EXPRESSION OF COMBINING ABILITY FOR QUALITY TRAITS IN ELITE BREEDING LINES OF BRINJAL (*SOLANUM MELONGENA* L.)

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Abstract: Combining ability effects were estimated for different characters of brinjal in a line × tester mating design comprising 12 lines and 3 testers and their 36 F_1 hybrids. Parents and F_1 crosses differed significantly for general combining ability and specific combining ability effects for all the characters respectively. The result revealed high and significant differences among the parents and hybrids for most of the characters except ascorbic acid content, indicating the importance of both additive and non-additive gene action. On the basis of GCA effects across six characters, Punjab Neelam, DBSR-31, Ramnagar Giant, BR-SPS-14, ABSR-2 and Pant Rituraj were identified as most promising parents for inclusion in hybridization programme with the aim to improving fruit yield as well as other important characters. The most promising crosses showing high *per se* performance and significantly positive SCA effects for fruit yield and some other important characters were Punjab Sanyog x Black Beauty, Arka Nidhi x Dudhiya, DBSR-31 x Pant Rituraj, Ramnagar Giant x Dudhiya, BR-SPS-14 x Pant Rituraj, Azad Kranti x Black Beauty, Pusa Uttam x Dudhiya, ABSR-2 x Dudhiya, ABSR-2 x Pant Rituraj, ABSR-2 x Black Beauty, Pant Samrat x Dudhiya and Pant Samrat x Black Beauty. Some of the crosses exhibited high dry matter with low moisture like Pusa Uttam x Black Beauty and Ramnagar Giant x Dudhiya. These crosses may exploit in the breeding programme for obtaining transgressive segregants towards developing hybrid varieties.

Keywords: Brinjal, *solanum melongena*, hybrid, trait

INTRODUCTION

In the recent past, selection of parents on the basis of combining ability has been an important breeding approach in the crop improvement. Brinjal (*Solanum melongena* L.) belongs to family Solanaceae, hermaphrodite in nature. It is widely cultivated as one of the most important vegetables in both tropical and subtropical areas of India as well as abroad. Fruit yield of brinjal is a polygenic in nature and is influenced by environmental factors. Looking into the great extent of diversity present in various quantitative traits among the genotypes of brinjal there is a tremendous scope for improvement in economic traits through conventional breeding. Earlier, eggplant breeding was relied both on mass selection and pureline selection from the land races for the development of improved varieties. It is a fact that selection of parents on the basis of their performance does not necessarily lead to desired results. Although several reports on the extent of combining ability are available in literature, but this information has not been utilized for commercial production of hybrids in India. Information regarding the general combining ability and specific combining ability and the types of gene effects influencing various traits enables the plant breeder to evaluate parental material and to decide a suitable breeding procedure for maximum characters improvement. Line × tester design has been found suitable to select the parents from germplasm which was employed in the present study to determine the extent of general and specific combining ability of parents and crosses for yield and quality traits, respectively.

MATERIAL AND METHOD

The present experiment was conducted during *kharif* season of 2010-11 at Vegetable Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The experimental material for the present study comprised of fifteen parents (twelve lines and three testers). The lines used for investigation, were Punjab Neelam, Punjab Sanyog, Arka Nidhi, DBSR-31, KS-235, Ramnagar Giant, BR-SPS-14, NUN-1521, Azad Kranti, Pusa Uttam, ABSR-2 and Pant Samrat and three testers namely, Dudhiya, Pant Rituraj and Black Beauty. The crosses were made in line × tester fashion during summer 2010. Parents and their hybrids were grown in a randomized block design with three replications. Seedlings were transplanted at a spacing of 60 cm between row to row and 60 cm plant to plant. All the recommended cultural practices were followed under irrigated conditions. The observations were recorded on five randomly selected plants per replication for each genotype on 6 various parameters *viz*. number of fruits per plant, yield (t/ha), dry matter (%), moisture percentage, ascorbic acid (mg) and TSS (^{o}brix). The analyses of variance were carried out as suggested (Snedecor and Cochran, 1967). The estimates of general and specific combining ability effects were calculated according to methodology suggested by Graffing (1956) and Kempthorne (1957), respectively.

