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Combining Ability and Gene Action Studies in Chilli (*Capsicum annuum* L.)

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Abstract A study was undertaken to estimate combining ability in nine diverse genotypes of chilli by following diallel cross analysis (excluding reciprocals). Thirty six hybrids along with nine genotypes were evaluated during 2011–2012. All the characters studied showed significant variability among the genotypes. For the combining ability analysis, the variances due to g.c.a were significant for all the characters except number of primary branches per plant showed non-significant s.c.a variance. Additive gene action was observed for all the characters studied except for days to first and days to 50% flowering where non additive gene action were found. Among the parents Pant C-3, BC-28, CO-4 and RHRC-16-5 were found good general combiner for fruit yield and yield contributing characters. Hybrids BC-28 × Pant C-3, RHRC-16-5 × BC-28, RHRC-16-5 × CO-4 and RHRC-16-5 × Pant C-3, RHRC-16-5 × Konkan Kirti and BC-28 × Konkan Kirti were found to be having good s.c.a effects for fruit yield and contributing characters and useful in further breeding program.

Keywords Chilli, Combining ability, GCA effects, SCA effects, Gene action.

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Introduction

Chilli (*Capsicum annuum* L.) (2n=24) is considered as one of the most important commercial spice crop and is widely used universal spice, named as *wonder spice*, essentially used in every Indian cuisine due to its pungency, spice, taste, appealing color and flavor. Chilli is an important spice cum vegetable crop in India. It belongs to family Solanaceae, which has about 90 genera and 2000 species. In genera, *Capsicum* (Greek word Kapsimo meaning to bite), *Capsicum annuum*, *C. baccatum*, *C. chinese*, *C. frutescens* and *C. pubescens* are commonly recognized as domesticated species, while approximately 20 wild species have been documented. In India, only two species viz., *Capsicum annuum* and *Capsicum frutescens* are known and most of the cultivated varieties belong to the species *Capsicum annuum*. Study of combining ability is important for selecting parents for hybridization. GCA variance is due to additive variance and SCA variance is due to non-additive variance, both acts as an important diagnostic tool in selection of suitable parents. Keeping in view all the above aspects, the present investigation combining ability studies in chilli (*Capsicum annuum* L.) was undertaken.

Materials and Methods

The experimental material for present study comprises of nine genotypes of chilli obtained from Vegetable Improvement Scheme, Wakavali were as Jayanti, RHRC Pendulus, RHRC-16-5, BC-24, BC-28, Pant C-3, Konkan Kirti, CO-4 and Jwala crossed in all possible

Table 1. Analysis of combining ability for 12 characters in 9×9 half diallel crosses in chilli (*Capsicum annuum* L.). *Significant at 5% level, **Significant at 1% level.

Sl. No.	Characters	Mean sum of squares g.c.a (df=8)	s.c.a (df=36)	Error (df=44)	σ^2g	σ^2s	σ^2g/σ^2s
1.	Plant height (cm)	293.25**	10.31**	2.18	26.46	8.12	3.26
2.	Days to first flowering	52.31**	8.59**	0.82	4.68	7.77	0.60
3.	Days to 50 per cent flowering	47.36**	20.47**	0.37	4.27	20.11	0.21
4.	Number of primary branches plant^{-1}	1.073**	0.092	0.082	0.090	0.011	8.18
5.	Number of secondary branches plant^{-1}	9.47**	0.54**	0.20	0.84	0.34	2.47
6.	Fruit length (cm)	4.96**	0.17**	0.038	0.45	0.14	3.21
7.	Fruit diameter (cm)	0.14**	0.0048**	0.0008	0.012	0.004	3.00
8.	Fruit length to width ratio	5.87**	0.29**	0.084	0.526	0.206	2.55
9.	Number of fruits plant^{-1}	1653.23**	62.69**	1.84	150.13	60.85	2.47
10.	Number of seeds fruit^{-1}	1072.35**	21.14**	6.53	96.89	14.61	6.63
11.	Average fruit weight (g)	1.78**	0.061**	0.0015	0.161	0.060	2.68
12.	Green fruit yield plant^{-1}	0.0046**	0.0004**	0.000015	0.00041	0.00036	1.14

