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Diallel analysis for study of combining ability for quantitative traits in chilli (*Capsicum annuum* L. var. *acuminatum* Fingerh.)

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Abstract

The study envisaged assessing the general combining ability of the parents and specific combining ability of the hybrids, using diallel fashion (excluding reciprocals). Fifteen hybrids along with their six parents and one check (Arka Harita), Totally 22 genotypes were evaluated for the estimation of combining ability at Vegetable Research and Demonstration Block of college of horticulture, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar during 2016-2017. The experiment was laid out in a Randomized Block Design (RBD) with three replications. The analysis revealed that parents and crosses differed significantly for general and specific combining ability effects. The relative magnitude of *gca* variances was higher than the *sca* variance, indicates the role of additive component in the expression of traits like plant height, number of primary branches and stem diameter except days to 50% flowering, days to first fruit harvest and stalk length which was found to be under the control of non-additive gene action. The parent Byadgi Dabbi, G-4 and Pant C-1 exhibited highly significant for plant height, number of primary branches, days to 50% flowering days, Byadgi Kaddi for stem diameter and stalk length were found to be the best general combiner. The crosses Arka Lohit × Pant C-1 for number of primary branches per plant, plant stem girth, days to 50% flowering and stalk length and Arka Lohit × Arka Suphal for number of primary branches per plant and days to first fruit harvest were the best specific combiners. This suggests the usefulness of heterosis breeding or any breeding plan which makes use of specific combining ability effects for improvement in these traits.

Keywords: Chilli, diallel, combining ability, variance, gene action

Introduction

Chilli (*Capsicum annuum* L. var. *acuminatum* Fingerh.) is a spice cum vegetable crop belonging to the family Solanaceae with the chromosome number $2n = 24$. It is a native of Mexico brought into India from Brazil by Portuguese prior to 1785 A.D. It can be regarded as universal spice of India. In the face of increasing population, there is a need for increased production and productivity levels of chilli. In achieving the nutritional security through vegetables, chilli crop also play a vital role. However, the present production and productivity of chilli is not sufficient enough to meet the nutritional security of increasing population. The success of any breeding programme depends on the selection of parents together with information regarding nature of gene action controlling the various characters. Application of biometrical techniques like diallel analysis has appeared to be the immensely useful breeding tool, which gives generalized picture of genetics of the characters under study. Studies on combining ability help to identify the best parents and provide genetic information on the inheritance pattern of characters. The superiority of parents may not depend so much on their superior *per se* performance but in their ability to transmit desirable genes to their progenies. Therefore, combining ability analysis was a powerful tool to discriminate the good and poor combiners. This analysis also furnishes useful information on nature of gene action involved for the expression of various quantitative characters, which can be utilized for planning an effective breeding programme. The main objective of this part of study was to identify the parents with better potential to transmit the desirable characteristics to the progenies and to sort out the best specific hybrids for yield and its component characters.

Materials and Methods

The experimental materials comprised of six diverse parents *viz.*, Byadgi Dabbi, Byadgi Kaddi, Arka Lohit, Arka Suphal, G-4 and Pant C-1 along with its 15 F_1 hybrids generated by

half-diallel in all possible combinations excluding reciprocals during 2016-2017. Arka Harita used as standard check. The experiment was laid out in randomized block design with three replications at the Vegetable Research and Demonstration Block, UHF, Bharsar, Uttarakhand (India). Each plot consisted of 8 plants. Inter and intra row spacing was kept 60 and 45 cm, respectively. The observations were recorded on five randomly selected plants from each treatment and replications for six characters viz., plant height (cm), number of primary branches per plant, stem girth (cm), days to 50 per cent flowering (days), days to first fruit harvest (days), stalk length (cm). The estimates of combining ability variances and effects were obtained using Method 2 of Model - I (fixed effect), suggested by Griffings (1956) [2].

Results and Discussion

The analysis of variance for combining ability of each character is presented in Table 1. It was observed that *gca* and *sca* variances were highly significant for almost all the characters studied indicating that both additive as well as non-additive types of gene action were involved in the inheritance of these traits. Importance of additive and non-additive genetic components in the expression of different characters in chilli has been reported by several workers viz., Pandey *et al.* (1981) [5], Gopalkrishna *et al.* (1987) [1], Srivastava *et al.* (2004) [6], Karthik *et al.* (2009) [3], Kalil *et al.* (2014) [4] and Suryakumari *et al.* (2014) [7].

Plant height (cm)

Out of six parents, significant positive *gca* effects were recorded by Pant C-1 (10.49), Byadgi Dabbi (6.23) and Byadgi Kaddi (4.13), G-4(2.65) indicated their good general combining ability (table 2). while, Byadgi Dabbi × Byadgi Kaddi (7.74) found good specific cross combination (table 3).

Number of primary branches per plant

Significant positive *gca* effects for this trait was exhibited by only three parent Pant C-1(0.655), Arka Lohit (0.376), G-4 (0.182) which indicated their good general combining ability

(table 2). while, Arka Lohit × Arka Suphal (36.69), Arka Lohit × Pant C-1 (21.02), Arka Suphal × Pant C-1(0.61) exhibited significant positive values, which indicated that these hybrid are good specific cross combinations (table 3).

Stem girth (cm)

Significant positive *gca* effect was exhibited by only one parent viz., Byadgi Kaddi (0.06), which indicated the good general combining ability of that parent (table 2). The results of specific combining ability effects for stem girth revealed by only one hybrid Arka Lohit × Pant C-1(7.49) has significant value, which indicated good specific cross combination (table 3).

