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Estimation of Gene Action and Combining Ability of Brinjal (*Solanum melongena* L.) for Quality Characters

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Abstract

The eight parents along with twenty-eight crosses and one standard check was evaluate in 3 x 3.6 m^2 plot size and spacing at 40cm x 60 cm with randomized block design with three replications in all three environments during *Kharif,* 2020, 2020-21 and *Rabi,* 2020-21 for important quality attribute of brinjal like, iron ($mg100g^{-1}$), total soluble solid (^OB) and anthocyanin content (%) in edible fruits of brinjal. Analysis of variance over environments indicates that variances due to brinjal genotypes were highly significant for iron ($mg100g^{-1}$), total soluble solid (^OB) and anthocyanin content (%) under study which revealed the presence of genetic variability among the genotypes for all trait. The parents SL-8-PB-1-3-1-4 was showed significant positive GCA effects in all three environments for iron ($mg100g^{-1}$), total soluble solid (^OB) and anthocyanin content (%). The positive significant SCA effects in all three individual environments reported in the cross of Pusa Purple Long x BL-219 and Pant Rituraj x S-324-465-2-2 for iron ($mg100g^{-1}$), total soluble solid (^OB) and anthocyanin content (%).

Key words *: Environment, iron, gca, genotypes, parent, sca and significant.*

Introduction

Brinjal (*Solanum melongena* L.) is one of the important vegetable crops belonging to the family Solanaceae. Brinjal is native of India having chromosome number is 2n = 24 (1). The flowers are hermaphrodite and the pollen dehisces at the same time when the stigma is receptive so that the self- pollination is the rule. But there is some degree of cross-pollination is due to heterostyled condition in flower.

Eggplant is a low-calorie vegetable with high nutritional value, due to the presence of a wide array of elements such as fibers, proteins, phenolics, vitamins, minerals, etc. (2). The nutritional value per 100 g of brinjal fruit contains 92.70 % moisture; 0.1 g fat; 5.7 g carbohydrate and 1.0 g protein. In addition, numerous vitamins, and minerals, such as B1, B6, folate, copper, manganese (0.25 mg), magnesium (14 mg), potassium (230 mg) and about 10 % of the daily value of fiber are also present. Brinjal fruits are poor sources of pro-vitamin-A and vitamin-A, with average values of 27 mg/100g fresh weight and 0.30 mg/100g fresh weight, respectively. However, eggplant fruit do contain ascorbic acid and phenolics, both of which are powerful antioxidants (3).

The breeding methods of any crop are depending upon its genetic architecture and inheritance of a character. For the development of an effective breeding programme in brinjal, one need to have the information about genetic architecture and estimated pre potency of parents in hybrid combinations of different genotypes. The knowledge of gene action and combining ability helps in proper understanding of inheritance of characters in selection of suitable parents for hybridization programme and for obtaining desirable segregate. Brinjal being in the preliminary stage of breeding, information on good combiner is lacking, therefore, the present investigation was undertaken to identify the potential combinations to have superior hybrids of excellent qualities coupled with high yields and nature of gene action for various characters in brinjal.

The information generated in this process will be used to understand the magnitude of general combining ability as well as specific combining ability effect and this knowledge helps in the selection of parents while starting a breeding programme in brinjal.

Materials and Methods

Eight brinjal genotypes were selected as parents on the basis of their origin and morpho-physiological characters. These genotypes were crossed in half diallel mating system to develop a total twenty-eight crosses. These eight genotypes were crossed in all possible combinations (excluding reciprocals) during Zaid 2019 to produce F_1 seeds by hand pollination.

The eight parents along with twenty-eight crosses and one standard check was evaluate in 3 x 3.6 m^2 plot size and spacing at 40cm x 60 cm with randomized block design with three replications in all three environment during *Kharif,* 2020, 2020-21 and *Rabi,* 2020-21.

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Results and Discussion

Analysis of variance for quality attributing traits in Brinjal over the environments : Analysis of variance over environments indicates (Table-1) that variances due to brinjal genotypes were highly significant for iron ($mg100g^{-1}$), total soluble solid (°B) and anthocyanin content (%) under study which revealed the presence of genetic variability among the genotypes for this trait. This provides an ample opportunity for selecting suitable genotypes with high mean for all the traits of interest. These results are in accordance to those of (4,5,6).