RESULT AND DISCUSSION

Analysis of variance for combining ability revealed that the variances due to general combining ability (gca) and specific combining ability (sca) were

highly significant for all the traits studied. Thus, both kinds of gene effects were important in controlling the inheritance of all the characters studied. However, the gca/sca ratio mostly favoured sca in all the traits, indicating the preponderance of non-additive gene effects in the genetic control of traits. The present findings, therefore clearly indicated that non-additive genetic variance was the main component of genetic variance of various traits in brinjal. The high desirable gca effects for different traits of economic importance are useful for selecting parents possessing favourable genes for these traits. The gca effects include additive and additive × additive components of gene action that represent fixable genetical effects as reported by Sprague (1942). Gilbert (1967) stated that additive gene effects, as measured by gca effects are of practical use to the plant breeders. Whereas, non-allelic interactions are not predictable and cannot be easily manipulated. Improvement in yield and other economic traits could be achieved through hybridization of good general combiners. Making use of the parents possessing high desirable gca effect for several traits could be used in developing open pollinated population in brinjal involving simultaneous crossing of several parental lines and adopting a recurrent selection procedures that will help in synthesizing a population possessing very high yielding ability. From the result it was evident that there were no significant variances due to male and female for all the characters. Further, variances were significant for all the characters due to female x male, except ascorbic acid which indicate prevalence of both additives and non-additive gene effects in expression of related characters. These variances were important for all the characters and combining ability contributed more heavily in the expression of these traits.

The ideal cross combination to be exploited is one where high magnitude of SCA is present in addition to high GCA in both or at least one of the parents. GCA largely involves additive gene effects, while SCA contains non-additive type of gene action by Sprague and Tatum (1942). Non-additive gene action entails dominance and epistasis intractions.

The estimates of combining ability effects (Table-1&2) revealed that neither the parents nor the combinations studied were good for all the characters. The parents proved to be the best general combiner for different characters such as Nun-1521, Punjab Neelam, Punjab Sanyog and Black Beauty for number of fruits per plant; ABSR-2, Pant Rituraj, BR-SPS-14, Ramnagar Giant, Punjab Neelam and DBSR-31 for fruit yield; KS-235, Pant Rituraj, Arka Nidhi and Pusa Uttam for dry matter; Arka Nidhi, Pusa Uttam, Pant Rituraj and KS-235 moisture; Arka Nidhi and Ramnagar Giant for ascorbic acid; Arka Nidhi and ABSR-2 for total soluble solids. These results are in closely agreement with Chaudhary and Malhotra (2000) and Suneetha *et al.* (2008). High gca effects are mostly due to additive gene effects or additive × additive interaction effects as earlier reported by Griffing (1956). In view of this, breeders may utilize the good general combiners in specific breeding programmes for amelioration of fruit yield in brinjal.

In general, the hybrids with significant SCA effects in the desired direction involve parents with either high x high, high x low, or low x low GCA effects, indicating high performance of these crosses due to additive, dominance or epistatic gene interaction. Specific combining ability is associated may be with dominance and epistatic component of variation that are non-fixable in nature. Therefore, it can be utilized in developing first generation hybrids. As in the case of studying GCA effect, in sca also significant specific combiner and desirable crosses were screened out.

The specific combining ability (SCA) effects of 36 F_1s hybrids with respect to six characters related to quality and yield are represented in Table 2. The findings (Table 2) revealed that the significant and desirable crosses were Punjab Sanyog x Pant Ritraj, Ramnagar Giant x Black Beauty, ABSR-2 x Pant Rituraj, Pant samrat x Black Beauty and Ramnagar Giant x Dudhiya, for number of fruits per plant; Punjab Sanyog x Black Beauty, Arka Nidhi x Dudhiya, DBSR-2 x Pant Rituraj, Pusa Uttam x Dudhiya, ABSR-2 x Black Beauty, ABSR-2 x Dudhiya and BR-SPS-14 x Pant Rituraj for fruit yield; DBSR-31 x Black Beauty, Ramnagar Giant x Dudhiya, Punjab Sanyog x Dudhiya, Pusa Uttam x Black Beauty and ABSR-2 x Pant Rituraj for high dry matter and low moisture; Punjab Sanyog x Pant Rituraj, Ramnagar Giant x Black Beauty, Pusa Uttam x Dudhiya and Pant Samratt x Dudhiya for ascorbic acid; Punjab Neelam x Black Beauty, DBSR-31 x Dudhiya and NUN-1521 x Black Beauty for total soluble solids. Suneetha *et al.* (2008) and Bhakta *et al.* (2009) have reported similar results.

Based on GCA effects across six characters (Table 1), Punjab Neelam, DBSR-31, Ramnagar Giant, BR-SPS-14, ABSR-2, Pant Rituraj and Black Beauty were identified as most promising parents for inclusion in hybridization programme with the aim to improving fruit yield as well as other important characters that were noticed. Significant GCA effects for fruit yield in either both the direction resulted from similar GCA effects for some of the other component characters, such as number of fruits per plant. These results are in close conformity with Chaudhary and Malhotra (2000) and Suneetha *et al.* (2008).

