

Heterosis and Combining Ability Studies in Tomato (*Solanum lycopersicum* L.)

SUMMARY of THESIS

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SUMMARY

Vegetable is the most important component of a balanced diet and acts as a protective food. India is the second largest producer of vegetables only next to china and is leader in the production of peas. Besides this, India also occupies the second position in the production of brinjal, cabbage, cauliflower and onion and third in the production of potato and tomato in the world.

According to ICMR about 300 g vegetables (125g leafy, 100g root and 75g other vegetables) per capita per day is required. But the availability of vegetables in India is only 180g per capita per day, which is very low as compared to the recommended intake.

Previously classified as *Lycopersicon esculentum*, tomato was renamed as *Solanum lycopersicum* L. on the basis of morphological and molecular studies. A high- quality genome sequencing of domesticated tomato has been completed by ‘The Tomato Genome Consortium’ in May, 2012, opening a new vista in tomato improvement.

Tomato plants typically reach 3–10 ft in height and have a weak, woody stem that often vines over other plants. The leaves are 10–25 cm long, odd pinnate with 5–9 leaflets on petiole and each leaflet up to 8 cm long, with a serrated margin both the stem and leaves are densely glandular hairy. The flowers are 1–2 cm across, yellow with five pointed lobes on the corolla they are borne in a cyme of 3–12 together. It is a perennial, often grown outdoors in temperate climates as an annual. *Lycopersicon esculentum* and near relatives are self-fertile but the former is out crossed to a considerable extent in certain part of subtropical areas and its native region. Tomato is universally known as “Protective Food”. It is a versatile vegetable for culinary purpose. Tomato is generally consumed as salad, cooked or as processed food. The unripe green fruits are used for making pickles, preserves and are consumed after cooking as vegetable. Tomato is a rich source of antioxidants (mainly lycopene and β -carotene), Vitamin A, Vitamin C and minerals like Ca, P and Fe . In tomato total antioxidant capacity ranges from 80 to 200 μ mol. Ascorbic acid contents of tomatoes

have been found to vary according to color and it ranged from 23.21- 40.44 and 24.38 - 33.87 mg/100g in red and yellow cultivars, respectively.

Most of the quality traits in tomato show continuous variation and is strongly influenced by environmental conditions. The genetic variance of any quantitative trait is composed of additive variance (heritable) and non-additive variance and include dominance and epistasis (non-allelic interaction) therefore, it essential to partition the estimated phenotypic variability into its heritable and non-heritable components with suitable parameters such as genetic variance, phenotypic variance, genotypic coefficient of variation, phenotypic coefficient of variation, genetic advance and heritability. High values of PCV and GCV were present for fruit per plant and plant height indicating the existence of higher magnitude of variability. Systematic study and evaluation of tomato germplasm is of great importance for current and future agronomic and genetic improvement of the crop, evaluation of germplasm is imperative in order to understand the genetic background and the breeding value of the available germplasm.

The present investigation entitled “**Heterosis and Combining Ability Studies in Tomato (*Solanum lycopersicum* L.)**” was carried out at Horticulture Research Farm, Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University (A Central University), Vidya Vihar, Rae Bareli Road, Lucknow- 226025 (U.P.), India, during the summer season of 2014-15 and 2015-16.

The present investigation was taken up in tomato with the following objectives:

- (1) To find out the general and specific combining ability studies of parents and their crosses of tomato.
- (2) To estimate the standard heterosis, heterobeltiosis and inbreeding depression for different characters of tomato.
- (3) To investigate the genetic variability, heritability and genetic advance of tomato.
- (4) To ascertain the correlation coefficient and path analysis among the different economic traits of tomato.

The experimental materials consisted of 12 lines, 3 testers and 36 F₁ hybrids obtained from Line x Tester mating design. The parents were randomly selected inbred representing wide range of variation in yield and different yield attributing traits. Data was observed from randomly selected plants for sixteen yield and quality attributing traits, namely plant height, number of branches per plant, days to 50% flowering, number of clusters per plant, number of flowers per cluster, number of fruits per cluster, number of fruits per plant, average fruit weight (g), number of locules per fruit, pericarp thickness (mm), fruit length (cm), fruit width (cm), number of ridges on fruit, fruit yield per plant (kg), TSS (⁰Brix) and Vitamin C (mg/100g).

