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Combining ability, variances and their effects in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.)

Sriom and GC Yadav

Abstract

The present study was undertaken on bottle gourd in a 10 x 10 diallel cross excluding reciprocal. The 45 F₁ hybrid along with their ten parent were sown in RBD with three replication at the Main Experiment Station (MES), Department of Vegetable Science, N.D. University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) India to study the general and specific combining ability during Zaid 2017 (E₁) and 2018 (E₂). The selected parental lines are Pusa Naveen (P₁), NDBG-601 (P₂), PBOG-3 (P₃), NDBG-517 (P₄), NDBG-603 (P₅), NDBG-624 (P₆), N. Pooja (P₇), NDBG-100 (P₈), Punjab Komal (P₉), and NDBG-11 (P₁₀) were crossed in the all possible combinations, excluding reciprocals. For this experiment observations were recorded on all the six plants maintained for 17 metric traits viz. days to first staminate and pistillate flower anthesis, node number to first staminate and pistillate flower appearance, primary branches per plant, vine length (m), fruit circumference (cm), fruit weight (kg), fruit yield per plant (kg), T.S.S. (°B), reducing and non-reducing sugar (%), ascorbic acid (mg per 100 g fresh weight) and dry matter content.

Parents, P₄ and P₇ during and pooled while, P₁ x P₆ in E₁ and P₂, E₂ had showed significant positive GCA effects indicating their good general combining ability for fruit yield per plant. Parent, (P₁), and (P₆) were also found good general combiners for days to first harvest during both the seasons and pooled. Parent (P₁) was also found as the best general combiners for non-reducing sugars during both the seasons and pooled. Out of significant crosses for sca in pooled for fruit yield per plant the crosses with top sca as well as per se performance were P₄ x P₇, P₆ x P₁₀, P₂ x P₇, P₃ x P₄ and P₇ x P₈ may be utilized as F₁ hybrid.

Keywords: combining ability, GCA, SCA

Introduction

Bottle gourd (*Lagenariasiceraria* (Mol.) Standl, 2n = 2x = 22) is an important cultivated annual cucurbitaceous crop grown throughout the country. Being warm season vegetable crop it thrives well in warm and humid climate, its off-season cultivation has progressively stretched throughout the year in northern Indian plains. In India, the total area covered under bottle gourd is 0.117 million ha with production of 2.18 million tonnes and its productivity is 18.6 tonnes per ha. (Anonymous, 2018) [2].

According to De Candolle (1882), bottle gourd has been found in wild form in South Africa and India. However, Cutler and Whitaker (1961) [3] are of the view that probably it is indigenous to tropical Africa on the basis of variability in seeds and fruits.

It is highly cross pollinated because of monoecious sex form and exhibits large amount of variation for its quantitative and qualitative traits. This crop is well suited for improvement through inbreeding followed by selection without significant loss in vigour. Therefore, high yielding in bred can be developed easily with desired uniformity in agronomically important morphological traits.

Combining ability analysis helps in the evaluation of in bred in terms of genetic value and in the selection of suitable parent for hybridization. The superior specific cross combinations are also identified by this technique.

Material and Methods

The present investigation entitled "Studies on heterosis, combining ability and gene action in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] for growth, yield and quality traits" was conducted during Zaid 2017 (E₁) and 2018 (E₂) to study the heterosis over better parent and standard variety using diallel mating design at the Main Experiment Station (MES), Department of Vegetable Science, N.D. University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) India. The experiments were conducted in a Randomized Complete Block Design (RBD) with three replications to assess the performance of 45 F₁ hybrids and their 10 parental lines.

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The selected parental lines *i.e.* Pusa Naveen (P₁), NDBG-601 (P₂), PBOG-3 (P₃), NDBG-517 (P₄), NDBG-603 (P₅), NDBG-624 (P₆), N. Pooja (P₇), NDBG-100 (P₈), Punjab Komal (P₉), and NDBG-11 (P₁₀) were crossed in the all possible combinations, excluding reciprocals.

The combining ability analysis for different characters was carried out following the method 2 model 1 of Griffing (1956b) [4], where parents and F1's were included but not the reciprocals. Thus the experimental material for this method comprises of n(n+1)/2 genotypes.

Result and Discussion

Combining ability studies (Griffing, 1956 b) [4] are not only useful in analysing genetic architecture of the traits on the study but also help in evaluating the breeding value of parental lines on the basis of several parameters. The information thus, obtained helps in designing suitable breeding procedures for the genetic improvement of the crop and the selection of suitable parents which when crossed will give rise to more desirable F1 or segregates. Fixed effect model is appropriate if the number of parents does not exceed ten. Genetic analysis in the present investigation was done by two methods namely, variance component analysis Hayman (1954 a) [6] and combining ability analysis (Griffing, 1956 b) [4]. This analysis can be equated as gca variance consist of additive genetic variance and additive x additive interaction. The sca variance accounts for non-additive type of gene

action which is composed of dominant and epistatis (Griffing, 1956 b) [4] and can be equated to dominance variance by Hayman analysis (1954a) [6]. The choice of parents especially for heterosis breeding should be based on combining ability test and their mean performance (Yadav and Murty, 1966) [12, 13].

In bottle gourd, combining ability analysis have been made for two seasons F1 following diallel analysis by Singh, *et al.*, 2006 [1, 10, 11], Gayakawad *et al.* 2016 [5] and Adarsh *et al.* 2017 [1].

Perusal of table-1.2 revealed that the mean squares due to environments were found significant for all the traits. The mean squares due to interaction effects of GCA vs environments and SCA vs environments were found significant for all the trait. The estimates of highly significant gca and sca variances revealed that both additive and non-additive gene action were important in the expression of all the 18 traits studied. Thus, both selection and heterosis breeding methods, respectively might be advantageous for effective utilization of additive and non-additive genetic variances for improvement of these traits. Similar findings had also been reported by Sharma (2007) [9, 10], Gayakawad *et al.* (2016) [5] and Adarsh *et al.* (2017) [1] in bottle gourd. Variation in the magnitude of gca and sca variances were also observed which may be due to environmental influence. Similar findings were also reported by Maurya (1994) [8].

Table 1.1: Analysis of variance (mean squares) for combining ability in 10 x 10 diallel cross of bottle gourd during two seasons (E₁, E₂)

Source of variation	Seasons	d.f.	Days to first staminate flower anthesis	Days to first pistillate flower anthesis	Node number to first staminate flower appearance	Node number to first pistillate flower appearance	Days to first fruit harvest	Vine length (m)	Number of primary branches per plant	Fruit length (cm)	Fruit circumference (cm)
GCA	E ₁	9	8.19**	36.09**	0.61	2.85**	26.22**	1.18**	40.02**	82.78**	7.76**
	E ₂	9	24.34**	26.02**	1.21**	3.14**	17.89**	1.10**	39.75**	217.53**	10.00**
SCA	E ₁	45	14.76**	8.72**	0.69**	1.21**	11.55**	0.68**	7.71**	75.73**	4.59**
	E ₂	45	18.57**	18.28**	0.81**	1.45**	13.64**	0.73**	16.09**	32.85**	6.19**
Error	E ₁	108	2.16	2.55	0.34	0.29	2.81	0.03	0.18	2.27	0.48
	E ₂	45	4.47	2.56	0.21	0.12	3.08	0.02	0.50	1.86	0.50

