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Combining ability studies in tomato (*Lycopersicon esculentum* Mill.)

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ABSTRACT : Combining ability studies conducted using a diallel set of ten varieties of tomato (excluding reciprocal) revealed highly significant GCA and SCA effects for all characters studied. This showed that both additive and non-additive gene action were involved in the inheritance of these characters. The parental line P10 (H-29), P5 (Angoor Lata), P1 (Pusa Bahar) and P7 (Kalyanpur Tuape-1) were the best general combiners and top performing hybrid was P9XP10 (KS-16XKS-29), P7XP10 (Kalyanpur Type-1X KS-29) and P1XP9 (Pant BaharXKS-16) for most of the economic characters including yield.

KEY **W**ORDS : Combining ability, Diallel, Epistatic, Hetrosis

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Tomato is an important vegetable crop consumed by all section either as a fresh, salad, ketchup, sauce and soup or coked. The cultivars available in country today are either introduction or developed through hybridization and selection. Very limited attention has been given for improvement of this crop. Tomato being self pollinated crop offers ample scope for exploitation of hybrid vigour. Knowledge of combining ability and relative among of additive and non-additive genetic variance present in cross-combination lead to achieve successful result in hybrid breeding. Hence, the present study was undertaken to identify the best potential combiner for importance quantitative character in tomato.

RESEARCH PROCEDURE

The present investigation was carried out during *Kharif* 2008-10 at research form of Gochar Mahavidhyalaya, Rampur Maniharan, Saharanpur. The ten varieties of tomato P1(Pant Bahar), P2 (Panjab Chuhara), P3(Pusa Ruby). P4(Pusa Gaurav), P5(Azad Type-2), P6(Azad Type-3), P7(Kalanpur Type-1), P8(Angoor Lata), P9(Ks-16) and P10(Ks-29) were crossed in diallel fashion (excluding reciprocals) and their resulting 45 F_1 hybrids were evaluated along with the parents in a Randomized Block Design with three replications. Parent and F_1 were grown in single row with ten plants in each row. The row was 5m long and spaced 50 cm apart. The plant to plant spacing was maintained at 50 cm. Observation of individual plant basis were recorded on the nine quantitative characters. The combining ability analysis was carried out as per the procedure suggested by Griffing (1956a and b), (Method 2 and Model-1).

RESEARCH ANALYSIS AND REASONING

The analysis of variance for combining ability revealed highly significant mean squares both for general combining ability (GCA) and specific combining ability (SCA) for most of the characters studies. The mean squre value of GCA were higher than SCA for most of

