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ANALYSIS OF COMBINING ABILITY TO RECOGNIZE SUPERIOR F_1 HYBRIDS IN TOMATO (*LYCOPERSICUM ESCULENTUM* L.) FOR YIELD AND ITS CONTRIBUTING TRAITS

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ABSTRACT
A study was conducted on 8×8 diallel set of tomato excluding reciprocals to find out the combining ability for yield and its contributing traits. The magnitudes of variance due to general as well as specific combining ability were highly significant. Among parents, Arka Alok and Arka Meghali were found positive significant good general combiner for yield and some of the yield related traits studied. The hybrids *viz*. Pant T-3 x H-24 (1.052), Arka Meghali x Punjab Chhuhara (0.768), H-88-78-1 x Azad T-5 (0.768), Punjab Chhuhara x H-88-78-1 (0.677), Punjab Chhuhara x Azad T-5 (0.671) had significant SCA effects for yield and were suggested for the exploitation of heterosis.

INTRODUCTION

Tomato (*Lycopersicum esculentum* L.) is one of the most important vegetable crops grown throughout the world because of its wider adaptability, high yielding potential and suitability for variety of uses in fresh as well as processed food industries (Meena and Bahadur, 2014). Efforts are being made to increase its productivity by developing superior varieties. Plant breeders have extensively explored and utilized heterosis to boost yield levels in several cross-pollinated crops in the recent past. It belongs to the large and diverse *Solanaceae* family also called Nightshades which includes more than three thousand species (Kumar and Singh, 2016).

Identification and selection of flexible parental lines are required to be used in any hybridisation programme to produce genetically modified and potentially rewarding germplasm by assembling fixable gene effects more or less in a homozygous line. Information pertaining to different types of gene action, relative magnitude of genetic variance, and combining ability estimates are important and vital parameters to mould the genetic makeup of tomato crop. This important information could prove an essential strategy to tomato breeders in the screening of better parental combinations for further enhancement (Pedapati *et al.,* 2013). Exploitation of heterosis is primarily dependent on the screening and selection of available germplasm that could be produced by better combinations of important agronomic characters (Hannan *et al.*, 2007). Although many commercial cultivars have high agronomic performances, they perform poorly because of some genetic hindrances in diverse cross combinations. Thus crossing in a diallel fashion is the only specific and flourishing approach of measurement for the identification and selection of superior genetically recombined material. Information about magnitude of general combining ability (GCA) in parents and specific combining ability (SCA) in F_1's crosses is imperative for crop improvement programmes (Sprague and Tatum, 1942). GCA reveals the existence of additive gene effects while SCA reveals non-additive gene effects. Information about GCA effects are beneficial while choosing best combiner parents and SCA effects information reveal best cross combinations for further judgement. Judicious application of information relevant to standard heterosis and SCA are fruitful for selecting best hybrids for desired traits. Considering this, the present investigation was undertaken to generate information on nature of combining ability in eight parental lines of tomato to assess the pre-potency of parents in hybrid combination develop by diallel matting design.

MATERIALS AND METHODS

The present study was conducted at Horticulture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (U.P.), India during *Rabi* season of 2012 and 2013. The soil of experimental field was alluvial type of soil with average fertility level and pH in the range of 6.6 to 7.4. The experimental materials was procured from Indian Institute of Vegetable Research, Varanasi (India) followed by selfing for maintenance. Eight genetically diverse lines (Arka

Meghali, Pant T-3, Punjab Chhuhara, H-88-78-1, Arka Alok, Azad T-5, H-24 (Hisar Anmol), Sel-7 (Hisar Arun)) were crossed in diallel mating design during *rabi* 2012. The resultant 28 F_1's were evaluated along with their parents was during *rabi* 2013 in randomized block design which was replicated thrice. Each entry was grown in one row of 10 plants in each by adopting inter row spacing of 60 cm and intra row spacing of 45 cm. The observations were recorded on five randomly selected plants for *viz*., number of flowers per cluster, days to first harvest, fruit diameter (cm), fruit length (cm), average fruit weight (g), number of fruit per plant, plant height at final harvest (cm), number of seeds per fruit and fruit yield per plant (kg/ plant).

Combining ability analysis was carried out according to Singh and Chaudhary (1979) based on Griffing's (1956) fixed effect model using the following formula:

$X_{ijk} = \mu + g_i + g_j + S_{ij} + e_{ijk}$

Where, μ = General mean, g_i = gca effect of i^{th} line, i = 1, 2,..... i (Number of lines), g_j = gca effect of j^{th} tester, j = 1, 2,..... j (Number of testers), S_{ij} = sca effect of the ij^{th} combination, e_{ijk} = Error associated with the observation, k = 1, 2,..... r (Number of replications).

