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Combining ability analysis for fruit yield and its component characters in mild pungent chilli (*Capsicum annuum* L.)

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ABSTRACT : Chilli is a high value crop grown commercially in almost all parts of India for its large green blocky fruits which are used as vegetable. The demand for its fruits is increasing with ever increasing population. A 8 X 8 half diallel set involving diverse parents was studied. The present study revealed that even though none of the parents were good general combiners for all the traits. The parents IVPBC-535 and SG-5 that were good general combiners for most of the traits which, could be used in future breeding programme in chilli for obtaining desirable segregants. The sca effects in general are relatively less significant in self pollinated crops like chilli. However, cross combinations with high degree of sca effects involving both the parents having good gca effects would be ideal for deriving desirable genotypes in advance generations. From the this point the combinations IVPBC-535 x ACS-03-14 and IVPBC-535 x SG-5 would ideal one which may serve as a better source population for deriving superior segregants in advanced generations.

KEY WORDS : Chilli, Diallel, General combining ability, Specific combining ability

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Chilli (*Capsicum annuum* L.) has its unique place in world diet as a spice as well as vegetable. Its improvement by breeding has been mostly limited to the exploitation of varietal differences and selection from local variability, with very little genetic investigations. The knowledge of gene action and combining ability not only provides information on inheritance of characters but also serves in selection of suitable parents for hybridization and promising hybrids for further exploitation in breeding programmes. The present investigation was under taken to get the information on combining ability for green fruit yield and its components and to select elite parents and crosses in chilli by half diallel analysis.

RESEARCH METHODS

Eight chilli genotypes comprising seven non-pungent (KTPL-19, IVPBC- 535, ACS-01-1, AVNPC-131, ACS-03-13, ACS-03-14 and SG-5) and one mild pungent (Kumathi) types were crossed in 8 x 8 diallel design in all possible combination excluding reciprocals during *Kharif-Rabi* 2006-07. The resultant 28 hybrids were grown along with their parents in Randomized Block Design with three replications. Each plot consisted of single row of 10 plants. Inter and intra row spacing was kept 60 cm. Observations were recorded on five randomly selected plants per replication in each treatments for 15 characters *viz*., days to flowering, plant height (cm), primary branches per plant, secondary branches per plant, fruits per plant, fruit length (cm), fruit girth (cm), pedicel length (cm), fruit shape index, fruit weight (g), green fruit yield per plant (g), seeds per fruit, 100 seed weight (g), moisture content in fruits (%) and weight loss in fruits (%). Combining ability analysis was performed with the data obtained for parents and hybrids according to Model-I, Model-II proposed by Griffing (1956).

RESEARCH FINDINGS AND DISCUSSION

The mean squares due to general combining ability (gca) and specific combining ability (sca) for different traits are presented in Table 1. The gca and sca mean squares were significant for all the traits. This indicates that both additive

Table 1 : Analysis of variance due to general and specific combining ability for different characters in chilli

Sources of variation	d.f.	Days to flowering	Plant height	Primary branches per plant	Secondary branches per plant	Fruits per plant	Fruit length	Fruit girth	Pedicel length	Fruit Shape index	Fruit weight	Green fruit yield per plant	Seeds per fruit	100 seed weight	Moisture content in fruits	Weight loss in fruits
gca	7	7.821**	441.436**	0.112**	0.196**	729.301**	12.872**	2.085**	0.095**	0.969**	9.418**	24566.250**	932.671**	0.307**	9.746**	94.321**
sca	27	11.300**	71.486**	0.039**	0.193**	340.646**	0.941**	0.120**	0.065**	0.039**	2.547**	22914.800**	643.376**	0.222**	1.636**	20.685**
error	70	0.564	1.916	0.013	0.051	33.487	0.222	0.011	0.010	0.010	0.036	2379.696	6.754	0.001	0.018	3.056
σ^2 gca		0.76	44.08	0.012	0.018	71.81	1.28	0.208	0.009	0.097	0.94	2377.30	93.04	0.031	0.97	9.330
σ^2 sca		11.11	70.85	0.035	0.176	329.48	0.87	0.116	0.062	0.036	2.54	22121.57	641.13	0.222	1.63	19.667
σ^2sca / σ^2gca		14.62	1.61	2.92	9.78	4.59	0.68	0.56	6.89	0.37	2.70	9.31	6.89	7.16	1.68	2.108