combinations i.e. in a diallel mating system, excluding reciprocals resulting in thirty six crosses. The crossing program was undertaken during first season November-May, 2010-11.The F_1's along with the parents were transplanted for evaluation for combining ability studies at Research farm, Department of Agric. Bot- any, College of Agriculture, Dapoli in *rabi* 2012. The standard cultural practices were carried out and various yield and yield related characters were recorded such as Plant height, Days to first flowering, Days to 50% flowering, Number of primary branches per plant, Number of secondary branches per plant, Fruit length, Fruit diameter, Fruit length to width ratio, Number of fruits per plant, Number of seeds per fruit, Average fruit weight (g) and Green fruit yield per plant (kg) from five plants selected for observation. The analysis of variance and combining ability was carried out as per standard methods using method 2 model I of Griffing for all the characters under study.

Results and Discussion

In any breeding program of all crops, selection of parent is primarily based on their phenotypic (external) appearance. In the case of quantitatively inherited characters prediction of ability of parents to combine well generates more variability and transmits the desirable gene combination to the progeny. The combining ability studies furnish useful information regarding the selection of suitable parents for effective hybrid program. Combining ability analysis has of significantly practical importance in plant breeding as it allows the prediction of the relative efficiency of parents in hybrid combination. In fact well adapted higher yielding genotypes would be of little use if it proves a poor combiner. The knowledge of the genetic control of quantitative characters would be of considerable importance in bringing about improvement of a particular character.

Table 2. Promising parents based on the general combining ability in chilli (*Capsicum annuum* L.).

Sl. No.	Parents	Mean performance	g.c.a effects	Best combiner for
1.	Pant C-3	71.02 cm	9.56	Plant height
		82.50 days	– 2.72	Days to first flowering
		86.50 days	– 2.85	Days to 50% flowering
		6.10	0.22	Number of primary branches per plant
		12.10	1.21	Number of secondary branches per plant
		97.10	17.51	Number of fruits per plant
		0.146 kg	0.003	Green fruit yield per plant
2.	Konkan Kriti	84.50 days	– 2.72	Days to first flowering
		6.20	0.24	Number of primary branches per plant
		11.57 cm	1.15	Fruit length
		11.02	1.21	Fruit length to width ratio
3.	BC-28	103.90	15.06	Number of seeds per fruit
		10.61 cm	0.49	Fruit length
		0.206 kg	0.032	Green fruit yield per plant
4.	CO-4	1.43 cm	0.22	Fruit diameter
		3.97 g	0.96	Average fruit weight
5.	RHRC-16-5	10.42	0.22	Fruit length to width ratio
		57.40	5.15	Number of seeds per fruit
6.	Jayanti	6.60	0.78	Number of primary branches per plant
		0.94 cm	– 0.10	Fruit diameter
7.	Jwala	56.55 cm	4.23	Plant height

At least one or more parents showed the significant g.c.a effect for all character. Among 9 parents, Pant C-3 showed maximum g.c.a for six characters and proved to be best general combiner. It showed maximum g.c.a effect for plant height (9.56), days to first flowering (-2.72), number of primary (0.22) and secondary branches per plant (1.21), number of fruits per plant (17.51) and green fruit yield per plant (0.003). Parent BC-28 exhibited high general combining ability effect for number of seeds per fruit (15.06), green fruit yield per plant (0.032) and fruit length (0.49), while parent Konkan Kirti was found good general combiner for days to first flowering (-2.72), number of primary branches per plant (0.25), fruit length (1.15) and fruit length to width ratio (1.21). Parent CO-4 found good general combiner for fruit diameter (0.22) and average fruit weight (0.96). Parent RHRC-16-5 was found good general combiner for fruit length to width ratio (0.22) and number of seeds per fruit (5.15), while parent Jayanti showed good general combining ability for number of primary branches per plant (0.78) and fruit diameter (-0.10). Parent Jwala was found good general combiner for plant height (4.23). These results were supported by various earlier workers such as [1] for plant height [2] for days to first flowering and fruit length, [3] for days to 50% flowering, number of fruits per plant and number of seeds per fruit, [4] for number of primary branches per plant and fruit length to width ratio and [5] for fruit diameter.

