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COMBINING ABILITY OF EGGPLANT (*Solanum melongena* L.) GENOTYPES FOR YIELD AND YIELD COMPONENTS DURING SUMMER

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Abstract

Combining ability in eight eggplant genotypes were crossed and studied at Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh during March 2007 to September 2008. Eggplant genotypes were crossed and evaluated for yield and yield contributing characters. Considering general combining ability (GCA) effects, the parents P_1, P_2 and P_6 were better general combiner for number of fruits plant^{-1} and yield plant^{-1}; P_3, P_5 and P_8 for fruit weight; P_4 for fruit length and P_3 and P_8 for fruit breadth and P_1, P_6, P_2 and P_7 for yield plant^{-1}. Considering specific combining ability (SCA) effects, the crosses $P_5\times P_7$ were important for fruit length, fruit weight, number of fruits and yield plant^{-1}; $P_5 \times P_8$ for fruit breadth, fruit weight, and yield plant-1; $P_1\times P_6$ and $P_2\times P_7$ for fruit breadth, number of fruit and yield plant^{-1}; $P_1\times P_6$, $P_2\times P_7$, $P_4\times P_7$ and $P_5\times P_7$ for number of fruits and yield plant^{-1}. Therefore, the parents P_1, P_6, P_2 and P_3, P_5 and P_8 could be considered as better parents for higher yield and the crosses $P_1\times P_6$, $P_5\times P_7$, $P_2\times P_7$, $P_2\times P_4$, $P_4\times P_7$, $P_4\times P_8$, $P_3\times P_8$ and $P_5\times P_8$ could be considered as promising hybrids for getting higher yield for summer cultivation in Bangladesh.

Keywords: combining ability, eggplant, yield, summer

Introduction

Eggplant (*Solanum melongena* L.) is one of the most important vegetable crops which can contribute substantially during lean period of Bangladesh. Fruit size and individual fruit weight, and fruit weight plant^{-1} are the main yield contributing characters in eggplant and higher yield contributes to the economic value as well. The variety and yield of eggplant during summer is scanty in Bangladesh and the yield of the fruits varies from place to place and season to season. It is therefore, required to improve the locally preferred cultivars with certain fruit characters along with high yield and adaptation in diverse climatic conditions. For the development of an effective breeding program in eggplant, a breeder need to have information about genetic architecture and combining ability effect of different genotypes. Combining ability is one of the important and powerful tools in identifying the best combiner that may be used in crosses to exploit heterosis; it also helps to know the genetic architecture of various characters that enable the breeder to design effective breeding plan for future improvement of the existing materials. Although eggplant is a major vegetable in Bangladesh, an organized and systematic attention has not been given so far for its improvement from a breeding point of view, particularly for summer production. Study on combining ability effects were carried out in eggplant by various workers at different places (Singh *et al.* 1991; Das and Baruha, 2001; Singh *et al.* 2002 and 2003, Singh and Maurya, 2003 and 2004; Panda *et al.* 2004; Bao *et al.* 2004; Biradar *et al.* 2005; Rai *et al.* 2005; Suneetha *et al.* 2005). There is little information in this regard during winter studied by Rashid *et al.* 1988; Saha *et al.* 1992; Rahman, 2003 in Bangladesh, but information during hot humid condition is meager. Considering the above facts, eight diverse parents were taken in this investigation to estimate the combining ability effects in eggplant for yield and yield contributing characters.

Materials and Methods

The present study was carried out at the experimental field of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh during March 2007 to September 2008. Eight parents and 28 F_1 hybrids produced from those parents were used as plant materials for the study. The salient features of the eight selected parental genotypes are presented in Table 1.

