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Study the general and specific combing ability in bottle gourd [*Lagenaria siceraria* (Mol.) Standl]

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Abstract

The present study was undertaken on bottle gourd in a 10 x 10 diallel cross excluding reciprocal. The 45 F_1 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 combing ability during Zaid 2017 (E_1) and 2018 (E_2). The selected parental lines are Pusa Naveen (P_1), NDBG-601 (P_2), PBOG-3 (P_3), NDBG-517 (P_4), NDBG-603 (P_5), NDBG-624 (P_6), N. Pooja (P_7), NDBG-100 (P_8), Punjab Komal (P_9), and NDBG-11 (P_{10}) were crossed in the all possible combinations, excluding reciprocals. For this experiment observations were recorded for 18 metric traits viz. days to first staminate and pistillate flower appearance, node number to first staminate and pistillate flower anthesis, days to first fruit harvest, primary branches per plant, vine length (m), fruit length (cm), fruit circumference (cm), T.S.S. (^{0} B), ascorbic acid (mg per 100 g fresh weight), reducing sugar, non-reducing sugar and total sugars (%),dry matter content, Fruit weight (kg), number of fruits per plant, fruit yield per plant (kg).

Highly significant variances over seasons were observed for general combining ability and specific combining ability for all the eighteen characters studied during both the seasons and pooled suggested that both additive and non-additive gene actions were very important in the expression of all the characters. Crosses viz., P_1 x P_2, P_3 x P_6, P_4 x P_9 and P_5 x P_6 reflected highly significant specific combining ability effect for fruit yield per plant during both the seasons and over seasons (pooled).

Keywords: Combining ability, GCA, SCA

Introduction

Bottle gourd [*Lagenaria siceraria* (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 but at present it's off season cultivation has progressively stretched throughout the year in northern Indian plains. In India, the total area covered under bottle gourd is 0.157 million ha with production of 2.683 million tonnes and its productivity is 17.09 tonnes per ha (Anonymous, 2018) [2].

The fruit is also known to be a good source of essential amino acids as leucine, phenyl alanine, threonine, cystine, valine, aspartic acid and proline, along with a good source of vitamin B, especially thiamine, riboflavin and niacin. The mineral matter reported to be present in fair amount which includes calcium, phosphorus, iron, potassium, sodium and iodine. At present per capita per day availability of vegetable in India is 175 g against 300 g/capita/day as recommended by ICMR. To meet out such a challenging target, there is need to develop new potential hybrids.

According to De Candolle (1882), bottle gourd has been found in wild form in South Africa and India. However, Cutler and Whitaker (1961) [4] are of the view that probably it is indigenous to tropical Africa on the basis of variability in seeds and fruits.

Out of all the cultivated cucurbits, bottle gourd with its high yield potential and adaptability to diverse climatic conditions holds a great promise to cope up with the per capita per day requirement of vegetables in the balanced diet of the fast growing population pressure and greater dietary awareness, particularly among the literate masses of a country like India. Bottle gourd was one of the first plant species to be domesticated for human use, providing food, medicine and a wide variety of utensils and musical instruments made from the large hard shelled mature fruits. A total of six species have been recognized belonging to the genus *Lagenaria*, of which only *L. siceraria* is the domesticated annual with monoecious sex form while the other five are wild congeners, perennial and dioecious (Bisognin, 2002) [3].

A stable andromonoecious sex form bearing hermaphrodite and male flower in same plant of *L. siceraria* have also been isolated and reported by Singh *et al*., 1996 [9]. The wild forms are native to the northern part of Africa. The *L. siceraria* (Sond.) Naud. And *L. breviflora* (Benth.) G. Roberty are found in South Africa and Zimbabwe, respectively (Jeffrey, 1967) [8].

Combining ability analysis helps in the evaluation of inbreds 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 "Diallel cross analysis for growth (earliness), fruit yield and quality traits in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]" was undertaken to the study of combining ability, variances and their effects 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 F_1 hybrids and their 10 parental lines. The selected parental lines *i.e*. Pusa Naveen (P_1), NDBG-601 (P_2), PBOG-3 (P_3), NDBG-517 (P_4)**,** NDBG-603 (P_5), NDBG-624 (P_6), N. Pooja (P_7), NDBG-100 (P_8), Punjab Komal (P_9), and NDBG-11 (P_{10}) 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) [6], 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, 1956b) [6] 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 (1954a) [7] and combining ability analysis (Griffing, 1956b) [6]. 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, 1956b) [6] and can be equated to dominance variance by Hayman analysis (1954a) [7]. The choice of parents especially for heterosis breeding should be based on combining ability test and their mean performance (Yadav and Murty, 1966) [13].

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

Perusal of table-1 revealed that 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 non-significant for all the traits. 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 approaches 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 Singh *et al.* (2005) [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.

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 × 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) [12] and Yadav and Kumar (2012) [14]. Parent P_1 had good gca effects for node number to first staminate flower appearance, node number to first pistillate flower appearance, days to first staminate flower anthesis, days to first pistillate flower anthesis, days to first fruit harvest. Parent had good GCA effects for P_2 fruit length and vine length, P_3 for fruit length (cm) and total soluble solid, P_4 for node number to first staminate flower appearance, node number to first pistillate flower appearance, total soluble solid, fruit length (cm), dry matter content in fruit, P_5 for vine length (m), number of primary branches per plant, fruit weight (kg), P_6 for all the characters except days node number to first staminate flower appearance, node number to first pistillate flower appearance, days to first staminate flower anthesis, days to first pistillate flower anthesis, days to first fruit harvest, P_7 for fruit weight (kg), P_8 for days node number to first staminate flower appearance, node number to first pistillate flower appearance, number of primary branches per plant, fruit length (cm), TSS, fruit weight (kg), fruit yield per plant, P_9 for node number to first staminate flower appearance, node number to first pistillate flower appearance, days to first staminate flower anthesis, number of primary branches per plant, fruit circumference (cm), fruit weight (kg), number of fruit per plant, fruit yield per plant and P_{10} for node number to first pistillate flower appearance, days to first pistillate flower anthesis, number of primary branches per plant, dry matter content in fruit and number of fruits per plant. Such variation may be due to differences in genotypic constitution of the parents for different characters. Similar results had also been reported by Singh *et al.* (2005) [10] and Yadav and Kumar (2012) [14].

The ranking of desirable parents on the basis of gca effects for 18 traits revealed that it was difficult to pickup a single good combiner for all the traits. However, parents P_8 and P_9 were found as good general combiners for fruits yield per plant. Parents P_1 and P_4 also emerged as good general combiner for days to first harvest (early maturity), node number to first staminate flower appearance, node number to first pistillate flower appearance, and P_6 for all yield component traits in both the season and pooled. This shows that parents having good gca effects for fruit yield also had good gca effects for one or more yield components. Further, the inbred mentioned above may serve as valuable donors for hybridization programme and may be chosen as most preferred parents for breeding of early maturing high yielding hybrids with good quality in bottle gourd.

Specific combining ability effects

The specific combining ability effects of the crosses showing significant sca effects for fruit yield and their relationship with other yield components. 12 crosses in E_1, 14 crosses during E_2 and 16 crosses in pooled exhibited significant positive and desirable SCA effects indicating good specific combing abilities for fruit yield per plant respectively. These crosses were found to be significant specific combiners for one or more yield components as well.

Development of high yielding F_1 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, P_1 x P_2, P_1 x P_{10}, P_2 x P_3, P_2 x P_8, P_2 x P_9, P_3 x P_6, P_4 x P_5 and P_7 x P_{10} which exhibited significant sca effects for fruit yield in season (E_1 and E_2) and over environments (pooled). Likewise crosses P_1 x P_2, P_2 x P_9, P_4 x P_5, P_4 x P_7, P_4 x P_8, P_7 x P_9 and P_7 x P_{10} 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 through good transgressive segregates combining more number of fruits coupled with high fruit yield in later generations of selection. There was a close correspondence between sca effect and the heterosis.

