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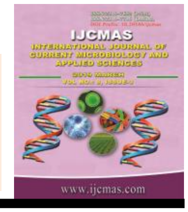

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Line × Tester Analysis of Combining Ability in Chilli

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A B S T R A C T

Eight genotypes were selected on the basis of performance of diversity for important characters to raise sixteen cross combinations in 4 × 4, line × tester mating design. The ANOVA shows significant difference among all the parents and hybrids. Line × tester genetic components were not found to be significant for plant height, fruit width and number of seeds/fruit. The control of plant morphological characters like plant height, width and others like day to 50% flower, fruit length and number of seeds/fruit were found to be effected by additive gene action, vitamin C content and fruit pedicel length were governed by non additive gene action and fruit yield/plant, 1000 seed weight, fruit weight and number of fruits/plant were evident to be controlled by both additive and non – additive gene action. BCC24 recorded highest and positive GCA effects for maximum characters.

Introduction

Chilli (*Capsicum annuum* L.) is most widely cultivated for its pungent (hot pepper) and non pungent (sweet pepper) fruits throughout the world (Bosland and Votava, 2000). Chillies are grown as annual crop, although it can also be grown as perennial shrub in suitable climatic conditions. The genus Capsicum consists of a different range of plants and fruits, and varies a lot with respect to morphology, yield and nutrition related parameters. In any sound breeding programme including hybrid technology, proper choice of parents based on their combining ability, is a prerequisite which also illustrate the nature and magnitude of gene action involved in the expression of the desirable traits. Chilli offers much scope for improvement through heterosis breeding which can further be utilized for the development of desirable recombinants. Information on gene action and combining ability facilitates the choice of suitable parents for hybridization programme to develop promising hybrids for further exploitation. Further, it helps in formulating the breeding methodology for crop improvement. Accordingly the present investigation was carried out to get an idea of the nature of gene action and magnitude of heterosis for fruit yield and yield attributing characters in chilli. Line × Tester analysis is a useful tool for preliminary evaluation of genetic stock for use in hybridization programmes with a view to identify good combiners, which may be used to build up a population with favourable fixable genes for effective yield improvement.

Materials and Methods

Eight genotypes were selected on the basis of performance of diversity for important characters to raise sixteen cross combinations in 4 × 4, line × tester mating design at Central Research Farm of BCKV Gayeshpur, Nadia, West Bengal. Eight parents along with 16 hybrids were evaluated in Randomized Block Design with 3 replication in 45 cm × 45 cm spacing keeping 20 plants in each plot during October to March, 2014-15. Five randomly selected plants/plot were taken to record observations on different characters. Biochemical analysis was done in laboratory of Dept. of Vegetable Science, BCKV. Combining ability analysis was done as per Kempthorne (1957). Heterosis was determined as per method suggested by Wynne *et al.,* (1970) and Bitzer *et al.,* (1967).

Results and Discussion

The analysis of variance revealed highly significant difference among all parents and hybrids for all the characters except fruit width indicating their suitability for developing divergent hybrids (Table 1). The variances due to parents vs. hybrids were significant that indicated average heterosis was also significant for all the characters except 1000 seed weight. The analysis of variances for combinig ability was highly significant for line, tester and line × tester in most of the characters. Variances for line and tester were not significant for fruit width only and line × tester components of genetic variations were not significant for plant height, fruit width and number of seeds/fruit.

