Annals of Plant and Soil Research 25(3): 494-500 (2023)
https://doi.org/10.47815/apsr.2023.10297

Combining ability studies for fruit quality and attributing traits in brinjal (*Solanum Melongena* L.) over different environments

RADHE SHYAM KHERWA, RAJU LAL BHARDWAJ*, ANUPAMA AND KUMARI PUSHPA

Department of Horticulture, College of agriculture, Jodhpur (Agriculture University, Jodhpur-342304)

Received: March, 2023; Revised accepted: July. 2023

ABSTRACT

Combining ability effects were estimated for fruit quality and its component traits in a line × tester analysis model comprising 32 crosses developed by using four lines and eight testers. The analysis of variance due to GCA and SCA was significant for all the fruit quality traits indicating that the both additive and non-additive gene actions were involved in the inheritance of traits. Estimates of GCA effects indicated that among female parent's PR-5, VR-2 and IIHR- 563 whereas, among male parents BCB-464, BCB-71-1, CO-2, CHBR-2 and PB-6 were good general combiners as they showed desirable GCA effects. The crosses viz., PLR-1 × CO-2, PLR-1 × PB-6, VR-2 × CHBR-2 and IIHR- 563 × BCB-71-1 showed significantly desirable SCA effects for all the qualitative traits and could be for future improvement in breeding programmes.

Keywords: Brinjal, GCA, Gene action, SCA, Qualitative traits

INTRODUCTION

A major solanaceous vegetable crop growing year-round in India is brinjal (*Solanum melongena* L.), often known as aubergine. The fruit of the brinjal is frequently used in a variety of culinary dishes, such as sliced bhaji, filled curries, bharta, and chatni *etc.* It has also been used as raw material in pickle making and dehydration industries (Yadav *et al.* 2020). It is high in dietary fiber and low in fat. It contains probably water, carbohydrates and some protein besides it is a good source of nutrients such as vitamin K, ascorbic acid, niacin, pantothenic acid, vitamin B_6 and rich in minerals like Ca, Mg, K, P and Fe (Konyak *et al.* 2019). Bitterness in brinjal is due to presence of glycoalkaloids content which vary from 0.4 to 0.5 mg per 100 g of fresh weight. Purple varieties have higher amino acid content, copper content and polyphenol oxidase activity, whereas iron and catalase activity found maximum in green cultivars. The fruits are excellent remedies for those suffering from liver troubles while, white coloured brinjal are good for diabetic patients (Yadav *et al.* 2020). Extracts of brinjal are known to have significant effect in reducing blood and liver cholesterol rates. The peel of brinjal has significant amounts of anthocyanin with antioxidant activity and protects against ageing, cancer, inflammation and neurological diseases (Hanur *et al.* 2006). The nature of gene action serves as a foundation for selecting efficient breeding techniques, and knowledge of general combining ability (GCA) and specific combining ability (SCA) aids in the selection of parents and hybrids, respectively. Keeping this in view, the present study was therefore conducted to estimate the general combining ability effect of parents, specific combining ability effect of hybrids and to elucidate nature of gene action for fruit quality and its component characters.

MATERIALS AND METHODS

The experiment was conducted at Instructional Farm, College of Agriculture, Mandor, Jodhpur, Agriculture University Jodhpur (Rajasthan). The experimental material for the present investigation was crossed in L × T fashion given by Kempthorne (1957) by using 4 females (PLR-1, PR-5, VR-2 and IIHR- 563) and 8 males (CHBR-2, RCMBL-49, CO-2, JB-64, PB-6, BCB-71-1, BCB-464 and Swarna Mani). These 32 F_1s, 12 parents (4 females, 8 males) and a commercial check variety (Pusa Uttam) created the material for the present investigation. The plants were planted in a randomized complete block design with three replications in three environments *viz.,* E_1: *Summer Season* – Sown on April 2020, E_2: *Kharif Season* – Sown on July, 2020 and E_3: Early *Winter Season* – Sown on October, 2020. Parents and hybrids

Corresponding author Email: rajubhardwaj3@gmail.com

were planted in a single row of 10 plants per entry in each replication. The separation between plants and rows was 60 and 60 cm, respectively. For growing a quality crop, the suggested agronomic practices and plant protection measures were applied. In order to collect data on four quality attributes, five competing plants were randomly chosen from the middle of each row in each replication. The percentage of TSS content in the juice of the brinjal fruit of each of five labeled plants was recorded with the help of Pocket Refractometer Pal-1, Atago (range 0 to 32) whereas, for ascorbic acid 2, 6 -dichlorophenol indophenol visual titration technique as outlined by Ranganna (1986) was adopted for its determination. Total phenolics content of brinjal fruit was resolute by used 2 N Folin-ciocalteau reagents and the method of Singleton *et al.* (1999) as well as for measurement of fruit dry matter at the time of maturity by selected five fruits were first sun dried up to constant weight and the dried materials were then weighed in grams and mean was calculated.

