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Combining ability for fruit quality parameters in chilli (*Capsicum annuum* L.)

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ABSTRACT

Eighteen divergent lines of chilli and 45 F_1 hybrids were studied to investigate the general combining ability (gca) and specific combining ability(sca) effects for fruit and seed related traits in chilli. Higher proportion of additive gene effect was observed for fruit related traits while seed related triats are under the control of non additive gene action. The parents having high gca like VN-2, B-Kaddi, Arkalohit, Phule-5 and LCA-312 exhibited high GCA and may be utilized for quality improvement or recurrent selection programme for improvement in fruit quality triats.

Key words : General combining ability, Specific combining ability, Heterobeltosis.

Chilli fruit forms an economical part of produce and quality parameters associated with fruit are of immense importance and provides value to the chilli produce. Very few information and little effort has been made for the improvement of fruit quality. Hence, there is a need to identify suitable parents with good combining ability for fruit parameters. Now exploitation of heterosis and selection of parents on the basis of combining ability are important breeding approaches in crop improvement.

It also provides necessary information on nature and magnitude of gene effects for fruit triats. Line x tester analysis is useful for preliminary evaluation of genetic stocks with large number for use in hybridization programme and to facilitate a sound breeding programme.

MATERIALS AND METHODS

The experiment material comprised of 45 F_1s developed from three females (Byadagi Kaddi, Byadagi dabbi, VN-2) 15 males (GPC-82, Jwala, Hissar Shakthi, CO-2, Arka Abir, LCA-301, AKC-86-39, LCA-312, BC-14-2, BC-24, KDC-1, Arkalohit, Phule-5, PMR-5 and CA-219. The 18 parents and their 45 F_1s were evaluated in a randomised block design with two replications at Chilli Research Centre, Hanumanamatti (under University of Agricultural sciences , Dharwad) during *kharif* 1999. Each entry was planted in two rows of ten plants each, both parents and hybrids were randomised completely among themselves but grown in a continuous block. Ten random competitive plants were tagged in each entry in each replication to record the observation on dry fruit yield and its important component characters (Table 1). Combining ability analysis was computed according to the model given by Kempthorne (1957).

RESULTS AND DISCUSSION

The analysis of variance for combining ability (Table 1) for fruit quality traits revealed that mean sum of squares due to female and male were highly significant for all the characters except for ascorbic content in female and stalk length in female x male indicated the presence of genetic variability among the parents for fruit quality triats.

The ratio of GCA variance and SCA variance (Table

Table 1 : Analysis of variance of parents and hybrids for fruit and seed characters in chilli

Source	df	Fruit length	Fruit width	Fruit weight	Stalk length	Pericarp weight /fruit	Seed weight per fruit	No. seeds per fruit	1000 seed weight	Ascorbic acid content	Capsaicin content
Parents	17	12.6**	37.7*	23.5*	0.669*	6.78**	4.71**	394.5**	2.44**	3217**	0.2095**
Females	2	18.7**	88.0**	1.12*	1.126*	13.6**	11.85**	435.1**	6.31**	273.5	0.0030**
Males	14	4.5**	12.4**	0.48	0.482	3.15**	1.85**	315.78**	1.07**	3319**	0.0078**
Females x males	1	114**	290**	0.23	0.239	43.8**	30.64**	1416**	14.24**	7683**	0.2449**
Hybrids	44	3.8**	4.47**	0.66**	0.666**	2.90**	1.80**	345.3**	1.28**	2758**	0.0036**
Parent x Hybrid	1	27.4**	2.16*	0.77	0.771	20.15**	22.47**	6076**	20.29**	15.00	0.0193**
Error	62	0.528	0.462	0.285	0.2858	0.1844	0.1934	42.5426	0.1125	842.43	0.0006

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

Table 2 : Variance of combining ability and their ratio

Characters	GCA	SCA	GCA/SCA
Fruit length	0.7053	0.8174	0.8628
Fruit width	0.7553	0.7094	1.0640
Stalk length	0.0785	0.0187	4.1981
Fruit weight	1.9676	0.9538	2.0629
Pericarp weight per fruit	0.6619	0.5445	1.2156
Seed weight per fruit	0.3556	0.1254	2.8350
No. of seeds per fruit	38.040	108.07	0.3519
1000 seed weight	0.1539	0.3322	0.4832
Ascorbic acid content	95.567	693.68	0.1377
Capsaicin content	0.0005	0.0811	4.2480

2) indicating that, preponderance of additive gene effect for fruit width, stalk length, fruit weight, pericarp weight, seed weight and capsaicin content. The fruit characters *viz.*,fruit length, number of seeds per fruit, 1000 seed weight and ascorbic acid content are under the control of non additive gene action as revealed by the degree of dominance. The higher magnitude of sca component in ascorbic acid might be due to instability of this characters for environmental fluctuations.

