Electronic Journal of Plant Breeding, 8(3): 825-833 (September 2017)
ISSN 0975-928X
DOI: 10.5958/0975-928X.2017.00131.4

Research Article

Combining ability studies for yield and yield components in chilli (*Capsicum annuum* L.)

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(Received: 14 April 2017; Revised: 01 Aug 2017; Accepted: 17Aug 2017)

Abstract
The present investigation was carried out at Horticultural Research Station, Lam farm, Guntur, Andhra Pradesh during *kharif*, 2013-14 and 2014-15 to estimate the combining ability effects employing the line x tester mating design with nine lines and six testers. The analysis of variance revealed that significant differences among the parents and crosses for all the 12 characters studied. Six characters *viz.* fruit yield per plant, plant spread, days to 50% flowering, days to fruit maturity, number of fruits per plant and number of seeds per fruit were exhibited higher magnitude of *sca* variances than *gca* variances which revealed that non-additive gene action was played an important role in the inheritance of these trait. According to *gca* effects, the genotypes LCA-442, LCA-654, LCA-655, LCA-703-2 and LCA-453 found to be promising general combiners for yield and yield components. The *sca* effects revealed that nine crosses *viz*., LCA 466 x LCA 705-2, LCA 607 x LCA 703-2, LCA 355 x LCA 678, LCA 504 x LCA 705-2, LCA 446 x LCA 703-2, LCA 615 x LCA 453, LCA 442 x LCA 453, LCA 607 x G4 and LCA 654 x LCA were identified as promising hybrids for fruit yield and it's yield component characters.

Key words
Chilli, *Capsicum annuum*, Combining ability, additive, non-additive

Introduction

Chilli (*Capsicum annuum* L.) is a member of the Solanaceae family, originated from South and Central America. Chilli has its unique place in the diet as a vegetable cum spice crop. India is the largest producer (1.492 million tonnes from 0.775 million hectares), consumer and exporter of chilli in the world (National Horticulture Board, 2014) with productivity of 1.9 metric t/ha. Andhra Pradesh leads the country in its production, productivity and export followed by Telangana, Karnataka, West Bengal, Madhya Pradesh, Orissa *etc.*

Even though India ranks first in area and production of chilli, its productivity is very low as compared to other countries like Japan (3.6 t/ha) and Korea (2 t/ha), USA and Indonesia (Patil *et al.*, 2012) due to poor yielding genotypes/varieties. One of the options to achieve quantum jump in yield is development of heterotic hybrids through hybridization programme. The knowledge of the relative importance of additive and non-additive gene action is essential to a plant breeder for the development of an efficient hybridization programme (Dudley and Moll, 1969) and proper choice of parents based on their combining ability is also prerequisite to gain better heterotic effects. The studies of combining ability in chilli have also been reported by Khalil and Hatem (2014), Suryakumari *et al*. (2014) and Kranthi Rekha *et al.* (2016).

Combining ability refers to the capacity or ability of a genotype to transmit superior performance to its crosses. The concept of combining ability was originally developed in maize by Richey and Meyar (1925). Sprauge and Tatum (1942) have defined the terms 'general combining ability' (GCA) and 'specific combining ability' (SCA) as a measure of gene action while working with maize. Griffing (1956), showed the relationship between GCA and SCA variances. The GCA variance is due to additive whereas SCA variance is due to non-additive gene action. Hence, both act as an important diagnostic tool in selection of suitable parents. Top crossing, line x tester, diallel and partial diallel crossing techniques are used to study the combining ability. Among the above techniques, the Line x tester (L x T) mating design provides more precise estimate of GCA, SCA and other parameters (Kempthorne, 1957). Therefore, the present investigation was carried out using Line x tester (L x T) mating design to estimate the combining ability effects for yield and it's component characters in chilli.