RESULTS AND DISCUSSION

Analysis of variance revealed that the mean squares due to line × tester were found significant for all the characters (except fruit dry matter in E_1) when tested against error mean square whereas, variance due to GCA and SCA was significant for all the traits (total soluble solids, ascorbic acid, total phenol content and fruit dry matter) indicating that the both additive and non-additive gene actions were involved in the inheritance of traits (Table 1 and 2).

Table 1: ANOVA for combining ability for total soluble solids (%) and ascorbic acid (mg/100g fw) in each environment and pooled over environments

Source of variance	d.f.	Total soluble solids (%)				Ascorbic acid (mg/100g fw)			
		E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
Environment	2				10.528**				28.725**
Replication	2	0.100	0.056	0.361*	0.361*	0.057	0.109	0.030	0.0005
Hybrids	31	1.121**	0.920**	0.845**	2.655**	2.044**	2.476**	2.072**	6.040**
Female (F)	3	1.117*	1.287*	1.065*	3.284**	2.869**	3.832**	3.137**	9.505**
Male (M)	7	3.775**	2.597**	2.550**	8.677**	6.247**	8.193**	7.194**	20.319**
Females × Males (F×M)	21	0.237**	0.308**	0.246**	0.557**	0.525**	0.377**	0.212**	0.785**
Hybrids × Environments	62				0.116*				0.276**
Female × Environment	6				0.093				0.167
Male × Environment	14				0.122				0.658**
(F × M) × Environments	42				0.117				0.164**
Pooled Error	186				0.081				0.075
Estimates									
σ^2 Environment					0.079**				0.217**
σ^2 Females		0.044*	0.046*	0.040*	0.044*	0.117**	0.156**	0.126**	0.131**
σ^2 Males		0.310**	0.200**	0.205**	0.239**	0.515**	0.675**	0.591**	0.562**
σ^2 gca		0.133**	0.100**	0.095**	0.109**	0.250**	0.329**	0.281**	0.275**
σ^2 sca		0.059**	0.057**	0.051**	0.053**	0.154**	0.095**	0.035*	0.079**
σ^2 gca/ σ^2 sca		0.088	0.057	0.065	0.095	0.340	0.040	0.097	0.491
σ^2 Females × Environments					0.001				0.004
σ^2 Males × Environments					0.003				0.049**
σ^2 gca × Environments					0.001				0.019**
σ^2 sca × Environments					0.012				0.030**

*E_1, E_2 and E_3 are different environments (seasons) viz., Summer Season, Kharif Season and Early Winter Season, respectively, *, ** Significant at 5 and 1 per cent probability levels, respectively*

The degree of variance due to females in individual environment was higher as compared to that of females at pooled for most of the characters. Similarly, significant results were also reported by Bhakta *et al.* (2009) and Rai and Asati (2011). Significant mean square variances due to environments for all the traits indicated the impact of environments on inheritance of these traits. The interaction mean square due to hybrids × environments was significant for all the characters except total phenol content.

Table 2: ANOVA for combining ability for total phenol content (mg/100g fw) and fruit dry matter (g) in each environment and pooled over environments

