Indian J. Hort. 67(1), March 2010: 50-55

Combining ability for yield and its contributing characters in tomato

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ABSTRACT

The experiment was conducted with 45 F_1s and F_2s developed through diallel technique excluding reciprocals along with ten parents namely, Pant Bahar, Punjab Chhuhara, Pusa Ruby, Pusa Gaurav, Azad Type-2, Azad Type-3, Kalyanpur Type-1, Angoorlata, KS-16 and KS-29 in randomized block design (RBD) with three replications. The study revealed that the significant general combining ability effects were shown by parents KS-29, Pant Bahar and Kalyanpur Type-1 and they were good general combiners for fruits yield in both the generations. Most of the crosses showed high sca effects for fruit yield in both the F_1 and F_2 generations. Crosses KS-16 x KS-29, Kalyanpur Type-1 x KS-29 and Pant Bahar x KS-16 were found to be the best specific combiners for fruit yield. In F_1 and F_2 generations, for fruit yield/plant (kg), the best specific combiners was KS-29 (6.30) followed by Angoorlata (4.29), Pant Bahar (3.79) and Kalyanpur Type-1 (2.37) and KS-29 (4.66) followed by Angoorlata (4.32), Pant Bahar (3.19), Kalyanpur Type-1 (2.35) and Pusa Ruby (2.26). Specific combining ability (sca) effects for fruit yield/plant of crosses in F_1 generation were significant in 35 of the crosses with the range from 14.71 to 17.13.

Key words: Tomato, diallel cross, combining ability, yield.

INTRODUCTION

India ranks second after China in world for vegetable production contributing 13.4% of total world production. In India, tomato has wider coverage in comparison to other vegetables. Tomato universally treated as "protective food", is being extensively grown as annual plant all over the world. It is a very good source of income of small and marginal farmers and contributes to the nutrition of the consumers. Tomato is used directly as raw vegetable in the sandwiches, juice, soup, salad *etc*. (Joshi and Kohli, 7). Tomato is very good appetizer and its soup is said to be a good remedy for patients suffering from constipation. The study of combining ability would help in selection of superior parents for hybridization. Combining ability of a strain to produce average performance of a genotype in a series of hybrid combinations as the performance of a parent in a specific cross in relation to general combining ability produce superior progeny upon hybridization with other strain is termed as the specific combining ability and as general combining ability respectively (Dessalegue and Caligari, 3; Hederson, 6). Furthermore, it was concluded that gca is primarily due to additive effects of genes, while sca is a consequence of interallelic interaction (epistasis) and interaction (dominance).

MATERIALS AND METHODS

The present experiment was conduced during the *rabi* seasons of 2005-2006 at Research Farm of G.M.V. Rampur Maniharan, Saharanpur. All 45 F_1s and F_2s along with ten parents were sown in randomized block design with three replications. Ten parents *viz*., Pant Bahar, Panjab Chhuhara, Pusa Ruby, Pusa Gaurav, Azad Type 2, Azad Type-3, Kalyanpur Type-1, Angoorlata, KS-16 and KS-29 were crossed in a diallel technique excluding reciprocals. Parents and F_1s were shown in single rows while F_2s in the double rows with twenty parents in each row. The rows were 5 m long and spaced 50 cm apart. The plant to plant spacing was maintained at 50 cm. The observations were recorded on randomly selected 10 plants in each parent and F_1 and 20 plants in each F_2 populations from each replication. The observations like days to flowering, days to maturity, plant height (cm), length of fruit (cm), width of fruit (cm), No. of primary branches/plant, No. of fruits/plant, biological yield/plant (kg), harvest index (%) and fruit yield/plant (kg) were recorded. The data was analysed for combining ability using gca and sca.

RESULTS AND DISCUSSION

The magnitude of gca variance was mostly higher than sca variance for all the characters in both the generations except the fruit width and harvest index in F_1 diallel (Table 1). The analysis of variance for combining ability revealed that general combining ability (gca) and specific combining ability (sca) variance were highly significant for all the characters except harvest index in F_1 for gca and F_2 for sca indicating thus the importance of both additive as well as the non-additive genetic variance in the expression of these characters. The magnitude of the ratio of gca/sca was less than

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Table 1. Best parents, best crosses and relationship between sca and gca effects of different crosses for different traits in tomato.