The estimates of general combining ability effect along with *per se* performance for fruit characters are presented in Table 3 Though none of the parent was found to be good general combiner in desirable direction for all the characters however, among the females Byadagi Kaddi, VN-2 and among male Arkalohit, phule-5, LCA-312 were found to be good general combiner. For fruit length VN-2, Arka Abir, Arkalohit and phule-5 found to be good general combiner. For fruit width (Byadagi. Dabbi, LCA-301, AKC-8639, LCA-312, Phule-5) stalk length, (Byadagi Kaddi, Hissarshakthi, CA-219). exhibited negative significant gca effects. Fruit weight and pericarp weight are the two important fruit characters by which the value of the produce is determined (Lippert. 1975). Hence, the parents VN-2, Arka Abir, LCA-312 can be used in breeding programe for their high gca.

The lower content and negative gca effects are important for seed weight per fruit, number of seeds per fruit and 1000 seed weight, these relates to increase in pericarp content. Hence, the parents Byadagi Kaddi, Jwala, Hissar Shakthi CA-219, LCA-301 and AKC-8639 can be utilized in breeding programme. Ascorbic acid is a highly variable component lower level is desirable hence, BC-24, can be used. For increasing capsaicin content Jwala and Hissarshakthi, could be considered as good general combiner.

The best crosses among 45 crosses having significant desired specific combining ability effects, gca status and heterobeltosis are presented in Table 4. The crosses

Table 3 : Estimates of general combining ability (gca) effects of parents for fruit and seed characters in chilli

Parents	Fruit length	Fruit width	Fruit weight	Stalk Length	Pericarp weight	Seed weight	No. seeds per fruit	1000 seed weight	Ascorbic acid content	capsaicin
Female										
Byadagi Kaddi	-0.32**	-0.85**	-1.43**	-0.27*	-0.80**	-0.60**	-7.34**	-0.31**	3.07	0.04
Byadagi Dabbi	-0.73**	0.95**	-0.05	-0.06	-0.14*	0.01	0.39	0.49**	-3.07	0.01
VN-2	1.05**	-0.10	1.49	0.33**	0.94**	0.59**	6.96**	-0.17**	0.001	-0.02
S.E. ±	0.10	0.09	0.10	0.08	0.06	0.06	0.82	0.05	3.85	0.001
Male										
GPC-82	0.64*	0.03	0.46	-0.06	0.24	0.22	4.82*	-0.05	-1.57	0.01
Jwala	-0.09	-0.60**	-0.80**	-0.26	-0.19	-0.50**	-7.68**	-0.32**	2.60	0.03*
Hissarshakthi	-0.73**	-1.44**	-2.01**	-0.49*	-1.17**	-0.85**	-6.84**	-0.69**	3.93	0.03*
Co-2	0.36	0.91**	0.30	0.23	0.23	0.01	10.66**	0.33**	17.93	0.02
Arka Abir	0.63*	0.28	2.95**	0.09	1.22**	1.78**	11.49**	0.71**	-9.23	-0.13*
LCA 301	0.09	0.91**	-0.20	-0.08	-0.16	0.02	-5.51*	-0.52**	34.27**	0.01
AKC 86-39	-0.84**	0.56**	0.07	-0.16	0.01	0.21	-4.34*	-0.28*	7.27	0.01
LCA-312	0.29	1.96**	2.48**	0.07	1.50**	1.05**	-0.18	0.71**	-5.73	0.01
BC 14-2	-.1.70**	-0.34+-	0.43	-0.27	0.29	0.24	11.32**	0.57**	-4.73	0.01
BC-24	0.33	0.82**	-0.61*	0.16	-0.01	-0.59**	-0.34	-0.08	-44.40	0.01
KDC-1	0.04	-0.22	-0.85**	-0.11	-0.39**	-0.35*	-1.68	-0.12	-4.07	0.01
Arkalohit	1.20**	-1.67**	0.45	0.32	-0.09	0.25	6.16**	-0.15	-25.57*	0.01
Phule-5	0.77**	1.68**	0.64*	1.10**	-0.44**	-0.27	-0.01	-0.18	29.10	0.01
PMR-5	0.24	-0.58**	0.30	-0.13	0.27	-0.1	-3.34	0.53**	-16.07	0.01
CA-219	-1.22**	-0.69**	-2.31**	-0.43*	-1.30**	-1.21**	-14.5**	-1.08**	16.27	0.01
S.E.±	0.25	0.24	0.25	0.20	0.16	0.16	2.17	0.12	10.20	0.01