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. Out of 45 F_1 hybrids, significant sca effects in favourable direction were exhibited by 7 crosses in E_1, 7 crosses in E_2 and 9 crosses in pooled for node number to first staminate flower appearance, 8 crosses in E_1, 7 crosses in E_2 and 13 crosses in pooled for node number to first pistillate flower appearance, 2 crosses in E_1, 3 crosses in E_2 and 6 crosses in pooled for days to first staminate flower anthesis, 4 crosses in pooled for days to first fruit harvest, 19 crosses in E_1, 17 crosses during E_2 and 21 crosses in pooled hybrids for number of primary branches per plant, 16 crosses in E_1, 13 crosses during E_2 and 20 crosses in pooled for vine length, 5 crosses in E_1, 7 crosses E_2 and 8 crosses in pooled for fruit length, 3 crosses in E_1, 6 crosses each in E_2 and 11 in pooled for fruit circumference, 3 crosses in E_1, 4 crosses during E_2 and 6 crosses in pooled for TSS, 5 crosses in E_1, 6 crosses during E_2 and 7 crosses in pooled for ascorbic acid, 11 crosses in E_1, 14 crosses in E_2 and 16 pooled for reducing sugar, 15 crosses in E_1, 15 crosses during E_2 and 19 crosses in pooled for non-reducing sugar, 12 crosses in E_1, 14 crosses during E_2 and 14 crosses in pooled for total sugars, 18 crosses in E_1, 18 crosses during E_2 and 20 crosses in pooled for dry matter content, 10 crosses each in E_1, 8 crosses in E_2 and 12 crosses in pooled for fruit weight, 12 crosses each in E_1, 13 crosses in E_2 and 16 crosses in pooled for number of fruits per plant and 12 crosses in E_1, 14 crosses E_2 and 16 crosses in pooled for fruit yield per plant. Significant sca effects had also been reported for these traits by earlier scientists.

Table 1: Analysis of variance (mean squares) for combining ability in 10 x 10 diallel cross of bottle gourd during two seasons (E_1, E_2).

Source of Variation	Seasons	d.f.	Node number to first staminate flower appearance	Node number to first pistillate flower appearance	Days to first staminate flower anthesis	Days to first pistillate flower anthesis	Days to first fruit harvest	Number of primary branches per plant	Vine length (m)	Fruit length (cm)	Fruit circumference (cm)
GCA	E_1	9	6.92**	3.62**	9.32**	15.29**	17.13**	10.17**	1.49**	53.18**	11.91**
	E_2	9	7.28**	3.88**	10.09**	17.24**	18.97**	11.15**	1.61**	57.44**	13.14**
SCA	E_1	45	1.02**	0.96**	3.45*	2.68	3.21	4.68**	0.60**	4.98**	3.15**
	E_2	45	1.09**	1.02**	3.73*	3.07	3.53	5.17**	0.65**	5.48**	3.48**
Error	E_1	108	0.15	0.18	2.31	3.13	3.18	0.20	0.03	1.56	0.61
	E_2	108	0.24	0.20	2.16	2.34	4.37	0.35	0.07	1.36	0.52

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

Table 1: Contd.

Source of Variation	Seasons	d.f.	T.S.S. (%)	Ascorbic acid (mg/100g) fresh fruit	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	Dry matter content fruit	fruit weight (kg)	Number of fruits per plant	Fruit yield per plant (kg)
GCA	**E_1**	9	2.10**	0.56**	0.79**	0.01**	0.74**	0.68**	0.06**	1.71**	1.69**
	E_2	9	2.15**	0.50**	0.81**	0.02**	0.78**	0.72**	0.07**	1.95**	1.94**
SCA	**E_1**	45	0.11**	0.79**	0.71**	0.03**	0.73**	0.41**	0.01**	0.40**	0.35**
	E_2	45	0.13**	0.84**	0.74**	0.03**	0.77**	0.43**	0.02**	0.46**	0.40**
Error	**E_1**	108	0.02	0.09	0.01	0.00	0.01	0.01	0.00	0.05	0.04
	E_2	108	0.01	0.07	0.01	0.00	0.00	0.01	0.00	0.04	0.03

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively.

Table 2: Estimates of G.C.A. effects of parents in 10 x 10 diallel cross of bottle gourd during two seasons (E_1, E_2) and over seasons (pooled)

Traits / Parents	Node number to first staminate flower appearance			Node number to first pistillate flower appearance			Days to first staminate flower anthesis			Days to first pistillate flower anthesis			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	-0.46**	-0.42**	-0.44**	-0.32**	-0.38**	-0.35**	-1.56**	-1.62**	-1.59**	-2.70**	-2.88**	-2.795**	-2.587**	-2.72**	-2.65**
P_2	0.03	0.01	0.02	0.86**	0.90**	0.88**	0.63	0.66	0.65*	0.05	0.10	0.08	1.48**	1.56 **	1.52**
P_3	0.23*	0.23	0.23**	0.27*	0.30*	0.29**	1.11**	1.16**	1.13**	0.95	0.94*	0.94**	0.08	0.09	0.09
P_4	-0.43**	-0.47**	-0.45**	-0.41**	-0.42**	-0.41**	0.03	0.03	0.03	0.42	0.49	0.46	1.25*	1.32*	1.29**
P_5	1.18**	1.21**	1.20**	0.88**	0.91**	0.89**	0.28	0.29	0.29	0.84	0.89*	0.87**	0.31	0.33	0.32
P_6	1.34**	1.36**	1.35**	-0.13	-0.18	-0.15	1.25**	1.30**	1.27**	0.12	0.05	0.09	-0.90	-0.94	-0.92 *
P_7	-0.06	-0.08	-0.07	0.32**	0.33**	0.32**	-0.10	-0.11	-0.11	0.86	0.95*	0.90**	0.32	0.34	0.33
P_8	-0.69**	-0.73**	-0.71**	-0.48**	-0.50**	-0.49**	-0.09	-0.10	-0.09	0.74	0.82	0.78*	-0.04	-0.04	-0.04
P_9	-1.00**	-1.0**	-1.02**	-0.49**	-0.48**	-0.49**	-0.86*	-0.90*	-0.88**	-0.38	-0.46	-0.42	-0.78	-0.82	-0.80*
P_{10}	-0.12	-0.07	-0.10	-0.48**	-0.47**	-0.47**	-0.69	-0.72	-0.71*	-0.92	-0.93*	-0.92**	0.85	0.89	0.87*
SE (gi)	0.24	0.30	0.27	0.26	0.27**	0.27	0.94	0.91	0.93	1.09	0.94	1.02	1.105	1.29	1.20
SE (gi-gj)	0.36	0.45	0.41	0.39	0.416 **	0.66	1.40	1.35	1.38	1.63	1.41	1.52	1.64	1.93	1.79

*, ** Significant at 5 per cent and 1 per cent probability levels, respective

Table 2: Contd..

