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Short Communication

Combining ability studies in chilli (*Capsicum annuum* L.)

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Chilli (*Capsicum annuam L)* is an important spice cum vegetable crop for domestic as well as export purpose. The crop was introduced in India by portugues and now cultivated all over the country. India produces nearly 8.5 lakh tons followed by China and Pakistan. The extent of genetic variation for different traits of economic values and their inheritance are pre requisite to breeder for further upgrading yield (Tembhurene *et al*. 2008). Similarly, knowledge of combining ability for yield and its components of different parents used in the development of superior hybrid is equally important for sustainable yield advantage (Shrivastav *et al*. 2004). Hence the genetic nature of yield and its components of various parents were studied to select parents and their superior cross and to understand gene action which helps breeder to formulate effective breeding methodology for genetic improvement.

The present investigation was undertaken at Vegetable Research Farm Department of Horticulture, JNKVV, Jabalpur during 2009-2010. Thirty five days old seedlings of thirty and seven parents were transplanted in randomized block design at 60 x 60 cm spacing with three replications. The data were recorded on 5 randomly selected plants in each treatment over replication for 16 major characters (table-1). The analysis of data were carried out as per standerd procedure. The combining ability estimates were worked using line X tester method (Kemthrone, 1957).

The analysis of variance for all 16 traits showed significant differences which revealed the existence of substantial genetic variability in parents and their progenies (table 2). High genotypic and phenotypic coefficient of variations were observed for number of fruits per plant, seed yield per plant, number of seeds per fruit, dry fruight, dry fruit yield, fruit length and fresh fruit weight. Similar finding was also reported by several workers namely Mishra et al. (2001) Manju and Sreelathakumary (2004) and Abu and Ugaru (2006). Heritability is the measure of contributing of crosses to total variation. It provides the relationship between genotypic variances and indicates heritable portion of the phenotypic variance. Similarly, genetic advance determines architecture of any population. Therefore, the estimate of heritability and genetic advance together give exact picture of superiority of parents and their crosses. High heritability coupled with high genetic advance was found for seed percentage, primary braches per plant, followed by days to maturity and plant height. These traits showed additive gene action; hence phenotypic selection on these above traits can bring genetic improvement.

Successful breeding programme depends on the correct understanding the genetics involved in determining different characters together. High significant estimates of g.c.a. were revealed that parent namely Sankeshwar was found good general combiner for plant height, branches fruit length, fruit dry weight likewise parents Hisarvizay, Phule Mukti and Pant C-1 were found good general combiners for day to maturity, fruit length, fresh fruit weight, fruits per plant and fruit yield per plant. Similarly, parent JM 218 and KA 2 found better for secondary braches, fruits per plant and seed yield per plant. These findings support the observations of Shrivastav *et al*. (2005). The best specific combiner for fruits per plant were ACBGA 2, Pant C-1 and JNKVVA-1 X JM 218 for seed per plant and JNKVVA-1 X JM 218 and JNKVVA-1 X Sankeshwar for plant height, dry fruit weight similarly JNKVVA-I X Sankeshwar were found good specific heterotic combinations may be due to gene concentration and interaction between favorable

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Table 1. Estimates of genetic parameters for different characters in chilli

Characters	Mean	Range		Coefficient of variation		Heritability (ns) (%)	G.A. as percentage of mean
		Min.	Max.	Phenotypic	Genotypic		
Plant height (cm)	57.3	42.00	81.33	19.02	19.02	26.22	6.51
No. of primary branches	4.65	3.27	8.30	23.92	22.78	29.67	0.77
No. of secondary branches	12.34	7.67	17.40	23.92	18.8	35.84	4.65
Days to first flower initiation	43.33	34.00	48.67	6.84	5.14	19.55	0.61
Days to 50% flowering	47.9	38.33	53.33	7.00	4.66	11.69	0.48
Days to maturity	98.5	15.67	85.00	10.93	10.74	33.10	2.97
No. of fruits plant $^{-1}$	167.7	47.33	512.33	61.70	60.67	7.56	2.8
Fruit length (cm)	7.48	4.17	19.70	44.50	44.37	18.22	1.21
Fruit diameter (cm)	1.02	0.67	2.17	24.70	23.8	16.25	0.44
Fruit fruit weight (g)	15.19	6.45	37.81	40.89	40.45	25.00	2.93
Dry fruit weight (g)	3.27	1.12	7.93	39.99	37.51	28.56	7.0
Number of seeds fruits^{-1}	63.33	30.00	110.00	33.39	31.18	16.66	7.40
1000 seed weight (g)	5.07	2.87	6.55	18.08	14.25	35.80	2.75
Seed per-cent	41.82	18.74	58.69	22.50	17.7	57.87	10.18
Seed yield plant $^{-1}$	55.69	8.74	188.37	76.69	73.83	28.12	6.4
Dry fruit yield plant $^{-1}$ (kg)	0.18	0.03	0.46	44.66	43.45	6.27	0.12