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

Table 4 : A effects ,GCA status and heterobeltosis for fruit quality parameters

	Crosses	SCA effect	GCA status	Heterobeltosis
Fruit length	Byadagi Kaddi x GPC-82	1.42**	L x H	-16.38**
	Byadagi Kaddi x Phule-5	1.43**	L x H	-15.44**
	Byadagi Dabbi x GPC-82	0.97**	L x H	-13.29**
	Byadagi Dabbi x AKC-8639	1.61**	L x L	2.77**
	Byadagi Dabbi x PMR-5	1.04*	L x L	-10.59**
	VN-2 x Arka Abiri	1.45**	H x H	-13.11**
			0.726	0.726
Fruit width	Byadagi Kaddi x LCA-301	0.94**	L x H	-23.89**
	Byadagi Kaddi x LCA-312	0.68**	L x H	-32.78**
	Byadagi Kaddi x BC-24	1.26**	L x L	-8.33**
	Byadagi Kaddi x Phule-5	0.90**	L x H	32.78**
	Byadagi Dabbi x Arka Abir	0.92**	H x L	-30.11**
	Byadagi Dabbi x BC-24	0.83**	H x L	-46.31**
	Byadagi Dabbi x Arka lohit	0.82	H x L	-41.76**
	Byadagi Dabbi x PMR-5	0.83*	H x L	-35.51**
	VN-2 x CO-2	0.98*	L x H	-45.80**
	VN-2 x AKC-8639	0.93**	L x H	–47.62**
	VN-2 x Arkalohit	1.01**	L x L	-7.41**
Stalk length	VN-2 x Arka lohit	0.71*	L x L	-28.91**
	VN-2 x Phule-5	0.75*	L x L	-11.91
			0.13	0.13
Fruit weight	Byadagi Kaddi x Hissar shakthi	1.36**	L x L	-8.61**
	Byadagi Kaddi x Phule-5	0.82**	L x L	-0.56
	Byadagi Dabbi x AKC-8639	10.13**	L x L	13.80**
	Byadagi Dabbi x BC-24	1.43**	L x L	-16.00**
	Byadagi Dabbi x PMR-5	0.92**	L x L	-12.93**
	VN-2 x Arka Abir	1.17**	H x H	-13.08**
	VN-2 x LCA-312	1.98**	H x H	-7.62**
	VN-2 x Arka lohit	1.19**	H x L	-25.91**
			0.67	0.67
Pericarp weight	Byadagi Kaddi x GPC-82	0.56**	L x L	-15.44**
	Byadagi Kaddi x Jwala	0.52**	L x L	– 13.59**
	Byadagi Kaddi x Hissar shakti	1.16**	L x L	– 6.12**
	Byadagi Kaddi x CO-2	0.47**	L x L	- 21.83**
	Byadagi Dabbi x AKC-8639	1.14**	L x L	– 9.45**
	Byadagi Dabbi x BC-24	0.91**	L x L	– 12.63**
	VN-2 x Hissar Shakthi	0.95	H x L	–54.81**
	VN-2 x LCA-312	1.19**	H x H	–2.78**
			0.43	0.43
Seed weight	Byadagi Kaddi x Arka Abir	0.44**	H x L	– 4.23**
	Byadagi Kaddi x Arkalohit	0.55**	H x L	– 6.98**
	Byadagi Dabbi x GPC-82	0.45	L x L	– 19.26**
	Byadagi Dabbi x LCA-312	0.67**	L x L	– 8.06**
	VN-2 x Phule-5	0.68**	L x L	– 49.15**
	VN-2 x PMR-5	0.46**	L x L	– 43.24**
	VN-2 x CA-219	0.68**	L x H	– 60.33
				0.44
No.of seeds/fruit	Kaddi x BC-14-2	14.16**	H x L	– 12.50
	Byadagi Kaddi x BC-24	20.49**	H x L	– 15.62
	Byadagi Kaddi x Kx-5	6.16**	H x L	– 4.69
	Byadagi Dabbi x Phule-5	11.56**	L x L	– 18.39**
	Byadagi Dabbi x PMR-5	19.22**	L x L	– 31.03**
	Byadagi Dabbi x CA-219	11.06	L x H	– 34.48**
	VN-2 x Hissar Shakti	16.29**	L x L	– 27.87**
	VN-2 x CO-2	12.79**	L x L	– 4.92
	VN-2 x LCA-301	11.12	L x H	– 18.58**
				6.52

Contd.

Table 4Contd.