Source of variance	d.f.	Total soluble solids (%)				Ascorbic acid (mg/100g fw)			
		E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
Environment	2				138.817**				58.426**
Replication	2	2.125	5.714	1.935	3.266	0.005	0.019	0.002	0.003
Hybrids	31	38.020**	55.595**	45.395**	134.939**	0.618**	1.123**	0.634**	2.173**
Female (F)	3	127.996**	176.240**	155.241**	456.219**	1.317**	1.111**	1.363**	3.597**
Male (M)	7	100.947**	138.389**	114.746**	349.506**	1.907**	4.330**	1.782**	7.510**
Females×Males (F×M)	21	4.190**	10.761**	6.586**	17.519**	0.089	0.055*	0.148**	0.191**
Hybrids × Environments	62				2.035				0.101**
Female × Environment	6				1.629				0.097
Male × Environment	14				2.289				0.255**
(F × M) × Environments	42				2.009				0.051
Pooled Error	186				1.568				0.044
Estimates									
σ2 Environment					1.040**				0.442**
σ2 Females		5.288**	7.225**	6.413**	6.315**	0.053**	0.045**	0.055**	0.049**
σ2 Males		8.321**	11.295**	9.451**	9.665**	0.155**	0.358**	0.145**	0.207**
σ2 gca		6.299**	8.582**	7.425**	7.431**	0.087**	0.149**	0.085**	0.102**
σ2 sca		1.033**	2.639**	1.749**	1.772**	0.014*	0.008*	0.035**	0.016**
σ2 gca/ σ2 sca		1.006	0.255	0.535	0.545	0.155	0.143	0.236	0.265
σ2 Females × Environments					0.003				0.002
σ2 Males × Environments					0.060				0.018**
σ2 gca × Environments					0.022				0.007**
σ2 sca × Environments					0.147				0.002

*E_1, E_2 and E_3 are different environments (seasons) viz., Summer Season, Kharif Season and Early Winter Season, respectively, *, ** Significant at 5 and 1 per cent probability levels, respectively*

General Combining Ability

A perusal of the general combining ability (GCA) effects for parents in Table 3 and 4 disclosed that, none of the parent was good general combiner for all the characters. However, for bio-chemical traits, among female parents, PR-5 and VR-2 (except in E_2) and among male parents CHBR-2, BCB-71-1, BCB-464 and Swarna Mani (except in E_2 & E_3) showed desirable GCA effect for total soluble solids, whereas for ascorbic acid among female parents, PR-5, IIHR- 563 (except in E_1) as well as among male parents CO-2, RCMBL-49 and PB-6 (except in E_2). For total phenol content among female parents, PR-5 and IIHR- 563 and among male parents CHBR-2, JB-64 and PB-6 showed significant GCA estimates in desirable direction in all the environments including pooled over environments. For fruit dry matter the female parents, PR-5 and VR-2, whereas among male parents CHBR-2, CO-2 (except in E_3), BCB-71-1, BCB-464 and Swarna Mani (except in E_3) were found as good general combiner. Similar results for quality traits have been reported by Siva *et al.* (2020), Suneetha and Kathiria (2006) and Rajan *et al.* (2022).

Specific combining ability

The estimate of SCA effects revealed that none of the cross was superior for all the traits in all three environments (seasons) as well as in pooled over environments (Table 3 and 4). The crosses which were significant and desirable in E_1 were PLR-1 × CO-2 for total soluble solids, ascorbic acid and total phenol content; PR-5 × JB-64 for total soluble solids, ascorbic acid and fruit dry matter; VR-2 × CHBR-2 for total soluble solids and total phenol content; IIHR- 563 × CO-2 for ascorbic acid and fruit dry matter; PLR-1 × Swarna Mani and PR-5 × PB-6 for total soluble solids; PLR-1 × PB-6, VR-2 × BCB-71-1, VR-2 × Swarna Mani and IIHR- 563 × JB-64 for ascorbic acid; PR-5 × Swarna Mani, VR-2 × CHBR-2, PR-5 × BCB-71-1, IIHR- 563 × PB-6 and IIHR- 563 × BCB-71-1 for total phenol content; PR-5 × PB-6 and VR-2 × PB-6 for fruit dry matter. While the crosses which were significant and desirable in E_2 were PLR-1 × JB-64, PLR-1 × Swarna Mani and PR-5 × RCMBL-49 for total soluble solids; PLR-1 × PB-6, PLR-1 × BCB-464, PR-5 × RCMBL-49, VR-2 × BCB-71-1, VR-2 × Swarna Mani and IIHR- 563 × JB-64 for ascorbic acid; PLR-1 × PB-6, PR-5 × JB-64,

Table 3: Estimates of general combining ability and specific combining ability effects in each environment and pooled over environments for total soluble solids (%) and ascorbic acid (mg/100g fw)