*, ** Significant at 5 percent and 1 percent probability levels, respectively

Source of variation	Seasons	d.f.	Fruit weight (kg)	Number of fruits per plant	Fruit yield per plant (kg)	T.S.S. (%)	Ascorbic acid (mg/100g)	Sugars		
								Reducing sugar (%)	Non-reducing sugar (%)	Dry matter content fruit
GCA	E ₁	9	0.08**	0.94**	0.76**	0.12**	0.07	0.19**	0.00**	0.21**
	E ₂	9	0.04**	1.84**	0.42**	0.24**	0.09*	0.31**	0.00**	0.21**
SCA	E ₁	45	0.07**	1.20**	0.49**	0.34**	0.04	0.30**	0.00**	0.15**
	E ₂	45	0.02**	2.18**	0.78**	0.35**	0.06	0.28**	0.00**	0.15**
Error	E ₁	108	0.00	0.13	0.05	0.02	0.05	0.02	0.00	0.02
	E ₂	45	0.00	0.14	0.04	0.02	0.04	0.02	0.00	0.02

*, ** Significant at 5 percent and 1 percent probability levels, respectively

Table 1.2: Analysis of variance (mean squares) for combining ability in 10 x 10 diallel cross of bottle gourd over seasons (pooled)

Source of variation	d.f.	Days to first staminate flower anthesis	Days to first pistillate flower anthesis	Node number to first staminate flower appearance	Node number to first pistillate flower appearance	Days to first fruit harvest	Vine length (m)	Number of primary branches per plant	Fruit length (cm)	Fruit circumference (cm)
GCA	9	20.24**	33.46**	1.07**	4.08**	42.38**	1.90**	57.65**	202.06**	14.39**
SCA	45	14.76**	18.75**	1.09**	1.22**	24.41**	1.13**	16.18**	53.10**	9.40**
Environments	1	408.29**	59.24**	0.00	3.32**	1.37	5.75**	97.73**	1867.84**	0.62
GCA×Environments	9	12.29**	28.66**	0.75**	1.90**	1.73	0.37**	22.12**	98.25**	3.36**
SCA×Environments	45	18.56**	8.25**	0.42*	1.45**	0.78	0.28**	7.62**	55.48**	1.38**
Error	216	3.32	2.55	0.27	0.21	2.94	0.03	0.34	2.06	0.49

*, ** Significant at 5 percent and 1 percent probability levels, respectively

Source of variation	d.f.	fruit weight (kg)	Number of fruits per plant	Fruit yield per plant (kg)	T.S.S. (%)	Ascorbic acid (mg/100g)	Sugars		
							Reducing sugar (%)	Non-reducing sugar (%)	Dry matter content fruit
GCA	9	0.02**	0.93**	0.51**	0.22**	0.13**	0.35**	0.01**	0.42**
SCA	45	0.04**	1.66**	0.55**	0.61**	0.09**	0.53**	0.01**	0.32**
Environments	1	0.64**	1.72**	0.00	0.10	0.01	0.00	0.00**	0.00
GCA×Environments	9	0.10**	1.85**	0.67**	0.14**	0.02	0.15**	0.01	0.00
SCA×Environments	45	0.05**	1.72**	0.72**	0.07**	0.01	0.06**	0.00**	0.00
Error	216	0.00	0.13	0.05	0.02	0.04	0.02	0.00	0.02

*, ** Significant at 5 percent and 1 percent probability levels, respectively

General combining ability effects

General combining ability study helps in making the choice of the parents and also helps in the isolation of suitable germplasm for further improvement. General combining ability is primarily a function of additive and additive x additive gene action.

Perusal of Table-2 revealed that gca effects of all the characters differed over seasons. Variation in gca effects had also been noticed by Singh *et al.* (1999) ^[1, 10, 11] and Yadav and Kumar (2012) ^[12, 13]. Parent P-1 had good gca effects for days to first staminate flower anthesis, node number to first pistillate flower anthesis, days to first fruit harvest. Parent had

good GCA effects for P₂ number of primary branches per plant, P₃ for fruit weight (kg), P₄ for vine length (m), number of primary branches per plant, fruit length (cm), non-reducing sugar (%), P₅ for vine length (m), number of primary branches per plant, P₆ for days to first fruit harvest, vine length (m), P₇ for dry matter content in fruit, P₈ for vine length (m), number of fruit per plant, P₉ for fruit circumference (cm), number of fruit per plant, TSS, ascorbic acid and dry matter such variation may be due to differences in genotypic constitution of the parents for different characters. Similar results had also been reported by Yadav and Kumar (2012) ^[12, 13].

Table 2: Estimates of G.C.A. effects of parents in 10 x 10 diallel cross of bottle gourd during two seasons (E₁, E₂) and over seasons (pooled)

Traits Um Parents	Days to first staminate flower anthesis			Days to first pistillate flower anthesis			Node number to first staminate flower appearance			Node number to first pistillate flower appearance			Days to first fruit harvest		
	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled
	P ₁	-0.81*	-3.15**	-1.98**	-0.35	-2.12**	-1.23**	-0.01	-0.34**	-0.18	-0.86**	-0.86**	-0.49**	-2.12**	-1.56**
P ₂	0.66	1.70**	1.18**	2.571**	0.14	1.35**	0.30	0.52**	0.41**	1.17**	1.17**	0.96**	2.61**	2.02**	2.32**
P ₃	-0.29	1.07	0.39	1.32**	-0.02	0.650*	0.16	-0.17	-0.00	0.03	0.03	-0.40**	1.34**	0.82	1.08**
P ₄	1.12**	0.22	0.67	1.84**	1.32**	1.58**	-0.15	-0.54**	-0.34**	0.24*	0.24*	0.08	1.21**	0.80	1.00**
P ₅	-1.02*	-0.60	-0.81*	-1.74**	-2.38**	-2.06**	-0.27	-0.02	-0.14	-0.10	-0.10	0.09	0.84	0.70	0.77*
P ₆	-1.23**	0.90	-0.16	-2.66**	1.91**	-0.37	-0.12	0.24	0.06	0.02	0.02	-0.19*	-1.79**	-1.90**	-1.84**
P ₇	-0.16	-0.56	-0.36	-1.39**	0.44	-0.47	0.20	-0.09	0.05	0.07	0.07	0.20*	-0.48	-0.07	-0.28
P ₈	0.34	1.46*	0.90*	-0.14	1.75**	0.80*	0.19	0.23	0.21*	-0.13	-0.13	-0.08	-0.49	0.61	0.06
P ₉	0.80*	-0.63	0.08	-0.90*	-0.68	-0.79*	-0.37*	0.25*	-0.06	-0.32**	-0.32**	0.11	-0.58	-0.75	-0.66*
P ₁₀	0.57	-0.41	0.08	1.47**	-0.37	0.54	0.07	-0.08	-0.00	-0.14	-0.14	-0.29**	-0.52	-0.68	-0.60
SE (gi)	0.91*	1.31*	1.03	0.99*	0.99*	0.91	0.36*	0.287*	0.30	0.33*	0.22**	0.26	1.03*	1.08*	0.97
SE (gi-gj)	1.35*	1.95*	1.36	1.47*	1.478*	1.20	0.54*	0.42*	0.39	0.50*	0.33**	0.34	1.54	1.62*	1.28