	Crosses	SCA effect	GCA status	Heterobeltosis
100 seed weight	Byadagi Kaddi x GPC-82	0.83**	H x L	– 9.15**
	Byadagi Kaddi x ArkaLohit	0.37*	H x L	– 14.23**
	Byadagi Dabbi x Hissar Shakti	0.45**	L x L	– 24,46
	Byadagi Dabbi x LCA-301	1.01**	L x H	– 14.44**
	VN-2 x LCA-312	0.48**	H x L	– 12.58**
	VN-2 x BC-14-2	1.26**	H x L	– 12.97**
				2.13
Ascorbic acid	Byadagi Kaddi x BC-14-2	46.23*	L x L	34.42**
	Byadagi Kaddi x Phule 5	49.07**	L x H	15.79**
	Byadagi Kaddi x CA-219	53.73**	L x L	9.67*
	Byadagi Dabbi x GPC-82	36.27**	L x L	11.06**
	Byadagi Dabbi x Jwala	31.43**	L x L	19.67**
	VN-2 x Arka Abir	53.67**	L x L	16.41**
	VN-2 x BC-14-2	32.67**	L x L	30.44**
				9.42
Capsaicin	Byadagi Kaddi x Arka Abiri	NS	L x L	3.71**
	Byadagi Dabbi x GPC-82	NS	L x L	11.03**
	Byadagi Dabbi x Arka Abir	NS	L x L	7.97**
	VN-2 x Arka Abir	NS	L x L	26.72**
				0.62

* and ** indicates significance of values at P=0.05 and P=0.01, respectively, N.S. = Non significant

having significant sca effects for fruit length are Byadagi Kaddi x GPC-82, Byadagi Kaddi x Phule-5 and Byadagi Dabbi x GPC-82 all had low x high gca parents and exhibited highly significant negative heterobeltosis. Where as the cross Byadagi Dabbi x AKC-8639 and Byadagi Dabbi x PMR-5, have exhibited highly significant sca effects with low x low gca parents and the heterobeltosis was significant. The low x low gca parents in crosses might be ascribed due to non allelic gene action producing over dominance which are non fixable. For fruit width 11 crosses exhibited significant sca effects with high x low combination besides expressing the favourable additive effect of the high parent manifested some complimentary gene interaction effects with higher sca. Only the crosses involving long slender parent Byadagi Kaddi exhibited significant heterobeltosis. Similar results were obtained by Lippert (1975) and Patel *et al.* (2003). Two crosses have exhibited significant negative gca effects with low x low gca parents indicating the non additive gene action for reducing stalk length. Majority of the crosses exhibited highly significant negative heterobeltosis. For fruit weight VN-2 x LCA-312 and Byadagi Dabbi x BC-24 exhibited highest positive sca effects along with other six crosses having low x low general combiner parent indicating the role of non allelic gene action. But additive gene action also exhibited by VN-2 x Arka Abir and VN-2 x LCA-312, it clearly indicates that fruit weight is highly responses to environment and *per se* performance of parents. Hence, careful selection of parents is required for increasing fruit weight and many crosses have exhibited negative heterobeltosis. (Patel *et al.*, 2003). One of the objective of chilli improvement is to combine maximum fruit yield with maximum pericarp content. It is based on the value of extractable carotenoid as a natural food colouring (Lippert, 1975) and these carotenoids are concentrated in the endocarp. Eight crosses showed significant sca effect with low x low gca parents and with significant positive heterobeltosis clearly indicating the importance of non additive gene action which can be exploited through heterosis breeding. Where as the cross combinations VN-2 x LCA-312 (High x High) with significant sca effect and heterobeltosis could be advanced to derive pure lines.

Seed content and pericarp content forms the important components of fruit weight which account for 85-90 per cent of total fruit weight. An increase or decrease in seed content in fruit corresponds to increase or decrease in pericarp weight. Seed related triats *viz.*, seed weight per fruit, number of seeds per fruit,1000 seed weight exhibited negative sca effect, negative heterobeltosis having parents high x Low, low x low gca status indicating the presence of non additive gene action. Similar results were reported by Mishra *et al.*, (1991), Popova (1973) and Marin and Lippert (1976).

Ascorbic acid is the most important vitamin present in chilli with good dietary source and is highly variable due to fluctuation due to environmental conditions. The increase in ascorbic acid content results in decrease the colour retention of red chillies. Eight crosses have exhibited significant negative sca effects having either

low x low, high x low gca parents with negative heterobeltosis indicating the importance of non allelic gene action.

For capsaicin content many of the crosses exhibited significant sca effects but the crosses Byadagi Kaddi x Arka Abir, Byadagi Dabbi x GPC-82 , Byadagi Dabbi x Arka Abir and VN-2 x Arka Abir have exhibited highly significant heterobeltosis. Even though *per se* performance of all female parents are low in capsaicin content, the heterobeltosis in due to the contribution of the male parents.

It was evident from the study that the fruit related traits are under the control of additive gene action and seed related traits are under non additive gene action. It is suggested that breeding procedure of population improvement or some form of recurrent selection may be beneficial for improving the fruit quality in chilli.

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