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Organic Tomatoes: Combining Ability for fruit yield and Component Traits in Tomato (*Solanum lycopersicum* L.) under Mid Himalayan Region

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A B S T R A C T

Combining ability effects were estimated for yield, yield components in a 8 × 8 diallel analysis excluding reciprocals. The variances for general combining ability (GCA) and specific combining ability (SCA) were highly significant indicating the presence of additive as well as non-additive gene effects in the traits studied. The relative magnitude of these variances indicated that additive gene effects were more prominent for all the characters. The tomato genotype Hawaii 7998 (P_3)proved to be the best general combiner for yield and its component traits followed by 12-1 (P_5) and BWR-5 (P_6).Cross combinations viz., Palam Pride × BWR-5 ($P_4 \times P_6$), 12-1 × BWR-5 ($P_5 \times P_6$), Palam Pride × 12-1 ($P_4 \times P_5$), Hawaii 7998 × 12-1 ($P_3 \times P_5$) and CLN 2123 A-1 red × Arka Abha ($P_2 \times P_8$) were the best five specific combinations for marketable yield per plant in pooled environment under organic farming conditions.

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crops grown throughout the world. It is used in fresh as well as processed food industries. Bacterial wilt has become a limiting factor for the commercial cultivation of tomato crop. Being safe and better in quality, the demand for organic tomatoes is increasing day by day. It is estimated that more than 95% of organic production is based on crop varieties that were bred for the conventional high-input sector. Recent studies have shown that such varieties lack important traits required under organic and low-input production conditions. This is primarily due to selection in conventional breeding programmes being carried out in the background of high inorganic fertilizer and crop protection inputs. Therefore high yielding organic input responsive varieties/hybrids with more pest tolerance/resistance are required. The hybrid cultivars in tomato have generated increased interest among the breeders due to possibility of combining a complex of valuable attributes in a genotype, *viz*. earliness, uniformity, high yield, resistance to diseases and strong adaptability to different environmental conditions. However in public sector there is still a dearth of F1 hybrids that have a complex of these valuable attributes. The systematic approach for developing F1 hybrids in any crop depends primarily on selection of desirable parents. The information obtained from general combining ability of parents and specific combining ability of crosses helps us to select suitable parents and cross combination respectively. An analysis of crosses produce by involving (n) lines in all possible combinations is known as a diallel analysis. This analysis is usually conducted to estimate the important genetic parameters; general combining ability (GCA), and specific combining ability (SCA) of the parents and crosses, respectively. Agro-climatic diversity acts as double-edged sword as in one hand it complicates the selection of suitable genotypes and on the other hand it gives information about the extreme environmental conditions which the genotype can withstand. Therefore, present investigation was planned to study the combining ability of some apparently superior genotypes for desirable horticultural traits across environment by involving bacterial wilt resistant parents under organic farming condition.

Materials and Methods

The tomato genotypes *viz.*, CLN 2070 (P_1), CLN 2123 A-1 red (P_2), Hawaii 7998 (P_3), Palam Pride (P_4), 12-1 (P_5), BWR-5 (P_6), Arka Abha (P_7) and Arka Meghali (P_8) werecrossed in diallel fashion following Griffing (1956), model I, method II, at Model Organic Farm, Department of Organic Agriculture, COA, CSKHPKV, Palampur. Characteristics and source of the parents and checks involved in the study given in table 1. This farms is situated at 32^{o}6' N latitude and 76^{o}3' E longitude at an altitude of 1290.8 m above the mean sea level. The parents and their resulting 28 F1 hybrids along with one standard check Avtar (7711) were evaluated in a randomized complete block design with three replications summer-rainy seasons. The seedlings were transplanted at the spacing of 75 cm between rows and 45 cm between plants. Recommended cultural practices were followed to raise a good crop. Data were collected for days to 50 per cent flowering, days to first harvest, gross yield per plant (kg), marketable yield per plant (kg), total number of fruits per plant, marketable fruits per plant, fruit weight (g), fruit shape index, pericarp thickness (mm), locules per fruit, plant height (cm), harvest duration (days), total soluble solids (%), ascorbic acid (mg/100g) and titrable acidity (%). The homogenized juice, obtained from 6 to 10 randomly chosen fruit for each genotype, was scored for soluble solid susing a manual Refractometer (A.O.A.C., 1970). The ascorbic acid contents and titrable acidity were estimated as described by Ranganna (1979). The diallel analysis was carried out as per Method 2 (parents plus one set of crosses and no reciprocal), Model I (fixed effect model) as described by Griffing (1956). The data was analysed for combining ability using gca and sca.

Results and Discussion

The analyses of variances for combining ability in 2012, 2013 and pooled over environments (Table 2) revealed that mean squares due to GCA were significant for all the traits studied in all the environments except harvest duration in 2013. Mean squares due to SCA were also found significant for all the traits studied except days to first harvest in all the environments, fruit shape index in 2012 and 2013, plant height in 2012 and TSS in 2013. Mean squares due to GCA × environment interaction were significant for all the traits studied except days to 50 per cent flowering, days to first harvest, fruit shape index, pericarp thickness and TSS, while mean square due to SCA × environment interaction were significant for all the traits studied except days to first harvest, fruit weight, fruit shape index, pericarp thickness, locules per fruit and TSS. Highly significant variation due to general combining ability as well as specific combining ability indicated the importance of additive as well as non-additive types of gene action for the expression of these traits. These findings are in close agreement with Farzane *et al.*, (2013), Kumar *et al.*, (2013), Saleem *et al.*, (2013), Shankar *et al.*, (2013) and Yadav *et al.*, (2013).

Estimation of general combining ability (GCA) effects

Nature and magnitude of combining ability effects provide guideline in identifying the better parents and their utilization. The GCA effects of the parents (Table 3) revealed that none of the parent found to be good general combiner for all the characters. An overall appraisal of gca effects revealed that among parents P_3 (Hawaii 7998) was found to be the best parent as it gave good general combining ability consistently in all the environments for maximum number of traits *viz*., days to 50 per cent flowering, gross yield per plant, total number of fruits per plant, marketable fruits per plant and plant height. P_3 was also found good combiner for other traits studied *viz.*, days to first harvest, marketable yield per plant, harvest duration, ascorbic acid and titrable acidity in pooled over environments. The second most desirable parent was observed to be P_5 (12-1) which revealed significant desirable GCA effects for gross yield per plant, marketable yield per plant, fruit weight, fruit shape index, pericarp thickness and plant height in all the environments including total number of fruits per plant in 2012 and pooled environment and ascorbic acid in 2013 and pooled environment. P_6 (BWR-5) was also a promising parent for inclusion in breeding programme as it revealed good general combing ability for marketable yield per plant, fruit weight and locules per fruit in all the environments, while it also exhibited significant desirable GCA effects for titrable acidity in 2012 and pooled environment.