*, ** Significant at 5 percent and 1 percent probability levels, respectively

Traits Um Parents	Vine length (m)			Number of primary branches per plant			Fruit length (cm)			Fruit circumference (cm)			Fruit weight (kg)		
	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled
P ₁	-0.22**	0.17**	-0.02	-0.74**	-1.89**	-1.32**	-	-0.35	-	0.41*	0.25	0.33*	0.14**	-	0.02*
P ₂	0.44**	0.07	0.22**	4.67**	1.35**	3.01**	0.20	-	-	-0.07	-0.19	-0.13	0.03	-0.03*	-0.01
P ₃	-0.20**	-0.27**	-0.23**	-1.06**	-1.03**	-1.05**	5.13**	0.05	2.60**	-0.55**	-0.23	-0.39**	0.08**	0.02*	0.05**
P ₄	0.22**	0.18**	0.20**	0.95**	0.94**	0.95**	4.28**	4.02**	4.15**	-0.25	-0.94**	-0.60**	0.08**	-	0.01
P ₅	0.14**	0.15**	0.14**	0.64**	0.59**	0.62**	-	2.15**	0.51	-1.01**	-1.20**	-1.10**	-	-0.00	-
P ₆	0.15**	0.37**	0.26**	-0.58**	3.88**	1.65**	-0.29	2.45**	1.08**	-0.72**	1.21**	0.24	0.11**	0.04**	-
P ₇	-0.10	0.12**	0.01	-1.64**	-1.76**	-1.70**	-0.88*	0.79*	-0.04	0.25	-0.48*	-0.11	0.01	-	-0.01
P ₈	0.31**	0.21**	0.26**	-0.31**	0.39*	0.04	-	5.48**	1.97**	0.41*	0.30	0.36**	-	0.10**	0.02*
P ₉	-0.13*	-0.43**	-0.28**	-0.73**	-0.69**	-0.71**	-	-	-	1.84**	1.72**	1.78**	-	0.07**	0.01
P ₁₀	-0.61**	-0.52**	-0.57**	-1.18**	-1.79**	-1.49**	-	-	-	-0.31	-0.43*	-0.37**	-0.02	-0.03*	-
SE (gi)	0.11	0.10	0.10	0.26	0.43	0.33	0.93	0.84	0.81	0.43	0.43	0.40	0.03	0.03**	0.03
SE (gi-gj)	0.17	0.15	0.07	0.40	0.65	2.38	1.39	1.26	8.33	0.64	0.65	0.57	0.05	0.04	0.01

*, ** Significant at 5 percent and 1 percent probability levels, respectively

Table 2 Contd.

Parents	Number of fruits per plant			Fruit yield per plant (kg)			Total soluble solids (TSS)			Ascorbic acid (mg/100 g fresh fruit)		
	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled
P ₁	-0.44**	0.26*	-0.09	0.19**	-0.29**	-0.05	0.14**	-0.15**	-0.00	-0.03	-0.08	-0.06
P ₂	-0.31**	0.11	-0.10	-0.26**	-0.17**	-0.22**	0.00	-0.08	-0.04	0.07	0.02	0.05
P ₃	-0.33**	-0.16	-0.24**	-0.09	0.06	-0.01	-0.17**	-0.24**	-0.21**	0.03	0.07	0.05
P ₄	0.11	0.199	0.15*	0.42**	0.08	0.25**	0.08	0.07	0.07*	0.03	0.08	0.06
P ₅	0.19	0.06	0.12	-0.01	-0.00	-0.013	-0.10*	0.16**	0.02	0.04	0.01	0.03
P ₆	0.42**	-0.54**	-0.062	0.15**	-0.20**	-0.00	0.08	0.04	0.06*	0.09	0.06	0.08
P ₇	0.06	0.77**	0.42**	0.09	0.35**	0.22**	0.08	0.17**	0.12**	-0.08	-0.17**	-0.13**
P ₈	-0.00	-0.33**	-0.16*	-0.43**	0.17**	-0.13**	-0.08	-0.11*	-0.09**	-0.05	-0.05	-0.04
P ₉	0.23*	-0.46**	-0.11	0.08	-0.002	0.04	-0.07	0.11*	0.02	-0.15*	-0.02	-0.09*
P ₁₀	0.07*	0.09*	0.08*	-0.17**	0.00*	-0.08*	0.03*	0.03*	0.03*	0.02*	0.09*	0.05**
SE (gi)	0.22*	0.23*	0.21	0.14*	0.13*	0.12	0.10*	0.10*	0.09	0.13*	0.13*	0.12
SE (gi-gj)	0.34*	0.34*	0.27	0.22*	0.19*	0.17	0.15*	0.15*	0.12	0.20*	0.20*	0.16

*, ** Significant at 5 percent and 1 percent probability levels, respectively

Parents	Reducing sugar (%)			Non-reducing sugar (%)			Dry matter content in fruit		
	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled
P ₁	0.15**	-0.05	0.05	-0.04**	-0.03**	-0.03**	-0.07	-0.07	-0.07*
P ₂	-0.15**	-0.15**	-0.13**	0.03**	0.01	0.02**	-0.06	-0.06	-0.06*
P ₃	-0.07	0.13**	0.02	-0.01*	-0.01	-0.0**	0.01	0.01	0.01
P ₄	-0.10**	-0.15**	-0.13**	0.02**	0.02**	0.02**	-0.04	-0.04	-0.04
P ₅	0.20**	0.04	0.12**	-0.02**	-0.00	-0.01**	0.06	0.06	0.06*
P ₆	0.02	0.23**	0.13**	-0.02**	-0.02**	-0.02**	0.06	0.06	0.06*
P ₇	-0.13**	-0.18**	-0.15**	0.02**	-0.00	0.01*	0.17**	0.17**	0.17**
P ₈	0.10*	-0.05	0.02	0.01*	0.00	0.01*	0.03	0.03	0.03
P ₉	0.05	0.26**	0.15**	-0.00	0.01	0.00	-0.29**	-0.29**	-0.29**
P ₁₀	-0.07	-0.12**	-0.10**	0.00	0.03**	0.01**	0.13**	0.13**	0.13**
SE (gi)	0.09*	0.09*	0.08	0.01*	0.01*	0.014	0.09	0.09*	0.08
SE (gi-gj)	0.13*	0.13*	0.11	0.02*	0.02*	0.019	0.14*	0.14**	0.11

*, ** Significant at 5 percent and 1 percent probability levels, respectively

The ranking of desirable parents on the basis of gca effects for 17 traits revealed that it was difficult to pickup a single good combiner for all the traits. However, parents P₄ and P₇ were found as good general combiners for fruits yield per plant. Parent P₁ and P₆ also emerged as good general combiner days to first harvest (early maturity), and P₄ for reducing sugar and P₈ x P₁₀ for dry matter in both the season and pooled. This show that parents having good gca effects for yield also had good gca effects for one or more yield components.

Specific combining ability effects

The crosses showing high SCA effects involving parents with high GCA effects may give rise desirable segregants in future

generation. The specific combining ability effects of the forty five crosses for 17 traits in both the seasons and over environments have been presented in Table-2. Perusal of Table-3 revealed that significant positive and negative sca effects were observed for all the traits. However, none of the crosses had significant sca effect for all the traits. Further, sca effects were found to vary in nature and magnitude for all the characters with the change of seasons. This varying magnitude of sca effects over seasons may be due to environmental effects and genotypes, respectively. Murya (1994)^[8] and Janaranjani *et al.* (2016)^[7] also reported similar results.