Trait	gca effect		*Per se* performance	Common parents on the basis of gca effects in F_1, F_2 and *per se* performance	Best crosses on the basis of mean		Best crosses on the basis of sca effects		gca effects of parents	
	F_1	F_2			F_1	F_2	F_1	F_2	F_1	F_2
Day to flowering	Pant Bahar Azad Type-3 Punjab Chhuhara Azad Type-2 Pusa Gaurav	Pant Bahar P. Chhuhara Angoorlata - -	Pant Bahar P. Chhuhara Angoortala - -	Pant Bahar P.Chhahara - - -	Pusa Guarav × Angoorlata Pusa Guarav × KS-16 P.Chhuhara × A.Type-3 Pant Bahar x Angoorlata Pant Bahar x A.Type-3	Pusa Ruby x K.Type-1 K.S.-16 x K.S.-29 P.Gaurav x A.Type-2 A.Type-2 x Angoorlata K.Type-1 x K.S.-16	A.Type-3 x K.S.-29 Pusa Ruby x A.Type-2 P.Gaurav x A.Type-2 P.chh. x Pusa Gaurav Pant Bahar x Pusa Ruby	A.Type-3 x K.S.-29 Pant Bahar x A.Type-2 Pusa Ruby x Angoorlata Pusa Gaurav x K.Type-1 Pant Bahar x Pusa Ruby	HxL LxH HxH HxH HxH	MxL HxM LxH MxM HxL
No. of fruits /plant	P. Chhuhara Azad Type-2 Azad Type-3 K.S.-29 Pant Bahar	Azad Type-3 Pant Bahar P. Chhuwar Azad Type-2 KS-29	Pant Bahar P. Chhuhara Azad Type-3 - -	Pant Bahar P.Chhawara Azad Type-3 - -	Pusa Ruby x A.Type-3 K.S.-16 x K.S.-29 Pant Bahar x K.S.-16 Pant Bahar x P.Gaurav Angoorlata x K.S.-16	Pant Bahar x P.Chhuwara P.chhuwara x K.Type-1 P.Chhuwara x K.S.-29 Pusa Gaurav x A.Type-2 P.Chhuhara x P.Gaurav	A.Type-2 x A.Type-3 Pusa Ruby x K.Type-1 Pusa Gaurav x K.S.-29 A.Type-3 x K.Type-1 K.Type-1 x K.S.-29	K.Type-1 x K.S.-29 Pusa Ruby x K.Type-1 Pant Bahar x K.S.-16 Pusa Ruby x Pusa gaurav Pusa Ruby x K.S.-16	LxH LxL HxL LxL LxL	LxH LxL HxL LxL LxL
Biological yield/plant	KS-29 Pant Bahar Angoorlata Kalyanpur Type-1	KS-29 - - - -	Pan Bahar P.Chhuhara K.S.-16 - -	- - - - -	A.Type-2 x Angoorlata A.Type-3 x Angoorlata Pusa Gaurav x A. Type-3 Pant Bahar x Pusa Gaurav -	Pant Bahar x K.S.-16 Pusa Gaurav x A.Type-2 Pusa Gaurav x K.Type-1 K.Type-1 x K.S.-16 P.Chhuhara x P.Gaurav	A.Type-3 x K.Type-1 K.S.-16 x K.S.29 Pusa Ruby x A.Type-3 K.Type-1 x K.S.-16 Pant Bahar x K.S.-16	K.Type-1 x Angoorlata Pant Bahar x K.S.-16 K.S.-16 x K.S.-29 Angoorlata x K.S.-29 Pusa Ruby x Azad Type-3	HxH HxL LxH HxH HxL	HxH HxL LxH HxH HxL
Fruit yield/plant	KS-29 Angoorlata Pant Bahar Kalyanpur Type-1	KS-29 Angoorlata Pant Bahar Kr Type 1 Pusa Ruby	Pant Bahar P. Chhuhara K.S.-29 - -	Pant Bahar K.S.-29 - - -	Pant Bahar x Pusa Gaurav A.Type-2 x A.Type-3 A.Type x K.S.-29 A.Type-2 x Angoorlata A.Type-3 x Angoorlata	Pusa Guarav x A. Type-2 Pusa Gaurav x K. Type-1 Pusa Gaurav x K.S.-16 K.Type-1 x K.S.-16 Pant Bahar x A.Type-2	K.S.-16 x K.S.-29 A.Type-2 x K.Type-1 Pant Bahar x K.S.-16 K.Type-1 x K.S.-16 Pusa Gaurav x K.S.-29	K.Type-1 x K.S.-29 Pant Bahar x K.S.-16 K.S.-16 x K.S.-29 Pusa Ruby x A.Type-3 K.Type-1 x Angoorlata	HxH HxL LxH HxH HxL	HxH HxL LxH HxH HxL
Days to maturity	Punjab Chhuhara Azad Type-2 Pant Bahar Azad Type-3	P. Chhuhara Azad Type-3 Pusa Gaurav - -	Azad Type-2 P.Chhuhara K.Type-1	P.Chhahara - - - -	Azad Type-3 x Angoorlata Azad Type- x K.S.-29 P.Chhuhara x A.Type-2 P.Chhuhara x P.Gaurav Pusa Ruby x K.S.-29	Pusa Ruby x K.Type-1 Pusa Gaurav x A.Type-3 K.Type-1 x Angoorlata A.Type-2 x Angoorlata Pusa gaurav x Angoorlata	P.Chhuhara x P.Gaurav Pant Bahar x A.Type-2 Pusa Ruby x Angoorlata Pant Bahar x A.Type-3 Azad Type-2 x Type-3	Pant Bahar x A.Type-3 P.Chhuhara x P.Gaurav Pusa Ruby x Angoorlata Pusa Ruby x Pusa Gaurav	HxH HxL LxL LxL -	LxM LxL LxL LxL -
Plant height	Azad Type-2 Punjab Chhuhara Pant Bahar Angoorlata -	Azad Type-2 P.Chhuhara Angoorlata Pant Bahar -	Pant Bahar P.Chhuhara Azad Type-2 Angoorlata -	Pant Bahar P.Chhuhara Azad Type-2 Angoorlata -	K.S.-16 x K.S.-29 Pant Bahar x Angoorlata Pusa Ruby x K.S.-29 P.Chhuhara x Pusa Ruby A.Type-2 x A.Type-3	Azad Type-2 x Angoorlata K.S.-16 x K.S.-29 K.Type-1x Angoorlata Pant Bahar x Pusa Gaurav Pant Bahar x P.Chhuhara	Azad Type-2 x K.S.-29 A.Type-2 x K.S.-16 P.Chhuhara x Angoorlata Pant Bahar x A.Type-3 A.Type-2 x A.Type-3	P.Chhuhara x K..S.-16 P.Chhuhara x Angoolata Azad Type-2 x K..S.-29 Pant Bahar x A.Type-3	HxL HxH HxL HxL HxL	HxL HxH HxL HxL HxH
Length of fruit	Kalyanpur Type-1 Pusa Ruby Pusa Gaurav K.S.-29	Pusa Gaurav Pant Bahar K. ype-1 K.S.-29 -	K.Type-1 K.S.-29 Pusa Gaurav Pusa Ruby -	K. Type-1 K.S-29 Pusa Gaurav - -	Pant Bahar x Pusa Gaurav A.Type-3 x K.S.-29 Pant Bahar x Pusa Ruby A.Type-2 x K.S.-29 A.Type-2 x K.Type-1	Angoorlata x K.S.-16 K.Type-1x K.S.-16 P.Gaurav x Angoorlata Pant Bahar x P.Gaurav Pant Bahar x P.Chhuhara	Pant Bahar x Angoorlata K.Type-1 x K.S.-29 K.Type-1 x K.S.-16 Pusa Ruby x K.S.-16 P.Gaurav x A.Type-3	K. Type-1 x K.S.-29 Pant Bahar x Angooralat Pusa Ruby x K.S.-16 K.Type-1 x K.S.-16 P.Gaurav x K.S.-29	HxH HxH HxL HxL HxH	HxL HxH HxL HxL HxL