Genotypes	Total soluble solids (%)				Ascorbic acid (mg/100g fw)			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
Females								
PLR-1	-0.24**	-0.18*	-0.22**	-0.21**	-0.05	-0.08	0.10	-0.01
PR-5	0.19**	0.31**	0.22**	0.24**	0.42**	0.43**	0.32**	0.39**
VR-2	0.16**	0.02	0.13*	0.10**	-0.41**	-0.51**	-0.51**	-0.48**
IIHR- 563	-0.11*	-0.15*	-0.13*	-0.134**	0.04	0.15*	0.08*	0.09**
Males								
CHBR-2	0.64**	0.61**	0.56**	0.60**	-0.25**	-0.34**	-0.79**	-0.46**
RCMBL-49	-0.46**	-0.14	-0.12	-0.24**	1.38**	1.63**	1.53**	1.51**
CO-2	-0.14*	-0.28**	-0.27**	-0.23**	0.60**	0.80**	0.57**	0.66**
JB-64	-0.89**	-0.72**	-0.67**	-0.76**	-0.45**	-0.15	-0.74**	-0.45**
PB-6	-0.39**	-0.41**	-0.47**	-0.43**	0.29**	0.003	0.12*	0.14**
BCB-71-1	0.41**	0.37**	0.40**	0.39**	-0.55**	-0.52**	-0.11	-0.40**
BCB-464	0.57**	0.41**	0.44**	0.47**	-0.80**	-0.84**	-0.53**	-0.73**
Swarna Mani	0.27**	0.16	0.15	0.19**	-0.19*	-0.57**	-0.054	-0.27**
S.E.(gi)	0.05	0.07	0.06	0.03	0.05	0.06	0.06	0.03
S.E.(gj)	0.07	0.10	0.08	0.04	0.07	0.08	0.09	0.04
SCA effects								
PLR-1 × CHBR-2	-0.47**	-0.29	-0.31	-0.36**	-0.12	-0.15	-0.12	-0.13
PLR-1 × RCMBL-49	0.19	-0.07	0.31	0.14	0.04	-0.34*	0.14	-0.05
PLR-1 × CO-2	0.48**	0.10	0.16	0.24**	0.45**	-0.08	0.13	0.16*
PLR-1 × JB-64	-0.20	0.37*	-0.23	-0.02	0.02	-0.22	-0.10	-0.10
PLR-1 × PB-6	-0.16	-0.006	-0.07	-0.08	0.67**	0.79**	0.10	0.52**
PLR-1 × BCB-71-1	-0.21	-0.29	-0.28	-0.26**	-0.47**	-0.33*	-0.14	-0.31**
PLR-1 × BCB-464	0.09	-0.26	-0.16	-0.11	-0.51**	0.27*	0.10	-0.04
PLR-1 × Swarna Mani	0.29*	0.45*	0.59**	0.44**	-0.07	0.05	-0.11	-0.04
PR-5 × CHBR-2	0.11	0.13	0.07	0.10	0.19	0.16	0.18	0.18*
PR-5 × RCMBL-49	-0.01	0.79**	-0.02	0.25**	0.006	0.34*	0.11	0.15
PR-5 × CO-2	-0.32*	-0.26	-0.11	-0.23*	-0.16	-0.02	-0.14	-0.11
PR-5 × JB-64	0.32*	-0.29	0.35*	0.12	0.41**	0.15	-0.16	0.13
PR-5 × PB-6	0.25*	-0.07	0.18	0.12	-0.20	-0.04	0.09	-0.05
PR-5 × BCB-71-1	-0.12	-0.16	-0.29	-0.19*	0.04	0.22	0.23	0.16*
PR-5 × BCB-464	-0.08	0.06	0.09	0.02	0.17	-0.22	-0.04	-0.03
PR-5 × Swarna Mani	-0.15	-0.18	-0.27	-0.20*	-0.46**	-0.58**	-0.27	-0.44**
VR-2 × CHBR-2	0.44**	0.19	0.33*	0.32**	-0.04	-0.21	-0.24	-0.16
VR-2 × RCMBL-49	-0.21	-0.41*	-0.30	-0.31**	-0.10	0.01	-0.09	-0.06
VR-2 × CO-2	-0.06	0.02	-0.02	-0.02	-0.55**	-0.05	-0.15	-0.25**
VR-2 × JB-64	0.18	0.16	0.10	0.15	-0.47**	-0.17	-0.25	-0.30**
VR-2 × PB-6	-0.15	0.01	-0.02	-0.05	-0.01	-0.09	0.10	-0.003
VR-2 × BCB-71-1	0.16	0.20	0.19	0.18*	0.33*	0.26*	0.29*	0.30*
VR-2 × BCB-464	-0.02	0.16	0.08	0.07	-0.01	-0.18	-0.14	-0.11
VR-2 × Swarna Mani	-0.32*	-0.35	-0.35*	-0.34**	0.88**	0.44**	0.48**	0.60**
IIHR- 563 × CHBR-2	-0.08	-0.02	-0.10	-0.06	-0.02	0.19	0.18	0.12
IIHR- 563 × RCMBL-49	0.02	-0.30	0.02	-0.08	0.05	-0.01	-0.16	-0.04
IIHR- 563 × CO-2	-0.08	0.14	-0.02	0.01	0.26*	0.16	0.17	0.20*
IIHR- 563 × JB-64	-0.30*	-0.25	-0.22	-0.26**	0.03	0.24*	0.51**	0.26**
IIHR- 563 × PB-6	0.06	0.06	-0.09	0.01	-0.44**	-0.65**	-0.31*	-0.47**
IIHR- 563 × BCB-71-1	0.17	0.24	0.39*	0.27**	0.09	-0.16	-0.38*	-0.15
IIHR- 563 × BCB-464	0.02	0.04	-0.01	0.01	0.35*	0.13	0.08	0.13*
IIHR- 563 × Swarna Mani	0.18	0.09	0.04	0.10	-0.34*	0.08	-0.09	-0.11
S.E. (Sij)	0.14	0.21	0.17	0.09	0.14	0.17	0.18	0.09