Hybrid BC-28×Pant C-3 was found to be best hybrid combination showing high specific combining ability for number of fruits per plant (19.56) and green fruit yield per plant (0.060), while hybrid BC-24× CO-4 showing high specific combining ability for days to 50% flowering (-6.64), number of secondary branches per plant (1.43) and fruit diameter (0.14). Hybrid Jayanti ×CO-4 found to be best combination for days to first flowering (-4.03) and days to 50% flowering (-5.45), while hybrid Jayanti × Jwala exhibited high specific combining ability for number of primary branches per plant (0.55) and green fruit yield per plant (0.014). For average fruit weight (0.68) and green fruit yield per plant (0.029), hybrid CO-4×Jwala exhibited high specific combining ability. For plant height hybrid Pant C-3×Jwala (6.47) exhibited high specific combining ability, while hybrid BC-28×Pant C-3 exhibited high specific combining ability for number of fruits per plant (19.56) and green fruit yield per plant (0.060). Hybrids Konkan Kirti×CO-4, RHRC-16-5×Konkan Kirti and RHRC-16-5 × BC-28 were found to be best cross combinations for fruit length (0.81),

Table 3. Promising hybrids for green fruit yield per plant based on heterosis and s.c.a effects in chilli (*Capsicum annuum* L.).

Sl. No.	Hybrids	Av. green fruit yield per plant (kg)	Heterosis (%) B.P	C.P	s.c.a effects	Other desirable characters
					19.56	Number of fruits per plant
1.	BC-28×Pant C-3	0.238	15.81	56.58	0.22	Average fruit weight
					0.060	Green fruit yield per plant
					0.93	Number of secondary branches per plant
2.	RHRC-16-5×BC-28	0.235	14.11	54.28		
					12.02	Number of fruits per plant
					0.036	Green fruit yield per plant
3.	RHRC-16-5×CO-4	0.194	10.22	27.63	3.98	Plant height
					– 3.62	Days to first flowering
					– 4.73	Days to 50% flowering
					0.13	Fruit diameter
					0.67	Average fruit weight
					0.016	Green fruit yield per plant
4.	RHRC-16-5× Pant C-3	0.184	4.54	21.05	16.50	Number of fruits per plant
					0.014	Green fruit yield per plant
5.	RHRC-16-5× Konkan Kirti	0.184	4.26	20.72	–3.64	Days to 50% flowering
					0.67	Fruit length
					0.90	Fruit length to width ratio
					3.72	Number of fruits per plant
					0.013	Green fruit yield per plant
6.	BC-28×Konkan Kirti	0.182	11.67	19.41	0.77	Fruit length to width ratio
					4.99	Number of fruits per plant
					7.39	Number of seeds per fruit

fruit length to width ratio (0.90) and green fruit yield per plant (0.036), respectively. These results also supported by Chadchan [4] for plant height, number of primary and secondary branches per plant, fruit length, fruit length to width ratio and number of seeds per fruit, [2] for days to 50% flowering, green fruit yield per plant and fruit diameter, [6] for number of fruits per plant.

The result showed that additive gene action were found for all of the characters except the days to first flowering, days to 50% flowering, whereas for other characters like plant height, number of primary branches per plant, number of secondary branches per plant, fruit length, fruit diameter, fruit length to width ratio, number of fruits per plant, number of seeds per fruit, average fruit weight and green fruit yield per plant showed additive gene action. These are in conformation with the work done by several workers like Singh and Pan [2], Chadchan [4], Prasath and Ponnuswami [3] for plant height, branches per plant, number of fruits per plant, fruit length, fruit girth, seeds per fruit and individual green fruit weight while Karthik et al. [5] for average fruit weight and Kamble et al. [7] for number of fruits per plant, average fruit weight and total yield per plant. Recurrent selection would be most effective for improvement of such characters. The pedigree selections are suggested for exploitation of additive gene action in some crosses while heterosis breeding is suitable to produce new hybrid combination for increasing the fruit yield.

Non additive gene action for the character days to first flowering was noticed earlier [1—5] where as for days to 50% flowering non additive gene action was reported by earlier Kamble et al. [7]. These traits can be improves through recurrent selection for specific combining ability through heterosis breeding.

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