The mean sum of square (Table-2) due to environments, genotypes, hybrids, parents vs hybrid, were significant for iron ($mg100g^{-1}$), total soluble solid (^{O}B) and anthocyanin content (%) which indicated genotypes interacted with environments significantly. This is in conformity with the findings obtained (7,8).

The combining ability analysis revealed that the SCA were significant for all the characters in each of the three environments and GCA was significant in E-I and E-II for total soluble solid (^{O}B) and anthocyanin content (%) indicating the importance of both additive and non-additive genetic control of all the characters under study. However, The GCA / SCA variance ratio (predictability ratio) was less than unity emphasizing the role of non-additive gene action for all the traits (Table-3). Similarly, (9,10,11,12) also reported preponderance of additive gene effect in the crop. It is thus evident that both additive and non-additive gene effects controlled different characters including fruit yield and its contributing characters.

A complete knowledge of the genetic control of the character is the basic requirement for purposeful management of the available genetic variability. The choice of most suitable breeding method (s) would depend primarily on the combining ability behavior and nature of gene action involved in the control of the trait of interest to the vegetable breeder. In the present investigation, the G x E interaction was significant for all the traits; hence the combining ability analysis was done for individual environments. The significant mean square due to GCA and SCA in all the environments indicated that all the characters were controlled by both additive and non-additive gene effects. (12,13,14,15) also obtained similar results in brinjal having influence of both additive and non-additive gene effect for the characters used in their study. The GCA / SCA variance ratio (predictability ratio) was less than unity emphasizing the role of non-additive gene action for all the traits. Similar results were earlier reported by (9,10,11,12) also reported preponderance of additive gene effect in the crop. It is thus evident that both additive and non-additive gene effects controlled different characters including fruit yield and its contributing characters.

General combining ability for quality attributing traits in Brinjal over the environments

Iron ($mg100g^{-1}$) : The Iron in fruit is desirable in brinjal, which is reflected by the positive combining ability effects. The GCA effects in all the three environments ranged from -0.01 to 0.01 (Table-4). The parents SL-8-PB-1-3-1-4 showed significant positive GCA effects in all three environments. The value of GCA effects in pooled ranged from -0.006 to 0.009. The parents BL-2011-219-8-1 and SL-8-PB-1-3-1-4 show the positive pooled (Table 1.5) GCA effect for average iron (Table 1.5).

Total soluble solid (^{O}B) : The TSS in fruit is desirable in brinjal, which is reflected by the positive combining ability effects. The GCA effects in all the three environments ranged from -0.15 to 0.18 (Table-4). The parents SL-8-PB-1-3-1-4 showed significant positive GCA effects in all three environments. The value of GCA effects in pooled ranged from -0.117 to 0.171. The parents BL-2011-219-8-1 and SL-8-PB-1-3-1-4 show the positive pooled (Table 1.5) GCA effect for average TSS.

Anthocyanin content (%) : The anthocyanin in fruit is desirable in brinjal, which is reflected by the positive combining ability effects. The GCA effects in all the three environments ranged from -0.81 to 1.0(Table-4). The parents SL-8-PB-1-3-1-4 showed significant positive GCA effects in all three environments. While, parent BL-2011-219-8-1 show the positive GCA in E-I. The value of GCA effects in pooled ranged from -0.625 to 0.870. The parents BL-2011-219-8-1 and SL-8-PB-1-3-1-4 showed the positive pooled (Table-5) GCA effect for average total soluble solid.

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. This, in turn, helps in identifying suitable parents for crossing programme. (16,17) emphasized the importance of combining ability analysis in selecting the parental lines in brinjal. Where GCA effects are more pronounced, an appreciable progress could be achieved through conventional breeding methods. However, for traits where non-additive gene effects are more pronounced some kind of recurrent selection e.g. half diallel selective mating (18,19) or bi-parental selection mating in early generations (20) might prove effective breeding approach. In brinjal, parents having good general combining ability have been reported by several workers viz. (17,21,22,23,24).