*E_1, E_2 and E_3 are different environments (seasons) viz., Summer Season, Kharif Season and Early Winter Season, respectively, *, ** Significant at 5 and 1 per cent probability levels, respectively.*

Table 4: Estimates of general combining ability and specific combining ability effects in each environment and pooled over environments for total phenol content (mg/100g fw) and fruit dry matter (g)

Genotypes	Total phenol content (mg/100g fw)				Fruit dry matter (g)			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
Females								
PLR-1	2.73**	2.97**	3.05**	2.92**	-0.14**	-0.12**	-0.24**	-0.168**
PR-5	-1.35**	-1.42**	-1.55**	-1.44**	0.26**	0.26**	0.19**	0.24**
VR-2	1.01**	1.45**	1.05**	1.17**	0.11*	0.07*	0.21**	0.13**
IIHR- 563	-2.38**	-3.00**	-2.55**	-2.65**	-0.24**	-0.22**	-0.16**	-0.21**
Males								
CHBR-2	-1.34**	-2.32**	-0.79*	-1.48**	0.33**	0.48**	0.49**	0.43**
RCMBL-49	0.36	1.05*	0.22	0.55**	-0.42**	-0.70**	-0.40**	-0.51**
CO-2	4.02**	3.99**	3.92**	3.98**	0.29**	0.25**	0.09	0.21**
JB-64	-3.43**	-3.67**	-3.51**	-3.54**	-0.46**	-0.70**	-0.44**	-0.54**
PB-6	-4.17**	-5.16**	-4.91**	-4.75**	-0.53**	-0.73**	-0.45**	-0.57**
BCB-71-1	1.72**	2.22**	2.13**	2.02**	0.24**	0.58**	0.34**	0.39**
BCB-464	-0.08	0.28	-0.18	0.007	0.31**	0.46**	0.20**	0.36**
Swarna Mani	2.91**	3.61**	3.12**	3.21**	0.24**	0.36**	0.07	0.23**
S.E.(gi)	0.21	0.34	0.23	0.14	0.04	0.03	0.04	0.02
S.E.(gj)	0.30	0.48	0.33	0.20	0.06	0.05	0.05	0.03
SCA effects								
PLR-1 × CHBR-2	-0.45	0.11	-0.37	-0.23	0.002	-0.15	-0.36**	-0.17*
PLR-1 × RCMBL-49	-0.50	-1.35	-1.19	-1.02*	-0.01	-0.14	-0.01	-0.05
PLR-1 × CO-2	-1.39*	-0.98	-1.59*	-1.32**	0.04	0.04	0.16	0.08
PLR-1 × JB-64	0.48	1.46	0.57	0.83*	-0.20*	0.05	-0.06	-0.07
PLR-1 × PB-6	-0.20	-4.34**	-1.39*	-1.98**	-0.19	-0.11	-0.10	-0.13*
PLR-1 × BCB-71-1	2.15**	2.85**	3.17**	2.72**	0.09	0.16*	0.001	0.08