Table 2. Estimates of GCA effects of parents for different traits in chillies

TESTER	PH	NFP	NSB	DFFI	DFPF	DM	NFP	FL	FD	FFW	DFW	NS	TSW	SPC	SYP	DFY
Sankeshwer	10.38**	1.07**	-1.29**	-0.01**	0.11	-6.72**	-56.74**	2.14**	0.05**	2.24**	0.64**	14.15	-0.07**	1.09	4.72	0.01**
Phule Jyoti	-4.84**	-0.77**	-0.92**	-1.78**	-0.77**	-3.39**	21.81	1.25**	-0.01**	5.00**	1.17**	15.93	0.17*	-9.31**	27.25	0.06**
Hisar Vijay	7.26**	0.60**	-0.30**	-0.01**	-0.22**	2.94*	-72.52**	2.01**	0.004**	5.13**	0.53**	10.82	-0.51**	-2.92**	-19.14**	-0.002**
Phule Mukti	-2.95**	-0.01**	-2.18**	1.65	0.89	2.17*	147	1.16**	0.05**	2.69**	0.26**	2.48	-0.59**	12.78	-1.29**	-0.001**
Pant c-1	-0.06**	-0.40**	-3.18**	1.98*	1.56	2.61*	54.36	-2.83**	0.03**	2.81**	-0.59**	-6.28**	0.24*	7.68	2.07	-0.03**
G-4	-0.51**	0.75**	1.83*	0.32	0.22	1.94*	-12.85**	-0.99**	-0.11**	-3.28**	-0.63**	-9.28**	0.006	2.99	-9.72**	-0.05**
HO-413	-1.73**	-0.11**	0.93	0.54	1.89	-1.94**	-11.41**	0.52**	-0.06**	-1.78**	-0.35**	-1.95**	0.24*	-13.44**	-6.01**	0.01**
K1-4c	10.71**	-0.66**	0.72	-1.56**	-2.89**	1.61	-28.96**	-2.10**	-0.02**	-3.87**	-1.26**	-18.06**	0.43**	1.19	-23.21**	-0.001**
JM-218	-8.84**	-0.40**	2.32**	-1.01**	-0.67**	1.06	94.92	-1.25**	0.04**	-4.11**	-0.23**	2.04	-0.07**	1.44	39.52	0.00**
KA-2	-9.40**	-0.08**	2.072*	-0.122**	-0.11**	-0.28**	-3.30**	0.08**	0.01**	0.78**	0.46**	-9.84**	0.15*	-1.52**	-14.19**	-0.003**
SED	0.92	0.11	0.55	0.65	0.83	0.67	6.26	0.08	0.02	0.29	0.15	2.52	0.18	1.39	3.85	0.001
CD 5%	1-85	0.22	1-11	1.31	1.66	1.35	12.53	0.16	0.04	0.59	0.30	5.05	0.37	3.88	7.71	0.013
CD 1%	2.47	0.29	1.48	1.74	2.22	1.79	16.67	0.22	0.05	0.79	0.40	5.72	0.50	5.16	10.26	0.02
LINE																
JNKVVA1	-1.02**	-0.06**	-0.07**	-0.08**	-0.48**	0.42	-11.22**	0.621**	0.04**	-0.44**	0.16**	4	0.22**	-4.09**	6.21	-0.01**
ACBGA1	3.44**	0.47**	0.56*	-0.25**	0.17	-1.34**	4.14	-0.067**	-0.04**	1.34**	0.23**	0.1	0.33*	1.85	4.977	0.01**
ACBGA2	-2.42**	-0.41**	-0.49**	0.34	0.31	0.92*	7.07	-0.55*	0	-0.90**	-0.39**	-4.10**	-0.55**	2.24	-11.1**	0.01**
SED	0.50	0.06	0.31	0.35	0.45	0.37	3.42	0.05	0.014	0.16	0.08	1.38	0.10	1.06	2.11	0.004
CD 5%	1.02	0.12	0.61	0.72	0.91	0.74	6.86	0.09	0.02	0.33	0.16	2.73	0.20	2.12	4.22	0.007
CD 1%	1.35	0.16	0.81	0.96	1.21	0.98	9.13	0.12	0.03	0.44	0.2	3.68	0.27	2.82	6.82	0.01