Table-1 : Analysis of variance quality attributing traits in brinjal over the three environments.

SOV	DF	Environment	Iron (mg 100g^{-1})	Total soluble solid (^{o}B)	Anthocyanin content (%)
Replication	2	E1	0.0002	0.09	1.92
		E2	0.0001	0.0403	0.44
		E3	0.00072	0.297	7.41
Genotypes	35	E1	0.0016**	0.58**	14.53**
		E2	0.0017**	0.598**	14.98**
		E3	0.0014**	0.51**	12.13**
Error	70	E1	0.0005	0.17	4.35
		E2	0.0005	0.1924	4.75
		E3	0.0005	0.1724	3.79

* and ** Significant at 1 and 5 per cent level of significance, respectively.

Table-2 : Analysis of variance for quality attributing traits in brinjal pooled over the three environments.

Source	Df	Iron (mg 100 g^{-1})	Total soluble solid (^{o}B)	Anthocyanin content (%)
Environments	2	0.012**	3.418**	212.251**
Blocks within Environments	6	0	0.142	3.256
Genotypes	35	0.004**	1.585**	38.700**
Parents	7	0.001*	0.402*	9.665*
Hybrids	27	0.005**	1.631**	40.347**
Parents vs Hybrids	1	0.024**	8.617**	197.473**
Genotypes * Environments	70	0	0.052	1.468
Parent * Environments	14	0	0.024	0.734
Hybrids * Environments	54	0	0.061	1.709
Parent vs Hybrids * Environment	2	0	0	0.074
Error	210	0	0.178	4.302
Total	323	0.001	0.322	8.683

* and ** Significant at 1 and 5 per cent level of significance, respectively.

Table-3 : Analysis of variance of combining ability for quality attributing traits in brinjal over the three environments.

Source	EN	Iron (mg 100g^{-1})	Total soluble solid (^{o}B)	Anthocyanin content (%)
GCA	E1	0.0004	0.14*	3.79*
	E2	0.0004	0.1324	3.314
	E3	0.0003	0.119	2.9195*
SCA	E1	0.0006**	0.21**	5.11**
	E2	0.0006**	0.2158**	5.4118**
	E3	0.0005**	0.1828**	4.3251**
Error	E1	0.0002	0.06	1.45
	E2	0.0002	0.0641	1.585
	E3	0.0002	0.0575	1.2654
GCA Variance	E1	0.00002	0.008	0.234
	E2	0.00002	0.00683	0.1729
	E3	0.00001	0.00615	0.16541
SCA Variance	E1	0.0004	0.15	3.66
	E2	0.0004	0.1517	3.8268
	E3	0.0003	0.1253	3.0597
GCA/SCA	E1	0.05	0.05	0.06
	E2	0.05	0.05	0.05
	E3	0.03	0.05	0.05

* and ** Significant at 1 and 5 per cent level of significance, respectively.

Specific combining ability for quality attributing traits in Brinjal over the environments

Iron (mg 100 g^{-1}) : The Iron in fruit is desirable in brinjal, which is reflected by the positive combining ability effects. The SCA effects in all the three environments ranged from -0.04 to 0.06(Table-6). The cross, Pusa Purple Long x BL-219 and Pant Rituraj x S-324-465-2-2 show the significant positive SCA effects in all the three environments for iron. But cross BL-2011-219-8-1 x SL-8-PB-1-3-1-4 and SL-8-PB-1-3-1-4 x Pant Rituraj in E-1, BL-2011-219-8-1 x Pusa Purple Long,

Table-4 : Estimated of general combining ability effects of parents in quality attributing traits in Brinjal over the three environments.