the characters. Among the ten parental lines, the parent 10 (KS-29) has the highest significant GCA effects for days to maturity, width of fruit, biological yield per plant (Table 1). It also had appreciable GCA effects for primary braches /plant and number of fruit/ plant. GCA estimate for primary branches per plant, biological yield / plant and fruit yield / plant in line 8 (Angoor Lata). Fruit yield/ plant was positive significant GCA effect were observed for P1 (Pant Bahar), P7 (Kalyanpur Type-1), P9 (KS-16) and P10 (KS-29). Width of fruit showed significant GCA effects several parents but positive GCA was observed for P2, P3, P4, P7 and P10. Days to flowering had the highest significant GCA effects in desirable negative direction in P1, P3 and P9. On analysis of parental lines from the parents study it was observed that P10 (KS-29) gave the highest yield followed by P8 (Angoor Lata) and P1 (Pant Bahar). They also showed high GCA effects for yield and yield contributing characters. These result suggest that parental line having high general combining ability in respect of yield and its important component characters should be chosen for heterosis breeding in tomato. SCA effects was highly significant for all 9 characters observed in one or other cross combination (Table 2). Out of 45 F_1 hybrids, significant SCA effects were exhibited by 21 for days to flowering, 17 for plant height, 21 for length of fruit, 14 for width of fruit, 18 for primary branches/plant, 14 for number of fruit/plant, 33 for biological yield/plant and 25 for fruit yield/plant in a favourable direction. The three top hybrids showing the highest SCA effects in order to merit were 3x5 (Pusa Ruby x Azad T-2), 1X3 (Pant Baharx Pusa Ruby) and 1X6 (Pant Baharx Azad T-3) for days to flowering. Parent 2X3 (Panjab ChuharaxPusa Gaurav), 1X5 (Pant BaharXAzad T-2) and 3X8 (Pusa Ruby X Angoor Lata) for Day to maturity: 4X9 (Pusa GauravX KS-16), 3X6 (Pusa RubyXAzad Type-3) and 1X10 (Pant Bahar XKS-29) for plant height: 1X2 (Pant BaharXPanjab Chuhara), 3X6 (Pusa Gaurav XAzad Type-3) and 2X8 (Panjab Chuharax Angoor Lata) for length of fruits: 4X5 (Pusa GauravX Azad T-2), 5X7 (Azad T-2XKalyanpur Type-1) and 4X7 (Pusa GauravX Azad T-2) for width of fruit: 6X7 (Azad Type-3 XKalyanpur Type-1), 4X7 (Pusa GauravX Kalyanpur Type-1) and 3X9 (Pusa RubyX KS-16) for Number of primary branches/ plant: 2X5 (Panjab ChuharaX Azad T-2), 5X6 (Azad T-2X Azad Type-3) and 4X10 (Pusa GauravX Kalyanpur Type-1) for number of fruit per plant: 6X7 (Azad Type-3X Azad T-2), 9X10 (KS-16X KS-29) and 3X4 (Pusa RubyXPusa Gaurav)for biological yield per plant and 9X10 (KS-16X KS-29), 6X7 (Azad Type-3XKalyanpur Type-1) and 1X9 (Pant BaharX KS-16) for yield per plant.

HS-29, Angoo Lata, Pant Bahar and Kalyanpur Type-1 were good general combiner for fruit yield. Most of the crosses showed high SCA effects for fruit yield and associate characters. The hybrid KS-16XKS-29, Kalyanpur Type-1XKS-29 and Pant BaharXKS-16 were the tree top performing hybrid for fruit yield per plant. All these crosses showed significantly higher SCA effects for yield and several yield contributing characters. It is almost apparent that all combinations with significant SCA effects had at least one or both the parents with high GCA estimates. The parental line P10, P8, P1 and P7

Table 1: General Combining ability effects

Parents		Days to flowering	Days to maturity	Plant height	Length of fruit	Width of fruit	Primary branches/ plant	Fruit/ plant	Biological yield/ plant	Fruit yield/ plant
1.	Pant Bahar	-1.84**	-0.93**	-2.89**	0.88**	-0.89**	1.44	1.88**	10.00	3.80**
2.	Punjab Chuwara	-0.89**	-3.10**	-5.36**	0.76**	0.78**	-2.10	2.79**	-8.37	-4.01
3.	Pusa Ruby	-1.76**	-1.89**	-4.89**	0.86**	0.43**	0.33	-3.18	2.49	0.51
4.	Pusa Gaurav	-0.38*	-0.48**	-3.27**	0.65**	0.86**	-0.02	-0.99	-1.30	-0.10
5.	Azad type-2	-0.38**	-1.38**	-8.88**	-1.86**	-1.68**	-3.96	2.70**	-19.77	-9.21
6.	Azad type-3	-0.98**	-038**	4.94**	-0.58**	-0.36	-1.14	2.55**	-4.25	-2.57
7.	Kaiyanpur-type- 1	-0.35**	-0.26	-0.33	0.93**	0.85**	1.66**	-4.15	5.99**	2.39**
8.	Angoorlata	-0.36**	-1.08**	-1.86**	-0.26	-0.36**	1.88**	0.25	6.11**	4.40**
9.	KS-16	-1.53**	-1.36	3.78**	-0.58**	-0.28**	0.14	-4.08	-2.15	-1.44
10.	KS-29	-0.45**	1.49**	1.83**	0.43**	1.73**	1.77**	2.14**	11.97**	6.27**
	S.E.±	0.16	0.26	-0.33	0.13	0.18	0.05	0.17	1.40	0.32