*,**Significant at p = 0.05 and 0.01, respectively

Table 3. Estimates of SCA effects of crosses for different traits in chillies

Crosses	PH	NFP	NSB	DFFI	DFPF	DM	NFP	FL	FD	FFW	DFW	NS	TSW	SPC	SYP	DFY
Sankeshwer/JNKVVA1	11.35**	-1.41**	-2.16*	1.978	1.489	-3.31**	98.11**	6.62**	0.016	10.62**	6.067	34.11**	0.75*	2.634	75.73**	0.287
Phule Jyoti/JNKVVA1	-8.412**	-0.73**	-1.26	0.422	-1.289	-1.978	-134.11**	-2.55**	-0.019	-3.07**	3.737	-19.33**	0.01	-5.794	-71.09**	0.14
Hisar Vijay/JNKVVA1	9.80**	0.50*	1.209	-1.356	-0.844	0.689	14.556	-3.34**	-0.012	-2.26**	2.933	-30.22**	0.32	1.202	-18.93**	0.22
Phule Mukti/JNKVVA1	-1.978	0.37	-0.547	-0.356	-1.289	1.133	22.66*	1.12**	-0.042	3.44**	4.317	-12.55**	0.105	-1.224	-8.217	0.31
Pant c-1 /JNKVVA1	-5.20**	0.79**	1.52	-2.022	-0.956	0.689	-125.00**	-0.236	-0.065	0.369	2.743	14.55**	-1.18**	3.274	-34.33**	0.
G-4 /JNKVVA1	-3.42*	-1.08**	-2.69**	1.311	1.378	0.689	55.88**	-0.94**	0.14**	5.85**	3.427	22.55**	-0.14	-6.475	31.56**	0.113
HO-413 /JNKVVA1	3.80*	0.41*	0.498	0.422	-0.956	3.57**	-79.22**	-2.96**	-0.22**	-5.31**	1.687	-10.77*	0.393	-5.091	-36.56**	0.12
K1-4c /JNKVVA1	-13.97**	0.25	0.842	-0.8	0.489	-0.978	-60.33*	0.033	0.041	-0.875	2.11	1.00	-0.463	5.719	-20.77**	0.253
JM-218 /JNKVVA1	11.24**	-0.70**	0.642	0.311	2.267	-0.089	207.77**	0.683**	-0.041	-2.42**	3.113	1.889	0.76*	8.93*	86.96**	0.253
KA-2 /JNKVVA1	-3.20	1.59**	1.96*	0.089	-0.289	-0.422	-0.333	1.56**	0.20**	-6.33**	3.15	-1.222	-0.567	-3.185	-4.348	0.133
Sankeshwer/ACBGA1	7.89**	1.89**	2.02*	-0.189	-0.511	-0.878	-33.58**	-3.85**	-0.015	-8.64**	2.303	-22.65**	-0.65*	-0.27	-43.66**	0.13
Phule Jyoti/ ACBGA1	8.11**	0.75**	1.721	-1.411	0.711	-4.21**	165.85**	1.76**	0.08*	3.08**	5.407	8.567	-0.82*	2.458	62.50**	0.457
Hisar Vijay/ ACBGA1	-3.66*	0.48*	0.766	0.144	0.156	0.456	30.52**	4.90**	0.037	4.18**	5.343	39.01**	-0.448	0.201	28.07**	0.153
Phule Mukti/ ACBGA1	-0.78	-0.009	-0.757	-0.856	0.711	1.233	31.30**	0.73**	0.031	-1.25*	3.53	-0.656	1.11**	-1.082	23.74**	0.127
Pant c-1 / ACBGA1	2.00	-0.951**	-1.09	-0.189	-0.956	0.122	-.148.36**	-0.018	0.044	-2.20**	2.507	-10.21*	0.74*	-1.324	-38.95**	0.117
G-4 / ACBGA1	5.44**	0.93**	0.966	-0.522	-0.956	2.122	-57.47**	-0.31*	-0.009	-4.84**	1.687	-8.211	-0.74*	8.24*	-25.88**	0.197
