

Original Research Article

Combining ability analysis and gene action for productivity in roundbrinjal (*Solanum melongena* L.)

Abstract

A study was undertaken to estimate the general and specific combining ability and gene action 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.

Key words- general combining ability, specific combining ability, Brinjal

Introduction

Brinjal is an important vegetable crop of Indian origin having wide variability. In India, major growing area of brinjal is West Bengal, Odisha, Andhra Pradesh, Gujarat, Madhya Pradesh, Maharashtra, Chhattishgarh, Karnataka, Haryana, Jharkhand and Assam. 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 m ha with an annual production of 1.24 mt and productivity of 21.60 t/ ha (NHB-2014). Its immature fruits are generally used as vegetable and other culinary preparations. 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. The choice of parents especially for heterosis breeding should be based on combining ability test and their mean performance. 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.

MATERIAL 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 87°2’42” East and latitude of 25°15’40” 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 is 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 8.96°C 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 to make thirty hybrids. For hybridization, the floral buds of the female parents were emasculated a day before and bagged to prevent cross pollination. On the same evening following emasculaton or following morning pollen grains were collected from freshly opened flowers of the required male parent, gently applied to the stigma of the emasculated flowers, then crossed flowers were tagged for easy identification and were bagged for two to three days. The experiment with 6 parents and 30 F₁ 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. Observations 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 (1956) Method 2 Models I (fixed effect). In this approach, using a suitable statistical model the component of variances due to general and specific combining ability was estimated.

RESULTS AND DISCUSSION

The variances due to general combining ability (gca) and specific combining ability (sca) were presented in (Table-1). General combining ability (gca) largely involves additive gene action. The additive genetic effects are mainly due to polygene, which act in additive manner, producing fixable effects. It is evident from the table that mean squares due to gca were significant for almost all character except days to 50% flowering, fruit diameter and number of primary branches per plant and sca were significant for all the nine characters studied. The similar findings were reported by Rai and Asati (2011).

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. 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. Similar results were observed by Vinod Kumar *et al.* (2003), whereas genotypes KS-224 (6.96), SBRB-1/12 (3.01), Swarna Mani (3.00) for plant height only one genotype SBRB-6/12 (0.64) was found best general combiner for number of fruit per plant (Soni *et al.*; 2011). 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). 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 characters except days to 50 % flowering, Fruit diameter and number of primary branches/plant.

. The sca variance accounts for non-additive type of gene action which is composed of dominant and epistasis (Griffing, 1956b) and can be equated to dominance variance by Hayman analysis (1954a). For specific combining ability effects among 15 F₁ 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 combination, one of the parent was superior in respect to that character exhibiting high gca and sca effects, suggesting that superiority of a cross combination (F₁) a character, may be largely due to interaction of epistasis which is supported by Singh *et al.* (2002). 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 (Raian Asati, 2011). For number of primary branches per plant only one hybrid SBRB-6/12 x SBRB-1/12 (0.47) was best specific combiner. Further the cross SBRB-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. So in such crosses better transgressive segregants can be expressed in F₁ population. Similar results were reported by Rai and Asati (2011).

The higher 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.

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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 eleven studied characters in brinjal

Source variation	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

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Table 3: Estimate of sca effects of F₁ hybrids for eleven characters in brinjal

Source of variation		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

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* - Significant at 5 per cent probability level

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** - Significant at 1 per cent probability level