Estimates of specific combining ability (SCA) effects

For days to 50 per cent flowering (Table 4), out of the 28 crosses studied, $P_4 \times P_7$(poor × good), $P_3 \times P_6$ (good × average), $P_2 \times P_8$ (good × good), $P_4 \times P_5$ (poor × poor) and $P_4 \times P_8$ (poor × good) in 2012, $P_4 \times P_7$ (average × good) and $P_1 \times P_7$ (poor × good) in 2013 and $P_4 \times P_7$ (poor × good) and $P_2 \times P_8$ (good × good) in pooled environment expressed significant negative SCA effects indicating their good specific combining ability. For days to first harvest SCA effects of the cross combinations in all the environments were not worked out due to non-significant mean square due to SCA. For gross yield per plant (Table 4), 12 cross combinations each in 2012 and 2013 and 13 crosses in pooled environment had positive significant SCA effects, thereby revealing their good specific combining ability. Out of these good specific combinations $P_1 \times P_3$, $P_1 \times P_5$, $P_2 \times P_6$, $P_2 \times P_7$, $P_3 \times P_7$, $P_4 \times P_6$, $P_4 \times P_7$ and $P_4 \times P_8$ were common in all the environments. However, in order of preference in pooled environment P_4 (average) × P_6 (average), P_3 (good) × P_7 (poor), P_4 (average) × P_7 (poor), P_4 (average) × P_8 (poor) and P_1 (good) × P_5 (good) were the most desirable specific combinations. For marketable yield per plant (Table 4), 10 cross combinations each in 2012 and 2013 and 11 cross combinations in pooled environment exhibited significant positive SCA effects (good specific combiners) for marketable yield per plant. The top five crosses were $P_4 \times P_6$ (average × good), $P_5 \times P_6$ (good × good), $P_4 \times P_5$ (average × good), $P_3 \times P_5$ (good × good) and $P_2 \times P_8$ (poor × poor) in pooled environment and were common in all the environments. For total number of fruits per plant (Table 4), Eight cross combinations each in 2012 and 2013 and 10 in pooled environment exhibited significant positive SCA effects indicating their good specific combining ability. Out of these cross $P_2 \times P_7$ (average × poor), $P_3 \times P_6$ (good × poor), $P_3 \times P_4$ (good × poor), $P_2 \times P_5$(average × good) and $P_5 \times P_8$ (good × poor) in pooled environment were the top five good specific combinations and $P_2 \times P_7$, $P_3 \times P_6$ and $P_2 \times P_5$ were common in all the environments. Good specific combinations for marketable fruits per plant (Table 4) were $P_5 \times P_6$, $P_4 \times P_6$, $P_1 \times P_7$, $P_4 \times P_7$, $P_2 \times P_8$, $P_4 \times P_8$ and $P_2 \times P_7$ in 2012, $P_5 \times P_8$, $P_3 \times P_5$, $P_2 \times P_7$, $P_3 \times P_4$ and $P_6 \times P_7$ in 2013 and $P_5 \times P_6$, $P_4 \times P_6$, $P_3 \times P_5$, $P_2 \times P_7$, $P_5 \times P_8$, $P_3 \times P_4$, $P_2 \times P_8$, $P_4 \times P_7$, $P_4 \times P_5$ and $P_1 \times P_7$ in pooled over environments. All the parents of these crosses were average or poor general combiners except P_3 which was good general combiner in all the environments. Cross combination $P_2 \times P_7$ was the common in all the environment for marketable fruits per plant. The computation of SCA effect for fruit weight (Table 5) indicated that the cross combinations $P_4 \times P_5$ (good × good), $P_6 \times P_8$ (good × average), $P_1 \times P_3$ (good × poor), $P_1 \times P_2$ (good × poor), $P_7 \times P_8$ (average × average), $P_2 \times P_3$ (poor × poor) and $P_6 \times P_7$ (good × average) in 2012, $P_5 \times P_6$ (good × good), $P_4 \times P_6$ (good × good), $P_1 \times P_3$ (average × poor), $P_1 \times P_2$ (average × poor) and $P_2 \times P_3$ (poor × poor) in 2013 and $P_1 \times P_3$ (good × poor), $P_1 \times P_2$ (good × poor), $P_4 \times P_5$ (good × good), $P_5 \times P_6$ (good × good), $P_2 \times P_3$ (poor × poor), $P_7 \times P_8$ (average × poor), $P_4 \times P_6$ (good × good) and $P_6 \times P_8$ (good × poor) in pooled environment showed significant positive SCA effects and the cross combinations *viz*., $P_1 \times P_2$, $P_1 \times P_3$ and $P_2 \times P_3$ were common in all the environments. For fruit shape index (Table 5) SCA effects of the cross combinations in 2012 and 2013 were not worked out due to non-significant mean squares due to SCA. In pooled over environments, cross combinations *viz.*, $P_4 \times P_7$ (poor × poor), $P_6 \times P_8$ (average × poor) and $P_3 \times P_7$ (average × poor) exhibited significant positive SCA effects indicating their good specific combining ability. For pericarp thickness (Table 5) in 2012, the crosses $P_3 \times P_4$ (poor × average), $P_4 \times P_7$ (average × poor), $P_3 \times P_6$ (poor × average) and $P_2 \times P_4$ (average × average) in 2012, $P_4 \times P_7$ (average × poor), $P_2 \times P_4$ (good × average), $P_3 \times P_4$ (poor × average), $P_4 \times P_5$(average × good) and $P_3 \times P_6$ (poor × average) in 2013 and $P_4 \times P_7$ (average × poor), $P_3 \times P_4$ (poor × average), $P_3 \times P_6$ (poor × average), $P_2 \times P_4$ (good × average), $P_5 \times P_7$ (good × poor), $P_5 \times P_6$ (good × average) and $P_1 \times P_8$ (average × poor) in pooled environment revealed significant positive SCA effects indicating their good specific combining ability. The cross combinations $P_2 \times P_4$, $P_3 \times P_4$, $P_3 \times P_6$ and $P_4 \times P_7$ were the common in all the environments for pericarp thickness. For locules per fruit (Table 6), cross combinations $P_7 \times P_8$ (good × good) and $P_3 \times P_5$ (poor × poor) in 2012 were good specific combinations, whereas 7 crosses *viz.*, $P_1 \times P_2$ (good × poor), $P_1 \times P_6$ (good × good), $P_3 \times P_4$ (poor × average), $P_3 \times P_5$ (poor × poor), $P_4 \times P_5$ (average × poor), $P_6 \times P_8$ (good × good) and $P_7 \times P_8$ (good × good) in 2013 as well as in pooled environment exhibited significant positive SCA effects indicating their good specific combining ability. For plant height (Table 5), SCA effects of the cross combinations in 2012 were not worked out due to non-significant mean squares due to SCA. A total of 9 crosses each in 2012 and pooled environment exhibited significant positive SCA effects indicating their good specific combining ability and out of these cross combinations,P_5 (good) × P_8 (poor), P_5 (good) × P_6 (poor), P_3 (good) × P_6 (poor), P_5