None of the crosses exhibited significant and positive SCA effects for all the characters (Table 2). Heterosis in the cross involving low × high combiners might be due to dominant × additive type of interaction which is partially fixable and the crosses involving both the poor combining parents showing high sca must be due to intra and inter

allelic interactions. Generally the crosses were Punjab Neelam x Dudhiya, Punjab Sanyog x Black Beauty, Arka Nidhi x Dudhiya, DBSR-31 x Pant Rituraj, Ramnagar Giant x Dudhiya, BR-SPS-14 x Pant Rituraj, Azad Kranti x Dudhiya, Pusa Uttam x Dudhiya, ABSR-2 x Dudhiya, ABSR-2 x Black Beauty, Pant Samrat x Dudhiya and Pant Samrat x Black Beauty showing significantly positive SCA effects for fruit yield and some other important characters. Transgressive segregants may be produced by using these crosses in breeding programme. Similar results have been reported by Shanmugapriya *et al*. (2009).

Table 1. Estimation of general combining ability effect (GCA) for various yield contributing characters in line × tester analysis in brinjal (*Solanum melongena* L.)

Parents	No. of fruits per plant	Fruit yield (t/ha)	Dry matter (%)	Moisture (%)	Ascorbic acid (mg)	TSS (°brix)
Line						
Punjab Neelam	0.69	3.06**	-0.68	0.72	-0.14	-0.53
Punjab Sanyog	0.65	-0.91	0.00	0.04	-0.06	-0.01
Arka Nidhi	0.24	-2.63*	0.39	-0.35	0.21	0.75
DBSR-31	-0.67	5.56**	0.13	-0.10	0.03	0.10
KS-235	-0.74	-9.24**	0.73	-0.82	-0.17	0.29
Ramnagar Giant	-1.53	7.74**	0.21	-0.26	0.11	-0.24
BR-SPS 14	-0.08	7.85**	-0.04	0.08	0.05	-0.52
NUN-1521	1.01	-10.85**	-0.69	0.84	-0.06	-0.51
Azad Kranti	-0.47	-12.57**	-0.41	0.34	0.01	-0.27
Pusa Uttam	0.11	-4.26**	0.60	-0.67	-0.03	0.23
ABSR-2	0.46	18.00**	-0.38	0.41	0.06	0.69
Pant Samrat	0.40	-1.77	0.16	-0.22	-0.02	0.02
SEM ±	**0.18**	**0.88**	**0.13**	**0.13**	**0.07**	**0.12**
CD at 5%	**0.36**	**1.75**	**0.26**	**0.26**	**0.14**	**0.24**
CD at 1%	**0.48**	**2.33**	**0.34**	**0.34**	**0.18**	**0.32**
Tester						
Dudhiya	0.19	-5.73**	-0.18	0.15	-0.01	-0.09
Pant Rituraj	-0.54	8.34**	0.30	-0.33	0.01	0.05
Black Beauty	0.35	-2.61*	-0.14	0.18	0.00	0.03
SEM ±	**0.08**	**0.38**	**0.05**	**0.06**	**0.03**	**0.05**
CD at 5%	**0.16**	**0.76**	**0.10**	**0.12**	**0.06**	**0.10**
CD at 1%	**0.21**	**1.01**	**0.13**	**0.16**	**0.08**	**0.13**

*, ** Significant at 5% and 1% level of significance, respectively

Table 2. Estimation of specific combining ability (SCA) effect for various yield and yield contributing characters in line × tester analysis in brinjal (*Solanum melongena* L.)

Crosses	Number of fruits per plant	Fruit yield (t/ha)	Dry matter (%)	Moisture (%)	Ascorbic acid (mg)	TSS (^{0}brix)
H_1	-0.63	2.66**	-0.26	0.28	0.06	-0.55
H_2	0.49	-0.51	0.01	0.01	0.11	-0.25
H_3	0.14	-2.15*	0.25	-0.29	-0.16	0.80
H_4	-0.19	-10.78**	0.84	-0.83	-0.23	0.33
H_5	0.60	-3.49**	0.51	-0.48	0.32	-0.34
H_6	-0.41	14.27**	-1.35	1.32	-0.09	0.01
H_7	0.19	7.54**	0.35	-0.34	-0.05	0.24
H_8	0.55	2.75**	-0.02	0.04	-0.05	0.27
H_9	-0.74	4.79**	-0.33	0.30	-0.10	-0.51
H_{10}	0.27	7.38**	-1.07	1.09	0.08	0.65
H_{11}	0.49	14.49**	-0.33	0.35	-0.12	-0.12
H_{12}	-0.76	7.11**	1.41	-1.44	0.04	-0.53
H_{13}	0.10	5.24**	0.28	-0.18	-0.04	0.23
H_{14}	0.86	-3.36**	-0.82	0.63	-0.04	-0.34
H_{15}	-0.96	-1.88	0.54	-0.46	0.08	0.11

