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Studies on Combining Ability and Gene Action for Growth and Quality Characters in Tomato (*Solanum lycopersicum* L.)

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ABSTRACT

The present investigation was undertaken to study the combining ability of the parents and crosses for yield and yield contributing traits in tomato using twenty one hybrids involving seven lines and three testers in line x tester mating design. The genotypes were evaluated in Randomized Block Design with three replications at college of horticulture, SKLTSHU, Telangana. The present study revealed that none of the parent was best combiner for all the traits indicating differences in genetic variability for different characters among the parents. Line x Tester effect was found significant for all the characters under the study except for days to first flowering and days to last harvest. Combining ability analysis revealed that magnitude of specific combining ability variance was greater than general combining ability variance suggesting the predominance of non-additive gene action for all the characters studied. The gca effects of the parents revealed that EC 620494 and EC 654289 and testers Arka Meghali and Pusa Ruby were found to be promising general combiners for growth and quality traits. Based on significant sca effects three hybrids viz.,LA 3667 x Arka Vikas, EC 631407 x Pusa Ruby and EC 654289 X Pusa Ruby were identified as promising for growth and quality characters.

***Key words**: Tomato, Combining ability, Gene action, Gca, Sca.*

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is an important solanaceous vegetable crop widely grown in India for its fleshy fruits. It is the most important warm season vegetable crop, because of its wider adaptability, high yielding potential, multipurpose uses and grown across the world. Large quantities of tomato are used to produce soup, juice, ketchup, sauce, puree, paste and powder. Tomatoes are important source of lycopene, ascorbic acid and carotene valued for their colour, flavour and antioxidant properties. The increasing consumption of tomato makes it, a high value crop for generating income to the farmers.

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Lycopene reported to possess anticancerous properties[15] and it is powerful natural antioxidant (most efficient quencher of singlet oxygen) used in pharmaceuticals[5]. Combining ability analysis helps in identifying additive or non-additive gene action. A knowledge of general combining ability (*GCA*) variances, reveals the existence of additive gene action while specific combining ability (*SCA*) variances reveals non additive gene action. Combining ability effects reveal the genetic worth of parents and hybrids. The *gca* effects are fixable, while *sca* effects are non-fixable. Information about *gca* effects are beneficial while choosing best combiner parents and *sca* effects reveal best cross combinations. It is appropriate method to identify superior parents and hybrids based on general and specific combining ability effects, respectively and study the nature of gene action.

MATERIALS AND METHODS

The experimental material consists of seven diverse genotypes of tomato *viz.*, EC 620408, EC 620494, EC 654289, EC 620639, EC 631410, EC 631407 and LA 3667 was crossed with three testers *viz.*, Pusa Ruby, Arka Vikas and Arka Megahli in line x tester mating design to obtain twenty one cross combinations .The 21 hybrids along with parents and three standard checks (Arka Rakshak, US 440 and Punjab Chhuhara) were evaluated during early *Summer* 2017 at PG students Research farm, College of Horticulture, Sri konda Laxman Telangana State Hortcultural University, Rajendranagar, Hyderabad-30. The experiment was laid out in a Randomized Block Design with three replications.

Crosses were made manually using the standard procedure of hand emasculation and pollination. F_1s were evaluated along with their parents and standard checks to study the gene action, general combining ability (*gca*) effects of parents and specific combining ability (*sca*) effects of hybrids for growth and quality related traits *viz.*, plant height (cm), number of primary branches per plant, TSS (°Brix), pH, ascorbic acid (mg/100g) and lycopene (mg/100g).

RESULTS AND DISCUSSION

Analysis of variance for combining ability reveals that significant line effect was recorded in characters *viz.,* pH and ascorbic acid (mg/100g). Significant tester effect was not found in the characters studied. But the Line x Tester effect (Table 1.0) was found significant for all the characters under the study, representing specific combining ability and suggested manifestation of parental genetic variability in their crosses.

