INTRODUCTION

Brinjal is most common grown vegetable, easily cultivated and available round of the year and find its place as “Poor man’s vegetable” (Sharma *et al.,* 2004). Brinjal is rich source of vitamins, minerals and fatty acids thiamin, niacin, pantothenic acid and different minerals like calcium, iron, zinc, copper and manganese (Rajan *et al.,* 2020). . Brinjal extract reduce the blood and liver cholesterol in human beings. The nutritious variety beneficial to peoples but, exiting production can’t meet the demand the increasing population and it essential to develop high yielding variety for fulfillment of ever-growing demand of human population (Ray *et al.,* 2013). The main objective of combining ability analysis is to find out the parent that transfer the beneficial characteristic to their progenies and find out superior cross combinations for fruit yield and its attributing traits (Griffing, 1956). Selection of parents is crucial steps in any successful hybridization programme (Poehlman, 1977 and Acquaah, 2012). There was different biometrical procedure were developed for estimation of *gca* and *sca* effect, nature and magnitude of gene actions and heritability of traits but, diallel analysis was most frequent used in different types of crops (Shattuck *et al.,* 1993 and Geleta *et al.,* 2004). In this analysis, GCA is due to additive effects and additive × additive interactions, while SCA denotes dominance effects and additive × dominant and dominant × dominant interactions (Shattuck *et al.,* 1993). Soil fertility reduced day by day due to improper application of fertilizer, leaching, continuous cropping and nutrients losses during harvest. Hence, application of both chemical and organic fertilizers in balanced amount, at recommended time and in appropriate form had positive impact on the physiological and nutritional traits of a crop (Dumas *et al.,* 2003). The application of chemical fertilizer, organic manure and biofertilizer in combination increase the yield (Banjare *et al.,* 2015). Hence, the experiment was carried out to study on combining ability and correlation of combining ability with *per se* performance over environments.

MATERIALS AND METHODS

The present study comprises of seven diverse parental line (GJB-2, GJB-3, GRB-5, JBCL-10-12, JBCL-16-12, JBCL-17-01 and Swarna mani Black SWARNA MANI BLACK) were inter-mated in full diallel fashion (7 × 7) in *Rabi*-2020-21 at Vegetable Research Station

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Table 1: List of Parents and their sources

Parent	Source	Characteristics
GJB-2	Vegetable Research Station, J.A.U., Junagadh	Fruits are medium in size with medium long shape and pink in colour. Plants are semi-spreading type.
GJB-3	Vegetable Research Station, J.A.U., Junagadh	Plants are medium in size and semi spreading. Fruits are medium to big in size with oval shape. Fruits are green in colour with good shining. The fruit pulp is creamy white with less seeds. Calyx is green in colour.
GRB-5	Vegetable Research Station, J.A.U., Junagadh	Fruits are medium in size with round shape. Fruit pulp is white with less seeds. Fruits are green in colour with purple shadow strips and good shining. Plants are medium in size and erect type.
JBCL-10-12	Vegetable Research Station, J.A.U., Junagadh	Plants are medium in size and semi spreading. Fruits are long and big in size. Fruits are green in colour with long purple strips along the fruit length.
JBCL-16-12	Vegetable Research Station, J.A.U., Junagadh	Plants are medium in size and spreading. Fruits are long and big in size. Fruits are green in color with long purple strips along the fruit length.
JBCL-17-01	Vegetable Research Station, J.A.U., Junagadh	Plants are medium in size and erect with white colored flower. Fruit is long cylindrical in shape with green in color.
Swarna mani Black	Vegetable Research Station, J.A.U., Junagadh	Spreading type habit, black coloured fruits with grooves and round in shape. Calyx is purple coloured.

and evaluated (42 crosses + seven diverse parents) in RBD with three replications at three environments, one with normal fertilizer (E_1, 100: 50: 50 NPK, kg ha-^{1}) second with organic condition (E_2, well rotten FYM + Vermicompost) and third one with 25% high fertilizer dose (E_3, 125: 62.5: 62.5 NPK, kg ha-^{1}) at Instruction farm of Agronomy, JAU, Junagadh during Sept. *Kharif*-2021-22. All agronomical practices and plant protection measure except, for fruit borer infestation where unprotected condition was required, were followed for growing a normal crop. The observation was taken on days to first flowering, days to first picking, fruit length