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Table 1. Salient features of eight selected heat tolerant parental eggplant genotypes

Genotype	Identity	Place of collection	Parent symbol	Main features/Characteristics
SM001	BARI Begun-4 (Kazla)	HRC, BARI	P_1	Fruit is long, slight curved and deep purple uniform color. Plant height is medium with prostrate growth habit and moderately spreading purplish look. Flower light violet color with early flowering habit. Fruit position on the plant is pendant. Average fruit weight is 26.01g, number of fruit plant^{-1} is 32.17 and yield plant^{-1} is 828.85 g
SM002	Bottle	Tangail	P_2	Fruit is oblong, straight and purple uniform color. Plant is medium height with prostrate growth habit and moderately spreading purplish look. Flower light violet color. Fruit position on the plant is pendant. Average fruit weight is 26.38 g, fruits plant^{-1} is 31.93 and yield plant^{-1} is 865.47 g
SM004	BARI Begun-6	HRC, BARI	P_3	Fruit is oval, straight and light green uniform color. Plant height is medium with intermediate growth habit and moderately spreading with purplish green look. Flower bluish violet color. Fruit position on the plant is semi-pendant. Average fruit weight is 121.56 g, number of fruit plant-1 is 2.99 and yield plant^{-1} is 359.55 g
SM006	BARI Begun-8	HRC, BARI	P_4	Fruit is long, snaked shaped and deep purple uniform color. Plant height is high with intermediate growth habit and moderately spreading greenish purplish look. Flower bluish violet color. Fruit position on the plant is pendant. Average fruit weight is 48.65 g, number of fruit plant-1 is 7.01 and yield plant^{-1} is 341.03 g
SM024	D 68	PGRC, BARI	P_5	Fruit is oblong, slight curved and green stripe color. Plant growth habit is upright in nature. Plant is high with moderately spreading with light green look. Flower bluish violet color. Fruit position on the plant is semi-pendant. Individual fruit weight is 68.42 g, number of fruit plant^{-1} is 5.66 and yield plant^{-1} is 386.80 g
SM034	D 79	PGRC, BARI	P_6	Fruit is oblong, straight/slight curved and purplish grey color (light stripe). Plant growth habit is intermediate in nature. Plant is high with moderately spreading with light green look. Flower bluish violet color. Fruit position on the plant is pendant. Average fruit weight is 40.77 g, number of fruit plant-1 is 16.24 and yield plant^{-1} is 661.12 g
SM057	BD2840	PGRC, BARI	P_7	Fruit is round, straight and pale green mottle color. Plant growth habit is prostrate in nature. Plant is dwarf with low spreading purplish look. Flower bluish violet color. Fruit position on the plant is pendant. Average fruit weight is 52.23 g, number of fruit plant-1 is 10.10 and yield plant^{-1} is 526.11 g
SM067	Satkhira Local	Jessore	P_8	Fruit is round, straight and light green uniform color. Plant growth habit is intermediate in nature. Plant is medium high with moderately spreading light green look. Flower bluish violet color. Fruit position on the plant is semi-pendant. Very few to few prickles presence on both calyx and pedicel of both flower and fruit. Average fruit weight is 130.80 g, number of fruit plant-1 is 3.97 and yield plant^{-1} is 512.00 g

The selected eight parental genotypes were grown in summer 2007 for crossing in a half diallel fashion. For effective pollination and fertilization, the flower buds which just changed their color from green to purplish white and about to bloom next day were selected. Emasculation and pollination were done in the same day from 7.30-11.00 a.m. The pollinated flowers were bagged with butter paper and tagged along with necessary information. After complete maturity, some fruits from eight selfed parents and 28 F_1 crosses were harvested for obtaining the parental and F_1 hybrid seeds. Then the seeds of parents and F_1s were collected, air dried and preserved in desiccators with proper label and used for the study in the next season. Twenty eight F_1 hybrids along with their selected eight parental lines were grown for studying the combining ability. Seeds were sown on the tray on 14 March 2008 and after necessary hardening, the seedlings were transplanted in the main field on 20 April 2008. The experiment was laid out in a randomized complete block design with 3 replications. Ten seedlings were planted in a unit plot with a plant spacing of 70 cm apart in single row maintaining 50 cm drain between the plots. Observations were made on yield and yield contributing characters viz. days to 1st fruit harvesting, fruit length, fruit diameter, individual fruit weight, number of fruits plant^{-1} and yield plant^{-1}. The collected data were subjected to combining ability analysis following Model I and Method 2 (half diallel fashion) of Griffing (1956a). Griffing's analysis (Griffing, 1956b) was intended to determine the performance of the parents and their relative contribution to the F_1's as determined by general and specific combining ability (GCA and SCA) effects. The calculation of combining ability was performed from the following formula:

