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Combining ability and gene action studies for fruit yield and yield contributing traits in brinjal

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ABSTRACT

Combining ability and gene action were studied in diallel mating design using seven homozygous lines namely, RCMB-10, RCMB-7, RCMB-4, RCMB-3, RCMB-1, BB-40 and BB-64. General combining ability studies revealed that RCMB-10 and BB-64 were best combiners for major yield contributing characters viz. plant height, number of primary branches per plant, fruit weight and fruit yield. However, the estimates of specific combining ability showed the highest desirable sca effects in crosses RCMB-3 x BB-64 for plant height, number of branches and number of fruits, RCMB-10 x RCMB-4 for fruit breadth, fruit weight and yield, RCMB-10 x RCMB-3 for percent fruit set and RCMB-1 x BB-64 for fruit length. Gene action analysis revealed preponderance of both additive and non-additive genes for yield and its contributing characters.

Key words: Combining ability, diallel, brinjal, gene action.

INTRODUCTION

Brinjal (*Solanum melongena* L.) is widely cultivated as one of the most important vegetables in both sub-tropical and tropical areas of India as well as abroad. 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. Therefore, devising a sound breeding strategy to improve the yield of this crop is of paramount importance. The combining ability analysis help breeders in choosing suitable genotypes as parents for hybridization and superior cross combinations through gca and sca studies, respectively. At the same time, it also elucidate the nature and magnitude of different types of gene action involved, which is essential for an effective breeding programme. Hence, present investigation was undertaken to study the estimates of general and specific combining ability and gene action in brinjal for yield and its contributing characters.

MATERIALS AND METHODS

The present experiment was carried out at ICAR Research Complex for NEH Region, Umiam, Meghalaya by involving five genetically diverse homozygous brinjal lines namely, RCMB-10, RCMB-7, RCMB-4, RCMB-3 and RCMB-1. Two lines namely, BB-40 and BB-64 obtained from OUAT, Bhubaneswar crossed in diallel mating design without reciprocals and the seeds of 21 F_1 were grown in second year for getting F_2 seeds. Finally, seven parents, remaining seeds of F_1 and F_2 were sown for raising seedling and 30-days-old seedlings were planted at spacing of 60 cm x 60 cm in a randomized block design with three replications during *kharif* season. All recommended agronomic practices were followed to raise a good crop. The observations were recorded on twenty randomly selected plants of parents and F_1 and 50 plants of F_2 in each replication for yield and its contributing traits. Mean data was subjected for analysis of gca, sca and gene action as per method given by Griffing (2) (method 2 and model II), and Hayman (3), respectively.

RESULTS AND DISCUSSION

Analysis of variance for gca and sca presented in Table 1 revealed that mean sum of squares of combining ability for various yield and yield contributing characters were highly significant for all the characters except fruit length, for which gca effect was found non-significant. The mean squares of gca were larger than those of sca in all the characters except for fruit length indicating the preponderance of additive gene action in the control of most of the characters. This suggested that simple selection would be effective to make desirable improvements of the characters under study. On other hand, higher sca value recorded for fruit length than its gca value indicating involvement of non-additive genes. Involvement of non-additive gene action for the character fruit length in present investigation is also in consonance with the findings of Singh *et al.* (8).

Estimates of general combining ability for various traits have been presented in Table 2. The estimates

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Table 1. Analysis of variance for combining ability for various yield traits in brinjal.

Source of variation	Degree of freedom	Mean sum of square							
		Plant height	No. of primary branches	Fruit length	Fruit breadth	Fruit set percent	Fruit weight	No. of fruits	Yield (q/ha)
GCA	6	175.44**	1.86**	2.46	2.03**	349.52**	1457.45**	15.18**	19968.83**
SCA	21	173.60**	1.06**	5.74**	0.76**	118.64**	241.95**	7.49**	8659.64**
Error	96	5.47	0.27	1.13	0.11	1.28	2.19	1.16	4.07

* , ** Significant at 0.05 and 0.01 levels, respectively.

Table 2. Estimates of general combining ability for various yield traits in brinjal.

