

Combining Ability Studies for Yield and Yield Related Traits in Tomato (*Solanum lycopersicum* L.)

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Abstract The combining ability analysis involving 8 lines and three testers was carried out for 13 characters for yield and its related traits in $1 \times t$ design. The variance due to GCA and SCA showed that additive gene action was predominant for yield and its related traits, though the non additive component was also significant for some characters. Among the parents Bony Best, Black Prince and UK Local-2 were good general combiners for yield and its related traits. The crosses Podlandt Pink \times Sioux and Tommy Toe UK Local-2 were good specific combiners for yield and its related traits.

Keywords Tomato, General combining ability, Specific combining ability, Yield, $1 \times t$ analysis.

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most popular warm season fruit vegetable crop grown throughout the world because of its wider adaptability, high yielding potential. It is a member of Solanaceae family with $2n = 24$ and native to Peru Ecuador region. It is a typical day neutral plant and self-pollinated crop, but certain percentage of cross pollination also occurs. In any breeding program, the proper choice of parents based on their combining ability is prerequisite. Such studies not only provide necessary information regarding choice of parents but also simultaneously illustrate the nature and magnitude of gene action involve in expression of desirable traits. The present investigation was undertaken to identify parental combination that are likely produce superior hybrids having good yield and quality.

Materials and Methods

The material consists of eight lines (Tommy Toe, AR-4, AR-29, Black Prince, Bony Best, Podlandt Pink, AR-28 and AR-56) were crossed with three testers (UK Local-2, Sioux and Pant T-3) with a mating design of line \times tester. The resulting 24 hybrids and 11 parents along with check (Arka Samrat) were evaluated in randomized block design with two replications during *rabi* of 2015-16. Observations were recorded on five randomly selected plants statistical analysis was carried out using the model of line \times tester developed by Kempthorne [1].

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Table 1. Analysis of variance for yield and yield related traits in tomato.

Source	Repli- cations	Mean sum or squares					Error	σ GCA ²	σ SCA ²	σ SCA ²
		Hybrids	Lines	Testers	Line \times tester					
Degrees of freedom	1	23	7	2	14	23				
Plant height	0.12	2412.12**	4755.39**	4026.30**	1009.78**	18.05	795.40	496.83	1.60	
Number of primary branches	20.28**	4.79**	2.08	3.03	4.04**	0.67	0.32	1.64	0.19	
Number of fruits per cluster	4.08**	0.89*	0.85	0.49	0.97*	0.39	0.06	0.32	0.19	
Number of fruits per plant	8.41	69.30**	43.86	366.20**	39.61**	6.45	35.16	13.99	2.51	
Average fruit weight	4.94**	219.36**	245.32	594.31**	152.81**	0.48	76.18	76.03	1.00	
Yield per plant	0.007	0.67**	0.65	2.36*	0.44	0.04	0.26	0.20	1.30	

Results and Discussion

The analysis of variance along with GCA and SCA variance and their ratios for different traits is presented in Table 1. The analysis of variance for combining ability revealed that the lines differed significantly for character plant height and the testers showed significant difference for plant height, num-

ber of fruits per plant, average fruit weight and fruit yield per plant. Significant differences were observed among the crosses for all the characters, indicating contribution of both additive and non-additive gene effect to total genetic variation. The variance due to general combining ability (GCA) was greater than specific combining ability (SCA) for all the yield and its related traits indicating the predominance of additive gene action. Similar results were found by Rai et al.

Table 2. Estimation of general combining ability of parents. *and **indicates significance at 5% and 1% level respectively.