H_{16}	1.19	5.09**	0.92	-1.02	-0.15	-0.47
H_{17}	-2.68**	-0.98	-0.27	0.32	-0.09	0.22
H_{18}	1.50	-4.11**	-0.65	0.70	0.24	0.24
H_{19}	0.38	-9.23**	0.81	-0.80	-0.03	-0.26
H_{20}	-0.80	17.22**	-0.62	0.64	0.00	0.27
H_{21}	0.42	-7.99**	-0.19	0.16	0.03	-0.01
H_{22}	-0.31	1.74	-0.07	-0.03	-0.10	-0.68
H_{23}	-0.25	1.06	-0.34	0.59	0.09	0.29
H_{24}	0.56	-2.80**	0.41	-0.55	0.01	0.38
H_{25}	-0.07	1.94*	-0.20	-0.01	0.02	0.19
H_{26}	-0.37	-2.53*	0.55	-0.42	-0.05	-0.02
H_{27}	0.44	0.53	-0.36	0.43	0.02	-0.17
H_{28}	-0.25	14.43**	-1.05	1.17	0.25	0.25
H_{29}	-0.15	-6.13**	0.12	-0.32	-0.10	0.01
H_{30}	0.40	-8.31**	0.93	-0.85	-0.15	-0.27
H_{31}	0.00	11.98**	-0.54	0.47	-0.02	0.47
H_{32}	1.49	-9.72**	0.82	-0.80	0.00	-0.08
H_{33}	-1.49	21.70**	0.36	0.33	0.02	-0.39
H_{34}	-0.67	0.71	-0.10	0.21	0.22	-0.43
H_{35}	-0.24	-3.31**	0.38	-0.56	-0.08	0.09
H_{36}	0.91	2.60*	-0.29	0.35	-0.10	0.34
SEM±	**0.26**	**1.24**	**0.18**	**0.19**	**0.10**	**0.17**
CD at 5%	**0.52**	**2.47**	**0.36**	**0.38**	**0.20**	**0.34**
CD at 1%	**0.69**	**3.29**	**0.48**	**0.50**	**0.26**	**0.45**

*, ** Significant at 5% and 1% level of significance, respectively

Punjab Neelam x Dudhiya (H_1), Punjab Neelam x Pant Rituraj (H_2), Punjab Neelam x Black Beauty (H_3), Punjab Sanyog x Dudhiya (H_4), Punjab Sanyog x Pant Rituraj (H_5), Punjab Sanyog x Black Beauty (H_6), Arka Nidhi x Dudhiya (H_7), Arka Nidhi x Pant Rituraj (H_8), Arka Nidhi x Black Beauty (H_9), DBSR-31 x Dudhiya (H_{10}), DBSR-31 x Pant Rituraj(H_{11}), DBSR-31 x Black Beauty (H_{12}), KS-235 x Dudhiya (H_{13}), KS-235 x Pant Rituraj (H_{14}), KS-235 x Black Beauty(H_{15}), Ramnagar giant x Dudhiya (H_{16}), Ramnagar giant x Pant Rituraj (H_{17}), Ramnagar giant x Black Beauty (H_{18}),BR-SPS-14 x Dudhiya (H_{19}), BR-SPS-14 x Pant Rituraj (H_{20}), BR-SPS-14 x Black Beauty (H_{21}), NUN-1521 x Dudhiya (H_{22}), NUN-1521 x Pant Rituraj (H_{23}), NUN-1521 x Black Beauty (H_{24}), Azad Kranti x Dudhiya (H_{25}),Azad Kranti x Pant Rituraj (H_{26}), Azad Kranti x Black Beauty (H_{27}), Pusa Uttam x Dudhiya (H_{28}), Pusa Uttam x Pant Rituraj (H_{29}), Pusa Uttam x Black Beauty (H_{30}), ABSR-2 x Dudhiya (H_{31}), ABSR-2 x Pant Rituraj (H_{32}), ABSR-2 x Black Beauty (H_{33}), Pant Samrat x Dudhiya (H_{34}), Pant Samrat x Pant Rituraj (H_{35}), Pant Samrat x Black Beauty (H_{36}).

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