Table 2: List of F_1 from a 7 × 7 full diallel crosses of brinjal

S. N	Hybrids/ Crosses	S.N.	Hybrids/ Crosses
1	GJB-2 × GJB-3	22	JBCL-10-12 × JBCL-16-12
2	GJB-2 × GRB-5	23	JBCL-10-12× JBCL-17-01
3	GJB-2 × JBCL-10-12	24	JBCL-10-12 × Swarna mani Black
4	GJB-2 × JBCL-16-12	25	JBCL-16-12 × GJB-2
5	GJB-2 × JBCL-17-01	26	JBCL-16-12 × GJB-3
6	GJB-2 × Swarna mani Black	27	JBCL-16-12 × GRB-5
7	GJB-3 × GJB-2	28	JBCL-16-12 × JBCL-10-12
8	GJB-3 × GRB-5	29	JBCL-16-12 × JBCL-17-01
9	GJB-3 × JBCL-10-12	30	JBCL-16-12 × Swarna mani Black
10	GJB-3 × JBCL-16-12	31	JBCL-17-01× GJB-2
11	GJB-3 × JBCL-17-01	32	JBCL-17-01× GJB-3
12	GJB-3 × Swarna mani Black	33	JBCL-17-01× GRB-5
13	GRB-5 × GJB-2	34	JBCL-17-01× JBCL-10-12
14	GRB-5 × GJB-3	35	JBCL-17-01× JBCL-16-12
15	GRB-5 × JBCL-10-12	36	JBCL-17-01× Swarna mani Black
16	GRB-5 × JBCL-16-12	37	Swarna mani Black × GJB-2
17	GRB-5 × JBCL-17-01	38	Swarna mani Black × GJB-3
18	GRB-5 × Swarna mani Black	39	Swarna mani Black × GRB-5
19	JBCL-10-12 × GJB-2	40	Swarna mani Black × JBCL-10-12
20	JBCL-10-12× GJB-3	41	Swarna mani Black × JBCL-16-12
21	JBCL-10-12 × GRB-5	42	Swarna mani Black × JBCL-17-01

(cm), fruit girth (cm), average fruit weight (g), number of fruits plant^{-1}, number of primary branches, plant height, days to last picking, number of pickings, fruit yield plant^{-1},

TSS content (°B) and fruit borer infestation (%) on five randomly selected brinjal plants for each of traits except, days to first flowering, days to first picking and days to last picking where, observations recorded on plot basis. The combining ability analysis was performed in accordance with Daljit Singh (1974) which is the extension of model-I and method-I (Parents, F_1 and reciprocals) of Griffing's (1956). The simple correlation was estimated between *per se* performance and *gca*, and *sca* effect in accordance Pearson, 1896.

RESULTS AND DISCUSSION

Analysis of variance

The sum of squares (Table 3) due to GCA, SCA and RCA found significant for each of characters. The σ^2_{sca} were higher than σ^2_{gca} and $\sigma^2_{gca}/\sigma^2_{sca}$ ratio was less than one for all the characters indicated abundance of non-heritable gene action (Table 2). The result was in accordance with Gadhiya *et al.,* 2015 and Desai *et al.,* 2017. The mean sum of squares due to GCA × E, SCA × E and RCA × E were significant for each character indicating significant interaction with environments.

Table 3: ANOVA for combining ability analysis for various traits over environment in brinjal

Source	Df	DFF	DFP	FL	FG	AFW	NFP
GCA	6	135.21**	144.34**	15.86**	41.27**	786.19**	19.29**
SCA	21	59.96**	63.66**	6.25**	16.19**	555.58**	21.54**
RCA	21	32.17**	32.33**	6.31**	16.96**	370.53**	29.18**
Environments	2	736.09**	905.50**	170.37**	383.36**	22587.26**	556.17**
GCA × E	12	8.18**	8.42*	2.75**	9.13**	291.80**	2.28*
SCA × E	42	7.93**	7.76*	3.44**	7.63**	203.21**	5.23**
RCA × E	42	7.18**	7.98*	3.38**	5.34**	325.00**	5.18**
Pooled error	288	4.05	5.23	0.56	0.52	25.86	1.12