Parents	EN	Iron (mg 100 g^{-1})	Total soluble solid (^oB)	Anthocyanin content (%)
BL-2011-219-8-1	E1	0.01	0.15*	0.72*
	E2	0.01	0.13	0.63
	E3	0.01	0.11	0.56
SL-8-PB-1-3-1-4	E1	0.01*	0.18*	1**
	E2	0.01*	0.18*	0.85*
	E3	0.01*	0.16*	0.77*
Pusa Purple Long	E1	0	0.05	0.26
	E2	0	0.06	0.3
	E3	0	0.04	0.22
BL-219	E1	0	-0.05	-0.29
	E2	0	-0.07	-0.17
	E3	0	-0.05	-0.27
Pusa Purple Round	E1	0	0.01	0.02
	E2	0	0.03	0.08
	E3	0	0.06	0.32
Pant Rituraj	E1	-0.01	-0.12	-0.65
	E2	-0.01	-0.14	-0.81*
	E3	0	-0.08	-0.42
S-324-465-2-2	E1	-0.01	-0.1	-0.48
	E2	0	-0.06	-0.32
	E3	-0.01	-0.15*	-0.73*
BLW-2001-1-1-2	E1	-0.01	-0.11	-0.58
	E2	-0.01	-0.11	-0.57
	E3	0	-0.1	-0.45
SE(gi)	E1	0.0038	0.07	0.36
	E2	0.0038	0.0749	0.3724
	E3	0.0038	0.0709	0.3327
SE(gi-gj)	E1	0.01	0.11	0.54
	E2	0.0058	0.1133	0.563
	E3	0.0058	0.1072	0.5031

* and ** Significant at 1 and 5 per cent level of significance, respectively.

Table-5 : Estimated of pooled general combining ability effects of parents in quality attributing traits in brinjal over the environments.

Parents	Iron (mg 100 g^{-1})	Total soluble solid (°B)	Anthocyanin content (%)
BL-2011-219-8-1	0.007**	0.129**	0.640**
SL-8-PB-1-3-1-4	0.009***	0.171***	0.870***
Pusa Purple Long	0.003	0.049	0.261
BL-219	-0.003	-0.054	-0.243
Pusa Purple Round	0.002	0.031	0.138
Pant Rituraj	-0.006**	-0.117**	-0.625**
S-324-465-2-2	-0.006*	-0.103*	-0.508*
BLW-2001-1-1-2	-0.006*	-0.105*	-0.533**
Gi-Gj 95%	0.007	0.124	0.61
Gi-Gj 99%	0.009	0.163	0.804

* and ** Significant at 1 and 5 per cent level of significance, respectively.

SL-8-PB-1-3-1-4 x Pusa Purple Long in E-1 and E-2 and SL-8-PB-1-3-1-4 x Pusa Purple Round in E-1 and E-3show the significant positive SCA for iron. The cross Pusa Purple Long x BLW-2001-1-1-2 show the significant negative SCA for iron in all three environments.

The value of SCA effects in pooled (Table-7) ranged from -0.007 to 0.054. The ten crosses, BL-2011-219-8-1 x SL-8-PB-1-3-1-4, BL-2011-219-8-1 x Pusa Purple Long, SL-8-PB-1-3-1-4 x Pusa Purple Long, SL-8-PB-1-3-1-4 x Pusa Purple Round, SL-8-PB-1-3-1-4 x Pant Rituraj, SL-8-PB-1-3-1-4 x BLW-2001-1-1-2, Pusa Purple Long x BL-219, Pusa Purple Round x BLW-2001-1-1-2, Pant Rituraj x S-324-465-2-2 and S-324-465-2-2 x BLW-2001-1-1-2 show the positive SCA effect for iron.

Total soluble solid (°B) : The TSS in fruit is desirable in brinjal, which is reflected by the positive combining ability

Table-6 : Estimated of specific combining ability effects of cross quality attributing traits in brinjal over the environments.