Traits / Parents	Number of primary branches per plant			Vine length (m)			Fruit length (cm)			Fruit circumference (cm)			Total soluble solid		
	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	-1.74**	-1.82**	-1.78**	-0.31**	-0.32**	-0.31**	-0.94**	-0.98**	-0.96**	-0.11	-0.11	-0.11	-0.45**	-0.47**	-0.46**
P_2	-0.06	-0.06	-0.06	0.13*	0.13	0.132**	2.00**	2.06**	2.03**	-1.08**	-1.13**	-1.10**	-0.22**	-0.23**	-0.22**
P_3	-0.48**	-0.51**	-0.49**	0.03	0.03	0.03	0.71*	0.74*	0.72**	-0.12	-0.13	-0.13	0.24**	0.23**	0.23**
P_4	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	2.20**	2.28**	2.24**	-0.24	-0.25	-0.25	0.46**	0.47**	0.46**
P_5	0.43**	0.45**	0.44**	0.74**	0.77**	0.75**	-1.09**	-1.11**	-1.10**	-0.90**	-0.97**	-0.94**	0.03	0.03	0.03
P_6	0.85**	0.89**	0.87**	0.39**	0.40**	0.39**	0.72*	0.77*	0.75**	0.45*	0.46*	0.46**	0.16**	0.15**	0.16**
P_7	-1.21**	-1.26**	-1.23**	-0.22**	-0.23**	-0.22**	-0.32	-0.34	-0.33	0.07	0.08	0.08	-0.50**	-0.52**	-0.5**
P_8	1.15**	1.21**	1.18**	-0.22**	-0.23**	-0.22**	2.19**	2.27**	2.23**	-0.19	-0.19	-0.19	0.79**	0.80**	0.79**
P_9	0.45**	0.47**	0.46**	-0.43**	-0.45**	-0.44**	-4.73**	-4.93**	-4.83**	2.53**	2.66**	2.60**	-0.28**	-0.27**	-0.28**
P_{10}	0.65**	0.68**	0.67**	-0.04	-0.05	-0.05	-0.72*	-0.77*	-0.75**	-0.39	-0.40*	-0.40**	-0.22**	-0.20**	-0.21**
SE (gi)	0.28	0.37	0.33	0.12	0.16	0.15	0.77	0.72	0.75	0.48	0.44	0.47**	0.08	0.06	0.08
SE (gi-gj)	0.42	0.55	0.49	0.18	0.25	0.22	1.15	1.07	1.11	0.72	0.67	0.70	0.12	0.10	0.11

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

Table 2: Contd.

Traits / Parents	Ascorbic acid (mg/100 g fresh fruit)			Reducing sugar (%)			Non-reducing sugar (%)			Total sugar (%)		
	E_1	E_2	Pooled	E_1	E_2	Pooled	E_1	E_2	Pooled	E_1	E_2	Pooled
P_1	-0.06	-0.07	-0.07	-0.23**	-0.23**	-0.23**	-0.02**	-0.02**	-0.02**	-0.25**	-0.25**	-0.25**
P_2	0.13	0.10	0.11*	-0.01	-0.02	-0.02	0.04**	0.04**	0.04**	0.02	0.01	0.01
P_3	-0.17*	-0.16*	-0.16**	0.24**	0.24**	0.24**	-0.03**	-0.03**	-0.03**	0.20**	0.20**	0.20**
P_4	0.33**	0.32**	0.32**	-0.02	-0.02	-0.02	0.04**	0.05**	0.05**	0.02	0.02	0.02
P_5	-0.05	-0.03	-0.04	-0.04	-0.03	-0.03*	0.04**	0.04**	0.04**	0.00	0.02	0.01
P_6	0.07	0.10	0.09	0.15**	0.14**	0.14**	-0.01	-0.01	-0.01	0.14**	0.13**	0.13**
P_7	-0.21**	-0.22**	-0.22**	-0.13**	-0.12**	-0.12**	-0.04**	-0.04**	-0.04**	-0.17**	-0.16**	-0.16**
P_8	-0.10	-0.11	-0.10	-0.32**	-0.31**	-0.32**	0.00	0.00	0.00	-0.31**	-0.31**	-0.31**
P_9	0.34**	0.31**	0.33**	0.54**	0.56**	0.55**	-0.02*	-0.02*	-0.02**	0.51**	0.54**	0.53**
P_{10}	-0.27**	-0.24**	-0.25**	-0.17**	-0.19**	-0.18**	-0.00	-0.00	-0.00	-0.18**	-0.20**	-0.19**
SE (gi)	0.18	0.16	0.18	0.05	0.04	0.05	0.02	0.02	0.02	0.06	0.05	0.06
SE (gi-gj)	0.28	0.24	0.26	0.08	0.07	0.08	0.03	0.03	0.03	0.09	0.085	0.09

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

Table 2. Contd.

Traits / Parents	Dry matter content in fruit			Fruit weight (kg.)			Number of fruit per plant			Fruit yield per plant		
	E_1	E_2	Pooled	E_1	E_2	Pooled	E_1	E_2	Pooled	E_1	E_2	Pooled
P_1	0.37**	0.39**	0.38**	-0.03**	-0.03**	-0.031***	-0.30**	-0.32**	-0.31**	-0.70**	-0.75**	-0.73**
P_2	-0.12**	-0.11**	-0.12**	-0.14**	-0.15**	-0.145***	0.68**	0.72**	0.70**	-0.09	-0.09	-0.09*
P_3	-0.00	-0.00	-0.00	0.06**	0.06**	0.062***	-0.30**	-0.32**	-0.31**	0.18**	0.20**	0.19**
P_4	0.29**	0.30**	0.30**	-0.02*	-0.02*	-0.021**	-0.17**	-0.19**	-0.18**	-0.19**	-0.21**	-0.20**
P_5	-0.20**	-0.20**	-0.20**	0.06**	0.07**	0.069***	-0.61**	-0.65**	-0.63**	-0.26**	-0.28**	-0.27**
P_6	0.16**	0.16**	0.16**	0.03**	0.03**	0.033***	0.11*	0.12*	0.12**	0.19**	0.20**	0.198**
P_7	-0.26**	-0.27**	-0.27**	0.01*	0.01	0.018*	-0.01	-0.00	-0.00	-0.09	-0.10*	-0.10*

P_8	-0.28**	-0.29**	-0.28**	0.09**	0.10**	0.101 ***	-0.03	-0.04	-0.03	0.41**	0.44**	0.43**
P_9	-0.13**	-0.14**	-0.139**	0.02*	0.02*	0.022**	0.22**	0.24**	0.23**	0.63**	0.67**	0.65**
P_{10}	0.18**	0.17**	0.17**	-0.10**	0.11**	-0.10**	0.41**	0.44**	0.42**	-0.07	-0.08	-0.07*
SE (gi)	0.05	0.06	0.06	0.02	0.02	0.02	0.13	0.12	0.13	0.13	0.11	0.12
SE (gi-gj)	0.07	0.09	0.08	0.03	0.03	0.03	0.19	0.18	0.19	0.20	0.17	0.19

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

Table 3: Estimates of SCA effects of F_1 hybrids in 10 x 10 diallel cross of bottle gourd over two seasons (E_1, E_2) and pooled