RESULTS AND DISCUSSION

Analysis of variance (Table 1) for combining ability revealed that the variance due to genotypes effect was highly significant (@P d" 0.01) for all characters. Significant mean squares for GCA and SCA indicated joint role of additive, non-additive and maternal effects for the expression of all traits. The predictability ratio of GCA/SCA variance was less than 1 for number of flowers per cluster, days to first harvest, number of seeds per fruit and fruit yield per plant showing preponderance of non-additive gene effects while it was more than 1 for fruit diameter, fruit length, average fruit weight, number of fruit per plant and plant height indicating predominance of additive gene effect.

Mean sum of square due to parent were highly significant for all traits indicating genetic diversity among the parent (GCA) except number of flowers per cluster and days to first harvest, thus highest contribution by these characters towards combining ability. Whereas, variance due to hybrids (SCA) were also highly significant for all the characters and suggested manifestation of parental genetic variability in their crosses or possibility of better selection of cross combinations among 28 F_1 hybrids for these traits. The details of combining ability analysis of 8 parents and their 28 crosses are being furnished as under.

Number of flowers per cluster

Among 8 parents (Table 2) none of the parents recorded significance gca effects, 13 cross hybrids (Table 3) recorded significant sca effects and remaining 15 crosses were observed to be deviated from significance level. The cross Punjab Chhuhara x H-24 (1.512) had recorded highest positive significant value followed by the crosses Pant T-3 x H-88-78-1 (1.228) and Arka Meghali x H-88-78-1 (1.212). Hannan *et al*. (2007) and Kumar *et al*. (2013) they also reported significant variation due to SCA, that indicated the importance of non additive types of gene action of inheritance for this traits.

Days to first harvest

Table 1: Analysis of variance for combing ability

Source of variation	d.f	Number of flowers per cluster	Days to first harvest	Fruit diameter (cm)	Fruit length (cm)	Average fruit weight (g)	Number of fruits per plant vest (cm)	Plant height at final har	Number of seed per fruit (Kg.)	Yield per plant
GCA	7	0.944**	6.86	1.141**	0.907**	701.56**	310.61**	609.83**	465.07**	1.09**
SCA	28	2.511**	16.98**	0.473**	0.388**	135.98**	78.16**	120.32**	649.84**	1.11**
EROR	70	0.372	4.122	0.106	0.132	13.977	11.087	20.33	13.251	0.042
Gca/sca ratio		0.38	0.4	2.41	2.34	5.16	3.97	5.07	0.72	0.99

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

Table 2: General combing ability effects for parents

S.No	Parents	Number of flowers per cluster	Days to first harvest	Fruit diameter (cm)	Fruit length (cm)	Average fruit weight (g)	Number of fruits per plant	Plant height (cm)	Number of seed per fruit	Yield per plant (Kg.)
1	P1 (Arka Meghali)	0.285	-0.756	-0.029	0.281**	3.758**	-2.135**	0.722	1.327	0.207**
2	P2 (Pant T-3)	0.076	-0.023	0.103	-0.096	-8.758**	2.728**	0.876	-4.173**	-0.249**
3	P3 (Punjab Chhuhara)	0.165	0.375	-0.350**	0.241**	0.462	-0.701	3.081**	1.282	0.042
4	P4 (Arka Alok)	-0.276	-0.474	0.233**	-0.032	-1.201	-0.872	0.614	3.337**	0.222**
5	P5 (H-88-78-1)	0.004	0.310	-0.176**	-0.161	-2.564*	-0.601	1.532	-5.737**	-0.292**
6	P6 (Azad T-5)	-0.131	0.496	-0.003	-0.109	8.011**	-4.724**	1.936	3.817**	0.081
7	P7 (Hisar 0.011 Anmol) H-24	0.437	0.217**	-0.159	0.611	0.263	2.200	-3.738**	-0.062	
8	P8 (Hisar Arun) Sel-7	-0.112	-0.364	0.003	0.036	-0.318	6.040**	-10.962	3.885**	0.051
	SE (gi)	0.104	0.347	0.055	0.062	0.638	0.569	0.770	0.622	0.035
	SE (gi-gj)	0.157	0.524	0.084	0.094	0.965	0.860	1.164	0.940	0.053
	Cd at 5%	0.334	1.115	0.177	0.199	2.051	1.829	2.475	1.999	0.112