Hybrid	EN	Iron (mg 100 g^{-1})	Total soluble solid (°B)	Anthocyanin (%)
BL-2011-219-8-1 x SL-8-PB-1-3-1-4	E1	0.02*	0.45*	2.17*
	E2	0	0.08	0.42
	E3	0.02	0.37	1.83*
BL-2011-219-8-1 x Pusa Purple Long	E1	0.03*	0.48*	2.4*
	E2	0.03*	0.54**	2.7**
	E3	0.02	0.36	1.73
BL-2011-219-8-1 x BL-219	E1	-0.01	-0.11	-0.52
	E2	0	-0.02	-0.27
	E3	-0.01	-0.11	-0.47
BL-2011-219-8-1 x Pusa Purple Round	E1	0.01	0.17	0.86
	E2	0.01	0.24	1.27
	E3	0.01	0.2	0.91
BL-2011-219-8-1 x Pant Rituraj	E1	0	0.08	0.44
	E2	0.01	0.19	1.01
	E3	0	-0.03	-0.14
BL-2011-219-8-1 x S-324-465-2-2	E1	0	-0.03	-0.17
	E2	0	0.01	0.06
	E3	0	0.04	0.2
BL-2011-219-8-1 x BLW-2001-1-1-2	E1	-0.01	-0.14	-0.67
	E2	0	-0.07	-0.33
	E3	-0.01	-0.16	-0.8
SL-8-PB-1-3-1-4 x Pusa Purple Long	E1	0.04**	0.79**	3.85**
	E2	0.05**	0.89**	4.49**
	E3	0.01	0.2	0.66
SL-8-PB-1-3-1-4 x BL-219	E1	0	-0.06	-0.36
	E2	0	0.03	-0.03
	E3	0	-0.07	-0.28
SL-8-PB-1-3-1-4 x Pusa Purple Round	E1	0.03*	0.54**	2.62**
	E2	0.02	0.33	1.77
	E3	0.04**	0.71**	3.42**
SL-8-PB-1-3-1-4 x Pant Rituraj	E1	0.02	0.37	1.75
	E2	0.02*	0.45*	2.03*
	E3	0.02	0.4*	2.02*
SL-8-PB-1-3-1-4 x S-324-465-2-2	E1	-0.01	-0.13	-0.83
	E2	-0.01	-0.12	-0.57
	E3	-0.01	-0.11	-0.47
SL-8-PB-1-3-1-4 x BLW-2001-1-1-2	E1	0.01	0.23	1.05
	E2	0.02	0.3	1.58
	E3	0.01	0.19	0.95
Pusa Purple Long x BL-219	E1	0.05**	1.03**	5.22**
	E2	0.05**	0.93**	4.49**
	E3	0.06**	1.07**	5.27**
Pusa Purple Long x Pusa Purple Round	E1	-0.01	-0.27	-1.36
	E2	-0.01	-0.22	-1.09
	E3	0.01	0.24	1.44
Pusa Purple Long x Pant Rituraj	E1	-0.01	-0.12	-0.63
	E2	-0.01	-0.26	-1.26
	E3	0.01	0.13	0.66
Pusa Purple Long x S-324-465-2-2	E1	-0.02	-0.39*	-1.7
	E2	-0.02	-0.41*	-2.09*
	E3	-0.02*	-0.45*	-2.18*
Pusa Purple Long x BLW-2001-1-1-2	E1	-0.03**	-0.61**	-3.11**
	E2	-0.03**	-0.6**	-2.74**
	E3	-0.03*	-0.48*	-2.32*
BL-219 x Pusa Purple Round	E1	-0.02	-0.28	-1.38
	E2	-0.01	-0.25	-1.38
	E3	-0.02*	-0.43*	-2.05*
BL-219 x Pant Rituraj	E1	0	-0.01	-0.32
	E2	0	0.08	0.28
	E3	0	0.06	0.05
BL-219 x S-324-465-2-2	E1	0	0.03	0.13
	E2	0	0.06	0.1
	E3	0	0.02	-0.14

Table-6 : Contd.....