Traits / Crosses	Node number to first staminate flower appearance			Node number to first pistillate flower appearance			Days to first staminate flower anthesis			Days to first pistillate flower anthesis		
	E_1	E_2	Pooled	E_1	E_2	Pooled	E_1	E_2	Pooled	E_1	E_2	Pooled
$P_1 \times P_2$	-1.93**	-2.05**	-1.99**	-0.71	-0.70	-0.70*	-0.12	-0.12	-0.12	-0.63	-0.60	-0.61
$P_1 \times P_3$	-0.42	-0.51	-0.47	1.15**	1.21**	1.1**	1.02	1.06	1.04	-0.33	-0.16	-0.24
$P_1 \times P_4$	0.94*	0.90	0.92**	0.32	0.37	0.35	2.70	2.80*	2.75**	3.04	3.23*	3.14**
$P_1 \times P_5$	2.31**	2.30***	2.31**	0.49	0.55	0.52	2.62	2.72*	2.67**	0.58	0.70	0.64
$P_1 \times P_6$	1.65**	1.63**	1.64**	0.86*	0.46	0.66*	-5.67**	-5.90**	-5.78**	-1.29	-2.56	-1.92
$P_1 \times P_7$	1.57**	1.5**	1.56**	1.10**	1.18**	1.14***	1.04	1.09	1.06	-1.41	-1.39	-1.40
$P_1 \times P_8$	1.13**	1.10*	1.12**	0.81*	0.88*	0.85**	-0.76	-0.79	-0.78	1.87	2.03	1.95
$P_1 \times P_9$	1.05**	1.02*	1.03**	-1.42**	-1.44**	-1.43**	-1.09	-1.14	-1.11	0.86	1.07	0.96
$P_1 \times P_{10}$	-0.26	0.57	0.15	1.31**	1.36**	1.33**	0.13	0.14	0.13	-1.15	-1.10	-1.12
$P_2 \times P_3$	0.27	0.29	0.28	0.37	0.52	0.44	1.55	1.62	1.58	-0.59	-0.55	-0.57
$P_2 \times P_4$	0.01	0.02	0.02	0.66	0.67	0.66*	-2.17	-2.27	-2.22*	0.23	0.19	0.21
$P_2 \times P_5$	0.31	0.32	0.32	-0.34	-0.36	-0.35	-1.04	-1.08	-1.06	-1.63	-1.71	-1.67
$P_2 \times P_6$	1.15**	1.20*	1.17**	0.04	0.07	0.06	1.75	1.82	1.79	-0.35	-0.30	-0.33
$P_2 \times P_7$	0.39	0.41	0.40	0.33	0.32	0.32	4.14**	4.31**	4.23**	0.99	0.99	0.99
$P_2 \times P_8$	0.42	0.45	0.43	0.53	0.53	0.53	0.63	0.66	0.64	4.01*	4.13**	4.07**
$P_2 \times P_9$	0.80*	0.84	0.82**	0.04	0.01	0.03	0.11	0.10	0.11	-0.85	-0.82	-0.83
$P_2 \times P_{10}$	0.23	0.17	0.20	-0.36	-0.41	-0.39	-3.26*	-3.39*	-3.32**	-1.38	-1.46	-1.42
$P_3 \times P_4$	-0.99**	-1.02*	-1.01**	0.54	0.54	0.54	-3.77**	-3.92**	-3.85**	-0.54	-0.50	-0.52
$P_3 \times P_5$	0.21	0.38	0.30	0.84*	0.85*	0.84**	-1.62	-1.69	-1.65	0.51	0.62	0.57
$P_3 \times P_6$	0.95*	0.98*	0.97**	-0.63	-0.63	-0.63*	1.91	1.98	1.94*	1.63	1.88	1.76
$P_3 \times P_7$	0.17	0.18	0.17	-0.69	-0.73	-0.71*	-1.70	-1.75	-1.73	0.39	0.46	0.43
$P_3 \times P_8$	0.06	0.07	0.06	-1.19**	-1.24**	-1.22**	0.36	0.37	0.36	-0.93	-0.91	-0.92
$P_3 \times P_9$	-0.24	-0.24	-0.24	-0.18	-0.22	-0.20	-0.36	-0.38	-0.37	-0.30	-1.44	-0.87

Table 3. Contd.

$P_3 \times P_{10}$	0.83*	0.77	0.80**	-0.89*	-0.96*	-0.92**	1.66	1.72	1.69	2.70	2.90*	2.80**
$P_4 \times P_5$	0.68	0.71	0.69*	0.60	0.62	0.61*	0.15	0.15	0.15	0.54	0.55	0.54
$P_4 \times P_6$	1.02**	1.07*	1.04**	-0.88*	-0.87*	-0.88**	0.08	0.09	0.08	-0.73	-0.69	-0.71
$P_4 \times P_7$	-0.58	-0.58	-0.58*	0.10	0.10	0.10	-0.92	-0.95	-0.94	-1.58	-1.69	-1.64
$P_4 \times P_8$	0.42	0.45	0.44	-0.65	-0.67	-0.66*	-1.06	-1.10	-1.08	1.74	1.77	1.75
$P_4 \times P_9$	-0.01	-0.00	-0.01	0.40	0.38	0.39	0.20	0.21	0.21	1.27	1.38	1.33
$P_4 \times P_{10}$	0.50	0.45	0.47	-1.98**	-2.06**	-2.02**	-0.46	-0.48	-0.47	-0.69	-0.73	-0.71
$P_5 \times P_6$	-0.99**	-1.02*	-1.01**	-0.74	-0.72	-0.73*	1.73	1.80	1.77	1.15	1.29	1.22

$P_5 \times P_7$	-1.38**	-1.41**	-1.40**	-0.80*	-0.82	-0.81**	0.66	0.69	0.67	0.42	0.41	0.41
$P_5 \times P_8$	-0.21	-0.21	-0.21	-1.68**	-1.72**	-1.70**	0.48	0.50	0.49	-1.97	-2.06	-2.02
$P_5 \times P_9$	-0.64	-0.66	-0.65*	-0.14	-0.17	-0.15	-2.04	-2.12	-2.08*	1.76	1.92	1.84
$P_5 \times P_{10}$	-0.02	-0.10	-0.06	-0.50	-0.54	-0.52	-2.61	-2.72	-2.66**	0.72	0.38	0.55
$P_6 \times P_7$	0.15	0.17	0.16	-0.18	-0.15	-0.16	-0.66	-0.69	-0.67	-0.66	-0.62	-0.64
$P_6 \times P_8$	-0.52	-0.51	-0.52	-0.20	-0.16	-0.18	-1.27	-1.32	-1.30	-1.68	-1.66	-1.67
$P_6 \times P_9$	-0.91*	-0.91*	-0.91**	0.13	0.15	0.14	0.79	0.82	0.80	2.08	2.34	2.21*
$P_6 \times P_{10}$	-1.58**	-1.69**	-1.64**	-0.73	-0.73	-0.73*	0.52	0.54	0.53	-1.08	-1.03	-1.05
$P_7 \times P_8$	0.33	0.36	0.351	-0.31	-0.32	-0.31	0.68	0.71	0.69	0.40	0.37	0.39
$P_7 \times P_9$	-0.32	-0.31	-0.31	-1.62**	-1.69**	-1.6**	-1.54	-1.60	-1.57	2.24	2.39	2.31*
$P_7 \times P_{10}$	-0.87*	-0.96*	-0.92**	-0.63	-0.68	-0.66*	0.78	0.81	0.79	2.23	2.30	2.27*
P_8 × P9	-0.54	-0.54	-0.54	1.48**	1.50**	1.49**	1.44	1.50	1.47	-0.07	-0.01	-0.04
$P_8 \times P_{10}$	-0.14	-0.21	-0.17	-0.42	-0.46	-0.44	0.10	0.10	0.10	1.98	2.05	2.02
$P_9 \times P_{10}$	-0.06	-0.13	-0.09	1.12**	1.38**	1.25**	1.34	1.39	1.36	-1.57	-1.54	-1.56
SE (Sij)	0.72	0.90	0.81	0.78	0.83	0.81	2.82	2.72	2.77	3.28	2.84	3.06
SE (Sij-Sik)	1.06	1.33	1.20	1.15	1.22	1.19	4.14	4.00	4.08	4.82	4.17	4.50

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

Table 3. Cont….