Materials and Methods

An experiment was carried at Horticulture Research Station, Dr. Y.S.R.H.U., Lam farm, Guntur**.** The experimental material and their characters used in this experiment were presented in Table 1. The experimental material comprised of nine lines (LCA 504, LCA 615, LCA 446, LCA 466, LCA 442, LCA 654, LCA 607, LCA 655 and LCA 355) and six testers (G4, LCA 678, LCA 453, LCA 703-2, LCA 705-2 and LCA 315). These parents were crossed in Line × Tester fashion during *Kharif*, 2013-14 and developed 54 F_1 hybrids. The resulting 54 F_1 hybrids along with their 15 parents and two commercial checks (Tejaswini and Indam-5) were evaluated during *Kharif*, 2014-15 in a Randomized Block Design with three replications in two rows (one row of 4 m length) of each genotype at a spacing of 75 cm x 30 cm. The crop was raised as per the recommended package of practices. The observations were recorded on five randomly selected plants for twelve characters *viz.*, plant height (cm), plant spread (cm), number of primary branches, days to 50% flowering, days to fruit maturity, number of fruits per plant, fruit length (cm), fruit diameter (cm), average dry fruit weight (g), dry fruit yield per plant (g), number of seeds per fruit and seed weight (g/1000 seed) and the data were analyzed for combining ability according to the standard procedure given by Kempthorne (1957).

Results and Discussion

The analysis of variance for L x T in respect of yield and yield component characters is presented in Table 2. The analysis of variance revealed that significant differences among the parents and crosses for all the 12 characters studied. Whereas, among the parents *vs*. crosses only seven traits were registered significant differences and the characters *viz.* plant height, days to fruit maturity, fruit diameter, no. of seeds per fruit and seed weight were recorded non-significant differences. All genotypes were partitioned into lines, testers and lines x testers and the significant differences were observed among lines and testers for all the characters studied. The differences due to lines x testers were significant for all the traits studied except for plant height, plant spread, no. of primary branches per plant, days to fruit maturity, fruit yield and seed weight. This indicates the existence of wide variability in the material studied and there is an excellent scope to identify good general combiners and to develop promising hybrids. These results are in accordance with the earlier findings of Payakhapaab *et al.* (2012).

The estimates of *gca* and *sca* variances and their ratios are presented in Table 3. Variances due to general combining ability (*gca*) and specific combining ability (*sca*) were found to be significant for all the characters studied. Six characters *viz.* fruit yield per plant, plant spread, days to 50% flowering, days to fruit maturity, number of fruits per plant and number of seeds per fruit were exhibited higher magnitude of *sca* variances than *gca* variances and the *gca*:*sca* ratio is less than unity which revealed that non-additive gene action was played an important role in the inheritance of these traits and improvement of these traits can be made through heterosis breeding. These results are in agreement with the earlier reports of Hasanuzzaman *et al*. (2012). Whereas, the characters *viz.* plant height, no. of primary branches, fruit length, fruit diameter, average dry fruit weight and seed weight were showed predominance of additive gene action in governing these characters due to higher magnitude of *gca* variances than *sca* variances and high *gca*:*sca* ratio (> 1) suggesting that these traits can be improved through simple selection procedure in segregating generations. The results of this kind of gene action are in conformity with earlier findings of Khalil and Hatem (2014).

The estimates of general combining ability (*gca)* effects of nine lines and six testers for 12 characters are presented in Table 4. The general combining ability (*gca)* effects revealed that the lines *viz.* LCA 504 for plant height (7.14), plant spread (5.67) and days to 50% flowering (-2.11); LCA 615 for fruit diameter (0.07), dry fruit weight (0.06), no. of seeds per fruit (17.21) and seed weight (0.64); LCA 446 for days to 50% flowering (-2.33) and fruit diameter (0.08); LCA 466 for plant spread (3.17), no. of primary branches per plant (0.56), days to fruit maturity (-3.37) and fruit diameter (0.16); LCA 442 for no. of fruits per plant (28.27), fruit length (0.69), fruit diameter (0.06) and fruit yield per plant (11.69); LCA 654 for fruit length (0.92), fruit diameter (0.05), dry fruit weight (0.12) and no. of seeds per fruit (5.52); LCA 607 for plant height (3.52), dry fruit weight (0.11) and seed weight (0.28); LCA 655 for plant height (6.60), no. of fruits per plant (64.01) and fruit yield per plant (36.99) and LCA 355 for days to 50% flowering (-2.17), days to fruit maturity (-4.20) and fruit length (1.42) were found to be good general combiners for that respective characters as they exhibited significant *gca* effects in desirable direction due to contribution of large number of favorable alleles. These results are supported by the earlier findings of Kamble *et al.* (2009) and Hasanuzzaman *et al*. (2012).