Variance due to lines (female) was highly significant for all the characters except plant height(cm) and vitamin C (mg/100g). Variance due to testers (males) was also highly significant for all the characters except plant height, clusters per plant, fruits per plant, average fruit weight and fruit width . Whereas, variances due to parents vs. hybrids were highly significant for days to 50% flowering, clusters per plant, flowers per cluster, fruits per cluster, fruits per plant, average fruit weight (g), locules per fruit, pericarp thickness (mm), fruit length (cm), fruit width (cm), ridges on fruit except vitamin C (mg/100g) , plant height (cm), number of branches per plant fruit and yield per plant (kg) were non-significant under study.

General combining ability effects of twelve female lines and three male testers were estimated separately. The estimates of specific combining ability for crosses were also estimated. However, it was showed that the top two parents parents proved to be the best general combiners for different characters were Sel.-32 and G-3 for plant height, Pusa Sheetal and IIVR-Sel.-1 for number of branches per plant and S. Naveen and Flora Dode for days to 50% flowering, H-86 and Flora Dode for clusters per plant, FLA 7171 and Hisar Arun for flowers per cluster, Flora Dode and FLA 7171 for fruits per cluster, H-86 and Flora Dode for fruits per plant, H-88 and Kashi Amrit for average fruit weight , FLA 7171 and H-86 for locules per Fruit, Hisar Arun and H-88 for pericarp thickness, FLA 7171 and Flora Dode for fruit length, H-24 and Sel.-32 for fruit width, G-3 and IIVR-Sel.-1 for ridges on fruit. Hisar Arun and S. Naveen for fruit yield per plant, Sel.-32 and S. Naveen for TSS, H-24 and FLA 7171 for vitamin C.

The specific combining ability is represented the dominance and epistatic component of variation that are non-additive gene action. It can be utilized in generation like developing F₁ hybrids. In the present investigation, the thirty six cross manifested consistently high specific combining ability effects for most of the characters. In the present study findings (Table 4.6a, 4.6b, and 4.8) revealed that the significant and desirable cross in order of merit were H-86 x Pusa Sadabahar and S. Naveen x Kashi Vishesh for plant height FLA 7171 x Pusa Sadabahar for Number of branches per plant, H-24 x Kashi Amrit for days to 50% flowering, S. Naveenx Kashi Vishesh for clusters per plant, FLA 7171 x Pusa Sadabahar for flowers per cluster, FLA 7171 x Pusa Sadabahar for fruits per cluster, H-86 x Kashi Amrit for fruits per plant, H-88 x Kashi Vishesh for average fruit weight, H-24 x Pusa Sadabahar for locules per fruit, IIVR-Sel.-1 x Kashi Amrit for pericarp thickness, S. Naveen x Kashi Amrit for fruit length, H-86 x Pusa Sadabahar for fruit width, G-3 x Kashi Amrit for ridges On fruit, S. Naveenx Kashi Vishesh for fruit yield per plant, G-3 x Kashi Vishesh for TSS and H-88 x Kashi Amrit for vitamin C were showed significant and desirable specific combiner.

Estimate of genetic component of variance (additive and dominance), combining ability variance general combining ability and specific combining ability, degree of dominance and and predictability ratio for sixteen characters of tomato . The genetic component of variance for the dominance showed higher value than the additive variance for all the characters with value of greater than one (>1) degree of dominance except vitamin C. The variance of specific combining ability was also recorded to be higher than the general combining ability variance with the value of less than one (<1) predictability ratio for all the characters except vitamin C under study.

The range of heterosis over standard variety and better parents for almost all characters were carried out. The best cross combinations DVRT-2 x Kashi Vishesh and H-88 x Kashi Amrit the standard variety and FLA 7171 x Kashi Vishesh over better parents for plant height, cross combinations H-24 x Kashi Amrit and G-3 x Kashi Amrit over the standard variety and H-88 x Kashi Vishesh over better parents respectively for number of branches per plant, Sel.-32 x Pusa Sadabahar, and H-24 x Kashi Vishesh for the standard variety and S. Naveen x Pusa Sadabahar over better

parents for days to fifty percent flowering, cross combination H-24 x Pusa Sadabahar over the standard variety and G-3 x Pusa Sadabahar over better parent respectively for clusters per plant.

