

Original Research Article

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## Combining Ability and Variance Components for Yield and Quality Traits in Tomato (*Solanum lycopersicum* L.)

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### ABSTRACT

#### Keywords

Combining ability,  
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Ten single cross hybrids of diverse origin of tomato were crossed in a 10 x 10 diallel mating design excluding reciprocals. The 45 double cross hybrids along with their parents were evaluated in the field at COH, Mudigere following RCBD design with two replications. In the present study, significant and highest general combining ability effect for average fruit weight and number of fruits per plant was recorded in SCH-9(1.611 and 3.404 respectively), for yield per plant in SCH-9(0.152), number of locules per fruit lowest and desirable direction in SCH-10(-0.268), for pericarp thickness in SCH-5 (0.047) and for total soluble solids in SCH-1(0.694). Genetic components for GCA, SCA and GCA to SCA ratio were highest in number of fruits per plant and average fruit weight. Analysis of variance was highly significant for average fruit weight (gm), number of fruits per plant, fruit yield per plant (kg), number of locules per fruit, pericarp thickness (mm) and total soluble solids (TSS). Variance due to parents versus hybrids was highly significant for average fruit weight (gm), number of fruits per plant, fruit yield per plant (kg) and number of locules per fruit.

### Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most widely grown and the most popular vegetable crops in the world. It belongs to family *Solanaceae* with chromosome number of  $2n = 24$ . Primary centre of origin is South American region consisting of Peru, Bolivia Ecuador (11) and it is presumed to have been

brought to India during the second half of the 16<sup>th</sup> century through far eastern countries. Tomato ranks second in production after potato and in India it is being grown in an area of 8.79 lakh hectares with the annual production of 18.22 lakh tons with a productivity of 20.7 tons per hectare. It occupies 3<sup>rd</sup> position in area, 2<sup>nd</sup> in production and 3<sup>rd</sup> in productivity among the vegetables

grown in India. In Karnataka, it occupies an area of 57.8 thousand hectares with annual production of 1916.60 tons with productivity of 33.14 tons per hectare (2).

Combining ability studies are more reliable as they provide useful information for the selection of parents in terms of performance of the hybrids and elucidate the nature and magnitude of various types of gene actions involved in the expression of quantitative traits (8).

Use of  $F_1$  hybrids is the quickest way of combining the desired traits into one genotype, besides the added advantages of heterotic yields. Since the progress in breeding for economic characters depends upon the nature, extent and magnitude of genetic population.

Theoretically the double crosses provide an opportunity for recombination among genes from four parents creating large genetic variability and improvement of populations through favourable gene combinations and associations of desired traits. Considering this, the present investigation was undertaken to generate information on combining ability in ten parental single cross hybrids (SCH) of tomato to assess the prepotency of parents in hybrid combination.

### **Materials and Methods**

Forty five double cross hybrids of tomato developed by 10 x 10 diallell mating design using 10 single cross hybrids were evaluated in an Randomized Complete Block Design (RCBD) at the experimental plot in the Department of Crop Improvement and Biotechnology, College of Horticulture, Mudigere, Chickmagalore District, Karnataka. The spacing given was 90X45 centimeter. The experiment consisting of three rows with each row having ten plants and all together with

thirty plants and two varieties i.e., ArkaVikas and Punjab PKM-1 which are used as checks are planted. Observations were recorded for average fruit weight (gm), number of fruits per plant, yield per plant(kg), number of locules per fruit, pericarp thickness and Total soluble solids (T.S.S. in °brix) was estimated by using hand refractometer and dry matter content (%) by hot air oven drying. combining ability as suggested by Griffing (6) and genetic parameters by Hayman (7).

### **Results and Discussion**

#### **General combining ability (gca) effects**

The gca effects for this trait varied from -1.89 (SCH-3) to 1.61 (SCH-9). Among 10 parents, four parents SCH-9 (1.61), SCH-8 (1.52) and SCH-10 (1.47) were good combiner in desirable direction. None of other parents were contributing towards good combination of all characters (9 and 10). Similar results were obtained in case of Patil (2003) and Mallangoud (2005).

The gca effects in number of fruits per plant ranged from - 2.91 (SCH-2) to 3.40 (SCH-9). 3 parents viz. SCH-9 (3.40), SCH-8 (2.21) and SCH-10 (1.42) showed significant positive gca values for the trait and 3 parents exhibited negative gca effects viz. SCH-2 (- 2.91), SCH-5 (-2.24) and SCH-3(-1.41). Indicated that SCH-9, SCH-8 and SCH-10 were excellent good combiner.