Among the testers (Table 4), G4 for days to 50% flowering (-1.28), days to fruit maturity (-3.24) and no. of fruits per plant (22.62); LCA 678 for plant height (2.07), plant spread (5.33) and no. of fruits per plant (19.60); LCA 453 for fruit diameter (0.18), average dry fruit weight (0.24), no. of seeds per fruit (6.93) and seed weight (0.37); LCA 703-2 for plant height (10.58), plant spread (5.38), no. of primary branches per plant (0.42), no. of fruits per plant (49.39), fruit yield per plant (40.04) and seed weight (0.30); LCA 705-2 for days to 50% flowering (-1.06) and seed weight (0.26) and LCA 315 for fruit length (1.47), dry fruit weight (0.07) and no. of seeds per fruit (4.99) were found to be good general combiners for that particular traits as they exhibited significant *gca* effects in desirable direction. These results are in accordance with earlier reports of by Suryakumari *et al*. (2014) and Kranthi Rekha *et al.* (2016).

Among the 15 parents, the lines LCA-442 (no. of fruits per plant, fruit length, fruit diameter and fruit yield), LCA-654 (fruit length, fruit diameter, dry fruit weight, no. of seeds per fruit), LCA-655 (plant height, no. of fruits per plant and fruit yield) and the testers LCA-703-2 (plant height, plant spread, no. of primary branches per plant, no. of fruits per plant, seed weight and fruit yield), LCA-453 (fruit diameter, dry fruit weight, no. of seeds per fruit, seed weight) were found to be good general combiners as they showed significant *gca* effects in desirable direction for yield and yield components. Therefore, these parents were noted as good source of favourable genes for increasing fruit yield through various yield contributing characters. It was further noted that using of these parental lines in further breeding programmes would be more rewarding for boosting of fruit yield and will be resulted in development of promising heterotic crosses for various traits in chilli. These results are supported by earlier reports of Kranthi Rekha *et al.* (2016).

The estimates of specific combining ability (*sca)* effects of 54 hybrids for 12 characters are furnished in Table 5. Among the 54 hybrids, nine crosses each for fruit yield per plant, plant height, average dry fruit weight and no. of seeds per fruit; seven crosses for plant spread; three crosses each for no. of primary branches per plant, days to fruit maturity (-) and seed weight; ten crosses for days to 50% flowering (-), eleven crosses for no. of fruits per plant, six crosses for fruit length and four crosses for fruit diameter were exhibited superiority as they have manifested significant *sca* effects in desirable direction. The findings of earlier workers Kamble *et al.* (2009) and Suryakumari *et al.* (2014) are also report the significant positive *sca* effects for fruit yield and its component characters.

The *sca* effects from table 5 revealed that nine crosses *viz*., LCA 466 x LCA 705-2 (no. of fruits per plant, fruit yield), LCA 607 x LCA 703-2 (no. of fruits per plant, fruit yield), LCA 355 x LCA 678 (no. of fruits per plant, fruit yield), LCA 504 x LCA 705-2 (no. of primary branches, no. of fruits per plant, fruit yield), LCA 446 x LCA 703-2 (plant height, fruit yield), LCA 615 x LCA 453 (plant height, days to 50% flowering, no. of fruits per plant, dry fruit weight, fruit yield), LCA 442 x LCA 453 (plant spread, no. of fruits per plant, fruit yield), LCA 607 x G4 (plant spread, days to 50% flowering, no. of fruits per plant, fruit length, fruit yield) and LCA 654 x LCA 678 (no. of seeds per fruit, fruit yield) were identified as promising hybrids for fruit yield and their yield components as they have registered significant *sca* effects in desirable direction. The estimates of *sca* effects revealed that none of the crosses was constantly superior for all the traits. This indicated that the specific combining ability of the crosses was not always dependent on the *gca* of the parents involved. These results are in accordance with earlier reports of Khalil and Hatem (2014) and Kranthi Rekha *et al.* (2016).