The relative importance of the additive and non-additive genetic effects for these characters were reflected by the predictability ratio i.e. additive genetic variance express as proportion of total genetic variance as per Becker (1975). The results presented in Table 1 indicated that preponderance of additive gene action was evident in the control of characters like plant height, Plant canopy width, days to 50% flower, fruit length and number of seeds/fruit. The result is in conformity with the findings of Sahoo *et al.*, (1989) (for plant height and spread), Shukla *et al.*, (1999) (for fruit length). So, pure line selection in the advanced generations from the highly heterotic cross is suggested to develop these characters. Both additive and non additive gene action was important for the conditioning of fruit yield/plant, 1000 seed weight, fruit weight and number of fruits/plant. Result was supported by Singh and Singh (1978), Kordus (1991). There is possibility of deriving high performing pureline for these characters because longer proportion of non additive gene effects in self-pollinated crops seems to be due to additive × additive epistatic effect. So, deferred selection would be profitable for improving fruit yield/plant, fruits/plant, fruit weight and 1000 seed weight. The important fruit quality character i.e. vitamin C content, and fruit pedicel length were governed overwhelmingly by non additive gene action, which had been in conformity with the findings of Pandey *et al.*, (2002). For these two characters heterosis breeding is the best possible option for improvement. The estimates of GCA along with *per se* performance of parents for various characters are presented in Table 2. None of the parents proved to be good general combiners for all the characters.

Table.1 The analysis of variance for different parents and hybrids

Source	Replication	Parents	Lines	Testers	Line vs. Tester	Hybrids	Parents vs. Hybrids	Error	σ^2 GCA	σ^2 SCA	Predictability ratio
Degree of freedom	2	7	3	3	1	15	1	46			
Plant height (cm)	2.18	588.39**	608.47**	761.80**	793.35	278.68**	4426.14**	38.26	93.82	3.70	**0.98**
Plant canopy width (cm)	6.82	309.01**	532.91**	157.99**	90.37	242.91**	1020.35**	32.98	59.79	21.25	**0.84**
Days to 50% flowering	9.37	731.08**	664.75**	1038.00**	9.37	218.28**	351.56**	4.85	72.33	13.31	**0.91**
Fruit length (cm)	0.58	6.57**	11.20**	3.07**	3.18**	4.73**	8.00**	0.38	1.65	0.17	**0.95**
Fruit width (cm)	0.003	0.080	0.105	0.074	0.021	0.075	0.250*	0.050	0.00	0.01	**0**
Fruit pedicel length (cm)	0.19	1.31**	1.75**	1.11**	0.60	0.77**	2.79**	0.17	0.00	0.21	**0.04**
Placenta length (cm)	0.33	8.08**	14.33**	3.05**	4.44**	5.53**	10.17**	0.19	1.97	0.20	**0.95**
No. Of fruits/plant	1426.94**	557.24*	98.76	361.37	2520.29**	6224.83**	142251.4**	178.45	1554.67	755.26	**0.80**
Fruit weight (g)	0.005	0.62**	0.78**	0.46**	0.62**	0.76**	0.39*	0.060	0.17	0.10	**0.77**
No. of seeds/ fruit	207.15	1130.78**	1487.77**	855.97**	884.26**	717.65**	504.76*	116.32	216.62	13.44	**0.96**
1000 seed weight (g)	.021	2.14**	0.92**	3.85**	0.65**	0.82**	0.01	0.07	0.17	0.12	**0.73**
Fruit yield /plant	622.00	4892.35**	3582.64**	7051.92**	2342.81	58450.59**	915733.1**	744.84	10352.14	10929.13	**0.65**
Vit- C content	**25.93**	**4874.30****	**8220.87****	**3081.32****	**213.54**	**3883.32****	**22737.3****	**116.86**	**49.96**	**1291.95**	**0.07**