Xijk = μ+gi+gj+sij+eijk; where, Xijk is the genotype score, μ is the overall mean of the experiment, so that all other scores are expressed as deviations from this mean, gi is the GCA effects of the ith parent, gi is the GCA effects of the jth parent, sij SCA of the hybrid, eijk is the error deviation of the particular plot.

For the calculation of GCA of the parents and SCA of the hybrids, the mean was calculated over blocks and GCA and SCA were estimated from the means. Each column (or row) represented entries with one parent in common and crossed to all other parents including self. This column was referred to as an array. The GCA of any parent was estimated as the difference between its array mean and the overall mean.

Similarly, SCAs of the hybrids was also calculated as:

Sij= X-(μ+gi+gj); where, X is the score of the hybrid between the ith and jth parents and the other terms are defined as above.

Results and Discussion

Fruit length

Among the parents the highest positive and significant GCA effect was exposed in P_4 (52.45**) for fruit length (Table 2). Other parent like P_1 (3.05) and P_5 (2.09) also exhibited positive GCA effects but not significant. On the other hand, the highest significant negative GCA effect was found in other genotypes. Therefore, the parent P_4 was the best general combiner for fruit length in eggplant. Rahman (2003) also reported some good general combiners for fruit length in eggplant.

Table 2. Estimates of combining ability effects for fruit length in eggplant during summer

Parents	SCA							GCA
	P_2	P_3	P_4	P_5	P_6	P_7	P_8	
P_1	10.15	-5.84	11.49	-1.35	-2.04	12.53*	-22.27**	3.05
P_2		-0.29	13.75*	-7.66	12.44	2.08	-23.28**	-16.21**
P_3			5.16	3.52	4.75	0.31	6.02	-6.62**
P_4				-5.54	24.68**	-26.63**	-5.66	52.45**
P_5					-5.85	19.31**	2.53	2.09
P_6						-6.65	14.92*	-3.14
P_7							9.24	-19.83**
P_8								-11.79**
SE (Sij)				6.28				
SE (Gi)								2.35
CD (.05)				12.43				4.66
CD (.01)				16.44				6.17

** Significant at 5% and ** Significant at 1% level of probability*

The highest significant positive SCA effect was obtained from the cross $P_4 \times P_6$ (24.68**) followed by $P_5 \times P_7$ (19.31**), $P_6 \times P_8$ (14.92**) and $P_2 \times P_4$ (13.75**), $P_1 \times P_7$ (12.53**) indicated the heterotic performance of fruit length over the mean of their parents. Nevertheless, the highest negative significant SCA effects was observed in cross combinations $P_4 \times P_7$ (-26.63**) followed by $P_1 \times P_8$ (-22.27**), represents the decreasing of fruit length over the mean of their parents (Table 2). Ingale and Patil (1997) and Rahman (2003) also reported hybrid performance in some crosses in eggplant.

Fruit breadth

Among the parents, the highest positive and significant GCA effect was obtained from P_8 (15.81**) followed by P_3 (15.39**) whereas non-significant positive GCA effect was observed in P_7 (0.47). Whilst, the highest significant negative GCA effect was found in P_5 (-11.46**) followed by P_1 (-10.21**), P_6 (-7.50**) (Table 3). Therefore, the parent P_8 and P_3 were the best general combiner for fruit breadth in eggplant. Rahman (2003) also reported some good general combiners for fruit breadth in eggplant.