Conclusion

According to *gca* effects, the genotypes LCA-442, LCA-654, LCA-655, LCA-703-2 and LCA-453 found to be promising general combiners for yield and yield components. All these parents might be contributing positive alleles for yield and yield attributes and these can be used in multiple crosses for screening of segregants with all the favourable alleles distributed among the population. The *sca* effects revealed that nine crosses *viz*., LCA 466 x LCA 705-2, LCA 607 x LCA 703-2, LCA 355 x LCA 678, LCA 504 x LCA 705-2, LCA 446 x LCA 703-2, LCA 615 x LCA 453, LCA 442 x LCA 453, LCA 607 x G4 and LCA 654 x LCA were identified as promising hybrids for fruit yield and their yield components and these can be evaluated over locations or seasons in larger plots to draw valid conclusion for their commercial exploitation on their hybrid vigour.

Acknowledgements

I extend my deep sense of reverence and gratitude to Associate Dean, Horticultural College and Research Institute, Venkataramannagudem, Dr. Y.S.R.H.U for allotting me to HRS, Lam to take up my research work. I am highly thankful to Dr. Y.S.R. Horticultural University, Venkataramannagudem for providing financial assistance in the form of stipend to complete this endeavour.

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 DOI: 10.5958/0975-928X.2017.00131.4

Table 1. Salient features of parents used in Line x Tester analysis of chilli

S.No	Parents	Features
Lines		
1	LCA-504	Drought resistant, highly pungent
2	LCA-615	High yielding line with parrot green fruits
3	LCA-446	Bold pod, high colour and oleoresin
4	LCA-466	Bold and long pod, high colour and oleoresin
5	LCA-442	Bold and long pod, high colour and mild pungent
6	LCA-654	Medium bold, shiny fruit surface, light green in colour
7	LCA-607	Light green pod, profuse branching
8	LCA-655	Dual purpose variety, bold light green pod
9	LCA-355	High colour with wrinkled surface
Testers		
1	G4	Dark green (olive green) fruits, virus resistant
2	LCA-678	More primary branches, semi erect plant habit
3	LCA-453	Bold pod, erect growth habit
4	LCA-703-2	Virus resistant, dark green fruits
5	LCA-705-2	More no. of fruits, shiny dry pod
6	LCA-315	Virus resistant, fruits are long and dark green
Checks		
1	Indam-5	Indo-American Hybrid Seeds (India) Pvt.Ltd. (IAHS)
2	Tejaswini	Maharashta Hybrid Seeds Co.Ltd. (MAHYCO)

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Table 2. Analysis of variance for combining ability analysis in respect of yield and yield component characters in chilli

Source of variation	Df	PH	PS	NPBPP	DFF	DFM	NFPP	FL	FD	ADFW	FYPP	NSPF	SW
Replications	2	35.36	35.31	0.11	3.27	16.71	233.40	0.47	0.00	0.03	50.82	285.78*	0.68
Treatments	68	247.43**	184.04**	0.72**	40.28**	61.11**	9776.15**	6.25**	0.13**	0.13**	4478.00**	539.91**	1.30**
Parents	14	272.38**	107.87**	0.71**	37.40**	55.51**	7290.72**	8.87**	0.28**	0.22**	4302.95**	577.65**	1.99**
Lines	8	219.22**	62.17*	0.38*	54.34**	39.01**	3414.52**	7.06**	0.24**	0.09**	4457.92**	457.92**	2.34**
Testers	5	402.36**	202.30**	1.39**	14.36**	87.29**	11844.51**	9.72**	0.38**	0.40**	4708.59**	691.03**	1.66**
Line x Tester	1	47.80	1.41	0.00	17.13**	28.68	15531.43**	19.17**	0.10**	0.31**	1034.96	968.63**	0.85
Parents *vs* Crosses	1	92.42	358.89**	1.65**	309.95**	0.41	29217.10**	41.66**	0.00	0.05*	24233.62**	96.68	0.13
Crosses	53	243.76**	200.86**	0.71**	35.95**	63.73**	10065.87**	4.89**	0.09**	0.11**	4151.50**	538.30**	1.14**
Error	136	23.79	27.19	0.17	2.14	13.18	860.72	0.46	0.01	0.01	602.37	89.20	0.37

*; Significant at 5% level; **; Significant at 1% level

Table 3. Estimates of general and specific combining ability variances and proportionate gene action for 12 yield and yield components in chilli.