Source	Df	NPB	PH	DLP	NP	FYP	TSS	FBI
GCA	6	1.77**	179.63**	176.50**	1.92**	0.10**	1.05**	80.49**
SCA	21	1.23**	134.49**	232.50**	5.61**	0.19**	0.56**	39.08**
RCA	21	0.57**	89.44**	127.03**	2.86**	0.34**	0.27**	83.96**
Environments	2	1.70**	8450.68**	1003.15**	135.74**	19.44**	1.16**	19.76**
GCA × E	12	1.60**	58.11**	62.21**	1.48**	0.12**	0.20**	21.68**
SCA × E	42	0.45**	55.96**	23.62**	0.56**	0.10**	0.17**	22.90**
RCA × E	42	1.05**	48.34**	57.94**	1.43**	0.15**	0.07**	20.67**
Pooled error	288	0.10	23.84	9.78	0.23	0.02	0.04	0.17

** and ** significant at 0.05 and 0.01 level of probability, respectively*

Combining ability analysis

The *gca* effect of parents given in Table 5. The desirable *gca* effect observed in parents GJB-2 and Swarna mani Black (SB) for days to first flowering and days to first picking revealed them as good general combiner for earliness. The positive significant value observed for fruit length in parents JBCL-17-01, JBCL-16-12 and JBCL-10-12; for fruit girth JBCL-10-12, Swarna Mani Black and GJB-3; for average fruit weight JBCL-10-12, JBCL-16-12, Swarna Mani Black and GJB-3; for number of fruit plant^{-1} GJB-2 and JBCL-17-01; for number of primary branches JBCL-10-12 and SB; for plant height GRB-5 and SB; for days to last picking JBCL-17-01, Swarna Mani Black and JBCL-10-12; for number of pickings JBCL-17-01 and SB; for fruit yield plant^{-1} JBCL-10-12, GJB-2 and JBCL-16-12 and for TSS content GRB-5 and GJB-3 found good general combiner over environment. The negative significant *gca* effects observed in parents SB, GJB-2, JBCL-16-12 and GRB-5 showed that these parents were good general combiner for fruit borer infestation over environment. The parents were good general combiner for fruit yield plant^{-1} was also showed good general combining ability for at least one component traits. Similar findings were also reported by Desai *et al.* (2017); Dhirendra et al.

Table 4: Estimates of GCA and SCA variance for various traits over environment

Source	DFF	DFP	FL	FG	AFW	NFP	NPB	PH	DLP	NP	FYP	TSS	FBI
σ^2_{gca}	9.37	9.94	1.09	2.91	54.31	1.30	0.12	11.13	11.91	0.12	0.01	0.07	5.74
σ^2_{sca}	55.91	58.43	5.69	15.67	529.72	20.42	1.13	110.65	222.72	5.38	0.17	0.52	38.91
σ^2_{rca}	14.06	13.55	2.88	8.22	172.34	14.03	0.24	32.80	58.63	1.32	0.16	0.12	41.90
σ^2_{gca} / σ^2_{sca}	0.17	0.17	0.19	0.19	0.10	0.06	0.11	0.10	0.05	0.02	0.03	0.14	0.15

** and ** significant at 0.05 and 0.01 level of probability, respectively*

(2017); Samalindsujin and Karuppaiah (2018); Ramesh *et al.,* (2019); Fayad *et al.* (2021) and Mondel *et al.* (2021).

The *sca* effects were given in Table 6a-6c for all traits over environment. The desirable *sca* effect for days to first flowering found in 10 crosses, among them top three direct crosses were JBCL-10-12 × JBCL-16-12, JBCL-10-12 × JBCL-17-01 and GJB-2 × Swarna Mani Black and reciprocal crosses were GRB-5 × GJB-3, Swarna Mani Black × GRB-5 and JBCL-17-01 × GJB-3; for days to first pickings found in nine crosses, among them top three direct crosses JBCL-10-12 × JBCL-16-12, JBCL-10-12 × JBCL-17-01 and GJB-2 × Swarna Mani Black and reciprocal crosses GRB-5 × GJB-3, Swarna Mani Black × GRB-5 and JBCL-17-01 × GJB-3 over environment.