The gca effects in parents for yield per plant ranged from -0.103 (SCH-1) to 0.152 (SCH-9). 3 parents viz. SCH-9 (0.152), SCH-8(0.097) and SCH10 (0.083) showed significant positive gca values for the trait and 4 parents exhibited negative gca effects viz. SCH-1 (-0.103), SCH-2 (-0.084), SCH-4(-0.073) and SCH-5 (-0.051). Indicated that SCH-9, SCH-8 and SCH-10 were good combiner in desirable direction (10 and 9).

Similar results were obtained in case of Patil (2003) and Mallangoud (2005).

The range for *gca* effects for locules per fruit in parents ranged from -0.26 (SCH-10) to 0.32 (SCH-6). six parents exhibited significant *gca* values, among which three parents SCH-6 (0.32), SCH-9 (0.17) and SCH-2 (0.07) showed significant positive *gca* effects for the trait and SCH-10 (-0.26), SCH-8 (-0.19) and SCH-1 (-0.09) showed significant negative values. Indicated that SCH-6, SCH-9 and SCH-2 were good combiners in desirable direction.

The *gca* effects for pericarp thickness ranged from -0.037 (SCH-1) to 0.04 (SCH-5). Among ten parents, SCH-5 (0.04) and SCH-9(0.02) showed significant positive contributor for this character, other parents displayed significant negative *gca* effect SCH-1 (-0.037), SCH-2 (-0.034) and SCH-7(-0.020). It can be conclude that SCH-5 and SCH-9 was good combiner in desirable direction to increase pericarp thickness which decides keeping quality of fruits.

For the quality parameter TSS, only 2 parents did not showed significant *gca* effect whereas rest of the 8 parents exhibited significant *gca* effect. The parent with highest positive *gca* value was SCH-1 (0.69) followed by SCH-4 (0.46) SCH-6 (0.29).

In case of negative direction the range of *gca* effect was distributed from -0.36 (SCH-9) followed by -0.33(SCH-5), -0.26(SCH-3),-0.20 SCH-7 and SCH-8.Rest of parents exhibited negative *gca* effects but not at significant level. From these results it can be conclude that SCH-1, SCH-4 and SCH-6 were good combiners (4, 5, 9 and 10) table 1. Similar results were obtained in case of Dundi (1991), Dharmatii (1995), Patil (2003) and Mallangoud (2005).

### **Analysis of variance for combining ability**

Variance due to parents was highly significant for average fruit weight (gm), number of fruits per plant, fruit yield per plant (kg), number of locules per fruit, pericarp thickness (mm) and total soluble solids (TSS) (Table 2).

Variance due to parents versus hybrids was highly significant for average fruit weight (gm), number of fruits per plant, fruit yield per plant (kg) and number of locules per fruit.

The ultimate choice of parents to be used in a breeding programme is determined by per se performance and their behavior in hybrid combination. Some ideas on the usefulness of the parents may be obtained from their individual performance, particularly in respect of yield components.

### **Estimation of variance components**

The average fruit weight was showed non-additive effects was predominant with higher SCA variance (10 and 14). These findings were in accordance with the study of Patil (2003) and sekhar *et al.*, (2010).

In case of number of fruits per plant, the  $\sigma^2GCA/\sigma^2SCA$  ratio less than 1 (0.098) which indicated non-additive gene action may be either dominance or epistasis interaction is involved in controlling that characters (12, 14, 15 and 19). These results were in accordance with study of earlier workers Sharma *et al.*, (2006), Saeed Ahmed *et al.*, (2008), Virupannavar (2009), Singh and Mishra (2010) and sekhar *et al.*, (2010).

In case of fruit yield per plant, the  $\sigma^2GCA/\sigma^2SCA$  ratio was 0.228 hence it revealed that for this trait non-additive effects and higher SCA variance was important (10, 11, 13 and 16).