Table 3: Estimates of SCA effects of F₁ hybrids in 10 x 10 diallel cross of bottle gourd over two seasons (E₁, E₂) and pooled

Crosses	Days to first staminate flower anthesis			Days to first pistillate flower anthesis			Node number to first staminate flower appearance			Node number to first pistillate flower appearance			Days to first fruit harvest		
	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled
P ₁ × P ₂	-4.53**	2.13	-1.20	1.42	2.22	1.82	0.72	0.17	0.44	-0.05	-1.84**	-0.94**	1.06	0.89	0.97
P ₁ × P ₃	5.93**	1.62	3.78**	2.29	-2.60	-0.15	0.01	0.07	0.04	0.50	0.30	0.40	-0.59	-0.82	-0.71
P ₁ × P ₄	-1.49	3.36	0.93	-0.29	-4.21**	-2.25*	-0.77	-0.39	-0.58	0.54	-0.13	0.20	0.24	-0.09	0.07
P ₁ × P ₅	-2.00	2.78	0.38	-1.68	-3.43*	-2.55*	-0.15	0.28	0.06	0.21	-0.51	-0.14	-0.44	-1.05	-0.74
P ₁ × P ₆	-3.68**	-5.35**	-4.52**	-2.10	2.67	0.28	-0.24	0.22	-0.01	0.05	0.09	0.07	2.73	2.09	2.41*
P ₁ × P ₇	-4.95**	-2.28	-3.61**	-2.67	-8.96**	-5.82**	-0.32	-0.13	-0.23	0.86	1.06**	0.96**	-0.18	-1.34	-0.76
P ₁ × P ₈	-1.22	1.38	0.08	2.19	-0.34	0.92	0.43	-0.17	0.13	-0.15	0.19	0.02	-2.81	-4.68**	-3.75**
P ₁ × P ₉	-0.75	-0.52	-0.64	-1.52	-3.93*	-2.72**	0.01	-0.54	-0.26	-1.90**	-0.30	-1.10**	0.49	-0.08	0.20
P ₁ × P ₁₀	2.33	8.95**	5.64**	3.12*	4.74**	3.93**	-1.62**	-0.63	-1.13**	0.54	0.38	0.46	2.17	1.59	1.88
P ₂ × P ₃	-2.68	-1.93	-2.30	-2.34	-0.65	-1.49	-0.09	-0.86*	-0.47	0.23	-0.14	0.04	-6.22**	-5.29**	-5.75**
P ₂ × P ₄	0.26	3.14	1.70	0.31	0.18	0.25	0.07	-0.83	-0.37	-1.08*	-1.72**	-1.42**	1.18	1.99	1.59
P ₂ × P ₅	-1.76	-1.21	-1.48	-2.69	-3.27*	-2.98**	-0.95	0.41	-0.26	-1.07*	1.13**	0.03	0.35	0.89	0.62
P ₂ × P ₆	-5.06**	-4.97*	-5.01**	-6.22**	-8.59**	-7.41**	0.87	-0.69	0.09	1.18*	0.59	0.89**	-2.24	-1.73	-1.99
P ₂ × P ₇	-6.50**	1.88	-2.30	-0.53	-0.45	-0.49	0.47	0.82	0.65	0.23	-0.34	-0.05	3.13*	3.12	3.12**
P ₂ × P ₈	5.60**	-1.22	2.19	9.46**	7.37**	8.42**	-0.09	1.18**	0.54	0.25	1.98**	1.11**	11.55**	10.84**	11.20**
P ₂ × P ₉	0.83	2.48	1.66	-0.12	1.07	0.47	0.53	0.00	0.26	-0.13	-0.79	-0.46	2.23	2.80	2.52*
P ₂ × P ₁₀	0.32	1.78	1.01	-1.33	1.86	0.26	-0.74	-0.35	-0.54	-0.95	-0.73	-0.84**	-0.01	0.55	0.26
P ₃ × P ₄	3.06*	-7.64**	-2.28	-0.41	0.034	-0.19	0.41	0.43	0.42	-0.33	1.20*	0.43	5.80**	6.55**	6.18**

P ₃ × P ₅	4.40**	-5.74**	-0.67	4.42**	3.79*	4.11**	-0.16	0.62	0.22	0.64	-0.35	0.14	4.76**	5.23 **	5.00**
P ₃ × P ₆	-5.71**	3.96*	-0.90	0.12	-3.26*	-1.57	-0.62	-2.16**	-1.39**	2.54**	-1.80**	0.36	0.80	1.24	1.02
P ₃ × P ₇	-5.29**	6.32**	0.51	-3.81*	3.62*	-0.09	-0.84	-0.87*	-0.86*	-3.81**	0.49	-1.63**	-3.38*	-3.45*	-3.42**
P ₃ × P ₈	2.62	-3.82	-0.59	1.48	0.67	1.08	-0.11	-0.52	-0.31	0.21	1.32**	0.79**	6.10**	5.33**	5.71**
P ₃ × P ₉	3.31*	3.28	3.30**	1.41	2.29	1.85	-0.16	0.79	0.31	1.15*	-1.19**	-0.01	2.40	2.90	2.65*
P ₃ × P ₁₀	-5.11**	3.92	-0.59	-0.78	-1.57	-1.17	1.33 *	0.73	1.03**	-0.95	0.01	-0.47	2.33	2.84	2.58*

