Asian Journal of Biological and Life Sciences | Original Research

Combining ability studies in elite breeding lines of brinjal (*Solanum melongena* L.) for plant characters

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Submitted : 19.08.2013 Accepted : 09.10.2013 Published : 31.12.2013

Abstract

Combining ability effects were estimated for seven different characters in brinjal comprising of thirty six hybrids obtained by crossing twelve lines and three testers by line × tester matting design. Significant differences were observed among the parents and hybrids/crosses for gca and sca effects respectively. Analysis of gca effects for parents revealed that the lines, 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 yield and yield contributing characters. Crosses exhibiting 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, Pusa Uttam x Dudhiya, ABSR-2 x Dudhiya and ABSR-2 x Black Beauty. These crosses may exploit in the breeding programme for obtaining transgressive segregants towards developing hybrid varieties.

INTRODUCTION

The brinjal (*Solanum melongena* L.) is the third most important vegetable crop in India. It is a versatile crop adapted to different agro-climatic regions and can be grown throughout the year. It is a perennial but grown commercially as an annual crop. Combining ability analysis is one of the efficient tools, which helps in selecting parents and crosses for improvement of particular (quantitative) characters. Information regarding general and specific combining ability enables the plant breeder to evaluate parental material and to decide a suitable breeding procedure for maximum character improvement. Among the several mating designs adopted for the study of genetic architecture in brinjal, line x tester mating design has been widely used for evaluating more number of genotypes at a time for combing ability effects [3]. Line x tester analysis is a good approach for screening the germplasm on the basis of combining ability effects and variances. It can evaluate relatively more number of germplasm lines at a time as compared to diallel and partial diallel crosses. Keeping in view, the present investigation was undertaken to study combining ability in respect of yield and its component traits in brinjal.

MATERIALS AND METHODS

The experimental material consisted of F_1 population of 36 crosses developed by crossing 12 lines *viz*., 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 with three testers viz., Dudhiya, Pant Rituraj and Black Beauty. 36 hybrids along with 15 parents were evaluated in *randomized block design with three replications* at Vegetable Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during the *kharif* season of 2010-11. 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 plant per replication for each genotype on 7 various parameters viz. days to 50% flowering, plant height (cm), plant spread (cm) (in both the directions i.e. in north-south and east-west), number of branches per plant, number of fruits per plant and fruit yield (t/ha). The analyses of variance were carried out as suggested [7]. The estimates of general combining ability [2] and specific combining ability [3] effects were calculated according to methodology suggested.

RESULTS

Analysis of variance revealed significant differences among the lines and testers for all the characters studied. It was further revealed that variance in case of hybrids (line × tester) were significant for all the characters studied. Combining ability analysis indicated significant variance due to parents and hybrids.

The GCA values of different parents with respect to various plant characters and yield characters are presented in table 1. The *per se* performance of the parent along with the gca effect offers reliability/authenticity of GCA effect as a guide to selection of parent. Many studies using Griffing's analysis have shown that the *per se* performance of the parents are often associated with their combining abilities, *i.e.,* promising parental performers tend to perpetuate desirable progeny [8]. The general combining ability (gca) effects revealed that the parents used were found good general combiners for most of the characters. But none of the parent was good general combiner for all the characters. However, among parents, KS-235, Ramnagar Giant and Black Beauty were good general combiners for days to 50% flowering; ABSR-2, Punjab Neelam, Pant Rituraj, KS-235 and Azad Kranti for plant height; Punjab Neelam, Azad Kranti, ABSR-2, Pant Rituraj and Dudhiya for plant spread- N to S; Punjab Neelam, ABSR-2 and Azad Kranti for plant spread- E to W; ABSR-2 and Pant Rituraj for number of primary branches per plant; 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 Neelum and DBSR-31 for fruit yield; These results