PLR-1 × BCB-464	-0.22	0.92	-0.18	0.17	0.10	0.11	0.20	0.14*
PLR-1 × Swarna Mani	0.15	1.34	0.99	0.82*	0.16	0.03	0.16	0.12
PR-5 × CHBR-2	0.07	0.19	0.05	0.10	0.06	0.09	0.06	0.07
PR-5 × RCMBL-49	1.13	1.15	0.94	1.07*	0.03	0.12	-0.03	0.04
PR-5 × CO-2	0.82	1.15	1.67*	1.22**	-0.25*	0.04	-0.25*	-0.15*
PR-5 × JB-64	-0.12	-1.79*	-0.59	-0.83*	0.21*	0.008	0.20	0.14*
PR-5 × PB-6	0.57	1.92*	0.67	1.05*	0.21*	0.12	0.21	0.18**
PR-5 × BCB-71-1	-1.15*	-1.22	-1.29*	-1.22*	-0.08	-0.01	0.14	0.01
PR-5 × BCB-464	-0.37	-0.28	-0.75	-0.47	-0.12	-0.14	-0.13	-0.13
PR-5 × Swarna Mani	-0.96*	-1.12	-0.70	-0.93*	-0.05	-0.23*	-0.20	-0.16*
VR-2 × CHBR-2	-1.18*	0.10	0.30	-0.26	-0.15	0.01	0.17	0.01
VR-2 × RCMBL-49	-0.31	-0.30	0.36	-0.08	0.04	-0.003	0.19	0.08
VR-2 × CO-2	0.002	-1.85*	-1.02	-0.96*	0.005	-0.06	0.03	-0.007
VR-2 × JB-64	0.48	0.76	0.57	0.60	0.10	-0.04	0.15	0.07
VR-2 × PB-6	1.33*	2.52*	1.31*	1.72**	0.24*	0.16*	0.10	0.17*
VR-2 × BCB-71-1	0.71	1.14	0.88	0.91*	-0.08	-0.01	-0.19	-0.10
VR-2 × BCB-464	-0.36	-0.73	-0.99	-0.69	-0.13	0.01	-0.22	-0.11
VR-2 × Swarna Mani	-0.66	-1.63	-1.41*	-1.24**	-0.03	-0.06	-0.25*	-0.11
IIHR- 563 × CHBR-2	1.57**	-0.41	0.01	0.39	0.08	0.04	0.11	0.08
IIHR- 563 × RCMBL-49	-0.30	0.50	-0.11	0.03	-0.06	0.02	-0.15	-0.06
IIHR- 563 × CO-2	0.56	1.69	0.94	1.06*	0.20*	-0.02	0.05	0.07
IIHR- 563 × JB-64	-0.84	-0.43	-0.54	-0.60	-0.12	-0.02	-0.29*	-0.14*
IIHR- 563 × PB-6	-1.69**	-0.10	-0.59	-0.79	-0.26*	-0.17*	-0.22	-0.22**
IIHR- 563 × BCB-71-1	-1.72**	-2.77**	-2.77**	-2.42**	0.08	-0.13	0.05	0.001
IIHR- 563 × BCB-464	0.96	0.09	1.93**	0.99*	0.15	0.02	0.15	0.10
IIHR- 563 × Swarna Mani	1.48**	1.42	1.13	1.34**	-0.07	0.27*	0.29*	0.16*
S.E. (Sij)	0.60	0.97	0.66	0.41	0.12	0.10	0.11	0.06

*E_1, E_2 and E_3 are different environments (seasons) viz., Summer Season, Kharif Season and Early Winter Season, respectively, *, ** Significant at 5 and 1 per cent probability levels, respectively*