Traits / Crosses	Days to fist fruit harvest			Number of primary branches per plant			Vine length (m)			Fruit length (cm)		
	E_1	E_2	Pooled	E_1	E_2	Pooled	E_1	E_2	Pooled	E_1	E_2	Pooled
$P_1 \times P_2$	-0.82	-0.85	-0.84	-1.07*	-1.14*	-1.11**	1.06**	1.10**	1.08**	5.29**	5.52**	5.40**
$P_1 \times P_3$	-0.45	-0.47	-0.46	-0.97*	-1.02	-0.99**	-0.79**	-0.82**	-0.80**	1.58	1.64	1.61*
$P_1 \times P_4$	2.93	3.07	3.00*	-1.65**	-1.74**	-1.69**	-0.30	-0.32	-0.31*	0.19	0.21	0.20
$P_1 \times P_5$	0.91	0.97	0.94	2.14**	2.24**	2.19**	1.09**	1.14**	1.11**	-0.60	-0.65	-0.63
$P_1 \times P_6$	-0.36	-0.37	-0.36	1.58**	1.59**	1.58**	-0.05	-0.05	-0.05	0.87	0.88	0.88
$P_1 \times P_7$	0.81	0.85	0.83	0.29	0.36	0.33	1.17**	1.21**	1.19**	-1.40	-1.46	-1.43
$P_1 \times P_8$	-1.28	-1.34	-1.31	0.29	0.30	0.29	0.32	0.34	0.33*	0.20	0.22	0.21
$P_1 \times P_9$	2.41	2.54	2.48	2.34**	2.45**	2.40**	0.61**	0.63*	0.62**	-2.96*	-3.08**	-3.02**
$P_1 \times P_{10}$	-2.65	-2.84	-2.75*	2.57**	2.71**	2.64**	1.08**	1.13**	1.11**	-0.07	-0.05	-0.06
$P_2 \times P_3$	-0.45	-0.48	-0.47	0.49	0.53	0.51	-0.13	-0.14	-0.14	-4.60**	-4.76**	-4.68**
$P_2 \times P_4$	-0.66	-0.70	-0.68	0.01	-0.03	-0.01	-0.25	-0.26	-0.25	-0.15	-0.14	-0.15
$P_2 \times P_5$	-1.45	-1.52	-1.49	1.25**	1.32*	1.28**	0.65**	0.68**	0.66**	0.94	0.96	0.95
$P_2 \times P_6$	1.56	1.64	1.60	3.83**	4.05**	3.94**	0.51**	0.53*	0.52**	-0.37	-0.40	-0.39
$P_2 \times P_7$	1.27	1.33	1.30	0.96*	1.01	0.98**	0.32	0.33	0.32*	1.27	1.34	1.30
$P_2 \times P_8$	2.60	2.73	2.67*	-0.46	-0.49	-0.47	-0.88**	-0.91**	-0.90**	-0.59	-0.60	-0.59
$P_2 \times P_9$	-0.59	-0.61	-0.60	1.29**	1.36*	1.33**	-0.26	-0.27	-0.26	3.18**	3.33**	3.259**
$P_2 \times P_{10}$	0.60	0.64	0.62	3.21**	3.38**	3.29**	-0.15	-0.15	-0.15	-6.85**	-7.26**	-7.05***
$P_3 \times P_4$	-0.99	-1.05	-1.02	1.15**	1.22*	1.19**	-0.65**	-0.68**	-0.66**	0.33	0.35	0.34
$P_3 \times P_5$	1.67	1.76	1.72	1.05*	1.11*	1.08**	0.75**	0.78**	0.76**	0.63	0.63	0.63
$P_3 \times P_6$	1.66	1.74	1.70	4.42**	4.65**	4.53**	-0.29	-0.30	-0.30	-0.99	-1.05	-1.02
$P_3 \times P_7$	-1.66	-1.75	-1.70	-0.61	-0.64	-0.63	0.01	0.01	0.02	0.55	0.58	0.57
$P_3 \times P_8$	-0.72	-0.76	-0.74	-0.32	-0.33	-0.33	-0.28	-0.29	-0.29	1.22	1.27	1.25
$P_3 \times P_9$	-0.99	-1.037	-1.01	0.72	0.76	0.74*	0.23	0.24	0.23	0.56	0.58	0.57
$P_3 \times P_{10}$	2.40	2.52	2.46	1.48**	1.56**	1.52**	0.44*	0.46	0.45**	-0.73	-0.74	-0.74

Table 3. Contd.

$P_4 \times P_5$	2.37	2.48	2.43	1.11*	1.17*	1.14**	0.93**	0.97**	0.95**	-0.05	-0.08	-0.06
$P_4 \times P_6$	-0.60	-0.64	-0.62	-0.37	-0.38	-0.37	0.09	0.09	0.09	-1.95	-2.05	-2.00*
$P_4 \times P_7$	0.66	0.79	0.73	-0.04	-0.04	-0.04	0.90**	0.94**	0.92**	-1.25	-1.30	-1.28
$P_4 \times P_8$	1.83	1.91	1.87	1.88**	1.98**	1.93**	-0.20	-0.21	-0.20	-1.14	-1.18	-1.16
$P_4 \times P_9$	-0.66	-0.69	-0.67	4.10**	4.30**	4.20**	0.31	0.32	0.32*	-1.34	-1.39	-1.37
$P_4 \times P_{10}$	0.03	0.03	0.03	0.94*	0.98	0.96**	-0.89**	-0.92**	-0.90**	1.07	1.13	1.10
$P_5 \times P_6$	0.93	0.98	0.96	0.01	0.01	0.01	0.72**	0.75**	0.74**	1.82	2.19*	2.00*
$P_5 \times P_7$	2.43	2.55	2.49*	0.43	0.44	0.43	0.50**	0.53*	0.51**	0.27	0.25	0.26
$P_5 \times P_8$	-0.18	-0.20	-0.19	0.90*	0.95	0.92**	0.40*	0.41	0.41**	0.05	0.03	0.04
$P_5 \times P_9$	-2.88	-3.02	-2.95*	-2.03**	-2.13**	-2.08**	-1.67**	-1.74**	-1.71**	-1.01	-1.08	-1.05
$P_5 \times P_{10}$	-2.65	-2.78	-2.71*	-1.59**	-1.67**	-1.63**	0.316	0.32	0.32*	0.47	0.47	0.47
$P_6 \times P_7$	-3.27	-3.44	-3.35**	-0.65	-0.68	-0.66	-0.64**	-0.66*	-0.65**	-0.58	-0.63	-0.60
$P_6 \times P_8$	-2.00	-2.10	-2.05	-0.11	-0.11	-0.11	0.65**	0.68**	0.66**	-1.76	-1.86	-1.81*
$P_6 \times P_9$	0.46	0.49	0.48	-2.53**	-2.66**	-2.59**	-0.52**	-0.54*	-0.53**	2.33*	2.39*	2.36**
$P_6 \times P_{10}$	0.09	0.10	0.10	-2.20**	-2.31**	-2.25**	-0.56**	-0.59*	-0.57**	-3.55**	-3.74**	-3.64**
$P_7 \times P_8$	-0.69	-0.73	-0.71	1.85**	1.94**	1.89**	-0.03	-0.03	-0.03	0.38	0.40	0.39
$P_7 \times P_9$	4.47**	4.62*	4.55**	-1.55**	-1.62**	-1.58**	-0.30	-0.32	-0.316 *	3.72**	3.86**	3.79**
$P_7 \times P_{10}$	0.97	1.02	0.99	0.43	0.45	0.44	-0.80**	-0.83**	-0.81**	2.10	2.20*	2.15**
$P_8 \times P_9$	0.57	0.61	0.59	1.84**	1.93**	1.88**	0.48**	0.50	0.49**	-0.73	-0.75	-0.74
$P_8 \times P_{10}$	0.60	0.64	0.62	-3.28**	-3.45**	-3.37**	-0.20	-0.21	-0.20	1.02	1.08	1.05
$P_9 \times P_{10}$	0.57	0.61	0.59	-0.48	-0.51	-0.50	-0.08	-0.08	-0.08	2.32*	2.46*	2.39**
SE (Sij)	3.31	3.88	3.60	0.849	1.11	0.98	0.36	0.50	0.44	2.320	2.16	2.24
SE (Sij-Sik)	4.86	5.70	5.28	1.248	1.63	1.44	0.53	0.74	0.64	3.411	3.18	3.30

*, ** Significant at 5 per cent and 1 per cent probability levels, espectively

Table 3: Cont….