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Trait	gca effect		*Per se* performance	Common parents on the basis of gca effects in F_1, F_2 and *per se* performance	Best crosses on the basis of mean		Best crosses on the basis of sca effects		gca effects of parents	
	F_1	F_2			F_1	F_2	F_1	F_2	F_1	F_2
Width of fruit/plant	K.S.-29	K.S.-29	K.S.-29	K.S.-29	A.Type-2 x K.S.-29	P.Chhuhara x K.Type-1	Pusa Ruby x A. Type-2	P.Gaurav x A.Type-2	HxL	HxL
	Kalyanpur Type-1	Pusa Gaurav -	Pusa Gaurav Pant Bahar	Pusa Gaurav -	A.Type-2 x A.Type-3	Pusa Ruby x K.S.-16	A.Type-2 x K. Type-1	K. Type-1 x Angooralat	HxL	LxM
					P.Gaurav x K.Type-1	Pant Bahar x K.S.-16	P.Gaurav X Angoorlata	P.Gaurav x Angooralat	HxL	HxM
	Pusa Ruby	-	-	-	P.Gaurav x A.Type-2	P.Gaurav x K.S.-16	P.Chhuhara x K.S.-16	Pusa Ruby x K.S.-16	HxL	MxL
	Pusa Gaurav	-	-	-	Pant Bahar x K.S.-29	Pusa Ruby x A.Type-3	Pusa Ruby x A.Type-3	A.Type-2 x A. Type-3	LxL	LxM
No. of primary branches/ plant	K.S.-29	K.S.-29	Pant Bahar	K.S.-29	Pant Bahar x Pusa Ruby	Pusa Ruby x K.S.-16	Pant Bahar x K.Type-1	A.Type-3 x K.S.-29	LxH	MxH
	Angoorlata		Punjab	-	Pant Bahar x A.Type-2	K.Type-1 x K.S.-16	K.S.-16 x K.S.-29	Pant Bahar x K.Type-	HxH	MxM
	Kalyanpur	Azad Type-2	Chhuhara	-	A.Type-2 x Angoorlata	P.Gaurav x K.Type-1	Angoorlata x K.S.-16	-	-	-
	Type-1	Punjab	K.S.-29	-	Pant Bahar x P.Gaurav	Pusa Ruby x A.Type-2	A.Type-2 x K.Type-1	-	-	-
	Pant Bahar	Chhuhara	-	-	Pant Bahar x A.Type-3	Pusa Ruby x K.Type-1		-	-	-
			-	-						
Harvest index	Angoorlata	Angoorlata	Angoorlata	Angoorlata	K.S.-16 x K.S.-29	Pant Bahar x Azad Type-2	Pusa Ruby x A.Type-2	P.Chhuhara x K.S.-16	LxL	HxL
	-	Punjab	K.S.-29	-	P.Chhuhara x Angoorlata	Pant Bahar x P.Chhuhara	Pant Bahar x P.Chhuhara	Azad Type-2 x K.S. -29	LxM	LxM
	-	Chhuhara	Pusa Ruby	-	Pant Bahar x A.Type-2	Pusa Ruby x K.S.-16	Pusa Ruby x K.S.-16		-	-
	-	Pusa Ruby	-	-	P.Chhuhara x Pant Ruby	Pant Bahar x Pusa Ruby	Pant Bahar x Pusa Ruby		-	-
	-	-	-	-	P.Gaurav x K.S.-29	Pant Bahar x Pusa Gaurav	Pant Bahar x Pusa Gaurav		-	-