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

Parents	Days to 50% flowering	Plant height (cm)	Spread- N to S (cm)	Spread- E to W (cm)	No. of branches per plant	No. of fruits per plant	Fruit yield (t/ha)
Line							
Punjab Neelam	-0.64	3.41**	2.79**	6.00**	0.77	0.69	3.06**
Punjab Sanyog	-0.53	-4.76**	0.63	-1.35	-0.07	0.65	-0.91
Arka Nidhi	-1.64	-4.69**	-4.45**	-4.05**	-0.40	0.24	-2.63*
DBSR-31	1.14	-0.83	-0.79	0.79	-0.72	-0.67	5.56**
KS-235	-2.14*	3.39**	0.01	-2.59*	0.07	-0.74	-9.24**
Ramnagar Giant	-2.86**	-2.82**	0.38	0.67	0.37	-1.53	7.74**
BR-SPS 14	-0.86	-3.71**	-1.83	-1.33	-0.57	-0.08	7.85**
NUN-1521	0.14	-0.41	-2.90**	-2.49*	-0.34	1.01	-10.85**
Azad Kranti	0.81	2.94**	2.30*	2.99**	-1.18	-0.47	-12.57**
Pusa Uttam	0.14	-0.28	-1.95	-1.60	-0.66	0.11	-4.26**
ABSR-2	2.47*	9.22**	8.89**	5.94**	2.39*	0.46	18.00**
Pant Samrat	2.36*	-1.46	-3.10**	-2.98**	0.34	0.40	-1.77
SEM ±	**0.29**	**0.50**	**0.47**	**0.52**	**0.19**	**0.18**	**0.88**
CD at 5%	**0.58**	**0.99**	**0.93**	**1.03**	**0.38**	**0.36**	**1.75**
CD at 1%	**0.77**	**1.32**	**1.24**	**1.38**	**0.50**	**0.48**	**2.33**
Tester							
Dudhiya	2.58*	-0.11	0.65	-0.16	-0.15	0.19	-5.73**
Pant Rituraj	-0.06	1.71	0.87	1.15	0.41	-0.54	8.34**
Black Beauty	-2.53*	-1.61	-1.51	-0.99	-0.26	0.35	-2.61*
SEM ±	**0.12**	**0.21**	**0.20**	**0.22**	**0.08**	**0.08**	**0.38**
CD at 5%	**0.29**	**0.42**	**0.40**	**0.44**	**0.16**	**0.16**	**0.76**
CD at 1%	**0.32**	**0.56**	**0.53**	**0.58**	**0.21**	**0.21**	**1.01**

*, ** 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	Days to 50% flowering	Plant height (cm)	Plant spread- N to S (cm)	Plant spread- E to W (cm)	Number of branches per plant	Number of fruits per plant	Fruit yield (t/ha)
H_1	-1.14	2.14*	4.99**	2.55*	0.46	-0.63	2.66**
H_2	0.17	3.55**	-2.57*	-0.70	1.07	0.49	-0.51
H_3	1.31	-5.69**	-2.52*	-1.85	-1.53	0.14	-2.15*
H_4	-0.92	-0.56	-2.85**	-2.14*	0.11	-0.19	-10.78**
H_5	-1.28	-0.35	0.37	1.38	-0.19	0.60	-3.49**
H_6	2.19*	0.91	2.48*	0.76	0.08	-0.41	14.27**
H_7	-1.14	-0.36	-1.03	-2.54*	0.23	0.19	7.54**
H_8	-0.17	2.35*	2.04*	1.18	0.17	0.55	2.75**
H_9	1.31	-1.99*	-1.01	1.36	-0.40	-0.74	4.79**
H_{10}	1.42	-0.49	-0.90	0.66	0.02	0.27	7.38**
H_{11}	-0.94	-1.21	-1.46	-3.59**	-0.64	0.49	14.49**
H_{12}	-0.47	1.71	2.36*	2.93**	0.63	-0.76	7.11**
H_{13}	1.42	1.05	-0.90	-1.39	0.33	0.10	5.24**
H_{14}	2.06*	-1.04	0.01	-0.34	-0.43	0.86	-3.36**
H_{15}	-3.47**	-0.01	0.89	1.74	0.10	-0.96	-1.88
H_{16}	-5.58**	2.26*	-1.80	1.05	-0.17	1.19	5.09**
H_{17}	3.06**	-2.56*	0.28	0.70	0.30	-2.68**	-0.98
H_{18}	2.53*	0.30	1.52	-1.75	-0.13	1.50	-4.11**
H_{19}	-1.58	-0.95	-0.19	1.55	-0.09	0.38	-9.23**
H_{20}	0.06	0.03	0.32	-1.67	0.28	-0.80	17.22**
H_{21}	1.53	0.92	-0.13	0.11	-0.19	0.42	-7.99**
H_{22}	0.75	0.92	0.61	2.21*	0.24	-0.31	1.74
H_{23}	-0.61	2.80**	-0.54	0.52	-0.95	-0.25	1.06
H_{24}	-0.14	-3.71**	-0.10	-2.73**	0.71	0.56	-2.80**
H_{25}	0.42	1.47	-0.32	1.00	-0.58	-0.07	1.94*
H_{26}	0.06	1.05	0.55	-1.12	0.16	-0.37	-2.53*
H_{27}	-0.47	-2.53*	-0.23	0.13	0.43	0.44	0.53
H_{28}	3.08**	-1.14	0.90	-0.18	0.06	-0.25	14.43**
H_{29}	-1.28	-0.16	-0.29	0.97	0.03	-0.15	-6.13**
H_{30}	-1.81	1.30	-0.61	-0.79	-0.10	0.40	-8.31**

