COMBINING ABILITY ANALYSIS IN CHILLI (*CAPSICUM ANNUM* L.) TO IDENTIFY SUITABLE PARENTS FOR HYBRID PRODUCTION

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Abstract: The present experiments was undertaken to study the combining ability for yield and yield attributing traits in chilli. Six parents *viz,* Ujwala, Anugraha, Vellayani Athulya, Jwalasakhi, Pant C1 and Pusa Sadabahar were crossed in a diallel pattern and the resultant 30 hybrids were evaluated in full diallel fashion. The field experiment was laid out in randomized block design (RBD) with three replications. Combining ability analysis showed significant *gca, sca, rca* variances and *gca, sca* effects for all the traits. Moreover *gca/sca* variance ratio indicated preponderance of dominance / non-additive gene action for the inheritance of all traits. Among parents, Pusa Sadabahar exhibited positive and significant *gca* effect for plant height, branches per plant, number of fruits per plant, yield per plot and negative and significant effect for incidence of leaf curl virus disease. Among crosses, Vellayani Athulya x Pusa Sadabhar (P3 x P6) exhibited positive and significant sca effect for fruit weight and yield per plot whereas; Ujwala x Vellayani Athulya (P1 x P3) exhibited negative and significant sca effect for leaf curl virus disease incidence.

Keywords: Chilli, combining ability and diallel analysis.

Introduction: Chilli [*Capsicum annuum* (L.)] belongs to Solanaceae family is one of the most important crops grown for its green form as vegetable and red form as spice. Besides, it is used in processing industries for preparing various products *viz.,* pepper sauce, pickled pepper, ground pepper and dried pepper. Originated in Latin American regions of New Mexico, Guatemala and Bulgaria. To plan an appropriate breeding programme, the plant breeders must possess an adequate knowledge of combining ability and nature of gene action, character association patterns and the extent of contribution of each character to fruit yield. It is, therefore, imperative to carry out genetic studies on gene action involved in the manifestation of important quantitative and qualitative traits for the improvement of yield and for breeding resistant cultivars. Knowledge of relative importance of general combining ability and specific combining ability for quantitative characters influencing yield and its components is very helpful in selecting parents for production of superior hybrids. Several biometrical methods are available for studying the combining ability and gene action. The diallel analysis which was first developed by Griffing (1956) is one such method. In the light of these, the present investigation is framed to study the inheritance of leaf curl virus resistance, yield, and yield related traits in chilli through combining ability analysis and to identify high yielding chilli hybrids.

Material and Methods: The experiment was carried out in the Department of Plant breeding and Genetics, College of Agriculture, Vellayani, during 2012-2014. Based on the performance, six parents – four high yielding (Ujwala, Anugraha, Vellayani Athulya and Jwalasakhi), leaf curl virus susceptible varieties and two (Pant C1 and Pusa Sadabahar) leaf curl virus resistant/tolerant types were raised and crossed in a diallel pattern and 30 F_1 combinations including reciprocals were produced. The crossing technique consisted of hand emasculation and artificial pollination. The spacing of 45 cm between row to row and 45 cm between plants to plant was adopted. Two lines each with ten plants for parents and F_1s were planted in net experimental plot of 4.5m^2. FYM @ 10 t/ha was mixed at the time of field preparation. The crop management was followed as per package of practices recommendations of Kerala Agricultural University (KAU, 2011), without the application of plant protection chemicals. Spraying of insecticides in the field was avoided. The observations on five randomly selected plants in each treatment under each replication were recorded for Plant height (cm), Number of branches per plant, Number of fruits per plant, Average fruit length (cm), Average fruit girth (cm), Fruit weight (g), Yield per plot (kg) and Incidence of leaf curl disease. To estimate the combining ability analysis to the parents and the hybrid combinations, method I - model I given by Griffing, (1956) was used.

Result And Discussion: A good knowledge of combining ability is necessary for the selection of appropriate parents in hybridization. Since it gives an idea whether a particular parent combines well in a cross and also to denote the specific performance of a cross combination against the expectations from the *gca* of the parents. On the contrary, the reciprocal effect gives an idea of which parent could be used as female or which as male so as to maximize performance of the crop that was predicted on the basis of *gca* of parent and *sca* of the cross. Sprague and Tatum in 1942 used the term combining ability to describe the average performance of a line in a series of cross combinations. Analysis of variance in diallel

design revealed that the mean sum of squares due to treatments were highly significant for all the traits. These results are in conformity with the findings of Gouda *et al*. (2003) in chilli.

Combining ability analysis showed significant *gca, sca* and reciprocal variances for all the traits. Among parents, Pusa Sadabahar (P6) exhibited positive and significant *gca* effect for plant height, branches per plant, number of fruits per plant, yield per plot, negative and significant effect for incidence of leaf curl virus disease. Jwalasakhi (P4) for fruit girth, Vellayani Athulya (P3) for fruit length, fruit weight, Anugraha (P2) for incidence of leaf curl disease.