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 2 : General combining ability effects for different characters in chilli

Parents	Days to flowering	Plant height	Primary branches per plant	Secondary branches per plant	Fruits per plant	Fruit length	Fruit girth	Pedicel length	Fruit shape index	Fruit weight	Green fruit yield per plant	Seeds per fruit	100 seed weight	Moisture content in fruits	Weight loss in fruits
Kumathi	1.09**	12.59**	0.04	0.12	0.62	-0.89**	-0.46**	0.02	-0.02	-0.42**	-14.62	-9.35**	0.03*	-0.24**	0.16
KTPL-19	0.13	-2.94**	-0.14**	0.07	-19.32**	1.08**	0.78**	0.07*	-0.10**	2.10**	-38.85**	14.36**	-0.16**	-1.81**	6.38**
IVPBC-535	-1.47**	-9.63**	-0.11**	-0.24**	6.30**	2.15**	-0.38**	0.00	0.65**	0.58**	97.22**	8.62**	-0.29**	1.33**	-0.38
ACS-01-1	0.32	2.47**	-0.05	-0.10	2.87	-0.24	-0.38**	0.06*	0.10**	-0.77**	-31.35*	-11.43**	-0.06**	0.96**	-0.25
AVNPC-131	-0.27	-3.45**	0.04	-0.11	-2.65	-0.16	0.10**	-0.04	-0.09**	-0.51**	-55.98**	3.52**	0.26**	-0.26**	-2.47**
ACS-03-13	0.69**	2.92**	-0.04	0.06	8.37**	-0.31*	0.12**	-0.07*	-0.14**	-0.90**	-9.68	-10.47**	0.07**	0.48**	-1.11*
ACS-03-14	0.52*	2.34**	0.10**	0.04	0.41	-1.48**	0.49**	-0.18**	-0.46**	0.05	12.62	5.63**	0.01*	-0.68**	-3.91**
SG-5	-1.01**	-4.24**	0.17**	0.17**	3.40*	-0.16	-0.27**	0.14**	0.06*	-0.13*	40.65**	-0.87	0.15**	0.21**	1.58**
S. E. (gi) ±	0.22	0.41	0.04	0.07	0.71	0.14	0.03	0.03	0.03	0.06	14.43	0.77	0.01	0.04	0.52

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 3 : Specific combining ability effects for different characters in chilli