Among the crosses, 16 crosses showed positive SCA values. Among these the highest significant positive SCA effect was found in the cross $P_2 \times P_3$ (10.32**) followed by $P_4 \times P_6$ (8.65**), $P_7 \times P_8$ ((8.10**), $P_5 \times P_8$ (6.81**), $P_2 \times P_7$ (6.72**), $P_1 \times P_6$ (6.34**), and $P_3 \times P_6$ (5.22**) indicating the heterotic performance of fruit breadth over the mean of their parents. In contrast, the highest negative significant SCA effects was observed in the cross combinations $P_2 \times P_8$ (-28.25**) followed by $P_3 \times P_4$ (-10.26**), $P_5 \times P_6$ (-7.39**) $P_1 \times P_8$ (-12.04**), indicating the decreasing of fruit breadth over the mean of their parents (Table 3). Prakash *et al.* (1994); Prasath *et al*. (2000) and Rahman (2003) also reported a good specific combination for fruit diameter in eggplant which corroborated the present findings.

Table 3. Estimates of combining ability effects for fruit breadth in eggplant during summer

Parents	SCA							GCA
	P_2	**P_3**	**P_4**	**P_5**	**P_6**	**P_7**	**P_8**	
P_1	1.92	3.36	1.05	-3.77	6.34*	1.35	-12.04**	-10.21**
P_2		10.32**	3.94	-0.03	-3.59	6.72**	-28.25**	-1.52
P_3			-10.26**	-3.94	5.22*	-2.04	0.25	15.39**
P_4				2.34	8.65**	-3.50	2.58	-11.46**
P_5					-7.39**	4.32	6.81**	-0.97
P_6						-3.50	-2.21	-7.50**
P_7							8.10**	0.47
P_8								15.81**
SE (Sij)					2.42			
SE (Gi)								0.91
CD (.05)					4.80			1.80
CD (.01)					6.35			2.38

** Significant at 5% and ** Significant at 1% level of probability*

Fruit weight

Among the parents the highest positive and significant GCA effect was exposed in P_8 (37.50**) followed by P_3 (25.13**) and P_5 (8.17**) for individual fruit weight. On the other hand, the highest significant negative GCA effect was performed by the parent P_1 (-26.78**) followed by P_2 (-24.71**) (Table 4). Therefore, the parent P_8 was the best general combiner followed by P_3 and P_5 for fruit weight in eggplant. These three parents could be used for improvement of fruit weight. Rahman (2003) also reported some good general combiners for fruit weight in eggplant.

Table 4. Estimates of combining ability effects for fruit weight in eggplant during summer

Parents	SCA							GCA
	P_2	**P_3**	**P_4**	**P_5**	**P_6**	**P_7**	**P_8**	
P_1	11.43**	-43.29**	10.36**	-12.99**	1.60*	23.96**	-8.24**	-26.78**
P_2		-36.52**	18.8**	2.65**	20.71**	0.03	-54.84**	-24.71**
P_3			-20.72**	6.85**	26.59**	-16.22**	29.91**	25.13**
P_4				1.13	11.79**	-6.85**	-4.66**	-11.11**
P_5					-17.25**	7.45**	18.31**	8.17**
P_6						-13.00**	-11.88**	-6.92**
P_7							-8.92**	-1.28**
P_8								37.50**
SE (Sij)				0.67				
SE (Gi)								0.25
CD (.05)				1.34				0.50
CD (.01)				1.78				0.67

** Significant at 5% and ** Significant at 1% level of probability*

Eighteen crosses showed positive SCA values for fruit weight. Among them the highest significant positive SCA effect was observed in the cross $P_3 \times P_8$ (29.91**) followed by $P_3 \times P_6$ (26.59**), $P_1 \times P_7$ (23.96**), $P_2 \times P_6$ (20.71**), $P_2 \times P_4$ (18.80**), $P_5 \times P_8$ ((18.31**), $P_4 \times P_6$ (11.79**), $P_1 \times P_2$ (11.43**), $P_1 \times P_4$ (10.36**) $P_5 \times P_7$ (7.45**), $P_3 \times P_5$ (6.85**) and $P_2 \times P_5$ (2.65**), representing the heterotic performance of fruit weight over the mean of their parents. On the contrary, the highest negative significant SCA effects was provided by the cross combinations $P_2 \times P_8$ (-54.84**) followed by $P_1 \times P_3$ (-43.29**) and $P_2 \times P_3$ (-36.52**), indicating the decreasing of fruit weight over the mean of their parents (Table 4). Hence, the crosses $P_3 \times P_8$, $P_3 \times P_6$, $P_1 \times P_7$, $P_2 \times P_6$, and $P_5 \times P_8$, $P_2 \times P_4$, $P_4 \times P_6$, $P_1 \times P_2$ and $P_1 \times P_4$ could be selected for improvement of fruit weight (Table 4). Prasath *et al*. (2000) and Rahman (2003) also reported some hybrid as good specific combiner for fruit weight in eggplant.