Table 5: Estimates of gca effect of parents for various traits over environment in brinjal

Parents	DFF	DFP	FL	FG	AFW	NFP	PH	NPB	DLP	NP	FYP	TSS	FBI
GJB-2	-3.10**	-3.26**	-0.94**	-1.13**	-2.26**	0.94**	0.03	-2.35**	-4.18**	-1.10**	0.04*	-0.18**	-0.94**
GJB-3	2.76**	2.76**	-0.54**	0.50**	2.46**	-0.70**	-0.09*	-2.75**	0.35	-3.30**	0.001	0.21**	0.07
GRB-5	-0.35	-0.22	-0.23*	-0.37**	-3.71**	-0.38	-0.03	3.01**	-0.88	-0.08	-0.08**	0.22**	-0.21**
JBCL-10-12	0.63*	0.71*	0.24*	1.43**	4.90**	-0.17	0.31**	1.08	0.90*	0.02	0.05**	-0.10**	0.31**
JBCL-16-12	0.80**	0.94**	0.57**	-0.78**	3.80**	-0.30*	-0.16**	-0.32	0.50	-0.06	0.04*	-0.08**	-0.27**
JBCL-17-01	0.20	0.04	0.81**	-0.70**	-6.81**	0.99**	-0.28**	-0.14	2.04**	0.28**	-0.02	0.02	2.74**
SB	-0.93**	-0.98**	0.08	1.04**	1.62*	-0.38*	0.21**	1.48*	1.27**	0.26**	-0.03	-0.09**	-1.70**
SE gca ±	0.28	0.33	0.11	0.10	0.73*	0.15	0.05	0.70	0.45	0.07	0.02	0.03	0.06

** and ** Significant at 0.05 and 0.01 level of probability, respectively*

The significant and desirable sca effect for fruit length found in 17 crosses among them top three direct crosses were JBCL-16-12 × SB, GJB-2 × JBCL-10-12 and GJB-3 × GRB-5 and reciprocal crosses were JBCL-10-12 × GJB-2, JBCL-17-01 × GJB-3 and JBCL-10-12 × GJB-3; for fruit girth found in 19 crosses among them top three direct crosses were GJB-2 × GJB-3, GJB-2 × GRB-5 and GJB-3 × JBCL-10-12 and reciprocal crosses were GJB-3 × GJB-2, GRB-5 × GJB-2 and Swarna Mani Black × GJB-2; for average fruit weight found in 13 crosses among them top three direct crosses were GJB-2 × GJB-3, JBCL-10-12 × Swarna Mani Black and JBCL-16-12 × Swarna Mani Black and reciprocal crosses were Swarna Mani Black × JBCL-10-12, JBCL-10-12 × GJB-3, GRB-5 × GJB-2; for number of fruits plant^{-1} found in 14 crosses among them top three direct crosses JBCL-10-12 × JBCL-16-12, JBCL-16-12 × SB, GJB-2 × JBCL-10-12 and reciprocal crosses GRB-5 × GJB-2, SWARNA MANI BLACK× GRB-5, JBCL-10-12 × GRB-5; for number of primary branches found in 11 crosses among them top three direct crosses were GJB-3 × SB, GJB-3 × JBCL-17-01 and GJB-2 × JBCL-16-12 and reciprocal crosses were JBCL-17-01× GJB-2, SWARNA MANI BLACK× GJB-3, JBCL-16-12 × GRB-5; for plant height six crosses among them top three direct crosses were JBCL-16-12 × JBCL-17-01, GJB-2 × JBCL-16-12 and GJB-3 × GRB-5 and reciprocal crosses were GRB-5 × GJB-3, JBCL-16-12 × GRB-5 and GRB-5 × GJB-2; for days to last picking found in 15 crosses among them top three direct crosses were JBCL-16-12 × SB, GJB-2 × GRB-5 and GJB-3 × JBCL-10-12 and reciprocal crosses were GRB-5 × GJB-2, JBCL-17-01 × GJB-2 and JBCL-17-01 × GRB-5; for number of pickings found in 17 crosses among them top three direct crosses were JBCL-16-12 × SB, GJB-2 × GRB-5 and GJB-3 × JBCL-10-12 and reciprocal crosses were GRB-5 × GJB-2, Swarna Mani Black × GRB-5 and JBCL-17-01 × GRB-5; for fruit yield plant^{-1} found in 17 crosses