Source of variation	PH	PS	NPBPP	DFF	DFM	NFPP	FL	FD	ADFW	FYPP	NSPF	SW
σ^2gca	31.43**	18.43*	0.076**	2.73**	5.81**	1156.53*	0.70**	0.012**	0.015*	373.57**	45.45**	0.11*
σ^2sca	26.97**	36.84**	0.063*	7.61**	7.29**	1532.72**	0.24**	0.008**	0.013**	717.03**	79.51**	0.09
σ^2gca/σ^2sca	1.17	0.50	1.22	0.36	0.80	0.75	2.92	1.43	1.20	0.52	0.57	1.22

*; Significant at 5% level; **; Significant at 1% level

PH - Plant Height (cm), PS - Plant Spread (cm), NPBPP - No. of Primary Branches Per Plant, DFF – Days to 50% Flowering, DFM – Days to Fruit Maturity, NFPP – No. of Fruits Per Plant, FL – Fruit Length (cm), FD – Fruit Diameter (cm), ADFW – Average Dry Fruit Weight (g), FYPP – Fruit Yield Per Plant (g), NSPF – No. of Seeds Per Fruit, SW – Seed Weight (g/1000 seed).

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Table 4. Estimates of general combining ability (*gca)* effects of parents for 12 yield and yield component characters in chilli

	PH	PS	NPBPP	DFF	DFM	NFPP	FL	FD	ADFW	FYPP	NSPF	SW
Lines												
LCA-504	7.14**	5.67**	-0.48**	-2.11**	3.69**	-6.64	0.08	-0.05	-0.05	1.39	0.49	-0.38**
LCA-615	-2.35*	0.35	-0.06	0.11	5.35**	-29.18**	-1.22**	0.07**	0.06*	-16.18**	17.21**	0.64**
LCA-446	-4.16**	-1.23	-0.14	-2.33**	-0.26	-12.70	0.17	0.08**	-0.03	-10.57	-5.11*	-0.30*
LCA-466	1.80	3.17*	0.56**	4.39**	-3.37**	-17.55*	-1.35**	0.16**	-0.03	-18.17**	2.82	-0.32*
LCA-442	-6.71**	-4.41**	0.15	1.61**	-1.31	28.27**	0.69**	0.06*	0.02	11.69*	-14.31**	-0.29*
LCA-654	-5.71**	-4.33**	-0.08	-0.56	-0.54	-22.51**	0.92**	0.05*	0.12**	7.47	5.52*	0.18
LCA-607	3.52**	2.26	0.02	1.72**	-1.37	-8.42	0.08	-0.04	0.11**	10.85	3.56	0.28*
LCA-655	6.60**	2.26	0.19	-0.67	2.02*	64.01**	-0.78**	-0.22**	-0.09**	36.99**	-3.21	0.24
LCA-355	-0.12	-3.75**	-0.16	-2.17**	-4.20**	4.73	1.42**	-0.12**	-0.11**	-23.47**	-6.97**	-0.06
SE (gi)	**1.15**	**1.23**	**0.10**	**0.35**	**0.86**	**6.92**	**0.16**	**0.02**	**0.03**	**5.78**	**2.23**	**0.14**
Testers												
G4	-0.27	1.35	0.11	-1.28**	-3.24**	22.62**	-0.22	-0.16**	-0.19**	-19.39**	-6.78**	-0.42**
LCA-678	2.07*	5.33**	0.09	1.98**	0.76	19.60**	-0.37**	-0.01	-0.09**	-1.14	-5.17**	-0.38**
LCA-453	-2.07*	-3.33**	-0.32**	0.06	-1.13	-53.68**	0.11	0.18**	0.24**	-7.45	6.93**	0.37**
LCA-703-2	10.58**	5.38**	0.42**	0.31	2.46**	49.39**	-0.77**	-0.01	-0.03	40.04**	-0.45	0.30*
LCA-705-2	-3.01**	-2.00*	-0.35**	-1.06**	-0.20	-9.96	-0.23	0.01	0.00	-4.48	0.47	0.26*
LCA-315	-7.30**	-6.72**	0.04	-0.02	1.35	-27.96**	1.47**	-0.01	0.07**	-7.59	4.99**	-0.13
SE (gj)	**0.94**	**1.00**	**0.08**	**0.28**	**0.70**	**5.65**	**0.13**	**0.02**	**0.02**	**4.72**	**1.82**	**0.12**