Table.2 General combining ability (bold) of parents and their per se performance

Lines	Plant height (cm)	Plant canopy width (cm)	Days to 50% flowering	Fruit length (cm)	Fruit width (cm)	Fruit pedicel length (cm)	Placenta length (cm)	No. Of fruits/ plant	Fruit weight (g)	No. of seeds /fruit	1000 seed weight (g)	Fruit yield /plant	Vit- C content
BCC-54	**9.44****	**3.22****	**-1.44**	**1.81**	**-0.05**	**0.33**	**1.97**	**-27.44****	**0.56**	**-16.96****	**0.34**	**26.54****	**-14.65****
	68.00	64.47	56.00	9.45	0.76	4.42	9.06	75.66	2.75	52.33	6.38	208.04	46.70
BCC-1	**1.95**	**4.89****	**7.56****	**-1.05**	**0.12**	**-0.02**	**-1.11**	**-7.70****	**-0.22**	**6.77****	**-0.21**	**-50.66****	**-23.68****
	57.07	69.60	70.00	4.84	1.19	3.65	4.43	87.32	2.06	98.33	5.48	180.26	33.28
BCC-11	**-5.78****	**-5.80****	**-5.44****	**-0.26**	**-0.07**	**-0.08**	**-0.29**	**29.55****	**-0.19**	**8.84****	**0.16**	**36.16****	**7.17****
	45.03	50.00	46.00	8.66	0.90	3.02	8.46	81.80	1.53	68.50	5.65	124.97	109.00
BCC-41	**-5.61****	**-2.31***	**-0.69**	**-0.50**	**0.00**	**-0.23**	**-0.57**	**5.59****	**-0.14**	**1.35**	**-0.30**	**-12.05****	**31.16****
	35.27	40.50	35.00	8.20	0.83	2.68	7.95	88.00	1.91	50.00	5.05	168.08	144.28
S.E.	1.33	1.22	0.44	0.10	0.05	0.08	0.09	3.08	0.05	2.56	0.05	5.84	2.30

Testers	Plant height (cm)	Plant canopy width (cm)	Days to 50% flowering	Fruit length (cm)	Fruit width (cm)	Fruit pedicel length (cm)	Placenta length (cm)	No. Of fruits/ plant	Fruit weight (g)	No. of seeds /fruit	1000 seed weight (g)	Fruit yield /plant	Vit- C content
BCC-30	**-8.01****	**-5.79****	**-8.44****	**0.17**	**-0.04**	**-0.37**	**0.18**	**-44.35****	**-0.28**	**-7.51****	**-0.25**	**-137.66****	**-2.80****
	30.03	44.22	33.00	6.53	0.83	2.87	6.30	64.00	2.00	68.00	4.33	128.00	83.40
BCC-23	**-3.46****	**2.19***	**2.81****	**-0.52**	**0.00**	**0.16**	**-0.57**	**-16.71****	**0.13**	**1.10**	**-0.22**	**-25.52****	**-3.23****
	65.48	56.50	50.00	6.13	1.15	4.10	5.89	57.00	2.61	91.00	6.66	148.59	49.19
BCC-24	**7.81****	**9.25****	**-2.44***	**0.55**	**0.05**	**-0.01**	**0.60**	**37.00****	**0.36**	**14.55****	**0.57**	**153.07****	**0.06**
	60.03	60.00	51.00	8.43	1.07	3.87	8.18	77.50	2.82	96.56	6.79	218.70	56.72
BCC-59	**3.66****	**-5.65****	**8.06****	**-0.20**	**-0.09**	**0.23**	**-0.21**	**24.06****	**-0.22**	**-8.13****	**-0.10**	**10.11****	**5.97****
	45.22	48.33	78.00	6.76	0.86	4.20	6.48	52.30	2.11	62.17	6.10	107.02	120.08
S.E.	1.33	1.22	0.44	0.10	0.05	0.08	0.09	3.08	0.05	2.56	0.05	5.84	2.30

Characters are as per Table 1   * Significant at P = 0.05   ** Significant at P = 0.01

Table.3 Specific combining ability (bold) of hybrids and their per se performance