Crosses	Days to flowering	Plant height	Primary branches per plant	Secondary branches per plant	Fruits per plant	Fruit length	Fruit girth	Pedicel length	Fruit shape index	Fruit weight	Green fruit yield per plant	Seeds per fruit	100 seed weight	Moisture content in fruits	Weight loss in fruits
Kumathi x KTPL-19	-1.49*	-3.34**	0.17	-0.14	40.61**	-0.71	-0.45**	0.00	0.02	-2.68**	145.30**	-13.46**	-0.75**	1.47**	2.96
Kumathi x IVPBC-535	2.11**	14.28**	-0.13	0.24	-9.15	-0.08	0.21*	0.11	-0.08	0.54**	-32.43	-16.26**	-0.13**	0.30**	6.04**
Kumathi x ACS-01-1	1.31	-13.75**	-0.06	0.30	29.17**	0.62	0.36**	0.23**	-0.01	0.39*	234.47**	35.66**	0.35**	-0.33**	0.36
Kumathi x AVNPC-131	0.58	6.17**	0.26*	0.24	5.93	0.21	0.09	-0.12	0.00	-0.23	23.77	20.91**	-0.15**	0.83**	0.51
Kumathi x ACS-03-13	1.28	1.33	-0.13	-0.53**	-7.08	-0.17	0.01	-0.12	-0.03	0.57**	-4.20	1.10	-0.10**	1.29**	0.18
Kumathi x ACS-03-14	1.11	-9.89**	-0.07	0.02	-14.54**	0.93*	-0.59**	-0.38**	0.36**	0.44*	-86.17	-8.14**	-0.66**	-0.97**	-5.05**
Kumathi x SG-5	-5.35**	6.23**	-0.01	-0.57**	11.79*	0.43	-0.18	-0.33**	0.23*	0.72**	131.13**	-1.90**	0.21**	-0.20	0.72
KTPL-19 x IVPBC-535	-3.25**	8.31**	0.12	0.23	-12.08*	0.40	-0.32**	-0.13	0.11	2.50**	21.47	49.30**	0.30**	-0.17	-2.84
KTPL-19 x ACS-01-1	-1.39*	-4.52**	0.06	-0.11	-13.33*	1.00*	0.12	-0.17	0.10	1.02**	-41.63	8.82**	0.26**	0.31**	-1.40
KTPL-19 x AVNPC-131	-0.45	7.80**	-0.09	-0.30	-4.67	0.36	-0.11	0.43**	0.10	-0.31	-38.67	-28.00**	-0.29**	-0.12	7.84**
KTPL-19 x ACS-03-13	0.25	-0.17	-0.21*	-0.34	-3.55	0.56	0.26**	0.04	0.03	1.86**	138.70**	-54.74**	0.14**	-0.83**	-6.02**
KTPL-19 x ACS-03-14	1.41*	-3.79**	0.12	-0.06	-6.58	-0.25	-0.06	0.01	0.00	3.80**	140.40**	-11.58**	0.68**	-0.19	4.69**
KTPL-19 x SG-5	1.28	-0.41	-0.36**	0.48*	-7.75	-1.71**	-0.80**	-0.32**	-0.05	-1.36**	143.30**	-11.08**	0.63**	0.92**	7.38**
IVPBC-535 x ACS-01-1	-2.45**	-9.24**	-0.04	0.20	20.07**	-0.59	0.23*	0.43**	-0.22*	-0.79**	79.30	9.96**	-0.60**	-0.51**	-1.89
IVPBC-535 x AVNPC-131	-1.52*	0.32	-0.12	-0.06	-12.66*	0.16	0.02	-0.19*	-0.01	0.25	-73.73	10.28**	0.14**	0.39**	1.53
IVPBC-535 x ACS-03-13	-1.82**	3.32**	0.42**	-0.23	26.44**	1.38**	0.25**	-0.04	0.14	-0.38*	167.63**	28.26**	0.51**	-0.61**	-3.22*
IVPBC-535 x ACS-03-14	-2.99**	-7.50**	-0.12	0.12	7.35	1.12**	-0.03	0.17	0.10	1.97**	248.67**	-4.77*	0.86**	1.92**	3.58*
IVPBC-535 x SG-5	-2.79**	1.34	0.08	0.13	8.69	1.18**	0.09	0.24**	0.26**	1.85**	240.30**	-9.94**	-0.32**	-0.73**	-5.55**
ACS-01-1 x AVNPC-131	-1.32	-7.34**	-0.12	-0.53**	-11.95*	-1.09*	-0.38**	-0.20*	-0.08	-0.57**	-108.83*	-31.61**	0.39**	-1.04**	-1.07
ACS-01-1 x ACS-03-13	-2.95**	19.49**	0.30**	-0.44*	0.88	-0.26	-0.12	-0.04	0.00	-0.01	3.20	-6.96**	0.22**	-3.25**	0.97
ACS-01-1 x ACS-03-14	-2.12**	8.13**	-0.11	-0.08	2.21	0.23	0.03	-0.18*	-0.04	0.00	16.90	34.68**	-0.15**	0.94**	3.24*
ACS-01-1 x SG-5	0.08	11.11**	0.28**	0.52*	10.28*	0.39	0.17	0.09	0.02	0.17	69.53	-7.49**	0.39**	0.13	-6.29**
AVNPC-131 x ACS-03-13	-1.02	-14.32**	-0.32**	-0.23	28.04**	1.98**	-0.11	-0.11	0.45**	-1.19**	60.50	44.83**	-0.48**	-0.17	1.62
AVNPC-131 x ACS-03-14	0.48	-3.21*	-0.06	0.66**	2.43	-0.12	0.04	0.55**	-0.05	-0.29	1.87	-17.80**	-0.58**	-2.57**	-2.27
AVNPC-131 x SG-5	-1.32	1.04	0.06	0.46*	15.44**	0.52	-0.19*	-0.05	0.19*	0.71**	167.50**	16.63**	0.31**	-0.05	-4.76**
ACS-03-13 x ACS-03-14	-5.49**	6.89**	0.08	0.55**	20.05**	0.14	-0.01	0.25**	0.03	-0.99**	46.57	13.32**	0.16**	0.95**	-3.64*
ACS-03-13 x SG-5	0.38	-8.87**	0.21*	0.56**	-16.71**	-1.06*	-0.10	-0.16	-0.20*	-0.40*	-156.80**	2.68	-0.29**	1.41**	4.55**
ACS-03-14 x SG-5	-4.45**	-3.02*	0.14	0.31	13.14*	0.43	-0.26**	-0.02	0.12	-2.64**	-34.10	10.65**	-0.08**	-1.71**	7.61**
S. E. (sij) ±	0.68	1.26	0.11	0.21	5.25	0.43	0.10	0.09	0.09	0.17	44.23	2.36	0.02	0.12	1.59

* and ** indicate significance of values at P=0.05 and 0.01, respectively

and non-additive gene actions played important role for the inheritance of the traits.