Traits / Crosses	Fruit circumference			Total soluble solids (TSS)			Ascorbic acid (mg/100 g fresh fruit)			Reducing sugar (%)		
	E_1	**E_2**	**Pooled**	**E_1**	**E_2**	**Pooled**	**E_1**	**E_2**	**Pooled**	**E_1**	**E_2**	**Pooled**
$P_1 \times P_2$	1.38	1.45*	1.42**	-0.11	-0.10	-0.10	0.39	0.47	0.43*	-0.44**	-0.45**	-0.44**
$P_1 \times P_3$	1.32	1.38*	1.35**	0.35**	0.37**	0.36**	-0.66*	-0.65*	-0.65**	0.88**	0.90**	0.89**
$P_1 \times P_4$	-1.44	-1.52*	-1.48**	0.13	0.14	0.13	0.19	0.25	0.22	-0.44**	-0.46**	-0.45**
$P_1 \times P_5$	1.18	1.27	1.23*	-0.04	-0.06	-0.05	0.28	0.30	0.29	-0.12	-0.15*	-0.14*
$P_1 \times P_6$	-0.05	-0.05	-0.05	0.03	0.01	0.02	-0.41	-0.41	-0.41*	0.57**	0.59**	0.58**
$P_1 \times P_7$	-1.54*	-1.62*	-1.58**	0.07	0.08	0.07	0.28	0.32	0.30	-0.43**	-0.36**	-0.40**
$P_1 \times P_8$	4.49**	4.71**	4.60**	0.11	0.11	0.11	0.16	0.20	0.18	-0.14	-0.16*	-0.15**
$P_1 \times P_9$	-3.30**	-3.46**	-3.38**	0.15	0.13	0.14	-1.08**	-1.43**	-1.25**	-0.71**	-0.75**	-0.73**
$P_1 \times P_{10}$	-1.26	-1.34	-1.30**	-0.21	-0.24*	-0.22**	0.63*	0.65*	0.64**	1.33**	1.37**	1.35**
$P_2 \times P_3$	-0.59	-0.62	-0.61	-0.27*	-0.27**	-0.27**	0.33	0.39	0.36	-0.93**	-0.93**	-0.93**
$P_2 \times P_4$	0.02	0.02	0.02	0.10	0.13	0.12	0.01	-0.32	-0.15	-0.36**	-0.36**	-0.36**
$P_2 \times P_5$	-0.58	-0.59	-0.59	0.09	0.10	0.09	0.25	0.29	0.27	2.98**	3.03**	3.01**
$P_2 \times P_6$	0.18	0.20	0.19	-0.03	-0.02	-0.02	-0.25	-0.21	-0.23	-0.70**	-0.83**	-0.77**
$P_2 \times P_7$	-0.67	-0.71	-0.69	0.04	0.04	0.04	-0.82**	-0.77**	-0.79**	-0.35**	-0.36**	-0.36**

$P_2 \times P_8$	-0.43	-0.46	-0.45	-0.42**	-0.43**	-0.42**	0.43	0.15	0.29	0.40**	0.41**	0.40**
$P_2 \times P_9$	1.00	1.04	1.02*	0.22	0.20	0.21**	-2.51**	-2.46**	-2.49**	-1.30**	-1.25**	-1.28**
$P_2 \times P_{10}$	0.98	1.03	1.01*	-0.14	-0.17	-0.15*	-0.87**	-0.85**	-0.86**	-0.47**	-0.49**	-0.48**
$P_3 \times P_4$	0.166	0.17	0.17	0.13	0.11	0.12	-0.96**	-0.95**	-0.96**	0.13	0.15*	0.14**
$P_3 \times P_5$	0.22	0.26	0.24	0.06	0.07	0.06	0.02	0.01	0.021	-0.71**	-0.72**	-0.72**
$P_3 \times P_6$	1.25	1.34*	1.30**	0.06	0.08	0.07	1.01**	1.03**	1.02**	0.12	0.15*	0.13*
$P_3 \times P_7$	-1.76*	-1.84**	-1.80**	0.07	0.08	0.07	-0.41	-0.40	-0.41*	-0.62**	-0.63**	-0.62**
$P_3 \times P_8$	-1.22	-1.28	-1.25*	-0.29*	-0.29**	-0.29**	-0.72*	-0.72**	-0.72**	-0.33**	-0.34**	-0.33**
$P_3 \times P_9$	-0.22	-0.29	-0.25	-0.24	-0.26*	-0.257 **	0.03	-0.09	-0.03	0.12	0.13	0.131*
$P_3 \times P_{10}$	-1.18	-1.25	-1.21*	-0.40**	-0.44**	-0.42**	0.13	0.12	0.13	-0.66**	-0.76**	-0.71**
$P_4 \times P_5$	0.27	0.31	0.29	-0.26*	-0.26*	-0.26**	-1.18**	-1.18**	-1.18**	-0.54**	-0.56**	-0.55**
$P_4 \times P_6$	-0.55	-0.56	-0.55	-0.09	-0.08	-0.08	-1.12**	-1.11**	-1.11**	0.79**	0.82**	0.81**
$P_4 \times P_7$	-0.60	-0.63	-0.62	-0.31*	-0.32**	-0.32**	0.08	-0.04	0.02	-0.35**	-0.36**	-0.35**

Table 3: Contd..

$P_4 \times P_8$	-0.43	-0.46	-0.45	-0.41**	-0.42**	-0.42**	-0.93**	-0.89**	-0.91**	-0.03	-0.07	-0.05
$P_4 \times P_9$	-0.49	-0.52	-0.51	0.06	0.04	0.05	-0.45	-0.38	-0.41*	0.39**	0.40**	0.40**
$P_4 \times P_{10}$	-0.09	-0.11	-0.10	-0.09	-0.13	-0.11	-0.87**	-0.86**	-0.86**	-0.21*	-0.19*	-0.20**
$P_5 \times P_6$	-0.14	-0.44	-0.29	0.23	0.25*	0.24**	0.20	0.18	0.19	-0.41**	-0.42**	-0.41**
$P_5 \times P_7$	2.21**	2.35**	2.28**	-0.12	-0.12	-0.11	0.60*	0.61*	0.60**	0.69**	0.69**	0.69**
$P_5 \times P_8$	-0.34	-0.34	-0.34	-0.39**	-0.39**	-0.39**	0.05	0.06	0.06	-0.45**	-0.36**	-0.41**
$P_5 \times P_9$	-0.47	-0.47	-0.47	-0.64**	-0.67**	-0.65**	-0.22	-0.19	-0.20	-0.91**	-0.95**	-0.93**
$P_5 \times P_{10}$	-0.17	-0.16	-0.17	0.52**	0.51**	0.52**	-0.17	-0.20	-0.19	1.14**	1.17**	1.15**
$P_6 \times P_7$	-1.44	-1.50*	-1.47**	-0.05	-0.04	-0.04	0.70*	0.71**	0.71**	-0.42**	-0.43**	-0.42**
$P_6 \times P_8$	-2.34**	-2.44**	-2.39**	-0.21	-0.21*	-0.21**	-0.87**	-0.89**	-0.88**	0.06	0.07	0.06
$P_6 \times P_9$	-0.47	-0.47	-0.47	-0.13	-0.18	-0.16*	0.04	0.07	0.06	0.16	0.17*	0.16**
$P_6 \times P_{10}$	-1.77*	-1.77*	-1.77**	-0.23	-0.26*	-0.24**	0.08	0.05	0.07	-0.58**	-0.65**	-0.62**
$P_7 \times P_8$	1.11	1.16	1.14*	-0.04	-0.04	-0.04	0.51	0.56*	0.53**	0.14	0.13	0.14*
$P_7 \times P_9$	-2.05**	-2.16**	-2.11**	0.10	0.08	0.09	0.10	0.04	0.07	0.50**	0.50**	0.50**
$P_7 \times P_{10}$	4.47**	4.68**	4.58**	0.01	-0.02	-0.01	-0.12	-0.12	-0.11	-0.09	-0.09	-0.09
$P_8 \times$ P9	-3.09**	-3.24**	-3.16**	-0.59**	-0.63**	-0.61**	0.12	0.19	0.16	-1.13**	-1.17**	-1.15**
$P_8 \times P_{10}$	1.14	1.18	1.16*	0.17	0.14	0.16*	1.00**	1.02**	1.01**	1.02**	1.05**	1.03**
$P_9 \times P_{10}$	-0.05	-0.02	-0.03	0.85**	1.22**	1.03**	-0.27	-0.24	-0.26	-0.77**	-0.78**	-0.78**
SE (Sij)	1.45	1.34	1.40	0.24	0.20	0.22	0.56	0.49	0.53	0.16	0.14	0.16
SE (Sij-Sik)	2.13	1.97	2.06	0.36	0.30	0.33	0.83	0.73	0.78	0.24	0.21	0.23