Gene action

The estimates of *GCA* and *SCA* variances, their ratios and gene action are presented in Table.2.0. General combining ability is generally associated with additive gene action, while specific combining ability is due to dominance and epistasis. In the present investigation, it was found that *SCA* variances were higher than *GCA* variances for all the characters, which indicated the predominance of non-additive gene action. Hence, heterosis breeding and recombination breeding with postponement of selection at later generations are ideal to improve these traits.

General combining ability and specific combining ability effects

General combining ability helps in the selection of suitable parents (good general combiners) for hybridization. None of the parent was best combiner for all the traits, indicating differences in genetic variability for different characters among the parents.(Table.3a &3b).[8,6,4.] There were significant differences in the general combining ability effects of ten parents for all the growth and quality parameters under study. High *gca* effects are related to additive gene effects or additive × additive effects, which represent the fixable genetic components of variance, as pointed out by Griffing.[3]The specific combining ability reveals the best cross combination among the genotypes which can be useful for developing hybrids with high vigour for the traits. Results revealed that no

cross combination consistently good for all the traits. (Table 4a & 4b.)

Plant height (cm)

***gca* effects**

The parents having high *gca* effects (Table.3) are regarded as superior general combiners for the plant height. Significant positive *gca* effect was observed in EC 620494 (22.88). Among testers, high *gca* effect was observed in Pusa Ruby (5.09) [13,16.]

***sca* effects**

Out of the twenty one crosses studied, significant and positive *sca* effects were recorded in nine hybrids. These hybrids were best specific combiners. Negative effects under the study might be due to unfavourable gene combinations. [10,14].

Number of branches per plant

***gca* effects**

The lines and testers showed significantly negative *gca* effects(Table .3) indicative for least branching habit. Among lines, EC 620494 (1.17) showed highly significant and positive *gca* effect. Among testers Pusa Ruby exhibited high *gca* effect (5.09).

***sca* effects**

Evaluation of crosses for *sca* effects for number of branches revealed that among 21 crosses, nine crosses recorded significant and positive *sca* effects, while ten crosses recorded significant and negative *sca* effects.(Table 4). The crosses with significant and positive *sca* effect were EC620408 x Arka Vikas (1.04), EC620494 x Arka Vikas (0.57), EC 620494 x Arka Meghali (0.36), EC 654289 x Pusa Ruby (1.86), EC 620639 x Pusa Ruby (1.34), EC 631407 x Pusa Ruby (0.47), EC 631410 x Arka Meghali (0.55), LA 3667 x Arka Vikas (1.24) and LA 3667 x Arka Meghali (0.50). [10,13]

TSS (°Brix)

***gca* effects**

For the trait total soluble solids, the *gca* effect of lines were ranged from LA3667 (-0.78) to EC 654289 (0.48). Among testers,*gca* effect was varied from -0.23 in Pusa Ruby to 0.21 in Arka Meghali. Positive *gca* effects of this trait are confirmed with result of Narasimhamurthy.[7]

***sca* effects**

Among hybrids *sca* effects (Table 4) were ranged from -0.81 in EC 620639 x Arka Meghali to 0.84 in EC 654289 x Arka Meghali. Evaluation of the cross combinations for total soluble solids revealed that seven crosses showed significant and negative *sca* effects and eight crosses showed significant and positive *sca* effects.These results are in accordance with the findings of Saeed [11].

pH

***gca* effects**

For character pH, *gca* effects (Table 3)in lines were ranged from -0.30 in LA3667 to 0.12 in EC 631407.Among the testers *gca* effect varied from -0.04 in Arka Meghali to 0.07 in Arka Vikas.

***sca* effects**

For the character pH, negative *sca* effects are desirable. Among crosses(Table 4), LA3667 x Arka Meghali(-0.28) showed significant and negative *sca* effect. This result is supported with the findings of Saleem[12] and Basavaraj [1]

Ascorbic acid (mg/100g)

***gca* effects**

Among lines , EC 620639 showed significant and positive *gca* effect (2.53). Significant and positive *gca* effect (Table 3) were observed in three lines. In testers, the *gca* effects were varied from -0.29 in Arka Meghali to 0.23 in Pusa Ruby.