*; Significant at 5% level; **; Significant at 1% level

PH - Plant Height (cm), PS - Plant Spread (cm), NPBPP - No. of Primary Branches Per Plant, DFF – Days to 50% Flowering, DFM – Days to Fruit Maturity, NFPP – No. of Fruits Per Plant, FL – Fruit Length (cm), FD – Fruit Diameter (cm), ADFW – Average Dry Fruit Weight (g), FYPP – Fruit Yield Per Plant (g), NSPF – No. of Seeds Per Fruit, SW – Seed Weight (g/1000 seed)

Electronic Journal of Plant Breeding, 8(3): 825-833 (September 2017)
ISSN 0975-928X
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Table 5. Estimates of specific combining ability (*sca*) effects of hybrids for 12 yield and yield component characters in chilli

Crosses	PH	PS	NPBPP	DFF	DFM	NFPP	FL	FD	ADFW	FYPP	NSPF	SW
LCA-504 x G4	2.29	-2.25	-0.45	-1.00	4.80*	-5.34	-0.24	-0.02	0.03	3.74	4.23	0.04
LCA-504 x LCA-678	-0.81	-0.13	-0.17	2.74**	-1.20	-19.72	-0.27	-0.01	0.03	-16.46	-4.42	0.25
LCA-504 x LCA-453	-3.91	-4.37	0.01	0.00	-1.65	-19.31	1.00*	-0.01	-0.02	0.58	11.94*	0.43
LCA-504 x LCA-703-2	-2.59	6.76*	-0.30	-0.93	-0.24	-36.28*	0.19	0.07	0.04	-35.52*	11.33*	-0.23
LCA-504 x LCA-705-2	2.54	-0.07	0.57*	-0.56	-0.91	71.08**	-0.88*	0.02	-0.12	38.64**	-21.26**	-0.39
LCA-504 x LCA-315	2.49	0.06	0.35	-0.26	-0.80	9.57	0.20	-0.05	0.03	9.02	-1.82	-0.09
LCA-615 x G4	9.25**	-8.86**	0.19	1.78*	2.80	-28.79	-0.55	0.07	-0.24**	-17.58	11.56*	0.15
LCA-615 x LCA-678	-1.60	3.36	-0.10	-0.81	2.80	-41.04*	1.04**	0.06	-0.02	-35.82*	-3.05	0.76*
LCA-615 x LCA-453	7.82**	2.65	0.08	-4.56**	-1.98	38.51*	-0.15	0.05	0.15*	37.50**	-2.95	0.00
LCA-615 x LCA-703-2	-12.66**	-1.19	0.24	1.52	-0.57	-23.04	-0.67	-0.05	-0.01	-26.48	-4.90	-0.60
LCA-615 x LCA-705-2	-2.47	-0.34	-0.16	2.56**	-1.24	17.02	0.11	-0.11	0.00	20.19	3.58	-0.33
LCA-615 x LCA-315	-0.35	4.38	-0.24	-0.48	-1.80	37.35*	0.21	0.00	0.11	22.20	-4.24	0.01
LCA-446 x G4	-4.41	5.68	0.04	1.22	-1.59	1.92	0.50	-0.17**	0.13*	5.73	-13.91*	0.24
LCA-446 x LCA-678	0.89	-3.57	-0.14	-0.37	1.41	26.21	-0.68	0.02	-0.01	17.30	-2.66	-0.29