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

Table 3: Cont….

Traits / Crosses	Non-reducing sugar (%)			Total sugar (%)			Dry matter content (%)		
	E_1	**E_2**	**Pooled**	**E_1**	**E_2**	**Pooled**	**E_1**	**E_2**	**Pooled**
$P_1 \times P_2$	0.13**	0.14**	0.13**	-0.30**	-0.30**	-0.30**	-0.91**	-0.95**	-0.93**
$P_1 \times P_3$	-0.03	-0.04	-0.03	0.84**	0.86**	0.85**	0.57**	0.57**	0.57**
$P_1 \times P_4$	-0.02	-0.02	-0.02	-0.47**	-0.48**	-0.47**	-1.23**	-1.27**	-1.25**
$P_1 \times P_5$	0.04	0.04	0.04*	-0.09	-0.10	-0.09	0.43**	0.43**	0.43**
$P_1 \times P_6$	-0.09**	-0.09**	-0.09**	0.47**	0.50**	0.49**	0.36**	0.36**	0.36**

$P_1 \times P_7$	0.13**	0.14**	0.14**	-0.30**	-0.22*	-0.26**	0.03	0.02	0.03
$P_1 \times P_8$	-0.11**	-0.12**	-0.11**	-0.27**	-0.27**	-0.27**	-0.45**	-0.47**	-0.46**
$P_1 \times P_9$	0.04	0.03	0.03	-0.66**	-0.70**	-0.68**	0.32**	0.47**	0.40**
$P_1 \times P_{10}$	0.19**	0.19**	0.19**	1.52**	1.57**	1.55**	0.14	0.15	0.15*
$P_2 \times P_3$	0.05	0.05	0.05**	-0.90**	-0.87**	-0.89**	-0.53**	-0.55**	-0.54**
$P_2 \times P_4$	-0.02	-0.02	-0.02	-0.38**	-0.37**	-0.38**	0.58**	0.73**	0.65**
$P_2 \times P_5$	-0.04	-0.04	-0.04*	2.93**	2.99**	2.96**	-0.34**	-0.35**	-0.34**
$P_2 \times P_6$	-0.01	-0.02	-0.02	-0.72**	-0.84**	-0.78**	0.83**	0.83**	0.83**
$P_2 \times P_7$	0.06*	0.06*	0.06**	-0.29**	-0.30**	-0.29**	0.32**	0.32**	0.32**
$P_2 \times P_8$	-0.07*	-0.07*	-0.07**	0.32**	0.30**	0.31**	-1.15**	-1.19**	-1.17**
$P_2 \times P_9$	0.37**	0.37**	0.37**	-0.92**	-0.86**	-0.89**	-0.01	-0.01	-0.01
$P_2 \times P_{10}$	-0.05	-0.05	-0.05**	-0.52**	-0.57**	-0.55**	-0.02	-0.02	-0.02
$P_3 \times P_4$	0.05*	0.06*	0.05**	0.19	0.21*	0.20**	0.72**	0.73**	0.73**
$P_3 \times P_5$	-0.09**	-0.09**	-0.09**	-0.80**	-0.82**	-0.81**	-0.26**	-0.26**	-0.26**
$P_3 \times P_6$	0.2	0.01	0.01	0.15	0.17*	0.16*	-0.32**	-0.33**	-0.32**
$P_3 \times P_7$	-0.06*	-0.06*	-0.06**	-0.68**	-0.69**	-0.69**	0.64**	0.66**	0.65**
$P_3 \times P_8$	0.09**	0.09**	0.09**	-0.24*	-0.23**	-0.24**	-0.07	-0.07	-0.07
$P_3 \times P_9$	-0.02	-0.02	-0.02	0.12	0.12	0.12	0.90**	0.92**	0.91**
$P_3 \times P_{10}$	-0.12**	-0.12**	-0.12**	-0.75**	-0.89**	-0.82**	-0.94**	-0.94**	-0.94**
$P_4 \times P_5$	0.08**	0.08**	0.08**	-0.45**	-0.47**	-0.46**	0.94**	0.95**	0.95**
$P_4 \times P_6$	-0.03	-0.03	-0.02	0.76**	0.80**	0.78**	-1.12**	-1.15**	-1.13**
$P_4 \times P_7$	0.36**	0.36**	0.36**	0.01	0.01	0.01	0.44**	0.43**	0.43**
$P_4 \times P_8$	0.12**	0.12**	0.12**	0.08	0.05	0.06	0.52**	0.52**	0.52**
$P_4 \times P_9$	0.05	0.05	0.05*	0.47**	0.42**	0.45**	-0.82**	-0.84**	-0.83**
$P_4 \times P_{10}$	-0.31**	-0.31**	-0.31**	-0.51**	-0.50**	-0.51**	-0.44**	-0.44**	-0.44**
$P_5 \times P_6$	-0.20**	-0.20**	-0.20**	-0.62**	-0.63**	-0.62**	-0.73**	-0.74**	-0.73**
$P_5 \times P_7$	0.17**	0.18**	0.17**	0.86**	0.87**	0.87**	-0.46**	-0.47**	-0.46**
$P_5 \times P_8$	-0.11**	-0.11**	-0.11**	-0.51**	-0.51**	-0.51**	0.75**	0.76**	0.75**
$P_5 \times P_9$	0.05	0.04	0.04*	-0.92**	-0.89**	-0.91**	-0.32**	-0.33**	-0.33**
$P_5 \times P_{10}$	0.23**	0.23**	0.23**	1.37**	1.40**	1.39**	0.72**	0.75**	0.73**
$P_6 \times P_7$	-0.07*	-0.07*	-0.07**	-0.47**	-0.51**	-0.49**	-0.56**	-0.57**	-0.56**
$P_6 \times P_8$	-0.05	-0.05	-0.05**	-0.01	0.02	0.01	-0.44**	-0.45**	-0.44**
$P_6 \times P_9$	0.21**	0.22**	0.21**	0.38**	0.39**	0.38**	-0.19*	-0.19*	-0.19**
$P_6 \times P_{10}$	0.18**	0.19**	0.19**	-0.39**	-0.46**	-0.43**	0.11	0.13	0.12*
$P_7 \times P_8$	-0.23**	-0.23**	-0.23**	-0.09	-0.10	-0.09	0.48**	0.49**	0.49**
$P_7 \times P_9$	-0.03	-0.03	-0.03	0.47**	0.43**	0.45**	0.03	0.04	0.04
$P_7 \times P_{10}$	-0.23**	-0.23**	-0.23**	-0.33**	-0.32**	-0.32**	-0.48**	-0.47**	-0.47**
$P_8 \times$ P9	-0.06*	-0.06*	-0.06**	-1.19**	-1.23**	-1.21**	0.62**	0.64**	0.63**
$P_8 \times P_{10}$	0.36**	0.36**	0.36**	1.38**	1.42**	1.40**	-0.06	-0.05	-0.05
$P_9 \times P_{10}$	-0.11**	-0.11**	-0.11**	-0.94**	-0.89**	-0.91**	0.56**	0.43**	0.50**
SE (Sij)	0.05	0.05	0.06	0.19	0.17	0.18	0.15	0.18	0.17
SE (Sij-Sik)	0.08	0.08	0.09	0.29	0.25	0.27	0.22	0.27	0.25

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

Table 3: Cont….