Characters	Crosses	SCA effects	Mean Values	Heterosis over mid parent	S.Em ±
Plant height (cm)	BCC 54 × BCC 59	7.51**	88.00	55.45**	**2.30**
	BCC 1 × BCC 23	3.40**	69.29	13.09	
	BCC 11 × BCC 24	2.67**	72.10	37.25**	
Plant canopy width (cm)	BCC 54 × BCC 23	3.72**	71.32	17.91**	**2.11**
	BCC 1 × BCC 30	10.91*	72.20	26.87**	
	BCC 11 × BCC 24	2.86**	68.50	24.55**	
	BCC 41 × BCC 23	1.13	63.20	30.31**	
Days to 50% flowering	BCC 11× BCC 24	2.19**	42.00	-13.40**	**0.77**
	BCC 1 × BCC 24	2.19**	55.00	-9.09**	
	BCC 54 × BCC 30	4.19**	42.00	-5.62	
Fruit length (cm)	BCC 54 × BCC 30	0.42	9.02	15.69**	**0.18**
Fruit width (cm)	BCC 54 × BCC 30	0.22	1.21	52.49**	**0.08**
	BCC 1 × BCC 24	0.14	1.38	22.34	
Fruit pedicel length (cm)					
Placenta length (cm)					
No. Of fruits/ plant	BCC 54 × BCC 30	41.05**	136.50	95.47**	**5.34**
	BCC 54 × BCC 30	8.21**	185.01	141.59**	
	BCC 1 × BCC 24	20.11**	216.65	162.89**	
	BCC 11 × BCC 23	38.03**	218.10	214.27**	
	BCC 41 × BCC 23	7.99**	164.10	126.34**	
	BCC 41 × BCC 59	24.86**	221.75	216.11**	
Fruit weight (g)	BCC 54 × BCC 30	0.15	2.81	18.19*	**0.09**
	BCC 54 × BCC 24	0.45	3.75	34.60**	
	BCC 11 × BCC 59	0.41	2.38	30.88**	
	BCC 41 × BCC 23	0.32	2.69	19.19*	
No. of seeds/fruit	BCC 11 × BCC 24	3.24**	105.60	27.95**	**4.44**

	BCC 11 × BCC 59	6.52**	86.20	31.94**	
	BCC 41 × BCC 30	3.19**	76.00	28.81*	
	BCC 41 × BCC 24	5.13**	100.01	36.47**	
1000 seed weight (g)	BCC 54 × BCC 30	0.47	6.34	18.39**	**0.09**
	BCC 11 × BCC 24	0.37	6.88	10.61**	
	BCC 41 × BCC 30	0.02	5.25	11.94**	
Fruit yield /plant	BCC54 × BCC 24	115.37**	694.68	225.58*8	**10.11**
	BCC 1 × BCC 24	67.71**	569.81	185.65**	
	BCC 11 × BCC 59	74.86**	520.83	349.02**	
	BCC 41 × BCC 23	79.68**	441.80	179.03**	
	BCC 41 × BCC 59	45.74**	443.50	222.43**	
	BCC 11 × BCC 23	66.64**	476.98	148.72**	
Vit- C content	BCC 54 × BCC 23	25.80**	126.00	162.80**	**3.99**
	BCC 54 × BCC 24	32.87**	136.30	163.59**	
	BCC 1 × BCC 59	46.68**	147.00	91.71**	
	BCC 11 × BCC 30	33.10**	155.50	61.64**	
	BCC 41 × BCC 23	14.04**	160.00	65.40**	
	BCC 41 × BCC 59	18.34**	173.50	31.26**	

Characters are as per Table 24* Significant at P = 0.05 ** Significant at P = 0.01

The highest significant and positive GCA effects were recorded by BCC 24 for maximum numbers of characters namely, fruit yield/plant, fruits/plant, seeds/fruit, plant height and plant canopy width. Next to BCC 24, BCC 59 was good general combiner for plant height, days to 50% flowering, fruits/plant, fruit yield/plant and vitamin C content of fruit. For fruit yield and number of fruit/plant BCC 24 and BCC 11 had significant positive GCA effects. For vitamin C content highest significant GCA along with highest mean performance observed in BCC 41 followed by BCC 11 and BCC 59. BCC 54 and BCC 24 exhibited highest GCA effects for plant height and plant canopy width.

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