LCA-446 x LCA-453	8.19**	-2.64	-0.40	-4.44**	1.63	-31.81	-0.57	-0.06	-0.01	-25.13	-5.66	-0.42
LCA-446 x LCA-703-2	5.92*	1.58	0.46	-1.37	0.37	31.25	-0.27	-0.01	-0.02	38.45**	-2.55	-0.41
LCA-446 x LCA-705-2	-9.89**	-1.94	-0.10	2.67**	-2.30	-27.60	0.30	0.19**	-0.06	-24.48	14.83**	0.84*
LCA-446 x LCA-315	-0.70	0.88	0.14	2.30**	0.48	0.03	0.73	0.02	-0.03	-11.86	9.95	0.04
LCA-466 x G4	-6.53*	-9.79**	-0.26	-5.50**	-1.48	-69.46**	0.13	0.14*	0.23**	-20.93	17.02**	0.12
LCA-466 x LCA-678	3.46	3.53	0.25	0.24	-7.48**	42.16*	1.28**	-0.07	-0.08	24.12	-12.52*	-0.50
LCA-466 x LCA-453	1.33	-5.88	-0.24	0.83	4.41*	-20.73	0.02	0.09	-0.08	-37.52**	-3.13	0.11
LCA-466 x LCA-703-2	4.49	-0.65	-0.38	-0.09	4.15	-4.34	0.02	-0.14*	-0.09	-1.96	-2.78	0.10
LCA-466 x LCA-705-2	2.55	-0.40	0.32	0.28	3.48	79.72**	-0.35	-0.02	0.01	64.49**	4.87	0.03
LCA-466 x LCA-315	-5.30	13.18**	0.31	4.24**	-3.07	-27.35	-1.10**	0.01	0.00	-28.21*	-3.45	0.15
LCA-442 x G4	-3.69	-1.31	-0.45	1.28	-7.20**	7.72	-0.07	-0.11	-0.14*	4.50	-2.04	-0.61
LCA-442 xLCA-678	-3.06	4.13	0.26	-1.31	1.80	12.11	-0.06	-0.06	0.00	9.03	8.41	0.39
LCA-442 x LCA-453	-5.46	7.34*	0.31	5.94**	1.35	73.06**	0.64	0.03	-0.22**	33.61*	-17.46**	-0.27
LCA-442 x LCA-703-2	7.17*	-6.93*	0.13	-1.31	-0.91	-11.85	0.35	0.02	0.13*	-16.15	14.76**	0.38
LCA-442 x LCA-705-2	6.76*	-1.86	-0.10	-0.94	-0.24	-77.36**	-0.15	0.20**	0.21**	-47.33**	7.21	0.21
LCA-442 x LCA-315	-1.72	-1.37	-0.15	-3.65**	5.20*	-3.67	-0.70	-0.08	0.02	16.34	-10.88*	-0.10
LCA-654 x G4	-3.80	-1.39	0.11	1.11	-3.31	-7.57	0.29	0.03	-0.02	-11.61	0.03	-0.06
LCA-654 x LCA-678	4.94	-1.83	0.39	0.52	5.02*	31.38	-0.74	0.03	-0.13*	31.11*	13.91*	0.35
LCA-654 x LCA-453	-1.16	3.76	0.23	-2.22**	0.91	-10.54	-0.18	0.20**	0.15*	8.42	4.38	-0.50
LCA-654 x LCA-703-2	-6.87*	-6.25*	-0.54*	-2.81**	-0.02	-23.01	0.39	-0.05	0.10	-8.61	-9.07	0.63
LCA-654 x LCA-705-2	7.05*	1.90	0.16	-0.44	-0.02	-31.12	0.24	-0.19**	-0.03	-19.33	-10.09	-0.43

*; Significant at 5% level; **; Significant at 1% level

Electronic Journal of Plant Breeding, 8(3): 825-833 (September 2017)
ISSN 0975-928X
DOI: 10.5958/0975-928X.2017.00131.4