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

unity for all the characters *viz.,* days to flowering, days to maturity, plant height, fruit length, fruit width, primary branches, fruits/ plant, biological yield, harvest index and fruit yield. This indicatied that these characters are primarily governed by non-additive gene action. However, the best combiners across two diallel was KS-29 for six character *viz.,* fruit length, fruit width, primary branches, fruit/plant, biological yield and fruit yield followed by Azad Type-2 and Kalyanpur Type-1 for three characters each *viz*., days to maturity , plant height, fruit length, fruit/plant, biological yield, fruit yield, respectively. Pusa Ruby and Pusa Gaurav for two characters each fruit length and primary branches and length and biological yield, respectively. Pant Bahar for six characters and Angoorlata for five characters *viz*., days to flowering, plant height, fruit length, fruits/ plant, biological yield and fruit yield and date of flowering, plant height, biological yield, harvest index and fruit yield respectively, while Pusa Chhuhara was identified as good combiner for fruits/plant.

General combining ability studies have successfully led to making choice of suitable parents. This information on yield and its components would greatly help in proper classification of parental lines. General combining effect includes both additive & additive x additive type of gene action (Griffing, 5), which represents fixable genetic variance. Consistent gca effect over F_1 and F_2 may prove advantageous, while evaluating varieties for combining ability. Furthermore, the varieties showing good gca for particular components may also be used in components breeding improvement in particular components, there contributing improvement in yield. Varieties KS-29, Angoorlata and Pant Bahar showing good gca ability for fruit yield appears to be worthy of their exploitation in tomato breeding. Therefore, it is suggested that population involving these lines may be developed through multiple crossing for isolating high yield varieties.