HO-4 ACBGA1	-1.333	-1.103**	-0.846	0.256	-2.289	-6.65**	39.07**	-1.06**	0.12**	3.67**	3.457	7.789	-0.218	3.997	19.92**	0.273
K1-4c / ACBGA1	7.88**	-0.56**	0.966	1.367	2.822	1.789	77.96**	-0.039	-0.12**	1.29*	2.49	-3.10	0.032	-3.906	12.906	0.257
JM-218 / ACBGA1	-16.22**	-0.29	-0.768	0.478	-1.067	1.34	-72.92**	-0.81**	0.055	1.83**	3.22	3.122	0.21	-11.94**	-27.26**	0.123
KA-2 / ACBGA1	-9.33**	-1.15**	-2.97**	0.922	1.378	4.67**	-32.36**	-1.29**	-0.22**	2.88**	4.007	-13.65**	0.79*	3.624	-11.375	0.203
Sankeshwer/ACBGA2	-19.24**	-0.47*	0.148	-1.789	-0.978	4.18**	-64.52**	-2.77**	-0.001	-1.97**	3.043	-11.45*	-0.10	-2.364	-32.06**	0.19
Phule Jyoti/ ACBGA2	0.31	-0.024	-.452	0.989	0.578	6.18**	-31.74*	0.78**	-0.066	-0.007	3.863	10.76*	0.81*	3.335	8.589	0.193
Hisar Vijay/ ACBGA2	-6.13**	-0.98**	-1.97*	1.211	0.689	-1.144	-45.07**	-1.56**	-0.026	-1.91**	2.823	-8.78*	0.128	-1.403	-9.135	0.21
Phule Mukti/ ACBGA2	2.75	-0.362	1.303	1.211	0.578	-2.36*	-53.96**	-1.86**	0.011	-2.19**	2.447	13.21**	-1.21**	2.305	-15.52**	0.15
Pant c-1 / ACBGA2	3.20	0.16	-0.43	2.211	1.911	-0.811	273.36**	0.255	0.021	1.83**	2.473	-4.344	0.442	-1.95	73.28**	0.277
G-4 / ACBGA2	-2.022	0.14	1.726	-0.789	-0.422	-2.81*	1.589	1.26**	-0.13**	-1.014	2.473	-14.34**	0.88**	-1.773	-5.678	0.13
HO-413 / ACBGA2	-2.467	0.68**	0.348	-0.678	3.24*	3.07*	40.14**	4.02**	0.10**	1.63**	3.293	2.989	-0.176	1.094	16.63*	0.23
K1-4c / ACBGA2	6.08**	0.30	-1.808	-0.567	-3.31*	-0.811	-17.633	0.007	0.08*	-0.421	1.117	2.1	0.431	-1.813	7.87	0.183
JM-218 / ACBGA2	4.97**	0.99**	0.126	-0.789	-1.20	-1.256	-134.85**	0.13	-0.014	0.592	2.463	-5.011	-0.97**	3.007	-59.70**	0.213
KA-2 / ACBGA2	12.53**	-0.44*	1.01	-1.011	-1.089	-4.25**	32.70**	`-0.27	0.027	3.45**	3.733	14.87**	-0.232	-0.439	15.72*	0.243
SED	1.60	0.19	0.96	1.13	1.44	1.16	10.84	0.14	0.04	0.52	0.26	4.37	0.32	3.35	6.67	0.01
CD 5%	3.21	0.38	1.93	2.27	2.89	2.34	21.71	0.28	0.07	1.03	0.52	8.75	0.65	6.72	13.36	0.02
CD 1%	4.28	0.51	2.51	3.02	3.84	3.11	28.88	0.38	0.10	1.38	0.69	11.64	0.86	8.94	17.76	0.03

*,**Significant at p = 0.05 and 0.01, respectively

dominant genes contributed by above parents. Therefore these crosses can be utilized as hybrid variety.

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