(good) × P_7 (poor) and P_3 (good) × P_7 (poor) in pooled environment were the top five good specific combinations. For harvest duration (Table 6) the perusal of SCA effects revealed that the crosses *viz*., P_3 × P_8, P_4 × P_7, P_2 × P_5, P_6 × P_8, P_1 × P_4 and P_1 × P_2 in 2012, P_1 × P_3, P_1 × P_7 and P_4 × P_7 in 2013 and P_4 × P_7, P_3 × P_8, P_2 × P_5, P_1 × P_3 and P_6 × P_8 in pooled environment had significant positive SCA effects indicating their good specific combinations. All the parents of these crosses were average or poor general combiners except P_3 which was good general combiner in pooled environment.

The cross combination P_4 × P_7 was common in all the environments. For total soluble solids (Table 6), SCA effects of the cross combinations in 2013 was not worked out due to non-significant mean squares due to SCA. Significant positive SCA effects were observed for the cross combinations P_7 × P_8, P_5 × P_8, P_1 × P_3, P_1 × P_5 and P_3 × P_7 in 2012 and they had average general combiners as their parents except P_1 which was good general combiner. In pooled environment, P_7 × P_8 (poor × average), P_3 × P_7(average × poor), P_1 ×P_3 (good × average), P_5 × P_8 (average × average), P_2 × P_6 (good × poor) and P_6 × P_7 (poor × poor) exhibited significant positive SCA effects indicating their good specific combining ability. For ascorbic acid (Table 6), a total of 10 crosses each in 2012 and pooled environment and 7 crosses in 2013 exhibited significant positive SCA effects indicating their good specific combining ability.

Out of these cross combinations P_1 (average) × P_2 (poor), P_4 (good) × P_8 (poor), P_5 (good) × P_7 (poor), P_1 (average) × P_6 (average) and P_6 (average) × P_7 (poor) in pooled environment were the top five good specific combinations. Cross combinations P_1 × P_2, P_4 × P_8 and P_6 × P_7 were common in all the environments. For titrable acidity (Table 6), 10 crosses each in 2012 and 2013 and 17 crosses in pooled environment exhibited significant positive SCA effects indicating their good specific combining ability. In order of preference, P_6 × P_7 (good × good), P_6 × P_8 (good × good), P_1 × P_4 (poor × poor), P_2 × P_4 (poor × poor) and P_3 × P_7 (good × good) in pooled environment were the most desirable specific combinations. The cross combinations *viz*., P_1 × P_4, P_2 × P_4, P_3 × P_7, P_3 × P_8, P_6 × P_7 and P_6 × P_8 were common in all the environments.Our results are in close conformity with the findings of Rattan *et al*., (2008), Singh *et al.*, (2010) and Singh and Asati (2011). Our results are in close conformity with the findings of Joshi *et al*., (2005), Pandey *et al.*, (2006), Sharma *et al*., (2007), Chishti *et al.*, (2008), Ahmad *et al*., (2009), Sharma and Sharma (2010), Singh *et al*., (2010), Dhaliwal and Cheema (2011), Singh and Asati (2011), Kumar *et al.*, (2013), Saleem *et al.*, (2013), Shankar *et al.*, (2013) and Yadav *et al.*, (2013).

Majority of the cross combinations exhibiting desirable SCA effects, had one of the parents atleast as good or average general combiner. Similar views have also been expressed by earlier researchers, Sharma and Sharma (2010), Singh and Asati (2011), Kumar *et al.*, (2013), Saleem *et al.*, (2013) and Yadav *et al.*, (2013). However, certain crosses also revealed good SCA effects although the parents of these crosses had poor × poor or average × poor GCA effects. This might be due to the origin of parental lines used in the present study from the diverse genetic background thereby exhibiting high SCA effects. The poor × poor crosses may perform better than good × good and good × poor combinations because of complimentary gene action. These findings corroborate the observations of Dhaliwal and Cheema (2011), Kumar *et al.*, (2013b) and Shankar *et al.*, (2013), who have also reported that the superior hybrids need not necessarily have parents showing high GCA effects only.

Table.1 Characteristics of the parents and checks involved in the study

Genotypes	Code No.	Sources	Growth habit	Bacterial wilt	Fruit shape, pedicel area and colour
CLN 2070	P_1	AVRDC/ CSK HPKV	Semi determinate	Resistant	Slightly flattened, medium, orange red colour
CLN 2123 A-1 (red)	P_2	AVRDC/CSK HPKV	Determinate	Resistant	Ovoid, shallow, deep red
Hawaii 7998	P_3	AVRDC/ CSKHPKV	Indeterminate	Resistant	Circular, shallow, red
Palam Pride	P_4	AVRDC/CSK HPKV	Indeterminate	Resistant	Heart shaped, shallow, red
12-1	P_5	CSKHPKV	Indeterminate	Resistant	Obovoid, shallow, red
BWR-5	P_6	IIHR/CSKHPKV	Determinate		Rectangular, deep, orange red
Arka Abha	P_7	IIHR	Semi-determinate	Moderate resistant	Flattened, medium, red
Arka Meghali	P_8	IIHR	Semi-determinate	Moderate susceptible	Flattened, medium, red
Standard check					
Avtar (7711)	SC	Nunhems	Indeterminate	Resistant	Obovoid, shallow, red
Susceptible check					
Roma		IARI/CSKHPKV	Determinate	Susceptible	Cylindrical, absent, red
Marglobe		IARI/CSKHPKV	Indeterminate	Susceptible	Round , medium, red