Hybrid	EN	Iron (mg 100 g^{-1})	Total soluble solid (°B)	Anthocyanin (%)
BL-219 x BLW-2001-1-1-2	E1	-0.02	-0.35	-1.7
	E2	-0.04**	-0.77**	-4.07**
	E3	-0.01	-0.16	-0.74
Pusa Purple Round x Pant Rituraj	E1	-0.01	-0.26	-1.29
	E2	-0.01	-0.23	-1.36
	E3	-0.02*	-0.45*	-2.21*
Pusa Purple Round x S-324-465-2-2	E1	0	0.07	0.3
	E2	0	0.05	0.35
	E3	0	0.03	0.15
Pusa Purple Round x BLW-2001-1-1-2	E1	0.02	0.31	1.59
	E2	0.02	0.36	1.54
	E3	0.01	0.27	1.25
Pant Rituraj x S-324-465-2-2	E1	0.03*	0.53**	2.99**
	E2	0.03**	0.58**	3.03**
	E3	0.03**	0.58**	2.85**
Pant Rituraj x BLW-2001-1-1-2	E1	-0.01	-0.17	-0.82
	E2	0	-0.08	-0.33
	E3	-0.02	-0.29	-1.4
S-324-465-2-2 x BLW-2001-1-1-2	E1	0.02	0.31	1.5
	E2	0.02	0.32	1.65
	E3	0.02	0.33	1.62
SE(sij)	E1	0.01	0.19	0.95
	E2	0.01	0.2	0.99
	E3	0.01	0.19	0.89
SE(sii-sjj)	E1	0.01	0.26	1.32
	E2	0.01	0.28	1.38
	E3	0.01	0.26	1.23
SE(sij-sik)	E1	0.02	0.32	1.62
	E2	0.02	0.34	1.69
	E3	0.02	0.32	1.51
SE(sij-skl)	E1	0.02	0.3	1.52
	E2	0.02	0.32	1.59
	E3	0.02	0.3	1.42

*and ** Significant at 1 and 5 per cent level of significance, respectively.

effects. The GCA effects in all the three environments ranged from -0.77 to 1.03 (Table-6). The cross, Pusa Purple Long x BL-219 and Pant Rituraj x S-324-465-2-2 show the significant positive SCA effects in all the three environments for iron. But cross BL-2011-219-8-1 x SL-8-PB-1-3-1-4 in E-1, SL-8-PB-1-3-1-4 x Pant Rituraj in E-2 and E-3, BL-2011-219-8-1 x Pusa Purple Long and SL-8-PB-1-3-1-4 x Pusa Purple Long in E-1 and E-2 and SL-8-PB-1-3-1-4 x Pusa Purple Round in E-1 and E-3 show the significant positive SCA for iron. The cross Pusa Purple Long x BLW-2001-1-1-2 and Pusa Purple Long x BLW-2001-1-1-2 show the significant negative SCA for iron in all three environments. This result confined with.

The value of SCA effects in pooled (Table 1.7) ranged from -0.563 to 0.625. The eight crosses, BL-2011-219-8-1 x SL-8-PB-1-3-1-4, BL-2011-219-8-1 x Pusa Purple Long, SL-8-PB-1-3-1-4 x Pusa Purple Long, SL-8-PB-1-3-1-4 x Pusa Purple Round, SL-8-PB-1-3-1-4 x Pant Rituraj, SL-8-PB-1-3-1-4 x BLW-2001-1-1-2, Pusa Purple Long x BL-219, Pusa Purple Round x BLW-2001-1-1-2, Pant Rituraj x S-324-465-2-2 and S-324-465-2-2 x BLW-2001-1-1-2 show the positive SCA effect for total soluble solid (°B).

Anthocyanin content (%) : The anthocyanin in fruit is desirable in brinjal, which is reflected by the negative combining ability effects. The SCA effects in all the three environments ranged from -4.07 to 5.22 (Table-6). The cross Pusa Purple Long x BL-219 and Pant Rituraj x S-324-465-2-2the significant positive SCA effects in all the three environments for anthocyanin. But cross BL-2011-219-8-1 x SL-8-PB-1-3-1-4 and SL-8-PB-1-3-1-4 x Pusa Purple Round E-1 and E-3, BL-2011-219-8-1 x Pusa Purple Long, SL-8-PB-1-3-1-4 x Pant Rituraj, and SL-8-PB-1-3-1-4 x Pusa Purple Long E-1 and E-2 reported positive significant SCA effect for anthocyanin.

The value of SCA effects in pooled (Table-7) ranged from -2.724 to 4.992. The eight crosses, BL-2011-219-8-1 x SL-8-PB-1-3-1-4, BL-2011-219-8-1 x Pusa Purple Long, SL-8-PB-1-3-1-4 x Pusa Purple Long, SL-8-PB-1-3-1-4 x Pusa Purple Round, SL-8-PB-1-3-1-4 x Pant Rituraj, SL-8-PB-1-3-1-4 x BLW-2001-1-1-2, Pusa Purple Long x

Table-7 : Estimated of pooled specific combining ability effects of cross in quality attributing traits in brinjal over the three environments.