VR-2 × CO-2 and IIHR- 563 × BCB-71-1 for total phenol content; PLR-1 × BCB-71-1, VR-2 × PB-6 and IIHR- 563 × Swarna Mani for fruit dry matter. The cross combinations which were significant and desirable in E_3 were VR-2 × Swarna Mani for ascorbic acid and total phenol content; PLR-1 × Swarna Mani, PR-5 × JB-64, VR-2 × CHBR-2 and IIHR- 563 × BCB-71-1 for total soluble solids; VR-2 × BCB-71-1 and IIHR- 563 × JB-64 for ascorbic acid; PLR-1 × CO-2, PLR-1 × PB-6, PR-5 × BCB-71-1 and IIHR- 563 × BCB-71-1 for total phenol content; IIHR- 563 × Swarna Mani for fruit dry matter. In pooled over environments the cross combinations which were significant and desirable were PLR-1 × CO-2 for ascorbic acid, total soluble solids and total phenol content; PR-5 × BCB-71-1 for ascorbic acid and total phenol content; PLR-1 × CO-2, PLR-1 × Swarna Mani, PR-5 × RCMBL-49, VR-2 × CHBR-2 and IIHR- 563 × BCB-71-1 for total soluble solids; PLR-1 × CO-2, PLR-1 × PB-6, PR-5 × CHBR-2, PR-5 × BCB-71-1, VR-2 × Swarna Mani, IIHR- 563 × CO-2 and IIHR- 563 × BCB-464 for ascorbic acid; PLR-1 × RCMBL-49, PLR-1 × CO-2, PLR-1 × PB-6, PR-5 × JB-64, PR-5 × BCB-71-1, PR-5 × Swarna Mani, VR- 2 × CO-2, VR-2 × Swarna Mani and IIHR- 563 × BCB-71-1 for total phenol content; PLR-1 × BCB-464, PR-5 × JB-64, PR-5 × PB-6, IIHR- 563 × Swarna Mani and VR-2 × PB-6 for fruit dry matter (Table 3 and 4). The current findings corroborated the findings of Sao and Mehta (2010), Rai and Asati (2011), Patel *et al.* (2013), Choudhary and Didel (2014), Reddy and Patel (2014), Naresh *et al.* (2014) and Rajan *et al.* (2022).

However, cross combinations with significant and high SCA impacts in all the three environments as well as in pooled across environments were regarded the best specific combiner for a certain character or different characters *viz.,* VR-2 × CHBR-2 (except in E_2) and PLR-1 × Swarna Mani for total soluble solids, PLR-1 × PB-6 (except in E_3), IIHR- 563 × JB-64 (except in E_1), VR-2 × BCB-71-1 and VR-2 × Swarna Mani for ascorbic acid, PLR-1 × PB-6 (except in E_1), PLR-1 × CO-2 (except in E_2), PR-5 × BCB-71-1 (except in E_2) and IIHR- 563 × BCB-71-1 for total phenol content, VR-2 × PB-6 (except in E_3) and IIHR- 563 × Swarna Mani (except in E_1) for fruit dry matter. The results obtained in the present study are in associated with the earlier findings of Vaddoria *et al.* (2008), Rai and Asati (2011) and Choudhary and Didel (2014).

CONCLUSION

It was found from this research that the variance estimations of both general combining ability (GCA) and specific combining ability (SCA) effects were significant for all the characters, showing the influence of both additive and nonadditive gene effects. Whereas, mean square variances due to environments were also significant for all the characters expressing the influence of environments on inheritance of all these traits. Further the outcomes of this investigation revealed that the female parent PR-5 was found to be good general combiner for all the four traits under study, however VR-2 and IIHR- 563 also have been proven to be effective GCA effects whereas, among male parents BCB-464, BCB-71-1, CO-2, CHBR-2 and PB-6 exhibiting good GCA effects for all the traits. These parents may be extensively used in crossing programme to accumulate desirable genes of qualitative characters leading to gene pyramiding, which may have immense value as pre-breeding material and for heterosis breeding. Among hybrids PLR-1 × CO-2, PLR-1 × PB-6, VR-2 × CHBR-2 and IIHR- 563 × BCB-71-1 exhibited high SCA effects and per se. Therefore, these cross combinations may be favored for commercial cultivation as hybrids after critical evaluation in varied environments or over locations. All of the parents involved in these crosses had GCA effects that were good or average. Hence, their hybrids are likely to produce transgressive recombinants in segregating generations, combining favourable traits into one genotype for development as improved varieties with increased nutritional quality.

ACKNOWLEDGEMENT

All the authors acknowledge the University of Agriculture University Jodhpur for providing all the resources for successfully conducting the experiment.