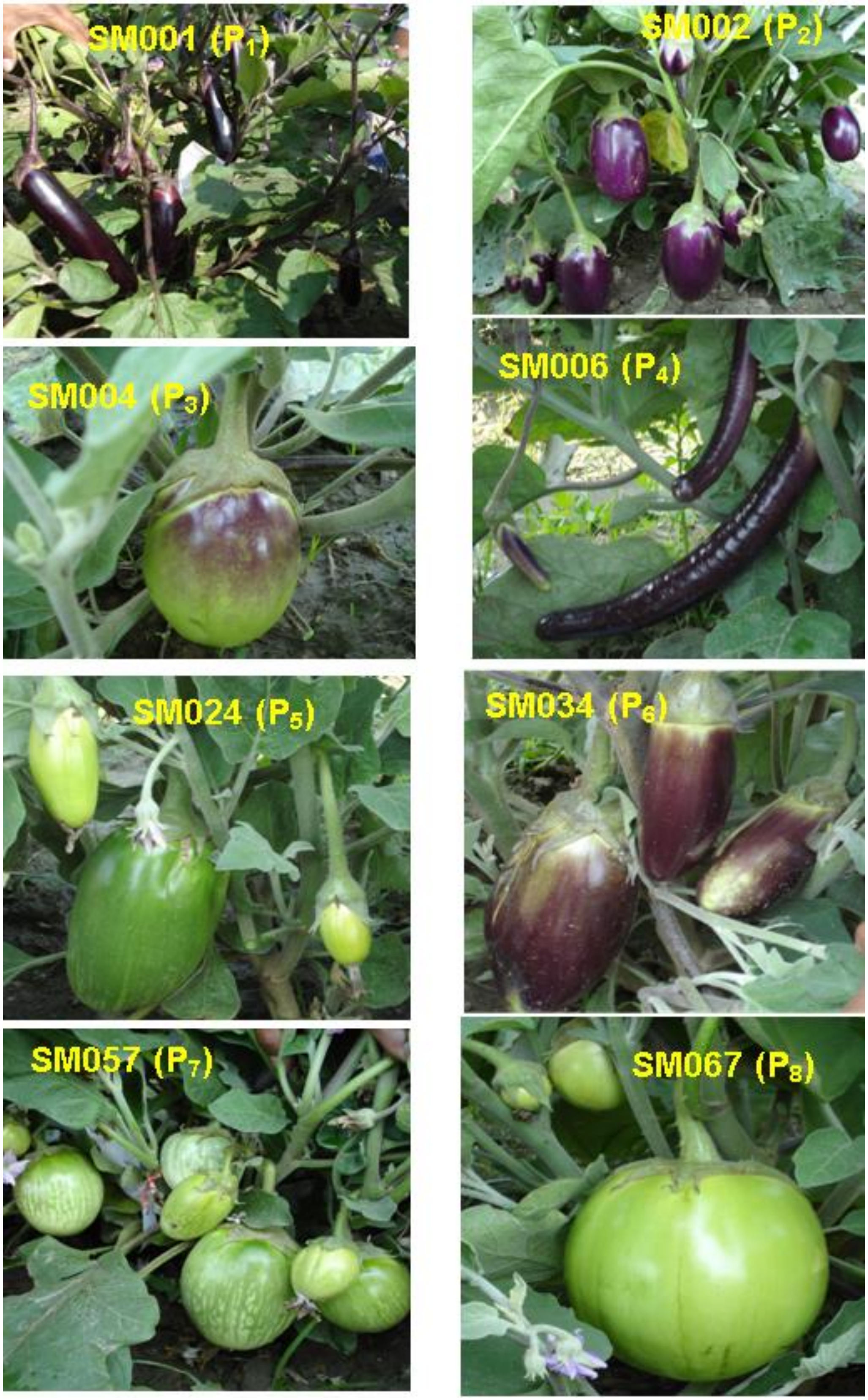

Fig. Fruit bearing plants of 8 (eight) selected eggplant genotypes for summer

Number of fruits plant^{-1}

Among the parents the highest positive and significant GCA effect was exposed in P_1 (11.25**) followed by P_2 (4.59**) and P_6 (2.01**) for number of fruits plant^{-1}. While, the highest significant negative GCA effect was provided by the parent P_5 (-5.37**) followed by P_8 and P_3 (-4.78** and -4.52** respectively) (Table 5). Therefore, the parent P_1 was the best general combiner followed by P_2 and P_6 for promoting the number of fruits plant^{-1} in eggplant. These three parents could be used for improvement of number of fruits plant^{-1}. Kumar *et al*. (1996) and Rahman (2003) also reported some good general combiners for number of fruits plant^{-1} in eggplant.

Table 5. Estimates of combining ability effects for fruits plant^{-1} in eggplant during summer

Parents	SCA							GCA
	P_2	P_3	P_4	P_5	P_6	P_7	P_8	
P_1	-0.23	4.76**	-4.14**	-7.22**	37.44**	-11.30**	-8.70**	11.25**
P_2		6.43**	2.28**	-0.72**	-13.11**	7.04**	6.61**	4.59**
P_3			-0.70*	0.11	-3.50**	-2.92**	0.40	-4.52**
P_4				1.82**	-1.88**	7.25**	2.25**	-2.09**
P_5					-0.82**	3.93**	2.36**	-5.37**
P_6						-4.28**	0.42	2.01**
P_7							-1.82**	-1.07**
P_8								-4.78**
SE (Sij)				0.27				
