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General and Specific Combining Ability for Nine Morphologic Characters in Round Brinjal (*Solanum melongena* L.)

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Authors' contributions

This work was carried out in collaboration between all authors. Authors Ravi Kumar and Randhir Kumar designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AK and SKS managed the analyses of the study. Author PK managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A study was undertaken to estimate general and specific combining in brinjal through diallel analysis involving 6 parents. The combining ability analysis revealed highly significant differences among the treatments for all the parameters studied except days to 50% flowering and number of primary branches per plant. The genotype SBRB-6/12 was found best general combiner for number of fruit per plant and yield per plant. The top three crosses (SBRB-3/12 x SBRB-2/12, SBRB-6/12 x SBRB-3/12 and KS-224 x Swarna Mani) with high per se performance have exhibited high sca effects for yield. Both additive and non-additive gene actions were operating for all the characters except days to 50% flowering, fruit diameter and number of primary branches/plant. Therefore, the general combiner can be exploited for the creation of varieties lines, and the presence of specific combining in the hybrids.

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1. INTRODUCTION

Brinjal is an important vegetable crop of Indian origin having wide variability [1]. In India, the major growing area of brinjal is West Bengal, Odissa, Andhra Pradesh, Gujarat, Madhya Pradesh, Maharashtra, Chhattisgarh, Karnataka, Haryana, Jharkhand and Assam [2]. Brinjal occupies an area of 0.71 m ha with an annual production and productivity of 13.56 mt and 19.10 t/ha, respectively. While, In Bihar brinjal occupies an area of 0.058 mha with an annual production of 1.24 mt and productivity of 21.60 t/ha [2]. Its immature fruits are generally used as vegetable and other culinary preparations [3]. As preference of colour and shape of the brinjal fruits varies from place to place, it is not possible to have one common cultivar to suit different localities and local preferences. It is therefore, required to improve the locally preferred cultivars with certain fruit characters along with high yield and adaptation in diverse agro-climatic conditions and now these traits are most desirable objectives for the breeders of brinjal in India as well as in the world. 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 [4]. The choice of parents especially for heterosis breeding should be based on combining ability test and their mean performance [1]. In this study, six diverse parents were taken to estimate the combining ability effects in brinjal. The information generated in this process is 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.

2. MATERIALS AND METHODS

The experiment was conducted in the “Permanent Experimental Area” (PEA) plot of Vegetable Research Farm, Bihar Agricultural College, Sabour. It is situated at a longitude of 87º2’42” East and latitude of 25º15’40” North. This place is situated at an altitude of 45.75 m in the vast Indo-Gangetic plain of North Eastern India. The climatic condition of this place in subtropical to slightly new arid nature and is characterized by summer, moderate rainfall and cold winter. January and February are usually the coldest months when the mean temperature falls as low as 8.96ºC normally. The rainfall is mainly distributed between middle of June to middle of October.The soil of the plot was sandy loam in texture having good fertility, properly leveled and well drained. The pH of the soil under study was 6.8. The six parental lines namely SBRB-6/12, SBRB-1/12, KS-224, SBRB-2/12, Swarna Mani, and SBRB-3/12 were of different morphological features and yield attributing characters obtained from different places. These lines were crossed in diallel fashion excluding reciprocal hybrid. For hybridization, the floral buds of the female parents were emasculated a day before and bagged to prevent cross pollination. Either on the same day or next morning pollination was done by collecting pollen grains from freshly opened flowers of the male parent and gently applied on the stigma of emasculated flowers. Manually pollinated flowers are tagged for easy identification and were bagged for two to three days. The experiment with 6 parents and 15 F_1 hybrids were laid out in a randomized complete block design with 3 replications having each experimental unit of single row with spacing of 60 x 60 cm during 2012-13. Observation were recorded on Days taken to 1st flower, Days taken to 50% flowering, Average length of fruit, Fruit diameter, Fruit weight, Number of primary branches per plant, plant height, Average number of fruits per plant and Average yield per plant. The data were subjected to appropriate statistical analysis. The combining ability analysis was carried out according to Griffing’s [5] Method 2 Models I. In this approach, using a suitable statistical model the component of variances due to general and specific combining ability was estimated. The analysis has been done using indo stat software.