The best cross combination IIVR-Sel.-1 x Pusa Sadabahar and Pusa Sheetal x Kashi Vishesh over the standard variety and Flora Dode x Kashi Vishesh over the better parent for number of flowers per cluster, cross combination H-24 x Kashi Vishesh and Pusa Sheetal x Kashi Vishesh over the standard variety and S. Naveen x Kashi Vishesh over the better parent for fruits per cluster, cross combination Sel.-32 x Kashi Amrit and FLA 7171 x Kashi Vishesh over the standard variety and H-86 x Kashi Vishesh over the better parent for fruits per plant, cross combination G-3 x Pusa Sadabahar over the standard variety and Flora Dode x Kashi Vishesh over the better parent for average fruit weight, cross combination Pusa Sheetal x Pusa Sadabahar, and Flora Dode x Kashi Amrit over the standard variety and IIVR-Sel. 1 x Kashi Vishesh over the better parent for number of locules per fruit, cross combination Sel.-32 x Kashi Amrit and FLA 7171 x Pusa Sadabahar over the standard variety and Sel.-32 x Pusa Sadabahar over the better parent for pericarp thickness, cross combination S. Naveen x Kashi Amrit and FLA 7171 x Pusa Sadabahar over the standard variety and IIVR-Sel. 1 x Kashi Vishesh over the better parent for fruit length. cross combination G-3 x Kashi Amrit and DVRT-2 x Kashi Vishesh over standard variety and S. Naveen x Kashi Amrit over the better parent for fruit width, cross combination G-3 x Kashi Vishesh over standard variety and G-3 x Kashi Amrit over better parent for ridges on fruit, cross combination H-86 x Kashi Amrit and Flora Dode x Kashi Amrit over the standard variety and Sel.-32 x Pusa Sadabahar over the better parent showed significant and desirable standard heterosis and heterobiltiosis for yield per plant. cross combination G-3 x Pusa Sadabahar and DVRT-2 x Kashi Amrit over the standard variety and DVRT-2 x Kashi Amrit over the better parent for TSS. cross combination S. Naveen x Pusa Sadabahar and Sel.-32 x Pusa Sadabahar over standard variety and H-24 x Kashi Amrit over the better parent for vitamin C.

Some of the crosses showed remarkable negative inbreeding depression for different characters such as plant height, days to fifty percent flowering, flowers per cluster and fruits per cluster etc. It is desirable for this trait, whereas most of the yield related component traits exhibited positive inbreeding depression such a length of

fruit, average fruit weight, fruits per plant, clusters per plant and number of branches per plant.

The phenotypic coefficient of variation than their respective genotypic coefficient of variation for all the characters under study, which indicates that the characters studied were influenced by the environmental. The phenotypic coefficient of variation and genotypic coefficient of variation was maximum for phenotypic coefficient of variation and genotypic coefficient of variation was higher for fruit yield per plant and Number of branches per plant, but was lowest for days to 50% flowering. The highest value of broad sense heritability was showed for fruit yield per plant followed by ridges on fruit. In genetic variability for the present investigation, widest range was revealed for average fruit weight followed by plant height. The highest genetic advance was recorded for fruit yield per plant followed by ridges on fruit.

Positive and significant genotypic correlation coefficient of fruit yield per plant, average fruit weight followed by fruits per plant. In phenotypic level observed that fruit yield per plant had negative and significant correlation with fruit length. The highest positive direct and indirect effect towards yield per plant was showed by average fruit weight followed by fruits per plant, pericarp thickness, locules per fruit, flowers per cluster, fruit width, plant height and vitamin C, while, highest negative effect towards fruit yield per plant was showed by days to 50% flowering followed by number of branches per plant ,fruits per cluster , fruit length , clusters per plant, ridges on fruit and TSS.

It is briefly concluded from the present investigation the best hybrids for flowers per cluster and fruits per cluster can be obtained from the cross combinations FLA 7171 x Pusa Sadabahar. The maximum plant height was found in the cross combination H-86 x Pusa Sadabahar and fruits per plant were found maximum in the cross combination IIVR-Sel.-1 x Kashi Amrit. The maximum fruit weight were found in the cross combination H-88 x Kashi Vishesh. The minimum Days to 50% flowering was found in the cross combination H-24 x Kashi Amrit .The minimum pericarp thickness was found in the cross combination IIVR-Sel. 1 x Kashi Vishesh. The highest TSS and Vitamin C were found in in the cross combination FLA 7171 x Kashi Vishesh and Pusa Sheetal x Kashi Vishesh.