Table.2 Analyses of variances for combining ability for different traits in tomato during 2012, 2013 and pooled over environments under organic conditions

Source of variation	→	**GCA**	**SCA**	**Error**	**Environment**	**GCA × Environment**	**SCA × Environment**	**Pooled error**
Traits	df→	7	28	70	1	7	28	140
Days to 50 per cent flowering	2012	36.921*	3.370*	0.714	-	-	-	-
	2013	29.267*	4.972*	3.711	-	-	-	-
	Pooled	64.839*	4.127*	-	399.824*	1.350	4.214*	2.213
Days to first harvest	2012	50.270*	9.620	7.646	-	-	-	-
	2013	31.032*	6.536	5.190	-	-	-	-
	Pooled	73.257*	8.583	-	254.408*	8.045	7.573	6.418
Gross yield/plant	2012	0.091*	0.064*	0.008	-	-	-	-
	2013	0.494*	0.171*	0.010	-	-	-	-
	Pooled	0.480*	0.186*	-	0.0004	0.104*	0.048*	0.009
Marketable yield/plant	2012	0.139*	0.066*	0.007	-	-	-	-
	2013	0.055*	0.036*	0.006	-	-	-	-
	Pooled	0.159*	0.077*	-	1.292*	0.035*	0.025*	0.006
Total number of fruits/plant	2012	316.704*	30.621*	5.160	-	-	-	-
	2013	234.112*	16.115*	1.254	-	-	-	-
	Pooled	529.201*	29.123*	-	189.088*	21.614*	17.613*	3.207
Marketable fruits/plant	2012	146.577*	19.490*	2.624	-	-	-	-
	2013	48.153*	9.102*	1.239	-	-	-	-
	Pooled	165.445*	14.912*	-	350.220*	29.285*	13.681*	1.932
Fruit weight	2012	235.022*	24.157*	3.730	-	-	-	-
	2013	185.392*	21.728*	5.704	-	-	-	-
	Pooled	409.160*	41.116*	-	130.876*	11.254*	4.770	4.717

Fruit shape index	2012	0.028*	0.002	0.001	-	-	-	-
	2013	0.024*	0.002	0.001	-	-	-	-
	Pooled	0.052*	0.003*	-	0.001	0.001	0.0004	0.001
Pericarp thickness	2012	0.478*	0.208*	0.060	-	-	-	-
	2013	0.492*	0.202*	0.048	-	-	-	-
	Pooled	0.932*	0.384*	-	0.277*	0.037	0.027	0.054
Locules per fruit	2012	1.958*	0.143*	0.047	-	-	-	-
	2013	2.269*	0.172*	0.025	-	-	-	-
	Pooled	4.141*	0.281*		0.061	0.086*	0.034	0.036
Plant height	2012	771.769*	41.905	28.175	-	-	-	-
	2013	2624.965*	239.146*	26.482	-	-	-	-
	Pooled	3034.157*	203.758*	-	353.975*	362.578*	77.294*	27.328
Harvest duration	2012	201.244*	47.152*	10.922	-	-	-	-
	2013	9.531	25.414*	6.887	-	-	-	-
	Pooled	110.647*	24.593*	-	296.085*	100.128*	47.973*	8.904
TSS	2012	0.375*	0.108*	0.038	-	-	-	-
	2013	0.277*	0.079	0.065	-	-	-	-
	Pooled	0.583*	0.152*	-	0.205*	0.069	0.035	0.051
Ascorbic acid	2012	2.918*	12.391*	0.757	-	-	-	-
	2013	16.511*	10.122*	0.798	-	-	-	-
	Pooled	10.736*	13.570*	-	0.880	8.693*	8.943*	0.777
Titrable acidity	2012	0.023*	0.007*	0.0003	-	-	-	-
	2013	0.010*	0.007*	0.0004	-	-	-	-
	Pooled	0.028*	0.010*	-	0.066*	0.005*	0.003*	0.0004

*Significant at 5% level of significance

Table.3 Estimates of general combining ability effects of parents for different traits in tomato during 2012, 2013 and pooled over environments under organic conditions

Traits	lines→	1	2	3	4	5	6	7	8	SE(gi) ±	SE(gi-gj) ±	CD (gi)	CD (gi-gj)
Days to 50 per cent flowering	2012	2.22*	-1.02*	-2.52*	1.08*	2.95*	-0.12	-1.68*	-0.92*	0.25	0.38	0.50	0.75
	2013	2.01*	-1.46*	-1.43*	0.84	2.91*	-0.46	-1.23*	-1.19*	0.57	0.86	1.14	1.72
	Pooled	2.11*	-1.24*	-1.97*	0.96*	2.93*	-0.29	-1.45*	-1.05*	0.31	0.47	0.62	0.94
Days to first harvest	2012	2.88*	-1.88*	-3.02*	0.08	3.52*	-0.08	-1.35	-0.15	0.82	1.24	1.63	2.46
	2013	2.33*	-1.17	-0.83	1.37*	2.20*	-0.27	-2.47*	-1.17	0.67	1.02	1.34	2.03
	Pooled	2.61*	-1.52*	-1.92*	0.73	2.86*	-0.17	-1.91*	-0.66	0.53	0.80	1.06	1.60
Gross yield/plant	2012	0.09*	-0.09*	0.15*	-0.02	0.09*	-0.04	-0.08*	-0.10*	0.03	0.04	0.05	0.08
	2013	0.06*	-0.27*	0.44*	0.00	0.08*	0.04	-0.15*	-0.21*	0.03	0.04	0.06	0.09
	Pooled	0.08*	-0.18*	0.30*	-0.01	0.08*	0.00	-0.11*	-0.15*	0.02	0.03	0.04	0.06
Marketable yield/plant	2012	0.01	-0.11*	0.14*	-0.04	0.13*	0.12*	-0.12*	-0.13*	0.02	0.04	0.05	0.07
	2013	-0.10*	-0.06*	0.03	0.01	0.12*	0.07*	-0.06*	-0.02	0.02	0.03	0.04	0.07
	Pooled	-0.04*	-0.09*	0.09*	-0.01	0.12*	0.10*	-0.09*	-0.07*	0.02	0.02	0.03	0.05
Total number of fruits/plant	2012	-1.69*	-0.73	13.15*	-2.79*	1.41*	-1.06	-4.35*	-3.94*	0.67	1.02	1.34	2.02
	2013	-4.88*	-0.25	11.34*	-1.11*	0.28	-1.90*	-2.24*	-1.24*	0.33	0.50	0.66	1.00
	Pooled	-3.29*	-0.49	12.24*	-1.95*	0.85*	-1.48*	-3.29*	-2.59*	0.37	0.57	0.75	1.13
Marketable fruits/plant	2012	-0.98*	-1.09*	8.91*	-2.00*	0.71	0.19	-3.14*	-2.59*	0.48	0.72	0.95	1.44
	2013	-2.84*	-0.16	4.80*	-0.23	-0.01	-1.11*	-1.01*	0.56	0.33	0.50	0.66	0.99
	Pooled	-1.91*	-0.63*	6.85*	-1.12*	0.35	-0.46	-2.08*	-1.02*	0.29	0.44	0.58	0.88
Fruit weight	2012	1.53*	-3.52*	-9.51*	1.16*	4.60*	5.91*	0.89	-1.06	0.57	0.86	1.14	1.72
	2013	1.09	-2.22*	-7.51*	2.57*	4.78*	5.32*	-1.19	-2.85*	0.71	1.07	1.41	2.13
	Pooled	1.31*	-2.87*	-8.51*	1.87*	4.69*	5.62*	-0.15	-1.96*	0.45	0.69	0.91	1.37