Days to 50 per cent flowering (days)

In this case flowering performance in the negative direction is desirable hence, the expressions in the negative direction are favourable. Here the parents/crosses which exhibited significant negative or positive *gca/sca* effects were designated as good or poor combiners, respectively. Among the parents, Byadgi Dabbi (-1.03) was found good general combiner as they exhibited the significant negative *gca* effect (table 2). While Arka Lohit × Pant C-1 (-7.04), Byadgi Dabbi × Pant C-1 (-1.57), Byadgi Dabbi × G-4 (-1.51), Byadgi Dabbi × Arka Suphal and G-4 × Pant C-1(-0.05) and Byadgi Kaddi × Arka Suphal (-0.02) exhibited significant negative *sca* effects indicated their good specific combining ability (table 3).

Days to first fruit harvesting (days)

The parents/crosses which exhibited significant negative or positive *gca/sca* effects were designated as good or poor combiners, respectively. Among the parents, Arka Suphal (-1.44) and G-4 (-0.67) were found good general combiners as they exhibited the significant negative *gca* effects (table 2). While, eight crosses exhibited significant negative *sca* effects indicated their good specific combining ability (table 3) and top two were Arka Lohit × Arka Suphal (-16.45), Byadgi Kaddi × Arka Lohit (-1.26).

Table 1: Analysis of variance for combining ability for six parameters in chilli.

Sourced of variation	D.F.	Plant Height (cm)	Number of Primary Branches	Plant Stem Diameter (cm)	Days to 50% Flowering (days)	Days to First Fruit Harvest (days)	Stalk Length (cm)
GCA	5	2156.00**	5.69**	0.05**	19.15**	34.35**	0.127**
SCA	15	318.19**	0.44**	0.01	66.62**	89.17**	0.327**
Error	40	1.63	0.01	0.01	0.29	1.02	0.000
Gca/sca ratio		6.78	12.86	4.12	0.29	0.39	0.389

*, ** significant at 5% and 1% level, respectively

Table 2: Estimates of general combining ability (GCA) effects of parents for six parameters in chilli.

S. No.	Parents	Plant Height (cm)	Number of Primary Branches	Plant Stem Diameter (cm)	Days to 50% Flowering (days)	Days to First Fruit Harvest (days)	Stalk Length (cm)
1	BD	6.23**	-0.331**	0.026	-1.030**	-0.089	0.014**
2	BK	4.13**	-0.645**	0.061*	0.144	2.002**	0.045**
3	AL	-11.53**	0.376**	-0.021	0.357	-0.427	-0.010*
4	AS	-11.97**	-0.238**	-0.023	-0.967**	-1.445**	0.030**
5	G-4	2.65**	0.182**	-0.070*	1.352**	-0.679	0.060**
6	PC-1	10.49**	0.655**	0.026	0.144	0.638	-0.140**
	SE (gi)	0.238	0.014	0.019	0.100	0.188	0.003
	Cd at 5%	0.527	0.031	0.042	0.221	0.416	0.007

*, ** significant at 5% and 1% level, respectively

Where,

BD = Byadgi Dabbi BK = Byadgi Kaddi AL = Arka Lohit AS = Arka Suphal PC-1 = Pant C-1

Table 3: Estimates of specific combining ability (SCA) effects of crosses for six parameters in chilli.

S No.	Parents	Plant Height (cm)	Number of Primary Branches	Plant Stem diameter (cm)	Days to 50% Flowering (days)	Days to First Fruit Harvest (days)	Stalk Length (cm)
1	BDXBK	7.74**	-15.92**	-7.55**	1.53**	21.27**	10.72**
2	BDXAL	-0.11	-0.47**	-0.06	0.30	0.10	0.09
3	BDXAS	0.02	0.02	0.03	-0.05	-0.01	-0.01
4	BDXG4	-6.29**	-0.06	-3.74**	-1.51**	3.22**	-8.58**
5	BDXPC1	-7.90**	0.06	-1.26**	-1.57**	3.18**	0.69**
6	BKXAL	-0.05	-0.41**	-0.29**	0.58*	-1.26*	0.20**
7	BKXAS	-0.13	-0.12**	0.17*	-0.02	-0.07	0.19**
8	BKXG4	0.10	0.13**	0.12	0.32	-0.01	0.23**
9	BKXPC1	0.62	0.21**	-0.24**	-0.17	0.12	-0.13**
10	ALXAS	-14.91**	36.69**	-9.99**	20.71**	-16.45**	-9.18**
11	ALXG4	0.01	0.02	-0.02	0.01	0.00	-0.12*
12	ALXPC1	-59.44**	21.02**	7.49**	-7.04**	30.91**	24.10**
13	ASXG4	-0.03	0.10	-0.01	0.09	-0.04	0.05
14	ASXPC1	-0.14	0.61**	-0.05	0.53	-0.20	0.05
15	G4XPC1	0.06	-0.01	-0.03	-0.05	-0.07	-0.02
	SE (sij)	0.654	0.04	0.052	0.274	0.517	0.01
	CD at 5%	1.317	0.081	0.105	0.552	1.041	0.020

*, ** significant at 5% and 1% level, respectively

Stalk length (cm)

Significant positive *gca* effects among the parents, was exhibited by G-4 (0.06) and Byadgi Kaddi (0.04), Arka Suphal (0.03) which established it as good general combiner (table 2). The specific combining ability for this trait revealed that five hybrid combinations, *viz.*, Arka Lohit × Pant C-1 (24.10), Byadgi Dabbi × Byadgi Kaddi (10.72), Byadgi Dabbi × Pant C-1 (0.69), Byadgi Kaddi × Arka Lohit (0.20) and Byadgi Kaddi × Arka Suphal (0.19) exhibited significant positive *sca* effects (table 3)

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