*, ** Significant at 5 percent and 1 percent probability levels, respectively

Traits Crosses	Days to first staminate flower anthesis			Days to first pistillate flower anthesis			Node number to first staminate flower appearance			Node number to first pistillate flower appearance			Days to first fruit harvest		
	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled
P ₄ × P ₅	-0.23	1.37	0.57	1.21	1.31	1.26	-0.39	-1.80**	-1.10**	1.94**	0.66*	1.30**	0.80	1.16	0.95
P ₄ × P ₆	-0.60	2.18	0.79	1.71	-0.90	0.40	-0.22	0.84	0.30	-0.16	-1.50**	-0.83**	0.10	0.43	0.27
P ₄ × P ₇	-4.32**	1.90	-1.20	1.15	-2.34	-0.59	0.47	0.28	0.38	0.52	-0.03	0.24	-1.41	-1.60	-1.50
P ₄ × P ₈	-1.30	3.785	1.241	0.040	-0.100	-0.030	-0.117	1.174 **	0.528	-0.693	-1.600 ***	-1.14**	-2.72	-3.61 *	-3.16**
P ₄ × P ₉	-1.13	-3.19	-2.16	1.14	-0.91	0.11	-1.22*	-2.19**	-1.70**	-0.21	-1.08**	-0.65*	1.01	1.40	1.21
P ₄ × P ₁₀	-0.19	-1.37	-0.78	0.74	2.30	1.52	0.65	0.28	0.46	-1.56 **	-0.12	-0.87**	1.36	1.75	1.56
P ₅ × P ₆	-2.20	-4.85*	-3.53**	-1.55	3.06*	0.75	-0.21	0.54	0.16	-1.04 *	1.68**	0.32	-0.97	-0.91	-0.94
P ₅ × P ₇	6.13**	5.69**	5.91**	2.55	-2.86	-0.15	0.29	-0.78	-0.24	0.52	-1.13**	-0.30	-1.23	-1.69	-1.46
P ₅ × P ₈	-2.67	5.71**	1.52	-3.73*	2.73	-0.50	0.98	0.41	0.70*	-0.80	0.66	-0.07	-3.82*	-4.99**	-4.40**
P ₅ × P ₉	0.11	4.14*	2.12	3.16*	5.10**	4.13**	-0.65	-0.38	-0.51	0.15	-0.31	-0.08	1.37	1.49	1.43
P ₅ × P ₁₀	3.16*	-4.36*	-0.60	1.93	5.49**	3.71**	0.85	-0.17	0.34	0.79	-1.87**	-0.54	3.89*	4.01*	3.95**
P ₆ × P ₇	4.05**	-7.85**	-1.90	4.48**	-1.73	1.37	-1.30*	-1.50**	-1.40**	-1.62**	-0.78*	-1.20**	0.02	-0.45	-0.21
P ₆ × P ₈	-2.68	2.44	-0.12	-1.77	-4.07**	-2.92**	-0.30	0.09	-0.10	0.37	-1.41**	-0.52	0.57	-0.61	-0.02
P ₆ × P ₉	2.61	-3.46	-0.42	-0.51	-0.65	-0.52	-0.28	0.91*	0.31	0.05	-0.45	-0.20	-1.37	-1.28	-1.32
P ₆ × P ₁₀	0.73	4.94*	2.84*	2.72	0.44	1.58	-1.66**	-0.20	-0.93**	0.26	-1.136**	-0.43	-1.59	-1.50	-1.55
P ₇ × P ₈	1.78	-0.72	0.53	-2.93	-3.30*	-3.12**	-0.19	-0.63	-0.41	-0.01	0.33	0.16	-1.39	-3.10	-2.25*
P ₇ × P ₉	3.23*	-5.09*	-0.92	5.34**	4.30**	4.82**	1.37*	-0.19	0.59	-0.24	-0.20	-0.22	-2.85	-3.27*	-3.06**
P ₇ × P ₁₀	2.29	0.38	1.34	-4.12**	3.90*	-0.13	-0.73	0.75	0.01	0.07	0.34	0.21	2.27	1.84	2.05
P ₈ × P ₉	2.21	2.90	2.56*	-2.94	2.49	-0.21	-1.38*	-1.03*	-1.21**	-0.09	-0.97**	-0.53	-0.88	-2.01	-1.45
P ₈ × P ₁₀	2.10	-1.10	0.49	-2.41	-1.35	-1.88	0.28	0.37	0.33	-0.40	1.74**	0.66*	-0.80	-1.93	-1.37
P ₉ × P ₁₀	-0.85	-0.33	-0.59	0.51	3.27 *	1.89	-0.26	-0.12	-0.19	-0.38	1.62**	0.62*	-2.36	-2.21	-2.28*
SE (Sij)	2.73	3.92	3.44	2.96	2.97	3.01	1.08	0.86	0.86	1.00	0.66	3.23	3.11	3.25	3.23
SE (Sij-Sik)	4.01	5.77	3.28	4.36	4.36	2.87	1.59	1.26	0.82	1.47	0.98	3.08	4.57	4.78	3.08

Table-3: Cont...

Traits Crosses	Vine length (m)			Number of primary branches per plant			Fruit length (cm)			Fruit circumference (cm)			Fruit weight (kg)		
	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled
P ₁ × P ₂	0.69**	0.09	0.39**	1.37 **	3.89**	2.63**	3.17 *	5.14**	4.15**	2.28**	2.44**	2.36**	-0.10*	-0.09*	-0.10**
P ₁ × P ₃	0.00	-0.41 *	-0.20	-1.21**	-1.88**	-1.55**	-4.42**	10.12**	2.85**	1.27	0.98	1.12*	0.01	0.16**	0.09**
P ₁ × P ₄	0.22	-0.47**	-0.12	-2.53**	-3.67**	-3.10**	-1.23	-5.66**	-3.45**	-3.03**	2.29**	-2.66**	-0.25**	0.13**	-0.05
P ₁ × P ₅	-0.69**	0.78**	0.04	1.64**	0.50	1.07**	-0.53	10.66**	5.06**	0.85	1.09	0.97*	-0.33**	0.011	-0.16**
P ₁ × P ₆	-0.57**	-1.14**	-0.85**	-0.09	-1.83**	-0.96*	3.34*	-8.27**	-2.44**	0.66	-1.23	-0.26	0.12*	0.01	0.06
P ₁ × P ₇	0.11	0.92**	0.52**	-0.39	-0.47	-0.43	0.60	1.29	0.94	0.69	1.47*	1.08*	0.56**	-0.21**	0.17**
P ₁ × P ₈	-0.75**	-0.00	-0.37**	-1.49**	-1.40*	-1.44**	-0.67	9.43**	4.38**	0.92	1.08	1.00*	0.14**	0.03	0.09**
P ₁ × P ₉	1.20**	0.22	0.71**	6.39**	7.68**	7.03**	-0.11	-2.84 *	-1.47	-1.89**	-1.74*	-1.81**	-0.02	-0.04	-0.03
P ₁ × P ₁₀	0.37*	-0.23	0.06	3.24**	4.22**	3.73**	-0.57	-3.22**	-1.89*	0.49	0.65	0.57	0.030	0.04	0.03
P ₂ × P ₃	-0.22	-0.22	-0.22	0.42	4.04**	2.23**	-2.76	1.29	-0.73	-2.14**	-2.47**	-2.31**	0.138*	0.074	0.10**
P ₂ × P ₄	-1.06**	-0.91**	-0.98**	-3.22**	1.99**	-0.61	-3.94**	-3.99**	-3.96**	0.71	1.41*	1.06*	0.02	-0.02	0.00
P ₂ × P ₅	-0.06	-0.09	-0.08	2.08**	3.53**	2.80**	6.55**	-3.62**	1.46	1.64*	1.84**	1.72**	-0.18**	0.25**	0.03
P ₂ × P ₆	0.57**	1.22**	0.90**	2.84**	1.60*	2.22**	-0.83	2.43	0.80	0.42	-1.51*	-0.54	-0.16**	-0.09	-0.12**
P ₂ × P ₇	0.11	0.69**	0.40**	-1.92**	2.84**	0.46	5.41**	-3.62 **	0.89	-0.42	0.32	-0.05	-0.20**	-0.07	-0.14**
P ₂ × P ₈	-0.90**	-0.60**	-0.75**	-3.08**	-2.56**	-2.82**	-1.21	4.91**	1.85*	1.94**	2.06**	2.00**	-0.15**	0.08	-0.03
P ₂ × P ₉	-0.62**	-0.46 **	-0.54**	-3.73**	1.16	-1.28**	-1.68	2.07	0.19	-4.30**	-4.19**	-4.25**	-0.21**	0.28**	0.03
P ₂ × P ₁₀	-0.02	-0.50**	-0.26*	-3.01**	2.44**	-0.28	-2.17	0.59	-0.79	-0.01	0.09	0.04	0.17**	0.27**	0.18
P ₃ × P ₄	0.51**	0.00	0.26*	4.18**	5.35**	4.77**	50.26**	0.53	25.39**	0.66	0.91	0.79	0.08	0.01	0.04
P ₃ × P ₅	-1.30**	-1.27**	-1.29**	2.22**	-0.25	0.98*	-8.40**	-1.54	-4.97**	-1.97**	-2.22**	-2.09**	-0.04	-0.15**	-0.09**
P ₃ × P ₆	-0.37*	-0.69**	-0.53**	-2.11**	2.27**	0.08	-0.06	-4.44**	-2.25 *	1.78**	-0.60	0.58	-0.01	0.12*	0.05
P ₃ × P ₇	0.83**	0.55**	0.69**	-2.91**	-3.32**	-3.12**	2.98*	5.61**	4.30**	3.39**	3.69**	3.54**	-0.05	-0.04	-0.05
P ₃ × P ₈	-0.68**	-1.02**	-0.85**	-0.11	-0.90	-0.50	-5.92**	1.47	-2.22*	-2.40**	-2.73**	-2.56**	-0.10	-0.31**	-0.20**
P ₃ × P ₉	-0.99**	-0.54**	-0.77**	2.01**	0.52	1.26**	-4.48**	2.94*	-0.76	-0.68	-1.02	-0.85	0.20**	-0.13**	0.03
P ₃ × P ₁₀	0.45*	0.56**	0.51**	3.49**	3.31**	3.40**	-1.27	0.02	-0.62	1.47*	1.13	1.30**	-0.37**	-0.05	-0.21**