Fruit shape index	2012	0.01	0.08*	-0.01	-0.02*	0.06*	0.01	-0.07*	-0.06*	0.01	0.02	0.02	0.03
	2013	-0.01	0.08*	0.00	-0.02*	0.05*	0.02*	-0.06*	-0.06*	0.01	0.02	0.02	0.03
	Pooled	0.001	0.08*	0.00	-0.02*	0.05*	0.01	-0.06*	-0.06*	0.01	0.01	0.01	0.02
Pericarp thickness	2012	0.18*	0.11	-0.17*	0.12	0.29*	0.03	-0.24*	-0.33*	0.07	0.11	0.14	0.22
	2013	0.18*	0.18*	-0.27*	0.04	0.34*	-0.08	-0.15*	-0.24*	0.07	0.10	0.13	0.20
	Pooled	0.18*	0.15*	-0.22*	0.08	0.32*	-0.02	-0.19*	-0.29*	0.05	0.07	0.10	0.15
Locules per fruit	2012	0.12	-0.66*	-0.57*	0.05	-0.21*	0.37*	0.43*	0.48*	0.06	0.10	0.13	0.19
	2013	0.16*	-0.65*	-0.46*	0.02	-0.49*	0.54*	0.46*	0.43*	0.05	0.07	0.09	0.14
	Pooled	0.14*	-0.66*	-0.51*	0.03	-0.35*	0.46*	0.44*	0.45*	0.04	0.06	0.08	0.12
Plant height	2012	2.40	-5.02*	5.99*	10.95*	11.29*	-6.83*	-8.13*	-10.64*	1.57	2.37	3.13	4.73
	2013	13.31*	-18.45*	10.87*	13.73*	21.28*	-12.31*	-12.69*	-15.74*	1.52	2.30	3.03	4.59
	Pooled	7.85*	-11.74*	8.43*	12.34*	16.29*	-9.57*	-10.41*	-13.19*	1.09	1.65	2.18	3.29
Harvest duration	2012	-5.52*	-0.95	10.08*	0.48	0.38	-0.78	-1.95*	-1.75	0.98	1.48	1.95	2.95
	2013	-	-	-	-	-	-	-	-	-	-	-	-
	Pooled	-2.01*	-0.12	5.48*	0.36	-0.22	-0.59	-1.36*	-1.52*	0.62	0.94	1.24	1.88
TSS	2012	0.21*	0.12*	0.05	0.19*	-0.08	-0.38*	-0.10	-0.01	0.06	0.09	0.12	0.17
	2013	0.22*	0.13	0.12	-0.03	0.08	-0.29*	-0.12	-0.11	0.08	0.11	0.15	0.23
	Pooled	0.22*	0.13*	0.08	0.08	0.00	-0.34*	-0.11*	-0.06	0.05	0.07	0.09	0.14
Ascorbic acid	2012	1.01*	-0.95*	0.04	-0.07	0.05	0.21	-0.05	-0.24	0.26	0.39	0.51	0.78
	2013	-0.36	-0.85*	1.30*	1.69*	1.47*	-0.55*	-1.49*	-1.21*	0.26	0.40	0.53	0.80
	Pooled	0.33	-0.90*	0.67*	0.81*	0.76*	-0.17	-0.77*	-0.73*	0.18	0.28	0.37	0.56
Titrable acidity	2012	-0.05*	-0.06*	0.07*	-0.03*	-0.04*	0.04*	0.03*	0.04*	0.01	0.01	0.02	0.03
	2013	-0.02*	-0.04*	0.01	-0.03*	-0.02*	0.01	0.04*	0.05*	0.01	0.01	0.02	0.03
	Pooled	-0.03*	-0.05*	0.04*	-0.03*	-0.03*	0.02*	0.03*	0.04*	0.004	0.01	0.01	0.01

Significant at 5% level of significance

Table.4 Estimates of specific combining ability effects for days to 50 per cent flowering, gross yield per plant, marketable yield per plant, total number of fruits per plant and marketable fruits per plant in tomato during 2012, 2013 and pooled over environments under organic conditions