Parent	Plant height	No. of primary branches	Fruit length	Fruit breadth	Percent Fruit set	Fruit weight	No. of fruits	Yield (q/ha)
RCMB-10	3.69**	0.82**	-0.23*	-0.17**	7.81**	8.44**	0.75**	57.29**
RCMB-7	-3.07**	-0.26**	1.11**	-0.29**	5.34**	-9.02**	1.22**	-3.04**
RCMB-4	-3.49**	-0.07**	-0.16	-0.15**	-8.12**	-3.42**	-2.00**	-80.24**
RCMB-3	2.65**	0.12**	-0.32**	-0.31**	2.94**	-14.36**	1.19**	-13.04**
RCMB-1	-6.31**	-0.69**	-0.11	-0.45**	2.94**	-8.54**	0.76**	-7.80**
BB-40	0.64	0.00	-0.43**	0.67**	-6.04**	4.33**	-1.30**	-10.17**
BB-64	5.88**	0.09**	0.15	0.69**	-4.88**	22.57**	-0.63**	56.99**
SE(g_i)	0.52	0.02	0.10	0.01	0.12	0.20	0.11	0.39
SE (g_i-g_j)	1.21	0.06	0.25	0.02	0.28	0.48	0.25	0.91

* , ** Significant at 0.05 and 0.01 levels, respectively.

of gca effects exhibited that the parent RCMB-10 and BB-64 were the best general combiners for major yield contributing characters *viz.*, plant height, number of branches, fruit weight and yield (q/ha). However, RCMB-10 and BB-64 were also recorded highest gca effects for fruit set (7.81) and fruit breadth (0.69), respectively *vis-a-vis* parent RCMB-7 showed the highest gca effect for fruit length (1.11) and number of fruits (1.22). In present investigation, it was observed that the parents which showed high gca effects for different characters also exhibited good performance with respect to other characters, which has earlier been observed by Singh *et al.* (8), Kumar *et al.* (4), and Chaudhary and Malhotra (1) in brinjal.

The estimates of sca effects (Table 3) revealed that the crosses RCMB-3 x BB-64 for plant height (23.08), number of branches (1.94) and number of fruits (7.26); RCMB-10 x RCMB-4 for fruit breadth (1.26), fruit weight (27.84) and yield q/ha (169.76); RCMB-10 x RCMB-3 for percent fruit set (17.85) and RCMB-1 x BB-64 for fruit length (5.67) expressed the highest desirable sca effects. In present experimentation, it was observed that in cross combination, one of the parent was supeior 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 epistatis, which was also supported by Singh *et al.* (8).

The estimates of D, H_1, H_2, F and E parameters along with its components obtained from diallel analysis (Hayman, 3) are presented in Table 4. Significant value of additive component (D) and non-additive component (H_1 and H_2) observed for plant height, fruit breadth, percent fruit set, fruit weight and yield (q/ha) indicated involvement of both additive and non-additive gene action for the expression of these characters. Involvement of additive and non-additive gene action in brinjal was also reported by Vagashiya *et al.* (9) for fruit weight, and Kumar *et al.* (4) for fruit breadth and yield, are in consonance with our present findings. However, non-additive effects (dominance component) were significantly higher than its additive component (D) for plant height, fruit breadth, percent fruit set, fruit weight and yield (q/ha). This suggests the preponderance of non-additive (dominance) genetic variation in the expression of these characters. Earlier, preponderance of non-additive gene action in brinjal has also been reported by Vagashiya *et al.* (9) and Patel *et al.* (7) for plant height, fruit breadth and yield; Padmanabham and Jagdish (5) and Chaudhary and Malhotra (1) for yield; which are in agreement with our findings. The mean degree of dominance $(H_1/D)^{1/2}$ was

Table 3. Estimates of specific combining ability for various yield traits in brinjal.