SE (Gi)								0.10
CD (.05)				0.54				0.20
CD (.01)				0.71				0.27

** Significant at 5% and ** Significant at 1% level of probability*

Among the crosses 14 showed positive SCA values for number of fruits plant^{-1}. Among these the highest significant positive SCA effect was exposed in the cross $P_1 \times P_6$ (37.44**) followed by $P_4 \times P_7$ (7.25**), $P_2 \times P_7$ (7.04**), $P_2 \times P_8$ (6.61**), $P_2 \times P_3$ (6.43**), $P_1 \times P_3$ (4.76**) $P_5 \times P_7$ (3.93**), $P_5 \times P_8$ (2.36**), $P_2 \times P_4$ (2.28**), $P_4 \times P_8$ (2.25**) and $P_4 \times P_5$ (1.82**), indicating that these crosses produced more number of fruits plant^{-1} than the means of their parents. Where as, the highest negative significant SCA effects was observed in $P_2 \times P_6$ (-13.11**) followed by $P_1 \times P_7$ (-11.30**) and $P_1 \times P_7$ (-8.70**), which represents the decreasing of number of fruit plant^{-1} over the mean of their parents. Thus, the crosses $P_1 \times P_6$, $P_4 \times P_7$, $P_2 \times P_7$, $P_2 \times P_8$, $P_2 \times P_3$, $P_1 \times P_3$ and $P_5 \times P_7$ could be used for improvement of number of fruits plant^{-1} (Table 5). Rahman (2003) also reported some superior hybrids as good specific combination for number of fruits plant^{-1} in eggplant.