Specific combining ability (*sca*) was defined as the deviation in the performance of specific cross from the performance expected on the basis of general combining ability effects of parents involved in the crosses. Specific combining ability (*sca*) can be either negative or positive and sca always refers to specific cross and never to particular parent by itself. Among the total 30 crosses, cross exhibiting high *sca* effect was selected from each character and the *gca* status of the parents of each hybrids has been observed as either low or high and from the results it is clear that none of the hybrids combined higher *sca* effect for all the economic characters.

In respect to plant height, the mean sum of squares due to gca, sca and reciprocal were found highly significant. P6 (12.95) recorded the highest significant positive gca effect and P2 (-8.69) recorded the highest significant negative gca effect. The sca effect was positive and maximum in P5 x P6 and P6 x P5. Among 30 hybrids, 17 exhibited significant sca effects towards positive direction. Similar results are reported by Khereba *et al.* (2008) and Muhamad syukur *et al.* (2013). Branches per Plant, of the six parents, P6 (1.24) recorded the highest significant positive gca effect. Out of 6 parents, 2 registered positive significant gca effects and 2 registered negative significant gca effects. The sca effects ranged from -1.17 (P6 x P4) to 2.23 (P2 x P5). Among 30 hybrids, 11 exhibited significant sca effects towards positive direction, Vandna *et al*. (2012) observed the similar results. Among parents for fruits per plant, P6 (54.10) recorded the maximum significant positive gca effect. Out of 6 parents, 2 registered positive significant gca effects. The sca effects ranged from -44.65 (P2 x P6) to 82.52 (P4 x P6). Out of 30 hybrids, 15 hybrids recorded significant positive sca effects. Similar finding were reported by Vandna *et al*. (2012) and Sharma and Munish (2013). Average Fruit Length, Out of 6 parents, P3 (0.92) had the highest significant positive gca effect followed by P4 (0.76), Though 18 hybrids recorded positive sca effects only 10 were significant. The cross P4 x P5 (3.16) had the maximum sca effect. Vandna *et al*. (2012) and Sharma and Munish (2013) observed the similar results. Average Fruit Girth, in accordance with earlier findings by, Vandna *et al*. (2012), among parents, P4 (0.61) recorded the maximum significant positive gca effect. Out of 6 parents, 2 registered negative significant gca effects and 2 registered positive significant gca effects. Out of 30 hybrids, 10 recorded significant negative sca effects and 11 hybrids recorded significant positive sca effects.

In respective of Fruit Weight, among the parents, P3 (3.22) exhibited the maximum significant positive gca effect and out of 6 parents, 4 registered negative *gca* effects and 2 registered positive gca effects. The sca effects ranged from -1.38 (P5 x P2) to 3.01 (P3 x P6). Among hybrids, 11 recorded significant negative sca effects and 10 recorded significant positive effects. The results are supported by Muthuswamy, (2004) and Khereba *et al*. (2008). The yield per plot *gca* effect was ranged from -3.58 (P1) to 6.58 (P6). The sca effects ranged from -15.5 (P5 x P3) to 24.43 (P3 x P6). A total of 10 hybrids exhibited significant positive sca effects. Similar results were reported by Prasath and Ponnuswami (2008) and Alok Chaudhary *et al.* (2013). For Incidence of leaf curl virus disease, Out of 6 parents, the gca effect ranged from -10.87 (P6) to 13.60 (P2). Out of 6 parents, 3 registered negative significant gca effects and 3 registered positive significant gca effects. The sca effects ranged from -16.84 (P3 x P2) to 13.01(P1 x P3). Ajith (2004) Desai *et al*. (2006), Kumar *et al*. 2009 and Kumar *et al*. 2011 observed similar results.

Conclusion: A positive correlation between host resistance and disease incidence and an in-depth knowledge in the relationship of disease incidence and biochemical components will be useful to carry out breeding for resistant varieties to overcome the menace posed by pathogen in host plants to develop superior hybrids from parental screening.

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Table 1: ANOVA for combining ability

SOURCE	df	Plant Height (cm)	Number of branches per plant	Number of fruits per plant	Average Fruit Length (cm)	Average Fruit Girth (cm)	Fruit Weight (g)	Yield per plot (kg)	Incidence of Leaf Curl Disease (vulnerability Index)
gca	5	707.97**	11.30**	10111.43**	7.70**	1.99**	34.03**	257.98**	1026.52**
sca	15	266.17**	8.10**	3717.39**	7.50**	2.55**	5.83**	164.03**	171.74**
rca	15	158.48**	1.10**	1072.15**	5.55**	1.65**	0.97**	46.00**	80.27**
Error	70	3.73	0.44	33.34	0.2	0.04	0.04	0.48	4.58