** indicates significance of value at P=0.01

Table 2 : Specific combining ability effects

Parents	Days to flowering	Days to maturity	Plant height	Length of fruit	Width of fruit	Primary branches/ plant	Fruit/ plant	Biological yield/ plant	Fruit yield/ plant
Pant Bahar									
X Punjab Chuwara	8.28**	2.12**	-5.55**	6.50**	0.72	-2.17**	-8.50**	-18.99**	-3.57**
X Pusa Ruby	-4.88**	6.89**	-4.88**	-0.40	-2.78**	-0.55	-4.10**	12.75**	8.18**
X Pusa Gaurav	-3.78**	-0.43	4.00**	-7.72**	-0.44	-0.12	0.40	-1.90**	-9.35**
X Azad Type-2	6.88**	-8.66**	-16.08**	-5.77**	-1.83**	-2.40**	-0.60	-9.62**	-7.66**
X Azad Type-3	-4.86**	-5.82**	6.25**	2.90**	2.70**	0.18	3.87**	14.22**	-12.58**
X Kaiyanpur-type- 1	3.83**	3.80**	3.50**	1.50**	0.72	-2.17**	-8.50**	-18.99**	5.22**
X Angoorlata	2.81**	2.45**	-8.01**	4.60**	-2.78**	-0.55	-4.10**	12.75**	1.60**
X KS-16	-4.87**	4.66**	3.37**	3.67**	-0.44	-0.12	0.40	-1.90**	14.67**
X KS-29	2.58**	3.66**	9.40**	1.15**	-1.83**	-2.40**	-0.60	-9.62**	3.72**
Punjab Chuwara									
X Pusa Ruby	5.43**	-3.88**	-0.60	-2.89**	3.70**	3.44**	0.46	35.50**	-1.50**
X Pusa Gaurav	-4.88**	-12.73**	3.76**	-2.00**	-2.55*	1.33**	-3.67**	-0.30	-5.38**
X Azad Type-2	-3.96**	2.67**	-4.55**	1.70**	1.65**	0.33	7.66**	21.25**	-0.77
X Azad Type-3	-3.93**	0.73	-8.67**	0.12	2.70**	0.18	2.00**	7.77**	1.86**
X Kaiyanpur-type- 1	3.20**	-3.77**	2.77**	-2.79**	0.72	-2.17**	-3.90**	17,15**	-4.76**
X Angoorlata	-3.63**	4.69**	-16.00**	4.70**	-2.78**	-0.55	3.01*	7.00**	-10.75**
X KS-16	-0.69	4.39**	3.70**	4.40**	-0.44	-0.12	3.40**	10.15**	4.95**
X KS-29	-3.78**	-3.49**	4.88**	-2.50**	-1.83**	-2.40**	-8.55**	1.69**	-4.77**
Pusa Ruby									
X Pusa Gaurav	3.43**	-4.95**	-12.15**	-4.99**	-2.40**	2.40**	0.22	25.00**	10.22**
X Azad Type-2	-9.37**	3.82**	-343**	3.77**	3.66**	1.15**	2.00**	7.77**	-1.44**
X Azad Type-3	2.70**	5.74**	19.00**	5.15**	0.40	1.75**	-3.90**	17,15**	0.06
X Kaiyanpur-type- 1	-2.47**	0.96	1.40**	0.97	2.40**	1.18**	3.01*	7.00**	2.71**
X Angoorlata	3.88**	-6.78**	-2.00**	-6.15**	3.55**	1.59**	3.40**	10.15**	9.99**
X KS-16	3.33**	4.35**	4.76**	4.36**	-0.81	2.00**	-8.55**	1.69**	-3.00**
X KS-29	2.26**	3.37**	-5.13**	2.40**	-0.82	0.92	3.00**	21.31**	3.50**
Pusa Gaurav									
X Azad Type-2	-7.00**	5.56**	0.10	1.40**	5.55**	2.00**	1.72**	5.40**	6.40**
X Azad Type-3	-0.07	6.02**	-6.99**	2.17**	-6.42**	404**	-4.14**	2.00**	1.74**
X Kaiyanpur-type- 1	-1.55**	5.35**	16.00**	-1.55**	1.57**	1.66**	0.44	15.00**	5.25**
X Angoorlata	-1.65**	2.70**	-0.55	-0.05	4.39**	0.44	0.33	11.02**	2.37**
X KS-16	-1.64**	0.91	24.01**	1.66**	-1.42**	1.88**	-7.21**	3.00**	-1.48**
X KS-29	4.77**	5.55**	-2.01**	2.15**	0.55	2.55**	5.59**	12.08**	11.55**
Azad Type-2									
X Azad Type-3	5.11**	-5.74**	-15.05**	-0.22	4.75**	0.31	6.00**	10.22**	4.45**
X Kaiyanpur-type- 1	6.23**	-3.87**	0.33	0.05	0.02	-3.33**	-6.35**	-15.25**	-7.70**
X Angoorlata	4.88**	1.05**	4.55**	0.06	-0.57	-0.90	-3.32**	4.04**	2.02**
X KS-16	5.55**	1.25**	-6.25**	0.02	-0.37	0.05	-0.50	4.70**	0.07
X KS-29	2.35**	5.99**	-20.00**	-2.15**	-1.74**	-1.15**	2.00**	-5.75**	-4.62**