The sca effects and *per se* performance of crosses are presented in Table 1. To confirm whether the crosses selected on the basis of sca effects were really the best performing ones, the five best crosses based on their mean performance and sca effects were selected. It was found that in F_1 out of five best crosses; Pusa Gaurav x Angoorlata, Pusa Gaurav x KS-16, Punjab Chhuhara x Azad Type-3, Pant Bahar x Angoorlata and Pant Bahar x Azad Type-2 for days to flowering, Pusa Ruby x Azad Type-3, Pant Bhar x KS-16 for fruits/plant, Azad Type-2 x Angoorlata, Azad Type-3 x Angoorlata, Pusa Gaurav x Azad Type-3, Pusa Gaurav x Azad Type-3 and Pant Bahar x Pusa Gaurav for biological yield, Pant Bahar x Pusa Gaurav, Azad Type-2 x Azad Type-3, Azad Type-2 x KS-29, Azad Type-2 x Angoorlata, Azad Type-3 x Angoorlata for fruit yield per plant, Azad Type-3 x Angoorlata and Azad Type-2 x KS-29 for days to maturity; KS-16 x KS-29, Pant Bahar x Angoorlata, Pusa Ruby x KS-29, Punjab Chhuhara x Pusa Ruby and Azad Type-2 x Azad Type-3 for plant height; Pant Bahar x Pusa Gaurav, Azad Type-3 x KS-29, Pant Bahar x Pusa Ruby, Azad Type-2 x KS-29 and Type-2 x Kalyanpur Type-1 for length of fruit, Azad Type-2 x KS-29, Azad Type-2 x Azad Type-3 , Pusa Guarav x Kalyanpur Type-1 and Pusa Guarav x Azad Type-2 for width of fruit, Pant Bahar x Pusa Ruby and Pant Bahar x Azad Type-2 for No. of primary branches/plant and Punjab Chhuhara x Angoorlata for harvest index showed high sca effects as well as *per se* performance. Similar findings had also been reported by Dhaliwal *et al*. (4), Joshi and Kohli (7), Thakur and Kohli (15), Resende *et al*. (11), and Sharma and Verma (13).

In F_2 out of five best crosses; Pusa Ruby x Kalyanpur Type-1, Pusa Ruby x Azad Type-2, Pusa Gaurav x Azad Type-2, Punjab Chhuhara x Pusa Gaurav and Pant Bahar x Pusa Ruby for days to flowering, Pant Bahar x Punjab Chhuhara and Punjab Chhuhara x KS-29 for fruits / plant, Pant Bahar x KS-16, Pusa Gaurav x Azad Type-2, Pusa Gaurav x Kalyanpur Type-1 x KS-16 and Punjab Chhuwara x KS-16 for biological yield, Pusa Gaurav x Azad Type-2, Pusa Gaurav x Kalyanpur Type-1, Pant Bahar x KS-16, Kalyanpur Type-1 x KS-16 and Pant Bahar x Azad Type-2 for fruit yield/ plant, Pusa Ruby x Kalyanpur-1 for days to maturity, Kalyanpur Type-1 x Angoorlata, Pant Bahar x Pusa Gaurav and Pant Bahar x Punjab Chhuhara for plant height, Angoorlata x KS-16, Kalayanpur Type-1 x KS-16, Pusa Gaurav x Angoorlata, Pant Bahar x Pusa Gaurav and Pant Bahar x Punjab Chhuhara for fruit length, Punjab Chhuhara x Kalyanpur Type-1, Pusa Ruby x KS-16, Pant Bahar x KS-16, Pusa Gaurav x KS-16 and Pusa Ruby x Azad Type-3 for width of fruit, Pant Bahar x KS-16, Kalyanpur Type-2 x KS-16 for No. of primary branches/ plant and Pant Bahar x Azad Type-2 and Pant Bahar x Punjab Chhuhara for harvest index proved high sca effects and good *per se* performance. The above findings are in conformity with the results of Bhatt *et al*. (2), Mukesh *et al*. (9), and Singh *et al*. (14).