Table 3: Specific combing ability effects for hybrids

S.No	Hybrids	Numb. of flowers/ cluster	Days to first harvest	Fruit diameter (cm)	Fruit length (cm)	Average fruit wt. (g)	Number of fruits per plant	Plant height (cm)	Number of seed per fruit	Yield per plant (Kg.)
1	Arka Meghali x Pant T-3	0.007	0.851	-0.291	-0.066	7.414**	1.374	0.433	-8.736**	-0.528**
2	Arka Meghali x Punjab Chhuhara	-0.015	0.726	0.596**	0.198	9.137**	0.076	0.341	28.685**	0.768**
3	Arka Meghali x H-88-78-1	1.212**	1.325	-0.188	0.071	-0.453	0.503	0.895	8.637**	0.435**
4	Arka Meghali x Arka Alok	0.706*	-2.702*	0.631**	0.566**	7.610**	2.185	-0.473	2.534	0.106
5	Arka Meghali x Azad T-5	-0.182	-1.405	-0.018	-0.019	-1.465	3.688*	-4.631	5.863**	0.576**
6	Arka Meghali x H-24	-0.672*	-4.053**	-0.138	0.398*	-3.415*	0.388	3.926	-4.572**	-0.238*
7	Arka Meghali x Sel-7	1.162**	0.195	0.026	0.403*	-0.737	-7.626**	0.147	12.828**	0.533**
8	Pant T-3 x Punjab Chhuhara	-0.172	2.139*	0.313	0.041	1.601	2.877	5.907*	-6.908**	0.144
9	Pant T-3 x H-88-78-1	1.228**	0.072	-0.12	-0.269	-0.437	0.508	4.491	7.387**	-0.222*
10	Pant T-3 x Arka Alok	0.642*	-0.709	0.139	0.309	-1.673	1.003	0.756	-0.572	0.242*
11	Pant T-3 x Azad T-5	0.58	-3.232**	0.017	-0.009	-14.69**	6.346**	11.551**	-8.440**	-0.155
12	Pant T-3 x H-24	0.45	-1.873	0.163	-0.542**	-5.315**	0.996	-1.529	18.248**	1.052**
13	Pant T-3 x Sel-7	0.835**	0.042	0.093	-0.087	-6.287**	6.262**	0.043	-5.875**	-0.078
14	Punjab Chhuhara x H-88-78-1	-0.267	-1.273	-0.333	-0.056	2.03	0.18	-0.381	24.165**	0.677**
15	Punjab Chhuhara x Arka Alok	0.827**	-2.557*	0.209	0.123	2.273	-2.335	1.518	14.072**	-0.029
16	Punjab Chhuhara x Azad T-5	0.995**	-2.280*	-0.363*	0.004	-7.335**	2.288	-0.047	2.138	0.671**
17	Punjab Chhuhara x H-24	1.512**	-1.404	-0.483**	0.238	0.598	2.828	2.5	-6.777**	0.474**
18	Punjab Chhuhara x Sel-7	-0.264	-0.529	0.33	0.476**	-2.007	7.137**	-1.889	-7.483**	-0.235*
19	H-88-78-1x Arka Alok	0.131	-0.844	0.526**	0.246	4.136*	-0.764	2.895	-8.229**	-0.092
20	H-88-78-1 x Azad T-5	-0.431	0.44	0.12	0.344	-1.972	4.712*	3.014	20.920**	0.768**
21	H-88-78-1 x H-24	-0.728*	-3.258**	0.650**	0.328	-1.406	2.432	12.277**	-11.99**	-0.089
22	H-88-78-1 x Sel-7	-0.91	-1.483	0.113	-0.234	4.689*	4.295*	-0.538	0.095	0.285**
23	Arka Alok x Azad T-5	-1.071**	-1.121	0.196	-0.527**	-8.642**	4.341*	5.679*	-2.783	-0.115
24	Arka Alok x H-24	0.216	-0.076	0.409**	-0.144	-0.242	-1.513	1.859	5.925**	0.129
25	Arka Alok x Sel-7	-0.533	-1.268	-0.044	-0.322	0.406	-6.933**	-1.453	13.036**	0.033
26	Azad T-5 x H-24	-1.423**	0.225	0.053	0.371	7.583**	-3.693*	2.828	-3.029	-0.498**
27	Azad T-5 x Sel-7	0.032	0.553	0.183	0.259	15.078**	-6.557**	-1.244	17.231**	0.416**
28	H-24 x Sel-7	0.459	0.995	0.18	-0.057	3.311	8.823**	8.372**	5.920**	0.506**
	SE (sij)	0.319	1.063	0.17	0.19	1.957	1.743	2.361	1.906	0.107
	CD at 5%	0.637	2.124	0.34	0.38	3.91	3.483	4.717	3.8	0.21

Early harvesting was desirable and preferable over late harvesting; data presented in Table 2 for days to first harvest also revealed that all parents exhibited non-significant gca effects. The sca effects showed desirable negative significant in seven crosses which was highest in cross Arka Meghali x H-24 (-4.053) followed by H-88-78-1 x H-24 (-3.258) and Pant T-3 x Azad T-5 (-3.232) crosses. This gca and sca effects are similar to the findings of Saleem *et al*. (2013) and Asati *et al*. (2007).