Traits Crosses	Vine length (m)			Number of primary branches per plant			Fruit length (cm)			Fruit circumference (cm)			Fruit weight (kg)		
	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled
P ₄ × P ₅	0.73**	0.59**	0.66**	0.53	2.06**	1.30**	-1.05	5.34**	2.14*	-0.54	0.22	-0.15	-0.10	0.02	-0.03
P ₄ × P ₆	-0.96**	0.49 **	-0.23*	3.00**	-0.71	1.14**	-3.60*	-1.75	-2.68**	2.33**	0.96	1.65**	-0.28**	0.14**	-0.06
P ₄ × P ₇	-0.46**	0.93**	0.23*	0.89*	0.91	0.90 *	-11.62**	-1.86	-6.74**	0.18	1.50*	0.84	0.20**	-0.12**	0.03
P ₄ × P ₈	-0.02	-0.33*	-0.17	5.59**	4.73**	5.16**	-5.49**	0.16	-2.66**	0.16	0.84	0.50	-0.01	-0.11*	-0.06
P ₄ × P ₉	-0.69**	0.69**	0.00	-0.11	3.87**	1.88**	-5.56**	-0.84	-3.20**	-0.60	0.08	-0.26	-0.07	-0.14**	-0.11**
P ₄ × P ₁₀	-0.72**	-1.29**	-1.00**	0.34	1.12	0.73	-1.82	8.27**	3.22**	-2.16**	-1.47*	-1.81**	0.10	-0.00	0.04
P ₅ × P ₆	1.27**	-0.35*	0.45**	-1.35**	-5.61**	-3.48**	-1.57	5.25**	1.83	0.23	-1.63 *	-0.70	0.43**	-0.06	0.18**

P ₅ × P ₇	0.37*	-0.32*	0.02	0.30	-0.44	-0.06	1.18	-6.00**	-2.41*	0.11	0.93	0.52	-0.09	-0.37**	-0.23**
P ₅ × P ₈	0.12	0.98**	0.55**	2.04**	1.82*	1.93**	-0.46	-9.87**	-5.16**	1.48*	1.67*	1.58**	0.04	0.04	0.04
P ₅ × P ₉	-1.26**	-1.50**	-1.38**	-1.27**	-2.49**	-1.88**	0.93	-3.21*	-1.14	-2.56**	-2.38**	-2.47**	-0.61**	-0.14**	-0.38**
P ₅ × P ₁₀	0.07	1.31**	0.69**	0.782	5.24**	3.01**	3.542*	-7.73**	-2.09*	1.32*	1.51*	1.41**	0.08	0.16**	0.12**
P ₆ × P ₇	0.52**	-0.51**	0.00	0.77	-2.35**	-0.78*	-0.24	9.01**	4.38**	-1.20	-2.52**	-1.86**	-0.75**	0.17**	-0.29**
P ₆ × P ₈	0.78**	0.85**	0.82**	3.07**	-1.16	0.95*	1.28	-4.76**	-1.73	0.00	-1.95**	-0.97*	-0.01	0.13**	0.06
P ₆ × P ₉	-0.18	0.10	-0.04	0.62	-5.59**	-2.48**	0.84	-4.09**	-1.62	-1.30*	-3.26**	-2.28**	0.01	-0.17**	-0.07*
P ₆ × P ₁₀	-0.91**	-1.29**	-1.10**	-1.78**	-5.12**	-3.45**	-5.74**	8.64**	1.45	-0.76	-2.71**	-1.73**	-0.03	-0.06	-0.05
P ₇ × P ₈	-0.21	-0.27	-0.24*	1.17**	1.28	1.22**	2.11	9.28**	5.69**	-0.03	0.70	0.33	0.27**	0.01	0.14**
P ₇ × P ₉	-1.41**	-1.11**	-1.26**	0.06	-1.78*	-0.83*	-0.07	-2.00	-1.03	-4.40**	-3.66**	-4.03**	-0.08	0.16**	0.04
P ₇ × P ₁₀	-0.89**	-1.1**	-1.03**	-0.25	0.27	0.00	0.21	-0.53	-0.16	-2.47**	-1.74*	-2.11**	-0.29**	0.04	-0.12**
P ₈ × P ₉	0.63**	0.83**	0.73**	1.26**	2.66**	1.96**	8.15**	-1.05	3.55**	0.33	0.43	0.38	0.33**	-0.07	0.13**
P ₈ × P ₁₀	0.70**	0.38*	0.54**	-0.38	-1.52*	-0.95*	1.03	0.67	0.85	0.59	0.69	0.64	-0.20**	0.08	-0.06
P ₉ × P ₁₀	-0.65**	-0.57**	-0.61**	-3.06**	-2.66**	-2.86**	3.13*	0.60	1.86*	-0.46	-0.35	-0.40	-0.148**	-0.11*	-0.13**
SE (Sij)	0.34	0.31	0.33	0.80	1.31	1.10	2.79	2.53	2.71	1.29	1.31	1.32	0.10	0.09	0.10
SE (Sij-Sik)	0.510	0.46	0.31	1.18	1.93	1.05	4.11	3.72	2.58	1.90	1.93	1.26	0.15	0.13	0.09

*, ** Significant at 5 percent and 1 percent probability levels, respectively

Table 3: Cont..