Yield plant^{-1}

From Table 6 it was clear that among the parents the highest positive and significant GCA effect was exposed by P_1 (327.75**) followed by P_6 (129.09**), P_2 (88.70**) and P_7 (28.50**) for fruit yield plant^{-1}. Though, the highest significant negative GCA effect was provided by the parent P_5 (-221.37**) followed by P_3 (-201.58**), P4 (-94.81**) and P_8 (-56.29**). Therefore, the parent P_1 was the best general combiner followed by P_6, P_2 and P_7 for promoting the yield of fruit plant^{-1} in eggplant. These three parents could be used for improvement of fruit yield plant^{-1}. Several workers also reported some good general combiners for fruit yield plant^{-1} in eggplant (Chadha and Hedge, 1989; Rahman, 2003).

Table 6. Estimates of combining ability effects for yield plant^{-1} in eggplant during summer

Parents	SCA							GCA
	P_2	P_3	P_4	P_5	P_6	P_7	P_8	
P_1	-73.91**	-76.10**	-94.78**	-359.98**	1843.45**	-257.85**	-183.74**	327.75**
P_2		158.45**	323.22**	19.29	-582.80**	356.19**	-108.21**	88.70**
P_3			-98.39**	-8.57	160.70**	78.19**	201.93**	-201.58**
P_4				84.27**	-24.76	300.62**	208.40**	-94.81**
P_5					-155.80**	387.33**	251.52**	-221.37**
P_6						-404.39**	186.36**	129.09**
P_7							-195.21**	28.50**
P_8								-56.29**
SE (Sij)				12.76				
SE (Gi)								4.78
CD (.05)				25.52				9.56
CD (.01)				33.93				12.61

** Significant at 5% and ** Significant at 1% level of probability*

Among twenty eight crosses 14 showed positive SCA values. Among these the highest significant positive SCA effect was shown by the cross $P_1 \times P_6$ (1843.45**) followed by $P_5 \times P_7$ (387.33**), $P_2 \times P_7$ (356.19**), $P_2 \times P_4$ (323.22**), $P_4 \times P_7$ (300.62*), $P_5 \times P_8$ (251.52**), $P_4 \times P_8$ (208.40**), $P_3 \times P_8$ (201.93**), $P_6 \times P_8$ (186.36**), $P_3 \times P_6$ (160.70**), $P_2 \times P_3$ (158.45**), $P_4 \times P_5$ (84.27**) and $P_3 \times P_7$ (78.19**) indicating that these crosses produced more fruit yield plant^{-1} than the means of their parents. However, the highest negative significant SCA effects was exposed by the cross combinations $P_2 \times P_6$ (-582.80**) followed by $P_6 \times P_7$ (-404.39**), representing the decreasing of fruit yield plant^{-1} over the mean of their parents (Table 6). Thus, the crosses $P_1 \times P_6$, $P_5 \times P_7$, $P_2 \times P_7$, $P_2 \times P_4$, $P_4 \times P_7$, $P_5 \times P_8$ $P_4 \times P_8$, $P_3 \times P_8$, $P_6 \times P_8$ and $P_3 \times P_6$ could be used for improvement of fruit yield plant^{-1}. The present finding was supported by Chadha and Hedge (1989) and Rahman (2003).

Considering general combining ability effects, the parents P_3, P_5 and P_8 were considered as better general combiner for fruit weight; P_1, P_2, P_6 for number of fruits plant^{-1}; P_1, P_6, P_2 and P_7 for yield plant^{-1}. Considering specific combining ability effects, the crosses $P_1 \times P_6$, $P_5 \times P_7$, $P_2 \times P_7$, $P_2 \times P_4$, $P_4 \times P_7$, $P_4 \times P_8$, $P_3 \times P_8$ and $P_5 \times P_8$ were better hybrids for improving yield plant^{-1} in eggplant. Therefore, the parents P_1, P_6, P_2 and P_3, P_5 and P_8 could be considered as better parents for higher yield and the crosses $P_1 \times P_6$, $P_5 \times P_7$, $P_2 \times P_7$, $P_2 \times P_4$, $P_4 \times P_7$, $P_4 \times P_8$, $P_3 \times P_8$, $P_5 \times P_8$ could be considered as promising hybrids for getting higher yield for summer season cultivation in Bangladesh.

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