***Significant at 5% level** ** **Significant at 1% level**

Table 2: Estimates of general combining ability effects of parents

TREATMENTS	Plant Height (cm)	Number of branches per plant	Fruits per plant	Average Fruit Length (cm)	Average Fruit Girth (cm)	Fruit Weight (g)	Yield per Plot (kg)	Incidence of Leaf Curl Disease (vulnerability Index)
P1	-6.10**	-1.62**	0.57	-1.08**	-0.58**	-1.44**	-3.58**	-2.74**
P2	-8.69**	0.41*	-27.87**	-0.11	0.04	-0.86**	-4.29**	13.60**
P3	3.22**	-0.51**	-17.79**	0.92**	0.24**	3.22**	4.99**	4.96**

P4	-1.95**	0.21	-13.24**	0.76**	0.61**	0.20**	-2.59**	3.87**
P5	0.57	0.27	4.22**	-0.73**	-0.1	-0.97**	-1.12**	-8.81**
P6	12.95**	1.24**	54.10**	0.24*	-0.22**	-0.15**	6.58**	-10.87**

***Significant at 5% level** ** **Significant at 1% level**

Table 3: *sca* effect of crosses for all the characters

CROSSES	Plant Height (cm)	No. of branches per Plant	Fruits per Plant	Average Fruit Length (cm)	Average Fruit Girth (cm)	Fruit Weight (g)	Yield per Plot (kg)	Incidence of Leaf Curl Disease (vulnerability Index)
P1XP2	3.91**	-0.21	27.66**	0.30	-0.37**	2.47**	8.17**	11.57**
P1XP3	-1.80	1.37**	-15.58**	-1.10**	-0.87**	-1.15**	-4.32**	13.01**
P1XP4	0.99	0.48	1.96	2.14**	0.66**	0.41**	2.93**	-6.91**
P1XP5	-5.41**	-0.24	-12.28**	-1.21**	-0.21	-0.49**	-1.81**	-1.87
P1XP6	-4.25**	-0.38	35.79**	1.30**	0.66**	-1.16**	-4.17**	-3.71*
P2XP1	6.10**	0.17	0.00	-0.43	-0.08	-1.27**	-2.65**	0.69
P2XP3	-0.58	-0.49	-4.17	2.72**	0.63**	-0.81**	-4.72**	-0.95
P2XP4	0.65	1.79**	-3.32	-1.21***	-0.06	-1.28**	-0.32	-7.10**
P2XP5	-2.97*	2.23**	28.51**	0.55	-0.48**	0.24	2.64**	-2.81*
P2XP6	3.61**	1.76**	-44.65**	-1.22**	1.98**	0.20	-5.59**	10.15**
P3XP1	2.53*	0.17	2.60	-1.93**	-0.15	0.36**	0.82	6.68**
P3XP2	-6.10**	0.33	17.94**	-0.23	-2.20**	0.48**	3.10**	-16.84**
P3XP4	-0.21	-0.63	-32.03**	-1.89**	0.69**	2.10**	-5.93**	4.32**
P3XP5	10.51**	1.31**	28.29**	-0.33	-0.78**	1.87**	7.64**	-6.25**
P3XP6	8.60**	1.01**	57.09**	1.85**	-1.04**	3.01**	24.43**	-7.52**
P4XP1	-3.12*	0.01	20.49**	1.08**	-0.32*	0.94**	-0.22	4.78**
P4XP2	-2.22	0.33	7.44*	-2.47**	1.05**	0.19	0.72	-7.55**
P4XP3	10.13**	0.01	-4.15	2.08**	1.97**	0.83**	-0.39	5.31**
P4XP5	4.76**	-0.74	-3.49	3.16**	2.06**	-0.62**	-2.73**	-1.07
P4XP6	7.24**	1.79**	82.52**	1.61**	-1.31**	-0.89**	6.07**	-11.90**
P5XP1	5.73**	-0.67	6.08	-0.10	0.33*	-0.08	0.15	3.10*
P5XP2	6.55**	-0.17	-8.63*	-0.30	-0.15	-1.38**	-3.70**	3.83**
P5XP3	-0.28	0.00	75.90**	1.82**	-0.92**	-0.02	-15.5**	8.78**
P5XP4	8.95**	1.00*	1.93	2.92**	0.57**	0.27*	0.39	-0.13
P5XP6	20.07**	0.90*	-6.38	-0.31	-0.30*	-0.01	-3.23**	10.13**
P6XP1	5.73**	1.50**	9.12*	2.62**	-0.52**	-0.36*	-0.96*	1.57
P6XP2	6.55**	1.67**	10.12*	0.00	0.62**	0.95**	2.56**	-5.53**
P6XP3	-0.28	-0.33	13.94**	0.40	-0.10	0.59**	5.89**	-5.46**
P6XP4	8.95**	-1.17*	23.25**	-2.63**	0.07	-0.55**	-4.80**	0.00
P6XP5	20.07**	0.00	20.60**	-0.48	0.70**	0.22	2.53**	1.01

***Significant at 5% level** ** **Significant at 1% level**

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