Crosses	Number of fruits per plant			Fruit yield per plant (kg)			Total soluble solids (TSS)			Ascorbic acid (mg/100 g fresh fruit)		
	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled
P ₁ × P ₂	-0.10	0.52	0.21	-0.75**	0.14	-0.36*	0.36*	-0.50**	-0.06	0.05	0.23	0.14
P ₁ × P ₃	0.07	-0.78*	-0.35	0.23	0.20	0.21	-0.52**	-1.07**	-0.79**	-0.38	-0.31	-0.34*
P ₁ × P ₄	1.51**	-1.68**	-0.08	-0.01	-0.83**	-0.42**	0.38*	0.34*	0.36**	0.13	0.15	0.14
P ₁ × P ₅	-0.12	0.07	-0.02	0.09	0.29	0.19	-0.56**	0.32*	-0.12	-0.18	-0.07	-0.13
P ₁ × P ₆	0.06	-0.37	-0.15	0.23	-0.16	0.03	0.08	-0.39*	-0.15	0.14	0.25	0.20
P ₁ × P ₇	-1.41**	1.77**	0.18	0.54*	-0.13	0.20	0.35*	0.51**	0.43**	-0.27	-0.11	-0.19
P ₁ × P ₈	-0.38	-0.98**	-0.68**	0.40	-0.62**	-0.10	0.41*	-0.20	0.10	-0.08	0.01	-0.03
P ₁ × P ₉	0.31	0.41	0.36	0.05	0.27	0.16	-0.91**	0.50*	-0.20	-0.44*	-0.49*	-0.47**
P ₁ × P ₁₀	0.20	-0.35	-0.07	0.38	-0.05	0.16	0.40*	-0.45**	-0.02	0.08	0.08	0.08
P ₂ × P ₃	0.12	-0.65	-0.26	0.76**	-0.00	0.37*	0.71**	0.82**	0.77**	0.15	0.17	0.16
P ₂ × P ₄	-0.56	-0.38	-0.47	-0.55*	-0.25	-0.40**	-0.67**	-0.53**	-0.60**	-0.35	-0.34	-0.34*
P ₂ × P ₅	-0.06	-1.00**	-0.53*	-0.38	0.32	-0.02	0.41*	0.28	0.34**	-0.19	-0.09	-0.14
P ₂ × P ₆	0.12	0.14	0.13	-0.15	-0.06	-0.11	0.22	0.39*	0.30**	-0.32	-0.22	-0.27
P ₂ × P ₇	1.258***	1.37**	1.31**	0.37	1.20**	0.78**	-1.37**	-1.32**	-1.34**	0.37	0.53*	0.45**
P ₂ × P ₈	1.183***	-0.61	0.28	0.51*	0.09	0.30*	-0.43**	-0.26	-0.34**	0.04	0.13	0.08
P ₂ × P ₉	1.07**	-1.54**	-0.247	0.09	-0.39	-0.15	-0.51**	-0.57**	-0.54**	-0.07	-0.13	-0.10
P ₂ × P ₁₀	-1.27**	-1.81**	-1.54**	-0.54*	-0.46*	-0.50**	0.37*	0.51**	0.40**	0.20	0.20	0.20
P ₃ × P ₄	-0.83*	1.88**	0.52*	-0.39	1.91**	0.76**	0.66**	0.80**	0.73**	0.02	-0.05	-0.01
P ₃ × P ₅	0.48	-0.52	-0.02	-0.20	-1.11**	-0.70**	-0.24	-0.38*	-0.31**	-0.09	-0.08	-0.08
P ₃ × P ₆	0.70*	-0.44	0.12	0.00	0.04	0.02	-0.76**	-0.59**	-0.67**	-0.00	0.00	0.00
P ₃ × P ₇	0.94**	-1.53**	-0.29	0.60**	-1.44**	-0.41**	0.66**	0.70**	0.68**	0.11	0.18	0.14
P ₃ × P ₈	-1.15**	3.85**	1.35**	-1.33**	1.69**	0.17	0.36*	0.52**	0.44**	0.10	0.10	0.10
P ₃ × P ₉	-0.48	0.44	-0.02	0.47*	-0.17	0.15	-0.54**	-0.60**	-0.57**	0.06	-0.08	-0.01
P ₃ × P ₁₀	1.63**	-0.30	0.66**	0.50*	-0.51*	-0.00	-0.38*	-0.25	-0.32**	-0.18	-0.27	-0.22

*, ** Significant at 5 percent and 1 percent probability levels, respectively

Crosses	Number of fruits per plant			Fruit yield per plant (kg)			Total soluble solids (TSS)			Ascorbic acid (mg/100 g fresh fruit)		
	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled
P ₄ × P ₅	1.35**	-0.36	0.49*	-0.07	-0.10	-0.08	0.23	0.02	0.13	-0.19	-0.20	-0.19
P ₄ × P ₆	0.08	-1.41**	-0.66**	0.69**	-0.88**	-0.09	-0.89**	-0.79**	-0.84**	0.04	0.04	0.04
P ₄ × P ₇	0.49	2.57**	1.53**	1.57**	1.46**	1.52**	-0.72**	-0.74**	-0.73**	0.00	0.05	0.02
P ₄ × P ₈	0.22	1.43**	0.83**	0.11	0.88**	0.49**	0.47**	0.57**	0.52**	-0.11	-0.13	-0.12
P ₄ × P ₉	1.52**	-0.54	0.48*	0.59**	-1.17**	-0.29*	-0.53**	-0.65**	-0.59**	0.18	0.01	0.10
P ₄ × P ₁₀	-1.45**	-0.04	-0.75*	-0.98**	-0.09	-0.53**	0.29	0.35*	0.32**	0.34	0.23	0.29*
P ₅ × P ₆	-1.54**	2.43**	0.44	-0.23	2.18**	0.97**	0.29	0.12	0.20	0.00	0.08	0.04
P ₅ × P ₇	1.92**	3.33**	2.63**	0.08	-0.10	-0.00	0.46*	0.16	0.31**	0.11	0.25	0.18
P ₅ × P ₈	0.91*	-1.41**	-0.25	0.45*	-1.14**	-0.34*	-0.13	-0.31*	-0.22*	0.15	0.25	0.22
P ₅ × P ₉	-0.01	-0.21	-0.11	1.03**	-0.77**	0.13	0.72**	0.32*	0.52**	0.52*	0.44*	0.48**
P ₅ × P ₁₀	0.54	-0.85*	-0.15	0.36	0.12	0.24	-0.48**	-0.69**	-0.59**	0.13	0.12	0.13

P ₆ × P ₇	0.92**	-1.97**	-0.52*	-0.25	-1.03**	-0.64**	0.50*	0.51*	0.50**	0.15	0.30	0.23
P ₆ × P ₈	0.26	-0.30	-0.01	-0.82**	0.25	-0.28	0.16	0.29	0.23*	-0.03	0.03	-0.00
P ₆ × P ₉	1.13**	2.28**	1.71**	-0.10	1.33**	0.61**	-0.87**	-0.96**	-0.91**	0.00	-0.07	-0.03
P ₆ × P ₁₀	0.22	1.16**	0.69**	0.94**	0.79**	0.86**	0.25	0.35*	0.30**	0.05	0.03	0.04
P ₇ × P ₈	-0.83*	0.12	-0.35	0.53*	0.70**	0.61**	0.24	0.24	0.24*	-0.09	0.02	-0.03
P ₇ × P ₉	-0.29	-1.17**	-0.73**	-1.21**	-0.07	-0.64**	0.50**	0.27	0.39**	0.03	0.01	0.02
P ₇ × P ₁₀	0.86*	0.25	0.55*	0.00	0.71**	0.36*	-0.67**	-0.70**	-0.69**	-0.35	-0.31	-0.33*
P ₈ × P ₉	-0.39	0.39	-0.00	1.28**	0.13	0.71**	0.76**	0.66**	0.71**	0.15	0.06	0.10
P ₈ × P ₁₀	0.29	0.29	0.29	-1.29**	0.70**	-0.29*	-0.47**	-0.38*	-0.43**	0.11	0.08	0.10
P ₉ × P ₁₀	1.50**	0.74*	1.12**	0.05	0.14	0.09	0.35*	0.22	0.28**	-0.23	-0.41*	-0.32*
SE (Sij)	0.68	0.69	0.70	0.44	0.39	0.42	0.31	0.30	0.31	0.41	0.40	0.41
SE (Sij-Sik)	1.00	1.02	0.66	0.65	0.58	0.40	0.46	0.44	0.30	0.61	0.59	0.39

*, ** Significant at 5 percent and 1 percent probability levels, respectively

Table 3: Cont.