Characters	Plant height	Number of primary branches	Number of fruits per cluster	Number of fruits per plant	Average fruit weight	Yield per plant
Lines/Female						
Tommy Toe	42.19**	1.20**	0.10	0.92	-9.10**	-0.37**
AR-4	-16.87**	-0.23	0.20	-0.80	-0.73	-0.09
AR-29	-38.14**	0.00	0.16	-1.60	6.02**	0.21*
Black Prince	33.89**	0.26	0.56*	5.01	5.02**	0.36**
Bony Best	16.92**	-0.20	-0.03	1.49	8.99**	0.52**
Podlandt pink	-5.27**	-0.83*	-0.23	-0.04	-6.00**	-0.14
AR-56	-20.42**	-0.33	-0.03	-4.40**	0.66	-0.20*
AR-28	-12.47**	0.13	-0.73**	-0.57	-4.87**	-0.29**
SEm \pm	1.63	0.35	0.23	1.39	0.36	0.08
CD 5%	3.39	0.73	0.47	2.87	0.75	0.17
CD 1%	4.60	0.99	0.65	3.90	1.03	0.24
Testers/Males						
UK Local-2	14.35**	0.47*	0.19	5.50**	3.09**	0.31**
Sioux	2.67*	-0.37*	-0.05	-2.32*	3.92**	0.10
Pant T-3	-17.02**	-0.10	-0.14	-3.17**	-7.02**	-0.42**
SEm \pm	1.00	0.21	0.14	0.85	0.22	0.05
CD 5%	2.07	0.44	0.29	1.76	0.46	0.10
CD 1%	2.81	0.61	0.39	2.39	0.63	0.14

Table 3. *Per se* performance of parents for different yield characters.

Parents	Plant height (cm)	Number of primary branches	Fruits per cluster	Number of fruits per plant	Average fruit weight (g)	Yield per plant (kg)
Tommy Toe	60.90	7.70	5.80	41.60	26.00	1.15
AR-4	91.30	8.20	4.60	39.20	65.60	2.51
AR-29	70.50	8.10	5.30	33.80	47.90	1.64
Black Prince	56.50	8.20	5.50	30.60	16.60	0.49
Bony Best	64.50	12.50	6.60	32.60	35.30	0.91
Podlandt Pink	69.80	7.30	5.10	42.80	19.50	0.65
AR-56	85.70	7.60	6.70	31.40	40.40	1.65
AR-28	71.40	7.90	5.60	44.80	17.30	0.76
Testers/Males						
UK local-2	120.30	11.50	5.30	36.40	61.95	2.27
Sioux	84.00	7.30	4.90	38.30	65.15	2.49
Pant T-3	62.80	8.70	5.20	39.20	43.20	1.52
Commercial check						
Arka Samrat	92.70	8.20	5.40	43.00	66.90	2.52

[2], Asati et al. [3] and Yashvantakumar [4] for all traits in tomato.

The general combining ability and *per se* value of parents is presented in Tables 2 and 3. Among the parents Bony Best, Black Prince and UK Local-2 exhibited the significant positive *gca* effect in desirable direction for most of yield and yield related traits. The line, Bony Best was good general combiner for yield per plant (0.52) and average fruit weight (8.99). This line has the highest number of primary branches (12.50) and good number of fruits per cluster (6.60). Black Prince was also good general combiner for yield per plants (0.36), number of fruits per plant (5.01) and average fruit weight (5.02). Among the testers UK Local-2 was good general combiner for yield per plant (0.31), number of fruits per plant (5.50), and average fruit weight (3.09). This parent has the highest plant height (120.30 cm), number of primary branches (11.50) and number of fruit clusters (5.30) and also having good yield per plant (2.27 kg). The *GCA* to *SCA* ratio is more than unity for number of fruits per plant and average fruit weight expressed the role of non-additive gene action (Table 1). The results are in confirmation with the findings of Mahendrakar [5], Singh et al. [6] and Marbhal et al. [7].

The specific combining ability of crosses for different traits is presented in Table 4. The hybrids Podlandt Pink \times Sioux (0.74), AR-29 \times Sioux (0.62) and Tommy Toe \times UK Local-2 (0.47) showed significant positive *SCA* effect for yield. This might be due to AR-29 and UK Local-2 was found to be good general combiner for yield (Table 2). The *GCA* to *SCA* ratio was more than unity indicating the preponderance of additive gene action for yield (Table 1). These results are in accordance of Kavitha et al. [8] and Singh et al. [9].