Table 6a: Estimates of sca effect of crosses for various traits over environments in brinjal

Crosses	DF		DFF		FL		FG	
	DC	RC	DC	RC	DC	RC	DC	RC
GJB-2 × GJB-3	1.99*	3.11**	1.09	2.72**	0.07	-0.35	2.28**	2.41**
GJB-2 × GRB-5	-0.13	3.33**	0.07	2.72**	0.27	1.21**	1.84**	2.13**
GJB-2 × JBCL-10-12	1.84	0.06	2.08	-0.22	1.43**	1.84**	-0.78*	0.23
GJB-2 × JBCL-16-12	0.001	1.94*	-0.04	1.44	0.47	0.13	-0.40	0.15
GJB -2 × JBCL- 17-01	2.60*	3.83**	3.31**	4.00**	0.28	1.18**	-0.07	-0.16
GJB-2 × SB	-4.27**	0.28	-4.12**	0.67	-0.85**	-0.30	-0.96**	3.66**
GJB-3 ×GRB-5	-0.60	-5.39**	-1.06	-5.83**	1.35**	0.79*	-1.60**	0.73*
GJB-3 × JBCL-10-12	-0.74	-1.00	-0.43	-1.50	0.46	1.29**	2.11**	0.60*
GJB-3 × JBCL-16-12	2.30*	0.78	2.11	0.61	0.24	0.33	-0.49	0.89**
GJB-3 × JBCL- 17-01	-3.37**	-2.83**	-3.54**	-2.83**	0.46	1.38**	-0.05	-0.93**
GJB-3 × Swarna Mani Black	-0.24	-0.28	0.26	-1.17	-1.27**	-1.10**	-3.40**	-0.68*
GRB-5 × JBCL-10-12	-2.13*	3.39**	-2.07	2.78**	0.16	0.83**	-0.70	-0.71*
GRB-5 × JBCL-16-12	2.52*	-1.22	2.48*	-1.33	-0.72	0.11	-1.76**	0.75*
GRB-5 × JBCL-17-01	2.24*	0.33	2.38*	0.22	1.15**	-1.32**	1.14**	0.74*
GRB-5 × Swarna Mani Black	1.64	-2.94**	1.23	-3.06**	-0.60	0.79*	1.42**	3.06**
JBCL-10-12 × JBCL-16-12	-5.95**	0.83	-6.34**	1.00	-1.44**	0.69*	0.63	-1.89**
JBCL-10-12 × JBCL-17-01	-5.18**	1.67*	-5.49**	1.61	-1.44**	0.33	1.20**	-0.81**
JBCL-10-12 × Swarna Mani Black	3.22**	-0.06	3.58**	-0.11	0.32	0.93**	1.80**	2.12**
JBCL-16-12 × JBCL- 17-01	2.37*	-1.06	2.39*	-1.28	-0.62	1.21**	-0.10	0.17
JBCL-16-12 Swarna Mani Black	-3.06**	2.28**	-3.37**	2.06*	1.82**	0.67*	1.44**	2.41**
JBCL-17-01 × Swarna Mani Black	1.65	-1.72*	1.59	-2.33*	0.84*	-1.92**	-0.79*	-2.65**
S.E.(S_{ij}) ±	1.00	-	1.10	-	0.37	-	0.36	-
S.E. (r_{ij}) ±	-	0.82	-	0.93	-	0.31	-	0.29

** and ** Significant at 5% and 1% levels of significance, respectively, * Parental status will be change in reciprocal cross*

Table 6b: Estimates of sca effect of crosses for various traits over environments in brinjal