Cross	Plant height	No. of primary branches	Fruit length	Fruit breadth	Fruit set percent	Fruit weight	No. of fruits	Yield
RCMB-10 x RCMB-7	-13.84**	0.13	-1.38	-0.53**	-6.13**	-13.02**	-0.18	-49.57**
RCMB-10 x RCMB-4	4.41	1.66**	0.10	1.26**	1.28	27.84**	1.73	169.79**
RCMB-10 x RCMB-3	-6.55	0.16	-2.54**	-0.86**	17.85**	-14.52**	1.41	-36.02**
RCMB-10 x RCMB-1	4.73	0.93**	-0.78	0.88**	6.41**	17.45**	0.76	99.44**
RCMB-10 x BB-40	16.32**	1.48**	-0.93	0.37**	-5.66**	2.28	0.35	10.90**
RCMB-10 x BB-64	18.68**	0.43	-2.21*	-1.82**	-13.62**	2.97	-1.76	-48.05**
RCMB-7 x RCMB-4	17.24**	1.03**	0.75	-0.03	9.06**	6.52**	0.07	55.74**
RCMB-7 x RCMB-3	1.77	-0.18	1.92*	-0.14	17.77**	-6.65**	2.23*	1.35
RCMB-7 x RCMB-1	0.30	-0.27	1.90*	1.01**	8.00**	-9.07**	1.30	-11.40**
RCMB-7 x BB-40	-8.56	0.64**	-0.68	-0.50**	5.87**	10.17**	-3.05**	-49.45**
RCMB-7 x BB-64	8.38	0.27	-0.75	0.40**	-4.18**	-0.79	-3.35**	-86.83**
RCMB-4 x RCMB-3	-16.21**	-0.78**	-2.01*	-1.28**	9.56**	-14.23**	0.26	-17.59**
RCMB-4 x RCMB-1	22.41**	-0.26	-1.32	0.10	6.55**	20.43**	-2.54**	-29.06**
RCMB-4 x BB-40	5.30	0.49*	-1.40	-0.32**	-1.16	-22.89**	-1.30	68.25**
RCMB-4 x BB-64	-0.84	-0.78**	0.22	-0.11	-6.05**	-14.78**	-1.05	-117.40**
RCMB-3 x RCMB-1	-4.59	0.24	-4.06**	0.86**	0.75	-5.25**	-3.28**	-91.15**
RCMB-3 x BB-40	0.97	-0.28	3.56**	0.13	-2.40*	0.68	-3.36**	-84.56**
RCMB-3 x BB-64	23.08**	1.94**	0.08	-0.44**	-6.02**	-10.91**	7.26**	169.17**
RCMB-1 x BB-40	-8.26	-0.80**	0.47	-1.32**	7.50**	-14.75**	3.39**	22.65**
RCMB-1 x BB-64	-3.34	0.36	5.67**	-0.14	-1.36	20.29**	1.40	145.71**
BB-40 x BB-64	-11.89**	-0.62**	-2.21*	-0.11	5.54**	9.82**	2.48**	117.35**
SE (S_{ij})	4.407	0.220	0.914	0.091	1.037	1.771	0.939	3.281
SE (S_{ij}-S_{ik})	9.727	0.485	2.017	0.203	2.289	3.909	2.072	7.242
SE (S_{ij}-S_{kl})	8.511	0.425	1.765	0.177	2.003	3.420	1.813	6.337

* , ** Significant at 0.05 and 0.01 levels, respectively.

Table 4. Components of genetic variation in a 7 x 7 diallel set of brinjal.

Genetic component	Plant height	No. of primary branches	Fruit length	Fruit breadth	Fruit set percent	Fruit weight	No. of fruits	Yield
D	110.91**	-0.09	1.10	2.09**	183.07*	537.88*	5.45	6095.75**
F	125.27	-0.52	3.78	2.04*	186.88	91.76	1.72	1362.25
H_1	701.20**	3.48**	22.22*	3.04**	541.04**	1127.44*	29.24	37989.25**
h^2	258.84**	3.45**	2.77	0.65	261.38*	6.53	0.25	1123.52
H_2	597.49**	2.78**	17.98*	2.45*	347.28*	828.98	25.50	31645.64**
E	5.47	0.27*	1.13	0.11	1.29	2.20	1.17	4.07
$(H_1/D)^{1/2}$	2.51	0.00	4.50	1.20	1.72	1.45	2.32	2.50
$H_2/4H_1$	0.21	0.20	0.20	0.20	0.16	0.18	0.22	0.21
KD/KR	1.58	0.37	7.56	2.36	1.84	1.13	1.15	1.09
h^2/H_2	0.43	1.24	0.15	0.27	0.75	0.008	0.009	0.036
Heritability (Narrow sense)	15.64	-1.75	4.55	58.92	33.75	33.99	14.49	14.26

* , ** Significant at 0.05 and 0.01 levels respectively.

more than unity for all the characters studied except number of branches which indicated over dominance for these characters. Whereas, $(H_1/D)^{1/2}$ value for number of branches recorded equal to zero which exhibited no dominance for this character. The ratio of $H_2/4H_1$, which was less than 0.25 in all the characters indicated asymmetrical distribution of positive and negative genes in the parents. The value of KD/KR was higher than the unity for all the characters except number of branches indicating presence of greater proportion of dominant gene in the expression of these traits. Whereas, for number of branches KD/KR value recorded less than unity, indicating presence of greater proportion of recessive genes. This result is also supported with the findings of Panda *et al.* (6).

On the basis of above results it is concluded that most of the yield traits *viz*., plant height, fruit breadth, percent fruit set , fruit weight and yield (q/ha) is governed by both additive and non-additive genes but later is predominant suggesting that bidirectional recurrent selection could be adopted for the improvement of these traits, *vis-a vis* additive gene action was found prominent for the expression of the character fruit length indicating simple selection could be effective for bringing improvement of this traits in brinjal.

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