REFERENCES

Bhakta, R.S., Patel, D.U., Patel, S.J., Patel, N.K. and Kodappully, V.C. (2009). Diallel analysis for combining ability studies in brinjal (*Solanum melongena* L.). *Research on Crops* 10(2): 362-365.

Bhushan, B., Sidhu, A.S., Dhatt, A.S. and Kumar, A. (2012). Studies on combining ability for yield and quality traits in brinjal (*Solanum melongena* L.). *Journal of Horticulture Sciences* 7(2): 145-151.

Choudhary, Santosh. and Didel, R.P. (2014). Combining ability analysis for growth and yield components in brinjal (*Solanum melongena* L.). *Asian Journal of Biological Science*, 9(1): 88-92.

Hanur, V.S., Prakash, D.P., Deepali, B.S., Asokan, R., Ramachandran, Y.I., Riaz, M. and Lalitha, A. (2006). Synergistic use of hypocotyls explants and high BAP preconditioning for enhanced transformation frequency in brinjal (*Solanum melongena* L.). *Journal of Horticulture Science* 1(2): 116-119.

Kempthorne, D. (1957). An introduction to genetic statistics*. John Wiley and Sons Inc.* New York, USA, pp. 468-447.

Konyak, W.L., Kanaujia, S.P., Jha, A. and.Verma, S.K. (2019). Characterization of brinjal (*Solanum melongena* L.) genotypes for growth, yield and quality traits under foothill condition of Nagaland. *Annals of Plant and Soil Research* 21(4): 380-385.

Naresh, V.B., Dubey, A.K., Tiwari, P.K. and Dabbas, M.R. (2014). Line x tester analysis for yield components and cercospora leaf spot resistance in brinjal (*Solanum melongena* L.). *Electronic Journal of Plant Breeding* 5(2): 230-235

Patel, J.P., Singh, U., Kashyap, S.P., Singh, D.K., Goswami, A., Tiwari, S.K. and Singh, M. (2013). Combining ability for yield and other quantitative traits in eggplant (*Solanum melongena* L.). *Vegetable Science* 40(1): 61-64.

Rai, N. and Asati, B.S. (2011). Combining ability and gene action studies for fruit yield and yield contributing traits in brinjal. *Indian Journal of Horticulture* 68(2): 212-215.

Rajan, N., Debnath, S., Dutta, A.K., Pandey, B., Singh, A.K., Singh, R.K., Singh, A.K. and Dugbakie, B.N. (2022). Elucidation of nature of gene action and estimation of combining ability effects for fruit yield improvement and yield attributing traits in brinjal landraces. *Journal of Food Quality* 2022: 1-12.

Rangana, S. (1986). Handbook of analysis and quality control for fruit and vegetable products, (2nd edn). Tata Mc Graw- Hill Publishing Company Limited, New Delhi, India, pp. 8893.

Sao, A. and Mehta, N. (2010). Heterosis in relation to combining ability for yield and quality attributes in Brinjal (*Solanum melongena* L.). *Electronic Journal of Plant Breeding* 1(4): 783- 788.

Singleton, V.L., Orthofer, R. and Lamuela-Ranventos, R.M. (1999). Analysis of total phenols other oxidation substrates and antioxidants by means of folic-ciocalteu reagent. *Methods Enzymol* 299: 152-178.

Siva, M., Uma, J.K., Rao, A.V.D., Krishna, B.B., Krishna, K.U., Rajyalakshmi, M., Patro, T.S.K.K.K. and Emmanuel, N. (2020). Studies on combining ability for qualitative and quantitative traits in brinjal (*Solanum melongena* L.) over environments. *Journal of Entomology and Zoology Studies* 8(3): 1688-1692.

Suneetha, Y. and Kathiria, K.B. (2006). Studies on combing ability for yield, quality and physiological characters in late summer brinjal. *Internal Journal of Agricultural Sciences* 2(1): 193-197.

Vaddoria, M.A., Dobariya, K.L., Chovatia, V.P., Mehta, D.R. (2008). Combining ability studies for fruit yield and fruit borer resistance in brinjal (*Solanum melongena* L.). *Crop Improvement* 35(2): 195-199.

Yadav, V.K., Singh, R.., Jha, R.K. and Kaushik, P. (2020). Biochemical variability of eggplant peel among Indian cultivars. *Indian Journal of Biochemistry & Biophysics* 57: 634-637.