The sca variance components were observed higher than respective gca variance components for all the traits except fruit length, fruit girth and fruit shape index indicating predominance of non-additive gene action for the inheritance of these traits. Similar results were also reported by Patel (2002), Anand and Subbaraman (2006) and Patel *et al*. (2006).

Estimates of gca effects showed that it was difficult to pick up a good combiner for all the characters together as the combining ability effects were not consistent for all the yield components (Table 2). It was possibly because of the negative association of the characters.

In the present investigation, two parents IVPBC-535 and SG-5 possessed significant gca effect for green fruit yield per plant. In addition to green fruit yield per plant, parent IVPBC-535 was good general combiner for days to flowering, fruit length, fruit shape index, fruits per plant, fruit weight and seeds per fruit. While, parent SG-5 was also observed to be good general combiner for traits like days to flowering, pedicel length, fruit shape index, fruits per plant, primary branches per plant, secondary branches per plant and 100 seed weight. These two parents were observed to be good general combiners for green fruit yield per plant along with other components traits. Thus, both the parents could be considered in the future breeding programme for exploitation of heterosis or to generate more number of desirable segregants for green fruit yield and its component traits. High gca effects for some characters in *Capsicum* have been reported earlier by Sharma and Saini (1977), Chen (1985) and Johri *et al.* (2004).

The sca effects for hybrids pertaining to different characters are given in Table 3. The crosses ACS-03-13 x ACS-03-14, Kumathi x SG-5 and ACS-03-14 x SG-5 were good specific combiners for days to flowering. The best sca effect for primary branches per plant was exhibited by combinations IVPBC-535 x ACS-03-13, ACS-01-1 x SG-5 and ACS-03-13 x SG-5. Crosses involving Kumathi x KTPL-19, Kumathi x ACS-01-1 and AVNPC-131 x ACS-03-13 had maximum sca effects for fruits per plant. The cross combination ACS-01-1 x ACS-03-13 was good specific combiner for plant height and moisture content in fruits. Specific combiner AVNPC-131 x ACS-03-14 was imposed highest effect for secondary branches per plant and pedicel length. The crosses Kumathi x ACS-01-1 and KTPL-19 x ACS-03-14 were good specific combination for fruit girth and fruit weight, respectively. High value of sca effects for fruit length and fruit shape index was obtained in the cross AVNPC-131 x ACS-03-13. Maximum sca effects for green fruit yield per plant and 100 seed weight was exhibited by combination IVPBC-535 x ACS-03-14. The cross combinations KTPL-19 X IVPBC-535 and ACS-01-1 x SG-5 were highly specific for seeds per fruit and weight loss in fruits, respectively. Above observations indicated that high general combining ability of parents seems to be reliable criterion for the prediction of specific combining ability. Heterosis in the crosses involving low and high combiners might be due to dominant x additive type of interaction which is partially fixable.

The crosses IVPBC-535 x ACS-03-14, IVPBC-535 x SG-5 and Kumathi x ACS-01-1 with significant and desirable sca effects for green fruit yield involved parents with good x good and good x average gca effects indicating the presence of non-allelic interaction and also manifested heterosis of higher magnitude.

Conclusion :

A 8 x 8 half diallel set involving diverse parents was studied. The present study revealed that even though none of the parents were good general combiners for all the traits. The parents IVPBC-535 and SG-5 that were good general combiners for most of the traits which, could be used in future breeding programme in chilli for obtaining desirable segregants. The sca effects in general are relatively less significant in self pollinated crops like chilli. However, cross combinations with high degree of sca effects involving both the parents having good gca effects would be ideal for deriving desirable genotypes in advance generations. From the this point the combinations IVPBC-535 x ACS-03-14 and IVPBC-535 x SG-5 would ideal one which may serve as a better source population for deriving superior segregants in advanced generations.

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