The perusal of data of top five performing hybrids suggested high sca effects for fruit yield (Table 1) indicating that highest effects are obtained with parents involving high x high (Kalyanpur Type-1 x KS-29), and high x low general combiner (Pusa Gaurav x KS-29 and Punjab Chhuhara x Kalyanpur Type-1) combinations. Of these hybrids, Kalyanpur Type-1 x KS-29 also had the higher *per se* performance and, therefore, can be exploited through conventional breeding for the isolation of high yielding pure lines. The hybrid KS-16 x KS-29 is likely to give good recombinants only if additive genetic systems are present in the good general combining parents and epistatic effects in the hybrids in the same direction.

Table 2. Estimates of general combining ability effects for 10 characters in 10 parents diallel crosses in F_1 and F_2 generations of tomato.

Parent	Generation	Days to flowering	Days to maturity	Plant height (cm)	Fruit length (cm)	Fruit width (cm)	No. of primary branches/ plant	No. of fruits/ plant	Biological yield/ plant (kg)	Harvest index	Fruit yield/ plant (kg)
Pant Bahar	F_1	-1.34**	-0.92**	-2.39**	-0.38**	-0.69**	1.45**	1.87**	9.34**	-0.35	3.79**
	F_2	-1.61**	1.39**	-1.04**	0.64**	-0.70**	0.91**	2.08**	7.82**	-0.59	3.19**
Punjab Chuhara	F_1	-0.79**	-3.10**	-5.26**	0.10**	0.17**	-2.09**	2.78**	-8.36**	-0.35**	-4.00**
	F_2	-0.65**	-3.16**	-4.50**	-0.09**	0.05**	-2.53**	1.85**	10.84**	1.51	-4.19**
Pusa Ruby	F_1	1.70	1.39	4.89	0.70	0.41	0.34	-3.17	2.48	0.18	0.52
	F_2	1.10	0.93	4.26	0.31	0.21	0.27	1.68	8.95	-1.60	2.26
Pusa Gaurav	F_1	-0.28	0.43	3.17	0.65	0.36	-0.01	-0.93	-1.31	0.41	-0.11
	F_2	-0.33	2.52	2.05	0.87	1.16	-0.22	-1.28	1.19	0.00-	0.83
Azad Type-2	F_1	-0.38	-1.37	-8.78	-1.86	-1.64	-3.95	2.69	-19.76	0.04	-9.20
	F_2	-0.13	-2.47	-9.18	-1.79	-1.22	-4.31	1.29	-2.70	-0.76	-9.48
Azad Type-3	F_1	0.98	-0.37	4.94	-0.57	-0.20	-1.13	2.53	-4.23	-0.82	-2.54
	F_2	-0.44	-1.42	4.08	-0.47	0.21	0.68	2.82	-1.52	-1.28	1.56
Kalyanpur Type-1	F_1	0.35	0.20	-0.22	0.92	0.45	1.64	-4.05	5.97	-0.75	2.37
	F_2	-0.25	0.18	-0.47	0.56	-0.07	1.09	-3.48	4.33	0.30	2.35
Angoorlata	F_1	-0.26	1.07	-1.86	-0.16	-0.36	1.87	0.28	6.12	2.63	4.29
	F_2	-0.58	0.74	-1.57	-0.02	0.20	1.38	0.66	7.45	1.92	4.32
KS-16	F_1	1.53	1.20	3.77	-0.58	-0.21	0.15	-4.06	-2.18	-1.04	-1.42
	F_2	1.38	0.45	4.07	-0.39	-1.28	-0.39	-3.39	-5.53	-0.12	-2.39
KS-29	F_1	0.45	1.49	1.73	0.41	-1.71	1.73	2.04	11.94	0.14	6.30
	F_2	1.51	0.83	2.30	0.38	1.44	3.13	1.13	8.87	0.62	4.66
SEm (±)	F_1	0.16	0.20	0.22	0.13	0.13	0.06	0.18	1.44	0.77	0.33
	F_2	0.28	0.92	0.21	0.06	0.28	0.97	0.23	1.32	0.78	0.39

However, these hybrids can be exploited for heterosis breeding, as their performance has been good. It is noteworthy that of the crosses showing high sca effects for fruit yield in both F_1 and F_2 generations were combinations of the strains having broad base types. This emphasizes the importance of combining two diverse germplasms to create maximum genetic variability which is the primary requirement and this alone world help in the raising yield levels through selection in any successful breeding. Results are in consonance with Ahuja (1), Dhaliwal *et al*. (4), Malik and Bhatnagar (8), Rosas and Sprague (12), and Rao *et al*. (10).

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Received: December, 2007; Revised: December, 2009; Accepted : January, 2010