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

Punjab Neelam x Dudhiya (H1), Punjab Neelam x Pant Rituraj (H2), Punjab Neelam x Black Beauty (H3), Punjab Sanyog x Dudhiya (H4), Punjab Sanyog x Pant Rituraj (H5), Punjab Sanyog x Black Beauty (H6), Arka Nidhi x Dudhiya (H7), Arka Nidhi x Pant Rituraj (H8), Arka Nidhi x Black Beauty (H9), DBSR-31 x Dudhiya (H10), DBSR-31 x Pant Rituraj(H11), DBSR-31 x Black Beauty (H12), KS-235 x Dudhiya (H13), KS-235 x Pant Rituraj (H14), KS-235 x Black Beauty(H15), Ramnagar giant x Dudhiya (H16), Ramnagar giant x Pant Rituraj (H17), Ramnagar giant x Black Beauty (H18),BR-SPS-14 x Dudhiya (H19), BR-SPS-14 x Pant Rituraj (H20), BR-SPS-14 x Black Beauty (H21), NUN-1521 x Dudhiya (H22), NUN-1521 x Pant Rituraj (H23), NUN-1521 x Black Beauty (H24), Azad Kranti x Dudhiya (H25),Azad Kranti x Pant Rituraj (H26), Azad Kranti x Black Beauty (H27), Pusa Uttam x Dudhiya (H28), Pusa Uttam x Pant Rituraj (H29), Pusa Uttam x Black Beauty (H30), ABSR-2 x Dudhiya (H31), ABSR-2 x Pant Rituraj (H32), ABSR-2 x Black Beauty (H33), Pant Samrat x Dudhiya (H34), Pant Samrat x Pant Rituraj (H35), Pant Samrat x Black Beauty (H36).

are in closely agreement [8].

The findings on sca were revealed that the significant and desirable crosses in the decreasing order were Ramnagar Giant x Dudhiya and KS-235 x Black Beauty for days to 50% flowering; ABSR-2 x Black Beauty, Punjab Neelam x Pant Rituraj, NUN-1521 x Pant Rituraj, Arka Nidhi x Pant Rituraj, Ramnagar Giant x Dudhiya and Punjab Neelam x Dudhiya for plant height; Punjab Neelam x Dudhiya, Punjab Sanyog x Black Beauty, DBSR-31 x Black Beauty and Arka Nidhi x Pant Rituraj for plant spread- N to S; ABSR-2 x Pant Rituraj, Pant Samrat x Black Beauty, DBSR-31 x Black Beauty, Punjab Neelam x Dudhiya NUN-1521 x Dudhiya and for plant spread- E to W; Punjab Neelam x Pant Rituraj and NUN-1521 x Black Beauty for number of branches per plant; Ramnagar Giant x Black Beauty, ABSR-2 x Pant Rituraj and Ramnagar Giant x Dudhiya, for number of fruits per plant; ABSR-2 x Black Beauty, BR-SPS-14 x Pant Rituraj, DBSR-31 x Pant Rituraj, Pusa Uttam x Dudhiya, Punjab Sanyog x Black Beauty and Arka Nidhi x Dudhiya for fruit yield [1], [5] and [8].

DISCUSSION

The information regarding general combining ability effects of the parents is of prime importance as it helps in successful prediction of genetic potentiality of crosses, which yield desirable individuals in segregating population. Estimation of GCA effects reflected that it was difficult to choose a good combination for all the traits as the combining ability effects were not consistent for all the yield components. Among seven characters based on Gca effects (Table 1), 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 yield and yield contributing characters. 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 days to 50% flowering, plant height, plant spread- E to W, number of fruits per plant. Association of Gca of fruit yield with that of early days to 50% flowering indicated possibility of combining early flowering and maturity with high fruit yield in brinjal [8].

The specific combining ability (SCA) effects of 36 F_1s hybrids with respect to seven characters are represented in Table 2 and these were screened out same as in the case of GCA. The most promising crosses showing high *per se* performance and significantly positive Sca effects for fruit yield and some other important characters 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, Pusa Uttam x Dudhiya, ABSR-2 x Dudhiya and ABSR-2 x Black Beauty.

The ratio gca/sca variance being less than unity for most of the characters revealed predominance of non-additive components of variance. The importance of both additive as well as non-additive components for number of fruits per plant, branches per plant, plant height and yield (kg/plot and q/ha) in brinjal [4] and [5]; and in tomato [6] was similarly reported.

CONCLUSION

In the present study we found that none of the parental lines and crosses exhibited significant and positive GCA and SCA effects respectively for all the seven characters. From the above findings we can conclude that crosses involving one or both the parents with high GCA effects were found to be superior thus indicating a close relationship between GCA and SCA effects. The genetic worth of parents is decided on the basis of its combining ability. The combining ability had given useful information on choice of parents in terms of expected performance of the crosses and their progenies. Also parents having high general combining ability (gca) could be useful in producing transgressive segregation from advance generations. The effects based on Sca are non-fixable and high value of Sca indicates that the combination did relatively better than other. Specific combining ability reveals, on the other hand, the best cross combination among the genotypes that could be used for developing hybrids with high vigour for the respective traits. For all the seven characters studied, the crosses with significant Sca effects involved parents with high x high, high x low, low x high or low x low Gca effects.

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