Crosses	AFW		NFP		NPB		PH	
	DC	RC	DC	RC	DC	RC	DC	RC
GJB-2 × GJB-3	13.46**	1.15	-0.40	-1.24**	-0.59**	-0.01	1.48	0.49
GJB-2 × GRB-5	0.54	11.52**	0.30	3.45**	-0.39*	0.11	3.53	6.13**
GJB-2 × JBCL-10-12	-0.74	-5.84**	1.65**	-1.38**	-0.05	-0.12	2.42	-0.34
GJB-2 × JBCL-16-12	-4.77	-4.48*	-0.29	-3.64**	0.42*	0.00	5.59*	-0.30
GJB -2 × JBCL- 17-01	10.11**	5.94**	-1.64**	2.86**	-0.15	0.66**	1.56	0.96
GJB-2 × Swarna Mani Black	0.65	6.01**	-2.64**	-1.58**	0.34*	0.21	-2.29	-1.65
GJB-3 ×GRB-5	-0.01	-1.22	0.25	1.92**	0.40*	0.27*	4.81*	7.28**
GJB-3 × JBCL-10-12	3.58	15.56**	-0.27	0.77	0.05	0.24	4.34	3.29
GJB-3 × JBCL-16-12	-12.73**	6.91**	-1.40**	1.06*	0.16	-0.16	-3.39	-0.70
GJB-3 × JBCL- 17-01	1.08	-3.65**	1.49**	2.38**	0.54**	-0.28*	-1.33	-2.41
GJB-3 × Swarna Mani Black	-12.24**	-0.56	1.01	-0.66	0.75**	0.55**	2.25	-7.41**
GRB-5 × JBCL-10-12	-11.79**	-14.44**	0.94	2.90**	-0.11	-0.13	2.26	-0.77
GRB-5 × JBCL-16-12	-2.75	-7.82**	-1.29*	1.34**	0.13	0.51**	-2.08	6.84**
GRB-5 × JBCL-17-01	8.59**	6.28**	0.61	2.33**	0.35*	-0.58**	0.94	-7.60**
GRB-5 × Swarna Mani Black	8.44**	-4.45**	-0.92	3.24**	0.30	-0.02	3.56	-1.52
JBCL-10-12 × JBCL-16-12	-8.39**	-0.68	3.81**	0.35	-0.08	0.44**	-1.54	1.29
JBCL-10-12 × JBCL-17-01	-5.95*	0.64	0.63	2.32**	-0.08	-0.30*	-1.48	-0.84
JBCL-10-12 × Swarna Mani Black	10.49**	16.27**	-2.37**	-0.16	-0.03	0.02	0.78	2.64
JBCL-16-12 × JBCL- 17-01	1.88	-8.81**	0.93	-4.38**	0.30	-0.07	6.96**	3.55
JBCL-16-12 × Swarna Mani Black	12.68**	1.42	1.97**	-0.75	-0.22	0.13	0.15	-2.48
JBCL-17-01 × Swarna Mani Black	-15.30**	-7.63**	0.77	-0.22	-0.44**	0.22	0.72	-3.31
S.E.(S_{ij}) ±	2.50	-	0.52	-	0.16	-	2.40	-
S.E. (r_{ij}) ±	-	2.00	-	0.43	-	0.13	-	2.00

** and ** Significant at 5% and 1% levels of significance, respectively, * Parental status will be change in reciprocal cross* among them top three direct crosses were 16-12 × SB, JBCL-10-12 × JBCL-16-12 and GRB-5 × JBCL-17-01 and reciprocal crosses were GRB-5 × GJB-2, JBCL-17-01 × GJB-2 and JBCL-10-12 × GJB-3; for TSS content found in 10 crosses among them top direct crosses were GJB-2 × JBCL-10-12, GJB-2 × Swarna Mani Black and GJB-2 × JBCL-16-12 and reciprocal crosses were JBCL-17-01 × JBCL-16-12, SWARNA MANI BLACK× JBCL-10-12 and JBCL-17-01 × GRB-5 over environment.