Crosses	Days to 50% flowering			Gross yield per plant			Marketable yield per plant			Total number of fruits per plant			Marketable fruits per plant		
	2012	2013	Pooled	2012	2013	Pooled									
$P_1 \times P_2$	0.71	-1.02	-0.16	0.03	0.08	0.05	0.03	0.13*	0.08	-2.36	0.61	-0.88	-1.95	-0.03	-0.99
$P_1 \times P_3$	-0.46	3.28	1.41	0.17*	0.33*	0.25*	0.28*	0.02	0.15*	0.35	-10.84*	-5.25*	0.15	-3.59*	-1.72
$P_1 \times P_4$	-0.73	1.68	0.48	-0.01	0.05	0.02	-0.13	0.10	-0.01	-4.98*	0.09	-2.44*	-2.25	1.26	-0.50
$P_1 \times P_5$	-1.26	1.94	0.34	0.32*	0.26*	0.29*	0.09	0.00	0.05	0.17	-0.09	0.04	0.36	-0.02	0.17
$P_1 \times P_6$	0.14	1.64	0.89	-0.09	-0.15	-0.12*	-0.23*	0.01	-0.11*	-4.50*	-0.21	-2.35*	-4.99*	0.21	-2.39*
$P_1 \times P_7$	1.37	-4.26*	-1.44	0.00	-0.11	-0.06	0.10	-0.11	-0.01	3.46	0.67	2.06	4.31*	-0.35	1.98*
$P_1 \times P_8$	-0.73	-2.29	-1.51	-0.07	-0.17	-0.12*	-0.03	-0.07	-0.05	0.05	5.94*	2.99*	1.48	0.58	1.03
$P_2 \times P_3$	0.44	1.08	0.76	-0.07	0.10	0.01	0.18*	0.14*	0.16*	0.75	-0.60	0.07	1.00	-0.13	0.43
$P_2 \times P_4$	-1.16	2.14	0.49	-0.02	-0.07	-0.04	-0.11	0.02	-0.05	-0.98	-0.36	-0.67	-2.35	-1.30	-1.82*
$P_2 \times P_5$	-0.69	-1.92	-1.31	-0.09	-0.08	-0.08	0.12	-0.09	0.01	4.52*	4.05*	4.28*	2.86	-1.60	0.63
$P_2 \times P_6$	0.71	0.78	0.74	0.18*	0.18*	0.18*	0.02	0.10	0.06	0.43	-2.14*	-0.85	-0.60	0.51	-0.05
$P_2 \times P_7$	-0.06	1.21	0.58	0.19*	0.25*	0.22*	0.19*	0.15*	0.17*	8.55*	5.37*	6.96*	3.00*	3.60*	3.30*
$P_2 \times P_8$	-1.83*	-2.49	-2.16*	-0.02	0.40*	0.19*	0.23*	0.15*	0.19*	4.42*	0.84	2.63*	3.83*	1.44	2.64*
$P_3 \times P_4$	-1.33	-1.56	-1.44	0.11	0.29*	0.20*	0.02	0.11	0.07	3.49	5.12*	4.30*	1.76	3.60*	2.68*
$P_3 \times P_5$	1.81*	-2.96	-0.57	0.41*	-0.09	0.16*	0.19*	0.21*	0.20*	2.85	-2.81*	0.02	2.71	4.28*	3.50*
$P_3 \times P_6$	-2.13*	1.74	-0.19	-0.16*	0.14	-0.01	0.00	-0.38*	-0.19*	4.47*	6.31*	5.39*	2.90	-6.34*	-1.72
$P_3 \times P_7$	-0.89	0.84	-0.02	0.20*	0.71*	0.46*	-0.19*	0.03	-0.08	-12.10*	-0.04	-6.07*	-3.62*	-0.11	-1.87*
$P_3 \times P_8$	-0.66	0.81	0.08	-0.02	0.43*	0.21*	-0.26*	-0.20*	-0.23*	-7.68*	2.32*	-2.68*	-5.41*	-5.65*	-5.53*
$P_4 \times P_5$	-1.79*	-1.56	-1.67	0.19*	-0.02	0.08	0.38*	0.18*	0.28*	-0.59	0.10	-0.24	2.63	1.34	1.99*
$P_4 \times P_6$	1.61*	-1.52	0.04	0.34*	0.65*	0.49*	0.45*	0.21*	0.33*	4.33*	1.27	2.80*	7.23*	0.71	3.97*
$P_4 \times P_7$	-3.83*	-4.42*	-4.12*	0.30*	0.36*	0.33*	0.23*	0.09	0.16*	6.47*	0.84	3.65*	4.10*	0.88	2.49*
$P_4 \times P_8$	-1.59*	2.21	0.31	0.17*	0.43*	0.30*	0.14	-0.02	0.06	5.64*	-2.71*	1.47	3.52*	-2.02*	0.75
$P_5 \times P_6$	-0.59	-1.92	-1.26	0.12	0.41*	0.26*	0.35*	0.26*	0.30*	9.50*	-3.24*	3.13*	10.65*	1.95	6.30*
$P_5 \times P_7$	-1.03	1.18	0.08	-0.11	0.03	-0.04	-0.17*	0.10	-0.04	-2.94	2.24*	-0.35	-4.12*	1.45	-1.34
$P_5 \times P_8$	-1.13	2.48	0.68	0.03	0.15	0.09	0.00	0.27*	0.13*	1.61	6.44*	4.02*	0.38	5.75*	3.07*
$P_6 \times P_7$	0.04	0.54	0.29	-0.06	-0.26*	-0.16*	-0.01	0.15*	0.07	-2.14	0.91	-0.61	-2.87	3.48*	0.31
$P_6 \times P_8$	-1.39	1.84	0.23	0.25*	-0.40*	-0.07	0.03	-0.08	-0.03	-2.80	-2.25*	-2.52*	-2.58	-1.15	-1.86*
$P_7 \times P_8$	0.51	0.94	0.73	0.19*	-0.27*	-0.04	0.24*	0.01	0.13*	2.66	0.63	1.64	2.15	-1.18	0.48
SE(Sij) ±	0.77	1.75	0.95	0.08	0.09	0.06	0.07	0.07	0.05	2.06	1.02	1.15	1.47	1.01	0.89
SE(Sij-Sik) ±	1.13	2.58	1.41	0.12	0.13	0.09	0.11	0.10	0.07	3.05	1.50	1.70	2.17	1.49	1.32
SE (Sij-Skl) ±	1.07	2.44	1.33	0.11	0.12	0.08	0.10	0.09	0.07	2.87	1.42	1.60	2.05	1.41	1.24
CD(Sij)	1.53	3.48	1.90	0.16	0.18	0.12	0.15	0.13	0.10	4.11	2.02	2.29	2.93	2.01	1.78
CD(Sij-Sik)	2.26	5.15	2.81	0.23	0.26	0.18	0.22	0.20	0.15	6.07	2.99	3.39	4.33	2.98	2.63
CD (Sij-Skl)	2.13	4.86	2.65	0.22	0.25	0.17	0.21	0.19	0.14	5.73	2.82	3.19	4.08	2.81	2.48

*Significant at 5% level of significance

Table.5 Estimates of specific combining ability effects fruit weight, fruit shape index, pericarp thickness, locules per fruit and plant height in tomato during 2012, 2013 and pooled over environments under organic conditions