3. RESULTS AND DISCUSSION

The variances due to general combining ability (gca) and specific combining ability (sca) are presented in Table 1. General combining ability (gca) largely involves additive gene action. The additive genetic effects are mainly due to polygenes, which act in additive manner, producing fixable effects. It is evident from the analysis that mean squares due to gca were significant for almost all the characters except days to 50% flowering, fruit diameter and number of primary branches per plant and sca were significant for all the nine characters studied. This indicated the importance of both additive

Table 1. ANOVA for combining ability in methods-II model-I of diallel analysis in brinjal

Source of variation	DF	Days to first flowering	Days to 50% flowering	Av. fruit length (cm)	Av. fruit diameter (cm)	Av. fruit weight (g)	No. of primary branches/ plant	Plant height (cm)	No. of fruits/ Plant	Yield/ plant (kg)
GCA	5.00	10.08*	4.69	7.76**	0.32	2382.69**	0.15	534.63**	5.07**	0.06**
SCA	15.00	7.90*	7.94**	7.56**	0.55**	589.03**	0.28**	107.69**	1.63 *	0.05**
Error	70.00	2.88	3.43	0.12	0.14	59.09	0.06	10.91	0.56	0.01

** - Significant at 5 per cent probability level, ** - Significant at 1 per cent probability level*

Table 2. Estimates of gca effects of parents for nine studied characters in brinjal

Parents	Days to first flowering	Days to 50% flowering	Av. fruit length (cm)	Av. fruit diameter (cm)	Av. fruit weight (gm)	No. of primary branches/ plant	Plant height (cm)	No. of fruits/ plant	Yield/ plant (kg)
SBRB-6/12	-0.72	-0.93	-0.99**	-0.19	-23.83**	0.10	-12.49**	0.64*	0.07*
SBRB-1/12	0.44	-0.35	0.68**	0.04	8.21**	0.06	3.01**	0.04	-0.03
KS-224	-0.47	0.30	-1.03**	0.17	18.16**	0.01	6.96**	-1.04**	-0.09**
SBRB-2/12	-0.92	-0.26	0.75 **	-0.05	2.56	0.00	-0.07	0.50	-0.01
Swarna Mani	1.55**	0.48	0.30*	0.20	-0.53	0.04	3.00 *	-0.49	-0.03
SBRB-3/12	0.13	0.76	0.30*	-0.17	-4.57	-0.22**	-0.41	0.35	0.09**
S.E. (gi)	0.45	0.49	0.09	0.10	2.02	0.06	0.87	0.20	0.02
S.E. (gi-gj)	0.70	0.76	0.14	0.15	3.13	0.10	1.35	0.31	0.03

** Significant at 5 per cent probability level, ** - Significant at 1 per cent probability level*

Table 3. Estimate of sca effects of F_1 hybrids for nine characters in brinjal

Hybrid or cross combination	Days to first flowering	Days to 50% flowering	Av. fruit length (cm)	Av. fruit diameter (cm)	Av. fruit weight (gm)	No. of primary branches/ plant	Plant height (cm)	No. of fruits/ plant	Yield/ plant (kg)
SBRB-6/12 x SBRB-1/12	1.68	1.04	-0.90**	0.08	-0.51	0.47*	-5.68	-0.43	0.01
SBRB-6/12 x KS-224	2.14	1.15	-0.89**	-0.32	3.36	-0.13	0.16	-0.08	-0.17*
SBRB-6/12 x SBRB-2/12	0.32	0.32	-0.98**	0.09	5.11	-0.61**	-3.42	-0.27	-0.02
SBRB-6/12 x Swarna Mani	-1.60	0.66	2.75**	-0.20	-0.24	-0.12	-3.64	0.40	0.03
SBRB-6/12 x SBRB-3/12	-0.07	-0.98	0.83*	-0.21	-2.91	0.18	3.93	0.98	0.15*
SBRB-1/12 x KS-224	-3.23*	-1.04	0.22	0.08	0.23	-0.40	7.56 *	0.50	0.01
SBRB-1/12 x SBRB-2/12	1.76	1.63	0.57	0.08	22.11**	0.29	-8.10**	0.09	0.02
SBRB-1/12 x Swarna Mani	0.42	1.39	-2.35**	-0.20	-0.73	-0.33	10.05**	0.60	0.11
SBRB-1/12 x SBRB-3/12	-1.57	-1.87	-1.58**	0.34	-28.87**	-0.29	9.19**	0.81	-0.15*
KS-224 x SBRB-2/12	1.98	-0.43	-1.01 **	-0.59	-5.71	-0.27	4.30	-1.72*	-0.22* *
KS-224 x Swarna Mani	0.19	0.14	0.66*	0.26	-5.33	0.23	-0.47	-0.30	0.28**
KS-224 x SBRB-3/12	0.82	-0.20	-0.12	0.60	35.55**	0.00	-1.61	-0.16	0.17*
SBRB-2/12 x Swarna Mani	0.76	-0.63	2.77**	-0.44	1.81	-0.01	-5.83	0.94	-0.13
SBRB-2/12 x SBRB-3/12	1.16	4.49*	2.56**	0.41	12.60	0.28	7.03*	0.19	0.20**
Swarna Mani x SBRB-3/12	-1.31	-2.64	-1.24**	0.73*	10.34	-0.50*	-3.24	-0.23	-0.05
S.E. (S_{ij})	1.02	1.11	0.21	0.22	4.62	0.14	1.99	0.45	0.05
S.E. (S_{ij}-S_{ik})	1.55	1.69	0.31	0.34	7.12	0.22	3.01	0.68	0.07

** - Significant at 5 per cent probability level, ** - Significant at 1 per cent probability level* and non-additive gene action. Further, mean square values for gca were higher than sca for all traits except days to 50% flowering, fruit diameter and number of primary branches per plant, indicating prevalence of wide variability and high degree of additive variance for the former traits while dominance for the later. The similar findings were also reported by [6].