Table 2 : Contd……..

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Azad Type-3									
X Kaiyanpur-type- 1	5.77**	3.87**	-3.20**	-3.44**	-1.55**	5.50**	5.25**	37.11**	15.15**
X Angoorlata	5.88**	3.00**	18.08**	-1.25**	-4.70**	2.15**	-2.66**	-1.61**	0.15
X KS-16	-2.85**	-2.31**	-16.50**	-0.08	2.70**	-2.90**	-6.51**	-20.51**	-6.77**
X KS-29	-3.99**	-3.44**	-10.00**	-1.19**	-1.25**	-5.70**	-4.00**	-33.12**	-15.00**
Kaiyanpur-type- 1									
X Angoorlata	-4.86**	4.06**	-6.50**	0.72	2.95**	3.22**	-2.13**	14.15**	8.07**
X KS-16	-4.44**	3.05**	-6.50**	2.72**	0.50	0.88	-1.18**	1.75**	0.78**
X KS-29	-15.5**	1.15**	-1.40**	3.77**	2.16**	3.00**	5.55**	30.55**	12.23**
Angoorlata									
X KS-16	0.76	-1.56**	-6.05**	-1.00**	-4.40**	5.50**	-1.35**	15.22**	4.46**
X KS-29	2.15**	-2.44**	5.00**	1.66**	-2.00**	3.23**	0.44	11.00**	7.11**
KS-16 x KS-29	1.85**	0.07	7.72**	1.88**	1.22**	5.70**	3.90**	36.80**	17.12**
S.E.±	-1.22	0.69	0.77	0.46	0.46	0.24	0.60	4.83	1.13

* and ** indicate significance of values at P=0.05 and 0.01, respectively

had high GCA effects for several yield and yield contributing characters. Similar results have been reported by Ahamad and Sharma (1989); Chandrakar and Mishra (1994); Chaturvedi and Gupta (1955); Mishra *et al*. (1995); Reddy *et al*. (1996); Khan *et al*. (2005); Malik and Bhatanagar (2006) observed significant GCA and SCA variation for all the economic character including yield. They suggested both additive and non-additive gene action were involved in the inheritance of these charecters. In the present investigation all GCA and SCA effects were highly significant for all 9 character studied. Hence, for improvement of these characters, both selection and hererosis breeding can be resorted to. The response to selection is expected to be the best in crosses involving parent having high GCA effects. The selected parental line having better performance can then be crossed in the suitable combinations. The crosses which showed high specific combining ability can be utilized in heterosis breeding.

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