Hybrid	Iron (mg $100g^{-1}$)	Total soluble solid (°B)	Anthocyanin content (%)
BL-2011-219-8-1 x SL-8-PB-1-3-1-4	0.015 *	0.300 *	1.476 *
BL-2011-219-8-1 x Pusa Purple Long	0.024 ***	0.458 ***	2.275 ***
BL-2011-219-8-1 x BL-219	-0.004	-0.079	-0.42
BL-2011-219-8-1 x Pusa Purple Round	0.01	0.2	1.015
BL-2011-219-8-1 x Pant Rituraj	0.006	0.079	0.438
BL-2011-219-8-1 x S-324-465-2-2	0.001	0.007	0.029
BL-2011-219-8-1 x BLW-2001-1-1-2	-0.007	-0.122	-0.602
SL-8-PB-1-3-1-4 x Pusa Purple Long	0.033 ***	0.625 ***	2.999 ***
SL-8-PB-1-3-1-4 x BL-219	-0.002	-0.035	-0.221
SL-8-PB-1-3-1-4 x Pusa Purple Round	0.028 ***	0.524 ***	2.601 ***
SL-8-PB-1-3-1-4 x Pant Rituraj	0.022 **	0.407 **	1.936 **
SL-8-PB-1-3-1-4 x S-324-465-2-2	-0.006	-0.119	-0.622
SL-8-PB-1-3-1-4 x BLW-2001-1-1-2	0.014 *	0.241	1.192
Pusa Purple Long x BL-219	0.054 ***	1.010 ***	4.992 ***
Pusa Purple Long x Pusa Purple Round	-0.004	-0.084	-0.336
Pusa Purple Long x Pant Rituraj	-0.005	-0.083	-0.412
Pusa Purple Long x S-324-465-2-2	-0.022 **	-0.416 **	-1.992 **
Pusa Purple Long x BLW-2001-1-1-2	-0.030 ***	-0.563 ***	-2.724 ***
BL-219 x Pusa Purple Round	-0.017 *	-0.319 *	-1.605 *
BL-219 x Pant Rituraj	0.002	0.045	0.005
BL-219 x S-324-465-2-2	0.002	0.036	0.03
BL-219 x BLW-2001-1-1-2	-0.023 ***	-0.425 **	-2.169 ***
Pusa Purple Round x Pant Rituraj	-0.017 *	-0.314 *	-1.623 *
Pusa Purple Round x S-324-465-2-2	0.003	0.052	0.266
Pusa Purple Round x BLW-2001-1-1-2	0.016 *	0.311 *	1.461 *
Pant Rituraj x S-324-465-2-2	0.030 ***	0.565 ***	2.957 ***
Pant Rituraj x BLW-2001-1-1-2	-0.01	-0.18	-0.852
S-324-465-2-2 x BLW-2001-1-1-2	0.017 *	0.320 *	1.591 *
SCA Comparisons			
Sij-Sik 95%	0.02	0.372	1.829
Sij-Sik 99%	0.026	0.49	2.411
Sij-Skm 95%	0.019	0.35	1.724
Sij-Skm 99%	0.024	0.462	2.273

* and ** Significant at 1 and 5 per cent level of significance, respectively.

BL-219, Pusa Purple Round x BLW-2001-1-1-2, Pant Rituraj x S-324-465-2-2 and S-324-465-2-2 x BLW-2001-1-1-2 show the positive SCA effect for anthocyanin content (%).

Nature and magnitude of combining ability effects provide an idea about the role of fixable and non-fixable gene effects in the inheritance of different traits. This helps in identification of suitable parents and crosses for hybridization/exploitation of heterosis. The mean squares due to GCA x E and SCA x E were found significant for most of the attributes in current study. As a general consequence of these interactions, the estimates of GCA and SCA effects frequently changed from environment to environment, complicating the problem of identification of promising parents and crosses.

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