***sca* effects**

Ascorbic acid content in hybrids (Table 4) was ranged from -1.34 in EC 620408 x Arka Meghali to 1.49 in EC 620494 x Arka Meghali.Among hybrids significant and positive *sca* effects were observed in four crosses *viz.*,EC 620494 x Arka Meghai (1.49), EC 620408 x Pusa Ruby (1.02), EC 631407 x Pusa Ruby (0.94) and LA 3667 x Arka Meghali (0.73). Similar results were observed by Ravindrakumar [10]and Pemba [9].

Lycopene (mg/100g)

***gca* effects**

The results for *gca* effects of parents for lycopene are presented in Table 3. Among lines, *gca* effects were varied from 1.63 in

LA3667 to -1.67 in EC 620639. Among testers, *gca* effects were ranged from -1.08 in Pusa Ruby to 1.18 in Arka Meghali.

***sca* effects**

For the character lycopene,*sca* effect (Table 4)were ranged from -2.65 in EC 620408 x Arka Meghali to 3.14 in EC 620408 x Arka Vikas. Significant and positive *sca* effects were present in nine crosses and significant and negative *sca* effects were present in twelve hybrids.The present results are in line with the earlier reports of Dechin [2] and Narasimhamurthy [7].

Based on *gca* effects among lines, EC 620494 and EC 654289 were promising general combiner for growth and quality characters in tomato. Among testers Pusa Ruby was found promising general combiner for plant height (cm), and pH. The tester Arka Meghali recorded significant *gca* effects for TSS, pH and lycopene (mg/100g).

Based on *sca* effects the hybrid LA 3667 x Arka Vikas was identified as promising for plant height, number of primary branches per plant, TSS and lycopene. EC 631407 x Pusa Ruby showed significant *sca* effects for plant height, number of primary branches, ascorbic acid and lycopene. EC 654289 x Pusa Ruby exhibited significant *sca* effects for plant height and number of primary branches per plant.

Table 1: Analysis of variance for combining ability for growth and quality characters in Tomato

Source of Variation	Degrees of freedom	Plant height (cm)	Number of primary branches	TSS (°Brix)	pH	Ascorbic acid (mg/100g)	Lycopene (mg/100g)
Replications	2	13.62	0.03	0.10	0.002	0.014	0.002
Crosses	20	548.08**	4.10**	1.23**	0.08**	10.66**	12.36**
Line effects	6	996.48	4.28	2.02	0.17*	29.36**	9.32
Tester effect	2	471.24	2.34	1.02	0.08	1.47	27.03
L x T effect	12	336.69**	4.30**	0.87**	0.04**	2.85**	11.43**
Error	40	2.19	0.01	0.03	0.002	0.34	0.01

Table 2: Combining ability variances and their ratios for twenty characters in Tomato

S.No.	Character	$\sigma^2 GCA$	$\sigma^2 SCA$	$\sigma^2 GCA / \sigma^2 SCA$
1	Plant height	25.88	680.60	0.04
2	No. of primary branches per plant	0.13	9.82	0.013
3	TSS	0.05	1.07	0.05
4	pH	0.001	0.04	0.03
5	Ascorbic acid	0.05	4.59	0.01
6	Lycopene	1.16	6.82	0.17

$\sigma^2 GCA$, $\sigma^2 SCA$= Additive and non-additive components of heritable variation, respectively

Table 3: Estimates of general combining ability (*gca*) effects of parents for plant height (cm), number of primary branches per plant, pH, TSS (°Brix), ascorbic acid (mg/100g) and lycopene (mg/100g) in Tomato