The negative desirable *sca* effect for fruit borer infestation found in 10 crosses among them top three direct crosses were GRB-5 × JBCL-10-12, JBCL-17-01 × SB, GJB-3 × JBCL-17-01 and reciprocal crosses Swarna Mani Black × GJB-3, Swarna Mani Black × JBCL-17-01, Swarna Mani Black × GRB-5 over environment. The desirable *sca* effect for fruit yield and its attributing traits was also reported by Prasad *et al.* (2015); Dhirendra kumar *et al.* (2017) and Mondel *et al.* (2021) in brinjal. Significant reciprocals effects were found for most of traits under study indicating that cytoplasmic inheritance had a major role in altering the inheritance of the yield parameters and selection of maternal parent should considered during breeding for these characters. The similar findings for fruit yield and its attributing traits were also recorded by Hubaity and Teli (2013); Nyadanu *et al.* (2017) and Santhosha *et al.* (2017) in brinjal.

Table 6c: Estimates of sca effect of crosses for various traits over environments in brinjal

Crosses	DLP		NP		FYP		TC		FBI	
	DC	RC	DC	RC	DC	RC	DC	RC	DC	RC
GJB-2 × GJB-3	0.32	3.19*	-0.08	0.05	0.18**	-0.09	-0.39**	-0.05	0.73**	-0.74**
GJB-2 × GRB-5	8.74**	13.70**	1.17**	1.51**	0.11	0.50**	-0.34**	-0.11	-1.35**	0.91**
GJB-2 × JBCL-10-12	3.36*	7.20**	0.19	1.03**	0.15*	-0.15**	0.40**	-0.05	3.41**	5.65**
GJB-2 × JBCL-16-12	0.93	-3.50**	0.09	-0.66**	-0.11	-0.37**	0.12**	-0.01	0.55*	1.28**
GJB -2 × JBCL- 17-01	2.90	8.12**	-0.06	0.58**	0.04	0.30**	-0.08**	-0.28**	-2.43**	1.11**
GJB-2 × Swarna Mani Black	1.21	-4.44**	0.76**	-0.72**	-0.19**	-0.02	0.22**	-0.11	0.18	-1.28**
GJB-3 ×GRB-5	3.31*	1.14	0.61*	0.92**	0.02	0.11*	-0.06**	-0.46**	-0.35	0.97**
GJB-3 × JBCL-10-12	5.82**	1.57	0.86**	0.44*	0.05	0.30**	-0.46**	-0.12	1.67**	4.42**
GJB-3 × JBCL-16-12	-0.35	-5.68**	-0.32	-0.89**	-0.28**	0.19**	0.001	-0.23**	1.45**	6.24**
GJB-3 × JBCL- 17-01	-0.90	0.05	0.34	0.40*	0.14*	0.13*	0.12**	-0.28**	-2.76**	6.40**
GJB-3 × Swarna Mani Black	-4.54**	2.68*	-0.64**	0.52*	-0.12	-0.07	-0.22*	0.06	-0.89**	-4.44**
GRB-5 × JBCL-10-12	-2.59	1.91	-0.08	-0.09	-0.14*	-0.03	-0.10**	0.07	-4.11**	-0.01
GRB-5 × JBCL-16-12	-2.89	1.33	-0.74**	0.36	-0.19**	0.02	0.02*	-0.02	-0.84**	-0.35*
GRB-5 × JBCL-17-01	1.50	7.93**	-0.14	1.11**	0.20**	0.23**	-0.27**	0.19*	7.81**	9.48**
GRB-5 × Swarna Mani Black	-0.96	5.22**	-0.26	1.16**	0.00	0.21**	-0.16**	0.06	0.96**	-1.50**
JBCL-10-12 × JBCL-16-12	-0.78	0.23	0.74**	-0.09	0.22**	-0.01	-0.03**	-0.22**	-1.74**	3.38**
JBCL-10-12 × JBCL-17-01	-1.76	4.70**	0.53*	0.42*	-0.04	0.19**	-0.05**	0.12	0.05	4.53**
JBCL-10-12 × Swarna Mani Black	3.80*	-1.06	-0.27	0.21	-0.06	0.23**	-0.05**	0.28**	-1.11**	2.50**
JBCL-16-12 × JBCL- 17-01	5.47**	-1.41	0.42	0.01	0.14*	-0.55**	0.06**	0.40**	0.10	1.75**
JBCL-16-12 × Swarna Mani Black	11.80**	-0.47	2.16**	-0.38	0.40**	-0.07	-0.20**	-0.31**	0.83**	0.16
JBCL-17-01 × Swarna Mani Black	1.70	-1.70	0.05	0.07	-0.19**	-0.18**	0.11**	-0.16	-3.05**	-1.55**
S.E.(S_{ij}) ±	1.50	-	0.24	-	0.06	-	0.01	-	0.21	-
S.E. (r_{ij}) ±	-	1.30	-	0.20	-	0.05	-	0.08	-	0.17