The perusal of the data on general combining ability effects none of the parents showed significant gca effect in desirable direction for the traits days to first flowering and days to 50% flowering, average fruit diameter, and number of primary branches. Lines mentioning the gca effects for all the traits are mentioned in Table 2. The parental lines *viz.;* SBRB-2/12, Swarna Mani, SBRB-3/12 and SBRB-1/12 found best general combiner for fruit length. For average fruit weight genotypes SBRB-1/12 (8.21) and KS 224 (18.16) were the best general combiners and for plant height genotypes KS-224 (6.96), SBRB-1/12 (3.01), Swarna Mani (3.00) were the best general combiners. Similar results were observed by [7]. Only one genotype SBRB-6/12 (0.64) was found best general combiner for number of fruit per plant [8]. For fruit yield per plant two parental lines *viz.;* SBRB-3/12 (0.09) and SBRB-6/12 (0.07) showed significant positive gca effect (Table 2). The estimate of gca of parent is an important indicator of its potential for generating superior hybrid. A high gca estimates indicates that the parental mean is superior or inferior to the general mean [9]. It tells about the favourable gene flow from the parents to offspring at high frequency [10]. From the analysis of combining ability estimates, it was observed that both additive and non-additive gene actions were operating for all the characters under study because mean squares due to gca were significant for almost all the characters except days to 50% flowering, Fruit diameter and number of primary branches per plant. Similar results were also observed by [4].

The sca variance accounts for non-additive type of gene action which is composed of dominant and epistasis [5] can be equated to dominance variance by Hayman analysis [11]. For specific combining ability effects among 15 F_1 hybrids SBRB-1/12 x KS-224 (3.23) was found good specific combiners for earliness as the parent KS 224 was positive general combiner for days to first flowering (Table 3). 5 hybrids namely SBRB-2/12 x Swarna Mani (2.77), SBRB-6/12 x Swarna Mani (2.75), SBRB-2/12 x SBRB-3/12 (2.56), SBRB-6/12 x SBRB-3/12 (0.83), KS 224 x Swarna Mani (0.66) showed significant positive sca effects in desirable direction for fruit length. In present experiment, it was observed that in cross combinations, one of the parent was superior in respect to that character exhibiting high gca and sca effects, suggesting that superiority of a cross combination (F_1) of a character, may be largely due to interaction of epistasis which is supported by [12]. The hybrid KS-224 x SBRB-3/12 (35.55) showed the maximum positive sca effects followed by SBRB-1/12 x SBRB-2/12 (22.11) for fruit weight. The increased fruit weight in the hybrids resulting due to one of the parents having high GCA [6]. For number of primary branches per plants only one hybrid SBRB-6/12 x SBRB-1/12 (0.47) was best specific combiner. Further the crossesSBRB-1/12 x Swarna Mani(10.05), SBRB-1/12 x SBRB-3/12(9.19), SBRB-1/12 x KS-224(7.56), SBRB-2/12 x SBRB-3/12(7.03) were found best specific combiner for the character plant height, whereas the hybrid KS-224 x Swarna Mani (0.28) had maximum positive significant sca effect followed by SBRB-2/12 x SBRB-3/12(0.20) and SBRB-6/12 x SBRB-3/12 (0.15) (Table 3). The parents SBRB-6/12 and SBRB-3/12 involved in these crosses exhibited high gca effects. Similar results were also reported by [6].

4. CONCLUSION

The mean squares due to gca and sca were significant for almost all characters except days to 50% flowering, Fruit diameter and number of primary branches per plant. Considering higher number of fruits per plant SBRB-6/12 considered good general combiner for earliness, SBRB-3/12 considered good general combiner for fruit yield per plant. Out of 15 crosses, four crosses namely KS224 x Swarna Mani, SBRB-2/12 x SBRB-3/12, KS224 x SBRB-3/12 and SBRB-6/12 x SBRB-3/12 have shown positive and significant sca effect for fruit yield per plant (kg) and best specific combiners for fruit yield per plant (kg).

The high value of yield per plant is the ultimate criteria of the breeder. In the present study, the top three crosses (SBRB-3/12 x SBRB-2/12, SBRB-6/12 x SBRB-3/12 and KS-224 x Swarna Mani) with high *per se* performance have exhibited high sca effects for yield. These may be further selected for commercial exploitation as they are not only high yielder but also possessed attractive fruit size, shapes and colour as per present market demand.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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