**Table.1** General combining ability (GCA) effects for different traits in tomato

Hybrids	Average fruit weight	No. of fruits per plant	Yield per plant	No. of locules per fruit	Pericarp thickness (mm)	TSS (°brix)
SCH-1	-0.109	-0.954	-0.103 **	-0.090 **	-0.037 **	0.694 **
SCH-2	-1.703 **	-2.918 **	-0.084 **	0.071 **	-0.034 **	-0.083
SCH-3	-1.892 **	-1.410 *	-0.034	-0.009	-0.006	-0.261 **
SCH-4	-1.034 **	0.909	-0.073 **	-0.012	0.005	0.464 **
SCH-5	-0.423	-2.441 **	-0.051 *	-0.012	0.047 **	-0.339 **
SCH-6	-0.373	-0.557	0.005	0.321 **	0.008	0.297 **
SCH-7	0.922 *	0.337	0.008	0.027	-0.020 *	-0.203 **
SCH-8	1.527 **	2.201 **	0.097 **	-0.198 **	0.005	-0.206 **
SCH-9	1.611 **	3.404 **	0.152 **	0.171 **	0.027 **	-0.369 **
SCH-10	1.474 **	1.429 *	0.083 **	-0.268 **	0.005	0.006
SE m+		0.578		0.019	0.008	0.061
CD@5%	0.807	1.309	0.052	0.044	0.019	0.139
CD@1%	1.159	1.880	0.075	0.064	0.027	0.200

**Table.2** Analysis of variance for combining ability

Source of Variation	Degree of freedom	No. of flowers per cluster	No. of fruits per clusters	Average fruit weight	No. of fruits per plant	Yield per plant(kg)	No. of locules per fruit	Pericarp thickness (mm)	TSS (°brix)
Replication	1	0.036	0.35*	29.17**	28.35	0.052*	0.64**	0.012*	0.092
Parents	9	0.98**	1.52**	39.79**	126.28 **	0.10**	2.11**	0.025**	5.57**
Hybrids	44	0.94**	1.03**	18.24**	124.99 **	0.14**	2.24**	0.013**	2.02**
Parents Vs Hybrids	1	0.08	0.03	73.58**	447.14 **	0.056**	0.58**	0.002	0.38
Error	54	0.12	0.09	5.09	13.38	0.02	0.015	0.002	0.15

**Table.3** Estimate of variance components

Sl. No	Source	$\sigma^2$ GCA	$\sigma^2$ SCA	$\sigma^2$ GCA / $\sigma^2$ SCA
1.	Plant height at 30 days (cm)	2.666	13.868	0.192
2.	Plant height at 60 days (cm)	4.617	27.113	0.170
3.	Plant height at 90 days (cm)	1.519	15.112	0.1005
4.	No. of primary branches	0.025	0.116	0.215
5.	No. of secondary branches	0.188	0.739	0.254
6.	Days to first flowering	0.300	7.903	0.037
7.	Days to 50% flowering	1.050	7.896	0.132
8.	No. of clusters per plant	0.113	0.903	0.125
9.	No. of flowers per cluster	0.013	0.295	0.044
10.	No. of fruits per clusters	0.079	0.209	0.377
11.	Average fruit weight	1.617	3.224	0.501
12.	No. of fruits per plant	3.750	38.115	0.098
13.	Yield per plant(gm)	0.0067	0.0293	0.228
14.	No. of locules per fruit	0.0282	0.804	0.035
15.	Pericarp thickness (mm)	0.0005	0.0035	0.142
16.	TSS ( $^{\circ}$ brix)	0.128	0.664	0.192

These results were in close proximity with the findings of Patil (2003), Premalakshmi *et al.*, (2006), Saeed Ahmed *et al.*, (2008) and sekhar *et al.*, (2010).

For number of locules per fruit, the ratio of  $\sigma^2$ GCA/ $\sigma^2$ SCA (0.035) revealed non- additive effects (16). These results were in close proximity with sekhar *et al.*, (2010).

For pericarp thickness,  $\sigma^2$ GCA/ $\sigma^2$ SCA ratio was 0.142 indicating the importance of non-additive effects and SCA variance (1, 10, 13 and 16). These findings were similar to the findings of Patil (2003), Saeed Ahmed *et al.*, (2008), Sekhar *et al.*, (2010) and Akshay (2011).

In case of total soluble solids, the ratio was 0.192 hence SCA variance was greater than GCA variance suggesting predominance of non- additive effect (3, 10, 14, 16, 18, and 19) table 3. These findings are in close proximity with the results of Sajjan (2001), Kulkarni (2003), Patil (2003), Ashwini (2005), Virupannavar (2009) and Shekar *et al.*,

(2010).

With respect to yield per plant, the top three performing single cross hybrids SCH-9, SCH-10 and SCH-8 have high gca effects. They are best and suitable for hill zone of Karnataka.

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