Fruit diameter (cm)

The highest significant positive gca effect was observed in Arka Alok (0.233) and sca effects ranged between -0.363 (Punjab Chhuhara x Azad T-5) to 0.650 (H-88-78-1 x H-24). Seven out of 28 crosses recorded significant to this trait in which five are positive or desirable direction and two crosses are negative or undesirable direction. Mondal *et al*. (2009) and Saleem *et al*. (2013) also reported that involvement of both additive and non additive gene action was operative for the control of equatorial diameter of fruit.

Fruit length (cm)

Among parents, (Table 2) Arka Meghali (0.281) and Punjab Chhuhara (0.241) exhibited significant positive gca effects. Among cross combinations, (Table 3) highest significant positive sca effect recorded in the cross Arka Meghali x Arka Alok (0.566) followed by Punjab Chhuhara x Sel-7 (0.476) and Arka Meghali x Sel-7 (0.403). The results with respect to gca and sca effects are similar to the finding of Saleem *et al*. (2013).

Average fruit wt. (Kg.)

Among parents, Azad T-5 (8.011) exhibited highly significant positive gca effects followed by Arka Meghali (3.758). Among F_1 hybrids, 13 out of 28 crosses showed significant positive and negative sca effect, the highest significant positive value for sca effect was recorded in Azad T-5 x Sel-7 (15.078) followed by the crosses Arka Meghali x Punjab Chhuhara (9.137) and Arka Meghali x Arka Alok (7.610). Similar results with respect to gca and sca effects were obtained by Asati *et al*. (2007) and Saleem *et al*. (2013).

Number of fruits per plant

The highly significant positive gca effects for this trait was recorded in Sel-7 (6.040) and Pant T-3 (2.728) parents which is desirable. Among F_1 hybrids, (Table 3) the highest significant positive value for sca effect was recorded in H-24 x Sel-7 (8.823) followed by Punjab Chhuhara x Sel-7 (7.137), Pant T-3 x Azad T-5 (6.346) and Pant T-3 x Sel-7 (6.262).

Plant height at final harvest (cm)

Only Punjab Chhuhara (3.081) parent was observed the

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REFERENCES

Asati, B. S., Singh, G., Rai, N. and Chaturvedi, A. K. 2007. Hetrosis and combining ability studies for yield and quality traits in tomato. *Veg. Sci.* **34(1):** 92-94.

Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing system. *Australian J. Biological Sciences*. **9:** 463-93.

Hannan, M. M., Ahmed, M. B., Razvy, M. A., Karim, R., Khatum, M., Hayder, A., Hussain, M. and Roy, U. K. 2007. Heterosis and correlation of yield and yield components in tomato. *Am-Eurasian J. Sci. Res.* **2(2):** 46-150.

Kumar, R., Srivastava ,K., Singh, N. P., Vasistha, N. K., Singh, R. K. and Singh, M. K. 2013. Combining ability analysis for yield and quality traits in tomato (*Solanum lycopersicum* L.). *J. Agri Sci.* **5(2):** 213-18.

Kumar, C. and Singh, S. P. 2016. Heterosis and inbreeding depression to identify superior F1 hybrids in tomato (*Solanum lycopersicum* L.) for the yield and its contributing traits. *J. Applied and Natural Sci.* **8(1):** 290-296.

Meena, O. P. and Bahadur, V. 2014. Assessment of genetic variability, heritability and genetic advance among tomato (*Solanum lycopersicum* l.) germplasm. *The Bioscan.* **9(4):** 1619-1623.

Mondal, C., Sarkar, S. and Hazra, P. 2009. Line × tester analysis of combining ability in tomato (*Lycopersicon esculentum* Mill.). *J. Crop Weed.* **5(1):** 53-57.

Pedapati, A., Reddy, R. V. K. S., Babu, D., Kumar, S. and Sunil, N. 2013. Combining ability analysis for yield and physiological drought related traits in tomato (*Solanum lycopersicum* l.) under moistures stress. *The Bioscan.* **8(4):** 1537-1544.

Saleem, M. Y., Asghar, M., Iqbal1, Q., Rahman, A. and Akram, M. 2013. Diallel analysis of yield and some yield components in tomato (*Solanum lycopersicum* l.). *Pak. J. Bot*. **45(4):** 1247-1250.

Salimath, P. M. and Bahl, P. N. 1985. Heterosis and combining ability for earliness in chickpea (*Cicer arietinum* L.). *Indian J. Genet.* **45:** 97-100.

Singh, R. K. and Chaudhary, B. D. 1979. Biometrical methods in quantitative genetics analysis. Kalyani, publisher, Ludhiana, New Delhi, India, p. 303.

Sprague, G. F. and Tatum, L. A. 1942. General vs specific combining ability in single crosses of corn. *J. American Society of Agronomy.* **34:** 923-932.