With respect to plant height the cross Tommy Toe \times UK local-2 (21.50) exhibited significant positive *sca* effect. It might be due to the male parent was positive combiner with respect to plant height Sekhar et al. [10] (Table 2). The cross Podlandt Pink \times Sioux had recorded significant *sca* effect for number of fruits per plant and average fruit weight. Among these three hybrids, none of the hybrid showed significant positive heterosis for number of primary branches and number of fruits per cluster.

Thus the present investigation revealed that Tommy Toe, AR-4, AR-29, Black Prince, Bony Best, Podlandt Pink, AR-28 and AR-56 were crossed with three testers UK Local-2, Sioux and Pant T-3. Among

Table 4. Estimation of specific combining ability of crosses. * and ** indicates significance at 5% and 1% level respectively.

Characters	Plant height	Number of primary branches	Number of fruits per cluster	Number of fruits per plant	Average fruit weight	Yield per plant
Tommy Toe × UK Local-2	21.50**	1.18	0.23	2.59	8.04**	0.47**
Tommy Toe × Sioux	30.19**	-1.56*	0.08	0.42	-9.59**	-0.47**
Tommy Toe × Pant T-3	-51.70**	0.37	-0.32	-3.02	1.55*	0.00
AR-4 × UK Local-2	-9.52**	-1.57*	0.33	-0.26	0.77	0.04
AR-4 × Sioux	-6.03**	2.57**	0.58	-4.44	-5.56**	-0.40*
AR-4 × Pant T-3	15.56**	-0.99	-0.92*	4.71	4.78**	0.35*
AR-29 × UK Local-2	-10.15**	0.58	-0.42	-0.76	-1.69*	-0.12
AR-29 × Sioux	-9.77**	0.33	0.72	4.15	9.87**	0.62**
AR-29 × Pant T-3	19.29**	-0.92	-0.29	-3.38	-8.17**	-0.49**
Black Prince × UK Local-2	25.30**	1.22	-0.02	4.41	-6.69**	0.00
Black Prince × Sioux	-21.80**	-1.52*	-0.17	-4.06	2.77**	-0.17
Black Prince × Pant T-3	-3.50	0.30	0.20	-0.35	3.92**	0.17
Bony Best × UK Local-2	0.67	0.58	0.77	5.23**	-1.25	0.13
Bony Best × Sioux	-3.93	-1.06	-0.27	-5.04**	8.01**	0.29
Bony Best × Pant T-3	3.26	0.47	-0.49	-0.18	-6.84**	-0.42**
Podlandt Pink × UK Local-2	-9.42**	-0.77	-0.02	-5.23*	-5.95**	-0.60**
Podlandt Pink × .Sioux	5.06	0.77	0.12	5.69*	11.90**	0.74**
Podlandt Pink × Pant T-3	4.36	0.00	0.09	-0.45	-5.94**	-0.14
AR-56 × UK Local-2	-19.15**	-0.17	-0.92*	-2.46	7.67**	0.23
AR-56 × Sioux	15.32**	1.07	-0.17	-0.44	-9.66**	-0.38*
AR-56 × Pant T-3	3.82	-0.89	1.10*	2.91	1.98**	0.14
AR-28 × UK Local-2	0.77	-1.04	0.07	-3.50	-0.89	-0.16
AR-28 × Sioux	-9.03**	-0.59	-0.87*	3.72	-7.82**	-0.21
AR-28 × Pant T-3	8.26**	1.64*	0.80	-0.22	8.72**	0.38*
SEM ±	2.83	0.61	0.40	2.41	0.63	0.14
CD 5%	5.87	1.27	0.83	4.98	1.31	0.30

these Bony Best, Black Prince, AR-29 and UK Local-2 were good general combiner for yield and yield related traits. The cross Podlandt Pink × Sioux and Tommy Toe × UK Local-2 were good specific combiners. Thus these hybrids are promising for yield and yield related traits and should be evaluated in the farmer's field on large scale to know the stability of yield characters before going for commercialization.

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