Parents	Plant height(cm)	Number of primary branches	TSS (°Brix)	pH	Ascorbic acid (mg/100g)	Lycopene (mg/100g)
LINES						
EC 620408	-4.83 **	0.02	0.43 **	0.04	-1.81**	0.01
EC 620494	22.88**	1.17 **	-0.29 **	0.04	-2.00 **	-0.53 **
EC 654289	-8.10 **	-0.36 **	0.48**	0.06 *	1.13 **	0.67**
EC 620639	0.70	-0.12 *	0.14*	0.02	2.53 **	-1.67**
EC 631407	-5.50 **	-1.11 **	0.34 **	0.12 **	1.33 **	-0.11 *
EC 631410	-0.60	0.10	-0.32**	0.03	0.46*	0.01
LA 3667	-4.56 **	0.31 **	-0.78 **	-0.30 **	-1.63 **	1.64 **
SE (lines)	0.47	0.06	0.05	0.02	0.19	0.05
TESTERS						
Pusa Ruby	5.09 **	0.36 **	-0.23 **	-0.03 *	0.23	-1.08 **
Arka Vikas	-4.28 **	-0.29**	0.02	0.07 **	0.06	-0.11 **
Arka Meghali	-0.80 *	-0.07	0.21**	-0.04 *	-0.29 *	1.18 **
SE (Testers)	0.31	0.04	0.03	0.02	0.12	0.03

Table 4a. Estimates of specific combining ability (*sca*) effects of hybrids for plant height (cm), number of primary branches per plant, pH, TSS (°Brix), ascorbic acid (mg/100g) and lycopene (mg/100g) in Tomato

Crosses	Plant height (cm)	Number of primary branches	TSS (°Brix)	pH	Ascorbic acid (mg/100g)	Lycopene (mg/100g)
EC 620408 x Pusa Ruby	-7.27 **	-0.61**	0.17	-0.02	1.02 **	-0.49**
EC 620408 x ArkaVikas	4.77 **	1.01 **	-0.14	0.02	0.32	3.14**
EC 620408 x Arka Meghali	2.49 **	-0.40**	-0.04	0.01	-1.34 **	-2.65 **
EC 620494 x Pusa Ruby	-6.51 **	-0.94 **	0.19 *	-0.01	-1.10 **	-0.85 **
EC 620494 x ArkaVikas	-6.34**	0.57 **	0.12	-0.02	-0.39	-1.10**
EC 620494 x Arka Meghali	12.85**	0.36 **	-0.31 **	0.03	1.49 **	1.95**
EC 654289 x Pusa Ruby	7.20 **	1.86 **	-0.28 **	0.07	0.47	-1.16 **
EC 654289 x ArkaVikas	-0.76	-0.82 **	-0.56**	-0.06	0.32	-1.15**
EC 654289 x Arka Meghali	-6.44 **	-1.04 **	0.84 **	-0.01	-0.79 *	2.31 **
EC 620639 x Pusa Ruby	8.10 **	1.34 **	0.53 **	-0.06	0.03	0.95 **
EC 620639 x ArkaVikas	-3.29 **	-1.21 **	0.29**	-0.01	-0.13	0.54**
EC 620639 x Arka Meghali	-4.81 **	-0.13	-0.81 **	0.07	0.10	-1.49**
EC 631407 x Pusa Ruby	5.07 **	0.42 **	-0.51 **	-0.07	0.94 **	1.82 **
EC 631407 x ArkaVikas	-6.69 **	-0.57 **	0.25 **	-0.03	-0.94**	-0.76**
EC 631407 x Arka Meghali	1.63	0.15	0.25 **	0.11 *	0.01	-1.06**
EC 631410 x Pusa Ruby	11.20 **	-0.33 **	0.38 **	-0.06	-0.28	-0.50**
EC 631410 x ArkaVikas	0.14	-0.22 *	-0.43**	-0.03	0.48	-1.32 **
EC 631410 x Arka Meghali	-11.34 **	0.55 **	0.04	0.09 *	-0.19	1.81**
LA 3667 x Pusa Ruby	-17.80 **	-1.74 **	-0.49**	0.15 **	-1.07 **	0.22 *
LA 3667 x ArkaVikas	12.17**	1.24**	0.47**	0.13**	0.34	0.64**
LA 3667 x Arka Meghali	5.63 **	0.50**	0.02	-0.28**	0.73*	-0.86 **
SE (Crosses)	0.82	0.1	0.09	0.04	0.32	0.09

CONCLUSION

From this experiment it can be concluded LA 3667 x Arka Vikas and EC 631407 x Pusa Ruby proved to be best crosses for growth and quality characters and for the development of vigorous high yielding genotype from the succeeding progenies.