** and ** Significant at 5% and 1% levels of significance, respectively, * Parental status will be change in reciprocal cross*
DFF = Days to First Flowering, FL= Fruit Length, FG = Fruit Girth, AFW = Average Fruit Weight, NFP = Number of Fruits/Plant, DLP = Days to Last Picking, NP = Number of Pickings, FYP = Fruit Yield/Plant, TSS = Total Soluble Solid, FBI = Fruit Borer Infestation, DC = Direct Cross, RC = Reciprocal Cross

Correlation

The significant and positive correlation was observed between *per se* performance and *gca* effects (Table 5) of parents for each character except, fruit girth, number of fruits plant^{-1}, number of pickings and fruit yield plant^{-1}. The correlation between *per se* performance and *gca* effects suggested that selection of parents for hybridization programme on the basis of mean of parents would be rewarding. Thus, if the characters uni-directionally controlled by set of alleles and additive effect is important, the selection of parents according to *per se*

Table 7: Correlation coefficient between *per se* performance and gca effect and *per se* performance sca effect

S.N.	Characters	*Per se* performance and gca effect	*Per se* performance and sca effect	
			Direct	Reciprocal
1.	Days to first flowering	0.80*	-0.18	-0.37
2.	Days to first picking	0.84*	-0.17	-0.34
3.	Fruit length (cm)	0.97**	-0.14	0.44*
4.	Fruit girth (cm)	0.57	-0.14	0.84**
5.	Average fruit weight (g)	0.86*	0.52*	0.40
6.	Number of fruits plant^{-1}	0.52	0.09	0.04
7.	Number of primary branches	0.78*	0.34	0.34
8.	Plant height (cm)	0.79*	-0.09	0.34
9.	Days to last picking	0.84*	-0.05	-0.28
10.	Number of pickings	-0.45	-0.04	-0.10
11.	Fruit yield plant^{-1} (kg)	0.11	0.14	-0.01
12.	TSS content (°B)	0.96**	-0.09	0.60**
13.	Fruit borer infestation (%)	0.85*	0.01	0.70**

** and ** significant at 5% and 1% levels of significance, respectively*

performance may be effective. The correlation between *per se* performance and direct and reciprocal *sca* effects (Table 5) were found positively significant for average fruit weight for direct crosses and fruit length, fruit girth, TSS content and fruit borer infestation for reciprocal crosses, indicated that selection of crosses according to *per se* performance for these traits may be rewarding, but advance analysis may also be required for correct data interpretation.

CONCLUSION

The significant variation and interaction with environment found for all characters and non-additive gene action was dominant for majority of characters revealed that utilization of hybrid vigour is more useful. The maternal effects also observed for most of the traits indicating that parental status as male or female also considered during hybridization. The parents JBCL-10-12, GJB-2 and JBCL-16-12 found good general combiner for fruit yield plant^{-1} in all three environments. The crosses 16-12 × Swarna Mani Black, JBCL-10-12 × JBCL-16-12, GRB-5 × GJB-2, JBCL-17-01 × GJB-2 and JBCL-10-12 × GJB-3 found specific combiner. The significant correlation between *per se* performance and *gca* effect and *sca* effect (direct and reciprocal) indicated that selection of parents and crosses should be on *per se* performance. The above crosses were used either as hybrid or as breeding material in future breeding programme over environment.

AUTHOR’S CONTRIBUTION

Conceptualization and designing of research work (G.U. Kulkarni, L.K. Sharma and C.K. Kumawat); Execution of field experiment and data collection (C. K. Kumawat); Analysis of data and interpretation (C. K. Kumawat and Suchitra); Preparation of manuscript (C.K. Kumawat).

DECLARATION

There is no conflict of interest.

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