Crosses	Fruit weight			Fruit shape index			Pericarp thickness			Locules per fruit			Plant height		
	2012	2013	Pooled												
$P_1 \times P_2$	6.66*	5.72*	6.19*	-	-	-0.06*	-0.24	-0.39	-0.31*	0.31	0.33*	0.32*	-	9.43*	6.60
$P_1 \times P_3$	6.96*	6.91*	6.93*	-	-	-0.01	0.17	0.33	0.25	0.14	0.01	0.08	-	-7.60	-2.91
$P_1 \times P_4$	1.18	0.82	1.00	-	-	-0.05*	-0.03	0.29	0.13	0.19	0.13	0.16	-	1.75	0.03
$P_1 \times P_5$	1.91	1.70	1.81	-	-	-0.03	0.35	-0.01	0.17	-0.08	-0.37*	-0.22	-	5.14	3.87
$P_1 \times P_6$	0.83	2.22	1.52	-	-	0.01	0.10	-0.26	-0.08	-0.06	0.74*	0.34*	-	-1.51	0.24
$P_1 \times P_7$	-4.62*	-4.85*	-4.73*	-	-	0.00	-0.09	0.08	-0.01	-0.42*	-0.31*	-0.36*	-	2.44	1.98
$P_1 \times P_8$	-3.49*	-4.92*	-4.21*	-	-	-0.01	0.32	0.31	0.32*	-0.37	-0.38*	-0.37*	-	5.66	5.93
$P_2 \times P_3$	6.10*	4.50*	5.30*	-	-	-0.02	-0.16	-0.27	-0.22	-0.11	0.02	-0.05	-	-4.39	1.30
$P_2 \times P_4$	1.03	1.49	1.26	-	-	0.00	0.51*	0.49*	0.50*	-0.06	0.00	-0.03	-	-21.58*	-10.25*
$P_2 \times P_5$	-1.45	-0.74	-1.09	-	-	0.04	0.10	-0.42*	-0.16	-0.43*	-0.02	-0.23	-	-26.81*	-14.31*
$P_2 \times P_6$	0.40	2.48	1.44	-	-	0.03	-0.12	-0.13	-0.13	-0.35	-0.38*	-0.37*	-	-6.41	-4.35
$P_2 \times P_7$	1.90	-0.74	0.58	-	-	0.00	-0.32	-0.19	-0.26	0.00	-0.04	-0.02	-	-1.03	-2.18
$P_2 \times P_8$	2.45	2.56	2.50	-	-	-0.02	0.06	0.23	0.15	0.15	-0.21	-0.03	-	-5.18	-1.71
$P_3 \times P_4$	-2.44	-4.40*	-3.42*	-	-	-0.04	0.73*	0.47*	0.60*	0.31	0.34*	0.33*	-	-10.57*	-7.86*
$P_3 \times P_5$	0.59	1.62	1.10	-	-	-0.01	-0.32	-0.17	-0.24	0.44*	0.45*	0.45*	-	-19.54*	-11.90*
$P_3 \times P_6$	-7.06*	-6.59*	-6.83*	-	-	-0.05*	0.70*	0.45*	0.58*	-0.04	-0.38*	-0.21	-	20.07*	13.27*
$P_3 \times P_7$	-3.16	0.58	-1.29	-	-	0.05*	-0.35	-0.41*	-0.38*	-0.40*	-0.50*	-0.45*	-	22.38*	12.68*
$P_3 \times P_8$	-2.09	1.46	-0.32	-	-	-0.02	0.01	0.02	0.02	-0.27	-0.40*	-0.34*	-	15.97*	8.78*
$P_4 \times P_5$	7.52*	3.38	5.45*	-	-	-0.03	0.04	0.46*	0.25	0.19	0.50*	0.35*	-	3.22	1.59
$P_4 \times P_6$	1.03	7.16*	4.09*	-	-	0.01	0.23	0.35	0.29	-0.49*	-0.72*	-0.60*	-	8.21	6.99*
$P_4 \times P_7$	1.52	1.19	1.35	-	-	0.06*	0.73*	0.62*	0.68*	-0.30	-0.51*	-0.40*	-	10.86*	8.29*
$P_4 \times P_8$	-0.88	2.57	0.84	-	-	-0.02	0.28	0.18	0.23	-0.32	-0.15	-0.23	-	14.18*	9.36*
$P_5 \times P_6$	3.22	7.57*	5.39*	-	-	-0.01	0.33	0.37	0.35*	-0.40*	-0.22	-0.31*	-	17.52*	13.80*
$P_5 \times P_7$	1.95	2.15	2.05	-	-	-0.04	0.36	0.38	0.37*	0.20	0.06	0.13	-	13.90*	12.79*
$P_5 \times P_8$	-2.04	-0.44	-1.24	-	-	0.00	-0.46*	-0.53*	-0.49*	-0.37	-0.44*	-0.40*	-	25.75*	17.50*
$P_6 \times P_7$	5.87*	-0.44	2.72	-	-	-0.02	0.21	0.13	0.17	-0.23	-0.16	-0.20	-	-2.40	-2.61
$P_6 \times P_8$	7.04*	-0.14	3.45*	-	-	0.06*	0.20	0.03	0.11	0.18	0.40*	0.29*	-	-10.32*	-7.41*
$P_7 \times P_8$	6.41*	4.12	5.26*	-	-	-0.06*	-0.03	0.03	0.00	1.05*	0.95*	1.00*	-	-17.39*	-13.35*
SE(Sij) ±	1.75	2.17	1.39	-	-	0.02	0.22	0.20	0.15	0.20	0.14	0.12	-	4.67	3.35
SE(Sij-Sik) ±	2.59	3.20	2.06	-	-	0.03	0.33	0.30	0.22	0.29	0.21	0.18	-	6.90	4.96
SE (Sij-Skl) ±	2.44	3.02	1.94	-	-	0.03	0.31	0.28	0.21	0.27	0.20	0.17	-	6.51	4.68
CD(Sij)	3.49	4.32	2.78	-	-	0.05	0.44	0.40	0.30	0.39	0.29	0.24	-	9.30	6.68
CD(Sij-Sik)	5.16	6.39	4.11	-	-	0.07	0.66	0.59	0.44	0.58	0.43	0.36	-	13.76	9.88
CD (Sij-Skl)	4.87	6.02	3.87	-	-	0.06	0.62	0.55	0.42	0.54	0.40	0.34	-	12.97	9.32

*Significant at 5% level of significance

Table.6 Estimates of specific combining ability effects for harvest duration, total soluble solids, ascorbic acid and titrable acidity flowering in tomato during 2012, 2013 and pooled over environments under organic conditions