Table 5. Contd.,

Crosses	PH	PS	NPBPP	DFF	DFM	NFPP	FL	FD	ADFW	FYPP	NSPF	SW
LCA-654 x LCA-315	-0.16	3.82	-0.36	3.85**	-2.57	40.87*	0.01	0.00	-0.07	0.03	0.85	0.01
LCA-607 x G4	3.81	10.29**	0.37	-1.83*	0.52	45.41**	0.81*	0.00	-0.09	32.30*	-5.98	-0.35
LCA-607 x LCA-678	-1.63	-6.62*	-0.31	0.24	-4.15	-59.44**	-0.26	0.00	-0.07	-49.13**	1.68	-1.01**
LCA-607 x LCA-453	-1.89	1.87	-0.40	4.83**	-3.59	-24.15	0.30	-0.07	0.21**	-32.76*	8.50	0.52
LCA-607 x LCA-703-2	-1.80	-10.70**	0.06	0.24	1.15	61.30**	-0.15	0.02	-0.15*	47.57**	-1.95	-0.04
LCA-607 x LCA-705-2	-1.54	10.77**	0.03	-3.39**	2.81	-23.91	-0.42	0.00	0.12	-5.01	-4.97	0.82*
LCA-607 x LCA-315	3.05	-5.60	0.24	-0.09	3.26	0.78	-0.27	0.04	-0.02	7.04	2.71	0.06
LCA-655 x G4	7.59**	13.46**	0.31	3.56**	3.13	52.85**	-0.76	0.06	0.14*	9.13	-3.05	0.44
LCA-655 x LCA-678	4.49	0.93	0.13	0.30	1.46	-61.77**	0.11	0.06	0.26**	-20.09	-4.39	-0.07
LCA-655 x LCA-453	-9.41**	0.16	-0.07	-3.11**	0.35	10.12	-0.67	-0.33**	-0.25**	11.07	3.54	-0.55
LCA-655 x LCA-703-2	-1.35	2.90	-0.21	4.96**	2.43	-2.46	0.82*	0.10	0.03	5.41	-17.18**	0.52
LCA-655 x LCA-705-2	-6.26*	-9.59**	-0.14	-1.00	-3.91	2.66	0.54	0.03	-0.13*	-33.00*	3.00	-0.35
LCA-655 x LCA-315	4.93	-7.87*	-0.02	-4.70**	-3.46	-1.41	-0.04	0.08	-0.05	27.49	18.08**	0.01
LCA-355 x G4	-4.51	-5.83	0.16	-0.61	2.35	3.26	-0.12	0.01	-0.04	-5.28	-7.85	0.03
LCA-355 x LCA-678	-6.68*	0.19	-0.32	-1.54	0.35	70.11**	-0.41	-0.02	0.02	39.95**	3.04	0.10
LCA-355 x LCA-453	4.49	-2.88	0.48*	2.72**	-1.43	-15.14	-0.39	0.11	0.05	4.23	0.83	0.69
LCA-355 x LCA-703-2	7.68**	14.48**	0.54*	-0.20	-6.35**	8.42	-0.67	0.05	-0.04	-2.70	12.35*	-0.34
LCA-355 x LCA-705-2	1.27	1.52	-0.59*	0.83	2.31	-10.49	0.62	-0.12*	0.00	5.84	2.83	-0.40
LCA-355 x LCA-315	-2.24	-7.49*	-0.27	-1.20	2.76	-56.17**	0.96*	-0.03	0.00	-42.04**	-11.19*	-0.08
SE (gij)	**2.82**	**3.01**	**0.24**	**0.85**	**2.10**	**16.94**	**0.39**	**0.06**	**0.06**	**14.17**	**5.45**	**0.35**

*; Significant at 5% level; **; Significant at 1% level

PH - Plant Height (cm), PS - Plant Spread (cm), NPBPP - No. of Primary Branches Per Plant, DFF – Days to 50% Flowering, DFM – Days to Fruit Maturity, NFPP – No. of Fruits Per Plant, FL – Fruit Length (cm), FD – Fruit Diameter (cm), ADFW – Average Dry Fruit Weight (g), FYPP – Fruit Yield Per Plant (g), NSPF – No. of Seeds Per Fruit, SW – Seed Weight (g/1000 seed).