REFERENCES

1. Basavaraj, L.B., Vilas, D.G., Shivappa, M.K., Vijayakumar,D.R., Nagesh, G.C. and Reshmika, P.K., Combining ability analysis for yield and quality traits in tomato (*Solanum lycopersicum* L.). *Green Farming*. **7(1):** 26-30 (2016).
2. Dechin, D., Raj Kumar., Subodh Joshi. and Yadav, R.K., Genetic studies of quality traits in tomato (*Solanum lycopersicum* L.) under low temperature, *Vegetable Science*. **39 (2):** 189-191 (2012).
3. Griffing, B., Concepts of general and specific combining ability in relation to diallel crossing system. *Australian Journal of Biological Science*. **9:** 463-493 (1956).
4. Kansouh, A.M. and Zakher, A.G., Gene action and combining ability in tomato (*Lycopersicon esculentum*. Mill) by line x tester analysis. *Journal of Plant Production.* **2(2):** 213-227 (2011).
5. Mascio, D., Kaiser, P.S. and Sies, H., Lycopene as the most efficient biological carotenoid singlet oxygen quencher. *Archives of Biochemistry and Biophysics*. 532-538 (1989).
6. Mondal, C., Sarkar, S. and Hazra, P. Line x Tester analysis of combining ability in tomato (*Lycopersicon esculentum* Mill.). *Journal of Crop and Weed*. **5:** 53-57 (2009).
7. Narasimha murthy, Y.K., Hanumantha gowda, P. Ramanjini gowda. Line x Tester analysis in tomato (*Solanum lycopersicum* L.): Identification of superior parents for fruit quality and yield attributing traits. *International Journal of Plant Breeding*. **7(1):** 50-54 (2012).
8. Naveen, G., Devinder, S., Cheema., and Ajmer, S.D. Genetics of yield, quality and shelf life characteristics in tomato under normal and late planting conditions. *Euphytica*. **159:** 275–288 (2008).
9. Pemba, S., Tania, S., Varun, D.S., Pandiarana, N., Subhra, M. and Chattopadhyay, A. Heterosis, dominance estimate and genetic control of yield and post-harvest quality traits of tomato. *Journal of Applied and Natural Science.* **6(2):** 625-632 (2014).
10. Ravindrakumar, Srivastava, K., Norang, P.S., Vasistha, N.K., Singh, R.K. and Singh, M.K., Combining ability analysis for yield and quality traits in tomato (*Solanum lycopersicum* L.). *Journal of Agricultural Science*. **5(2):** 213-218 (2013).
11. Saeed, A., Hassan, N., Shakeel, A., Saleem, M.F. and Khan, N.H., Genetic analysis to find suitable parents for development of tomato hybrids. *Journal of Life Sciences.* **11(12):** 122-127 (2014).
12. Saleem, M.Y., Asghar, M., Iabal, Q., Rahman, A.U. and Akram, M., Diallel analysis of yield and some yield components in tomato (*Solanum lycopersicum* L.) *Pakistan Journal of Botany*. **45(3):** 1247-1250 (2013).
13. Singh, A.K. and Asati, B.S., Combining ability and heterosis studies in tomato under bacterial wilt condition. *Bangladesh Journal of Agrilcultural Research.* **36(2):** 313-318 (2011).
14. Singh, B., Kaul, S., Kumar, D. and Kumar, V., Combining ability for yield and its contributing characters in tomato. *Indian Journal of Horticulture*. **67(1):** 50-55 (2010).
15. Srinivasan, R., (Ed.). Safer Tomato Production Methods: A field Guide for soil fertility and pest management. AVRDC-The World Vegetable Center, Shanhua, Taiwan. AVRDC Publication No. 10-740. Pp. 2. 22 (2010).
16. Sunil, K,Y., Singh, B.K., Baranwal, D.K. and Solankey, S.S. Genetic study of heterosis for yield and quality components in tomato (*Solanum lycopersicum*) *African Journal of Agricultural Research.* **8(44):** 5585-5591 (2013).