Crosses	Harvest duration			Total soluble solids			Ascorbic acid			Titrable acidity		
$P_1 \times P_2$	6.26*	-5.35*	0.46	-0.13	-	-0.32*	6.32*	3.51*	4.92*	0.03	0.01	0.02*
$P_1 \times P_3$	-0.10	8.15*	4.02*	0.41*	-	0.39*	-4.60*	0.64	-1.98*	0.01	-0.03	-0.01
$P_1 \times P_4$	8.16*	-4.21	1.97	-0.20	-	-0.04	-0.53	-1.48	-1.01	0.08*	0.10*	0.09*
$P_1 \times P_5$	3.60	-10.81*	-3.61	0.41*	-	0.28	2.13*	-1.29	0.42	0.03	0.05	0.04*
$P_1 \times P_6$	-4.24	1.75	-1.24	-0.06	-	-0.07	5.36*	1.45	3.40*	-0.03	0.07*	0.02*
$P_1 \times P_7$	-7.07*	7.12*	0.02	-0.45*	-	-0.42*	-2.97*	-4.68*	-3.82*	-0.05	0.07*	0.01
$P_1 \times P_8$	-0.94	-5.01*	-2.98	-0.20	-	0.00	-8.15*	2.65*	-2.75*	-0.07*	0.01	-0.03*
$P_2 \times P_3$	0.00	-6.05*	-3.03	-0.04	-	0.01	1.55	3.74*	2.65*	-0.04	0.04	0.00
$P_2 \times P_4$	2.60	0.25	1.42	-0.21	-	-0.15	-4.65*	0.99	-1.83*	0.06*	0.11*	0.08*
$P_2 \times P_5$	9.03*	0.65	4.84*	0.10	-	0.13	-0.85	1.02	0.08	0.06*	0.01	0.04*
$P_2 \times P_6$	-6.14*	4.55	-0.79	0.26	-	0.30*	-4.61*	-4.21*	-4.41*	-0.03	-0.02	-0.03*
$P_2 \times P_7$	5.70	-3.75	0.97	-0.22	-	-0.16	-1.58*	-5.97*	-3.77*	0.00	0.05	0.03*
$P_2 \times P_8$	-1.50	3.45	0.97	0.19	-	-0.03	3.72*	1.54	2.63*	-0.07*	-0.03	-0.05*
$P_3 \times P_4$	0.56	-2.91	-1.18	0.30	-	0.19	2.15*	-2.19*	-0.02	0.03	0.03	0.03*
$P_3 \times P_5$	1.66	0.82	1.24	-0.16	-	-0.11	1.44	-0.20	0.62	0.07*	0.03	0.05*
$P_3 \times P_6$	2.50	1.39	1.94	-0.13	-	-0.26	0.06	3.98*	2.02*	0.05	-0.05	0.00
$P_3 \times P_7$	2.66	-8.25*	-2.79	0.38*	-	0.45*	3.03*	1.49	2.26*	0.09*	0.06*	0.07*
$P_3 \times P_8$	9.46*	3.95	6.71*	0.23	-	0.13	0.94	-3.59*	-1.32*	0.07*	0.08*	0.07*
$P_4 \times P_5$	-0.74	3.79	1.52	0.00	-	-0.11	0.56	-6.07*	-2.76*	0.00	0.06*	0.03*
$P_4 \times P_6$	-0.90	-2.65	-1.78	-0.40*	-	-0.09	2.15*	-0.37	0.89	-0.08*	-0.01	-0.05*
$P_4 \times P_7$	9.26*	5.05*	7.16*	0.11	-	0.05	0.32	0.32	0.32	-0.09*	0.01	-0.04*
$P_4 \times P_8$	4.73	-6.75*	-1.01	-0.24	-	-0.18	3.81*	3.68*	3.74*	0.08*	-0.03	0.03*
$P_5 \times P_6$	4.86	2.42	3.64	-0.23	-	-0.09	1.16	-2.93*	-0.88	0.00	0.02	0.01
$P_5 \times P_7$	4.70	2.12	3.41	0.12	-	0.03	1.52	5.81*	3.67*	-0.04	0.07*	0.02*
$P_5 \times P_8$	2.16	-4.68	-1.26	0.43*	-	0.37*	0.66	-1.37	-0.36	-0.07*	0.05	-0.01
$P_6 \times P_7$	4.86	-1.65	1.61	0.28	-	0.30*	3.99*	2.73*	3.36*	0.16*	0.07*	0.11*
$P_6 \times P_8$	8.33*	-0.45	3.94*	0.07	-	0.12	-0.20	-2.65*	-1.43*	0.13*	0.10*	0.11*
$P_7 \times P_8$	-6.84*	-2.08	-4.46*	0.58*	-	0.46*	2.59*	0.75	1.67*	0.12*	0.02	0.07*
SE(Sij) ±	3.00	2.38	1.91	0.18	-	0.15	0.79	0.81	0.57	0.03	0.03	0.01
SE(Sij-Sik) ±	4.43	3.52	2.83	0.26	-	0.22	1.17	1.20	0.84	0.04	0.04	0.02
SE (Sij-Skl) ±	4.18	3.32	2.67	0.25	-	0.20	1.10	1.13	0.79	0.04	0.04	0.02
CD(Sij)	5.97	4.74	3.81	0.35	-	0.29	1.57	1.61	1.13	0.06	0.06	0.02
CD(Sij-Sik)	8.84	7.02	5.64	0.52	-	0.43	2.33	2.39	1.67	0.09	0.09	0.04
CD (Sij-Skl)	8.33	6.62	5.32	0.49	-	0.40	2.19	2.25	1.57	0.08	0.08	0.03

*Significant at 5% level of significance

The best five specific combinations for marketable yield per plant in pooled environment were $P_4 \times P_6$, $P_5 \times P_6$, $P_4 \times P_5$, $P_3 \times P_5$ and $P_2 \times P_8$. The cross combination $P_4 \times P_6$ (Palam Pride × BWR-5) also revealed significant desirable SCA effects in component traits *viz.,* gross yield per plant, total number of fruits per plant, marketable fruits per plant, fruit weight and plant height. The cross combination $P_5 \times P_6$ exhibited desirable SCA effects for gross yield per plant, total number of fruits per plant, marketable fruits per plant, fruit weight, pericarp thickness and plant height, whereas $P_4 \times P_5$ for marketable fruits per plant, fruit weight, locules per fruit and titrable acidity. On the basis of specific combining ability effects, it can be concluded that among 28 cross-combinations studied, no single cross-combination possessed consistently significant SCA effects for all the traits studied.

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