Traits Crosses	Reducing sugars (%)			Non-reducing sugar (%)			Dry matter (%)		
	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled
P ₁ × P ₂	-0.18	-0.02	-0.10	0.11**	0.14**	0.12**	0.30*	0.30*	0.30**
P ₁ × P ₃	0.69**	0.69**	0.69**	-0.02	-0.01	-0.02	0.24	0.24	0.24*
P ₁ × P ₄	-0.53**	-0.27	-0.40**	-0.02	-0.01	-0.02	0.37*	0.37*	0.37**
P ₁ × P ₅	-0.54**	-0.17	-0.36**	0.05*	0.04	0.05**	-0.91**	-0.91**	-0.91**
P ₁ × P ₆	0.59**	0.59**	0.59**	-0.13**	-0.13**	-0.13**	-0.09	-0.09	-0.09
P ₁ × P ₇	-0.50**	-0.24	-0.37**	0.07**	0.11**	0.09**	-0.16	-0.16	-0.16
P ₁ × P ₈	-0.74**	-0.37*	-0.55**	-0.14**	-0.12**	-0.13**	-0.07	-0.07	-0.07
P ₁ × P ₉	-0.39**	-0.39**	-0.39**	0.01	0.00	0.01	-0.52**	-0.52**	-0.52**
P ₁ × P ₁₀	0.69**	0.95**	0.82**	0.12**	0.12**	0.12**	0.25	0.23	0.23*
P ₂ × P ₃	-0.24	-0.50**	-0.37**	0.02	0.05*	0.03*	0.05	0.05	0.05
P ₂ × P ₄	0.08	0.08	0.08	-0.01	0.02	0.00	-0.09	-0.09	-0.09
P ₂ × P ₅	0.72**	0.83**	0.78**	-0.02	-0.07	-0.01	-0.08	-0.08	-0.08
P ₂ × P ₆	-0.35*	-0.61**	-0.48**	0.04	0.07**	0.05**	-0.74**	-0.74**	-0.74**
P ₂ × P ₇	0.10	0.10	0.10	-0.01	0.04	0.01	0.00	0.00	0.00
P ₂ × P ₈	0.83**	0.94**	0.88**	-0.02	0.02	-0.01	-0.10	-0.10	-0.10
P ₂ × P ₉	-0.37**	-0.63**	-0.50**	0.09**	0.11**	0.10**	0.20	0.20	0.20*
P ₂ × P ₁₀	-0.24	-0.24	-0.24*	-0.11**	-0.09**	-0.10**	-0.25	-0.25	-0.25*
P ₃ × P ₄	-0.29*	-0.45**	-0.37**	0.00	0.02	0.01	-1.03**	-1.03**	-1.03**
P ₃ × P ₅	-0.31*	-0.36*	-0.33**	-0.10**	-0.10**	-0.10**	-0.05	-0.05	-0.05
P ₃ × P ₆	0.82**	0.40**	0.61**	0.06**	0.06**	0.06**	0.09	0.09	0.09
P ₃ × P ₇	-0.27	-0.43**	-0.35**	-0.18**	-0.14**	-0.16**	0.19	0.19	0.19
P ₃ × P ₈	-0.20	-0.25	-0.23*	-0.00	0.01	0.00	0.11	0.11	0.11
P ₃ × P ₉	0.80**	0.38**	0.59**	0.05*	0.05*	0.05**	-0.42**	-0.42**	-0.42**
P ₃ × P ₁₀	-0.32*	-0.48**	-0.40**	0.13**	0.13**	0.13**	0.15	0.15	0.15

*, ** Significant at 5 percent and 1 percent probability levels, respectively

Traits Crosses	Reducing sugar (%)			Non-reducing sugar (%)			Dry matter (%)		
	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled	E ₁	E ₂	Pooled
P ₄ × P ₅	-0.28*	-0.07	-0.17	0.02	0.02	0.02	0.12	0.12	0.12
P ₄ × P ₆	0.85**	0.69**	0.77**	-0.05*	-0.04	-0.04**	0.20	0.20	0.20*
P ₄ × P ₇	-0.24	-0.14	-0.19*	0.10**	0.14**	0.12**	0.23	0.23	0.23*
P ₄ × P ₈	-0.17	0.03	-0.07	-0.02	0.00	-0.00	-0.82**	-0.82**	-0.82**
P ₄ × P ₉	0.83**	0.67**	0.75**	0.00	0.01	0.00	0.51**	0.51**	0.51**
P ₄ × P ₁₀	-0.29*	-0.19	-0.24*	0.08**	0.09**	0.08**	-0.03	-0.00	-0.00
P ₅ × P ₆	-0.41**	-0.46**	-0.44**	-0.07**	-0.08**	-0.08**	0.02	0.02	0.02
P ₅ × P ₇	0.70**	0.91**	0.80**	0.02	0.04	0.03*	0.13	0.13	0.13
P ₅ × P ₈	-0.79**	-0.47**	-0.63**	-0.00	0.00	-0.00	0.06	0.06	0.06
P ₅ × P ₉	-0.44**	-0.49**	-0.46**	-0.07**	-0.08**	-0.08**	0.52**	0.52**	0.52**
P ₅ × P ₁₀	0.64**	0.85**	0.75**	0.12**	0.11**	0.11**	0.10	0.10	0.10
P ₆ × P ₇	-0.37**	-0.53**	-0.45**	0.11**	0.14**	0.12**	-0.08	-0.08	-0.08
P ₆ × P ₈	-0.31*	-0.36*	-0.33**	-0.09**	-0.08**	-0.08**	0.13	0.13	0.13
P ₆ × P ₉	0.69**	0.27*	0.48**	0.05*	0.04	0.05**	0.58**	0.58**	0.58**
P ₆ × P ₁₀	-0.43**	-0.59**	-0.51**	0.00	0.00	0.00	-0.03	-0.03	-0.03
P ₇ × P ₈	-0.15	0.05	-0.04	-0.02	0.020	-0.00	-0.02	-0.02	-0.02
P ₇ × P ₉	0.85**	0.69**	0.77**	-0.04	-0.01	-0.03	0.21	0.21	0.21*
P ₇ × P ₁₀	-0.27	-0.17	-0.22*	-0.03	-0.01	-0.02	-0.14	-0.14	-0.14
P ₈ × P ₉	-0.33*	-0.38**	-0.36**	0.02	0.05	0.03	0.44**	0.44**	0.44**
P ₈ × P ₁₀	0.75**	0.96**	0.85**	0.09**	0.10**	0.10**	0.05	0.05	0.05
P ₉ × P ₁₀	-0.45**	-0.61**	-0.53**	-0.14**	-0.15**	-0.14**	0.24	0.24	0.24
SE (Sij)	0.27	0.27	0.27	0.04	0.04	0.04	0.29	0.29	0.29
SE (Sij-Sik)	0.40	0.40	0.26	0.05	0.07	0.04	0.42	0.42	0.28

Development of high yielding F₁ coupled with more number of fruits per plant is an important aspect. Out of 14 crosses which showed significant SCA effects for fruit yield per plant in either of the seasons, there were only crosses namely, P₂ x P₇, P₃ x P₄, P₅ x P₆ and P₇ x P₈ which exhibited significant sca effects for fruit yield in season (E₁ and E₂) and over environments (pooled). Likewise crosses P₂ x P₇, P₄ x P₇, P₄ x P₈, P₆ x P₉ and P₆ x P₁₀ were the significant crosses for number of fruit per plant and fruit yield in pooled. Therefore, these crosses may likely to fit for farmers demand and also throw good transgressive segregates combining more number of fruits coupled with high fruit yield in later generations of selection.

Perusal of Table-3 revealed that 12 cross combinations across the years showed significant and positive specific combining ability effects for fruit yield involving parents with Low x High (L x H), Low x Low (L x L), High x Low (H x L) and High x High (H x H) general combining ability effects for fruit yield.

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