Crosses \ Traits	Fruit weight (kg)			Number of fruit per plant			Fruit yield per plant (kg)		
	E_1	E_2	Pooled	E_1	E_2	Pooled	E_1	E_2	Pooled
$P_1 \times P_2$	0.19**	0.20**	0.20**	0.99**	1.06**	1.03**	1.47**	1.57**	1.52**
$P_1 \times P_3$	0.01	-0.01	0.01	-0.09	-0.10	-0.09	-0.55**	-0.58**	-0.56**
$P_1 \times P_4$	0.09**	0.10**	0.09**	-1.20**	-1.29**	-1.25**	-0.73**	-0.78**	-0.76**
$P_1 \times P_5$	-0.07*	-0.08*	-0.08**	0.92**	0.99**	0.95**	-0.59**	-0.63**	-0.61**
$P_1 \times P_6$	-0.05	-0.05	-0.05*	-0.21	-0.22	-0.21	-0.55**	-0.59**	-0.57**
$P_1 \times P_7$	-0.08**	-0.09*	-0.09**	-0.28	-0.30	-0.29*	-0.22	-0.24	-0.23
$P_1 \times P_8$	-0.08**	-0.09*	-0.09**	-0.18	-0.19	-0.18	0.02	0.02	0.02
$P_1 \times P_9$	0.10**	0.11**	0.10**	-1.33**	-1.42**	-1.38**	-0.78**	-0.83**	-0.81**
$P_1 \times P_{10}$	-0.03	-0.03	-0.03	-0.07	-0.07	-0.07	0.61**	0.65**	0.63**
$P_2 \times P_3$	-0.18**	-0.19**	-0.19**	-0.81**	-0.86**	-0.84**	0.47*	0.50**	0.48**
$P_2 \times P_4$	0.06*	0.07	0.06**	-0.86**	-0.92**	-0.89**	-0.46*	-0.49**	-0.47**
$P_2 \times P_5$	0.04	0.04	0.04	-1.01**	-1.07**	-1.03**	-0.06	-0.07	-0.07
$P_2 \times P_6$	-0.11**	-0.12**	-0.11**	-1.07**	-1.14**	-1.11**	-0.85**	-0.91**	-0.88**
$P_2 \times P_7$	-0.02	-0.02	-0.02	-0.29	-0.31	-0.30*	-0.07	-0.07	-0.07
$P_2 \times P_8$	0.08**	0.09*	0.08**	-0.20	-0.21	-0.20	0.50*	0.53**	0.52**
$P_2 \times P_9$	0.04	0.05	0.05*	0.67**	0.68**	0.68**	0.60**	0.65**	0.63**
$P_2 \times P_{10}$	0.01	0.01	0.02	0.45*	0.48**	0.47**	-0.05	-0.05	-0.05
$P_3 \times P_4$	0.013	0.01	0.01	-0.03	-0.03	-0.03	0.03	0.04	0.042
$P_3 \times P_5$	-0.073 *	-0.07*	-0.07**	0.55**	0.59**	0.57**	0.30	0.32	0.31*
$P_3 \times P_6$	0.12**	0.13**	0.12**	0.07	0.08	0.08	0.82**	0.87**	0.84**
$P_3 \times P_7$	-0.086 **	-0.08*	-0.08**	0.27	0.29	0.28*	0.05	0.06	0.05
$P_3 \times P_8$	-0.004	-0.01	-0.01	0.61**	0.65**	0.63**	0.29	0.32	0.30*
$P_3 \times P_9$	-0.057	-0.06	-0.05*	0.66**	0.71**	0.69**	0.21	0.22	0.21
$P_3 \times P_{10}$	-0.040	-0.04	-0.04	0.19	0.20	0.20	0.12	0.13	0.13
$P_4 \times P_5$	0.016	0.02	0.01	0.35	0.37*	0.36**	0.53**	0.57**	0.55**
$P_4 \times P_6$	-0.15**	-0.17**	-0.16**	0.48*	0.51**	0.50**	0.16	0.18	0.17
$P_4 \times P_7$	-0.01	-0.03	-0.02	0.63**	0.67**	0.65**	0.44*	0.47**	0.45**
$P_4 \times P_8$	0.04	0.05	0.04*	0.73**	0.79**	0.76**	0.63**	0.67**	0.65**
$P_4 \times P_9$	-0.11**	-0.12**	-0.12**	0.23	0.25	0.24	1.03**	1.11**	1.07**
$P_4 \times P_{10}$	-0.04	-0.04	-0.04	-0.06	-0.07	-0.07	-0.03	-0.04	-0.04
$P_5 \times P_6$	0.25**	0.27**	0.26**	-0.18	-0.19	-0.18	0.86**	0.92**	0.89**
$P_5 \times P_7$	0.02	0.03	0.03	0.10	0.11	0.11	0.37	0.40*	0.38**
$P_5 \times P_8$	-0.04	-0.04	-0.04	-0.02	-0.05	-0.04	-0.01	-0.01	-0.01
$P_5 \times P_9$	-0.16**	-0.17**	-0.16**	-0.15	-0.16	-0.15	-0.14	-0.15	-0.14
$P_5 \times P_{10}$	-0.09**	-0.09*	-0.09**	-0.17	-0.18	-0.18	-0.13	-0.13	-0.13
$P_6 \times P_7$	-0.21**	-0.22**	-0.22**	0.63**	0.68**	0.65**	-0.84**	-0.90**	-0.87**
$P_6 \times P_8$	0.14**	0.15**	0.14**	-0.11	-0.11	-0.11	0.08	0.08	0.08
$P_6 \times P_9$	-0.049	-0.053	-0.051 *	0.120	0.13	0.12	0.11	0.12	0.11
$P_6 \times P_{10}$	0.08**	0.09*	0.08**	0.09	0.10	0.10	0.23	0.25	0.24
$P_7 \times P_8$	-0.06*	-0.06	-0.066**	-0.29	-0.31	-0.302*	-0.38	-0.41*	-0.40**
$P_7 \times P_9$	-0.01	-0.01	-0.01	1.06**	1.14**	1.10**	0.39	0.42*	0.40**
$P_7 \times P_{10}$	0.13**	0.14**	0.14**	0.26	0.28	0.27*	0.71**	0.76**	0.73**
$P_8 \times$ P9	-0.10**	-0.11**	-0.11**	0.25	0.27	0.26	-0.25	-0.27	-0.26*
$P_8 \times P_{10}$	-0.18**	-0.20**	-0.19**	0.17	0.19	0.18	-0.20	-0.21	-0.21
$P_9 \times P_{10}$	-0.01	-0.01	-0.01	-0.07	-0.07	-0.07	-0.05	-0.05	-0.05
SE (Sij)	0.06	0.07	0.07	0.39	0.36	0.38	0.40	0.34	0.37
SE (Sij-Sik)	0.09	0.10	0.10	0.57	0.53	0.56	0.59	0.50	0.55

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

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