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# Correlation and path analysis in tomato (*Solanum lycopersicum* L.) for yield and yield contributing traits

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**Abstract**
The evaluation of sixteen genotypes of tomato (*Solanum lycopersicum* L.) were carried out at Vegetable Research Farm of Department of Horticulture, Institute of Agricultural Sciences, B.H.U., Varanasi-221 005, Uttar Pradesh during Rabi season of 2016- 2017. Genotypic correlations were comparatively higher than the respective phenotypic correlations for most of the traits. Average fruit weight, fruit width, fruit length, number of locules per fruit and number of seeds per fruit showed significant positive correlation with yield (q/ha) indicating that selection for higher yield through these traits would be effective. Path coefficient analysis indicated highest positive direct effect towards yield *via*. days to 50% flowering followed by fruit width, total soluble solids and average fruit weight. These traits may be given more emphasis for direct selection of high yielding tomato genotypes in future breeding programmes.

**Keywords:** Correlation, path coefficient, tomato, yield

## Introduction
Tomato (*Solanum lycopersicum* L.) is the second most popular vegetable after potato. It is commercially grown throughout the world for fresh fruit market and processing industry. Tomato is a native of Central and South America, most likely in the region of Andes Mountains in Peru and Bolivia. It was introduced in India by the Portuguese in 1700 (Kale and Kale, 1984). The name tomato derived from the word "Tomat" in the Nahua tonque of Mexico. Today tomatoes are more consumed than any other fruit or vegetable and are one of the top selling vegetables throughout the world. Present days, cultivation of tomato is the focus of horticultural industry in the world and takes a distinct place in the realm of vegetable crops.
Fruit yield is a complex character influenced by many of its contributing characters which is controlled by polygenes as well as environmental factors. Understanding of inheritance of yield and its related traits, heritability, genetic advance and association between the components traits and yield is necessary for effective selection procedure for evolving high yielding genotypes. The greater genetic diversity in the population is providing wider scope for the improvement of the crop.
To explore the extent of genetic variability and heritability along with the genetic advance is essential for the improvement of the crop by selection. Yield is a complex character influenced by several genetic factors interacting with the environment and requires giving a better insight of the ancillary characters for better selection.
Correlation coefficients merely describe the existence of association between characters. It is rather difficult to explain a system of correlation whenever there is increase in an indirect association of the character. The method of path coefficient analysis is helpful in assessing whether association of characters has either direct or indirect effect on yield or a consequence in indirect effect through some other traits.

## Materials and Methods
The present investigations entitled "Evaluation and genetic studies in tomato (*Solanum lycopersicum* L.) genotypes for yield and contributing traits" were carried out at Vegetable Research Farm of Department of Horticulture, Institute of Agricultural Sciences, B.H.U., Varanasi-221 005, Uttar Pradesh during Rabi season of 2016- 2017. The details of materials and methods used in the experiment are given below.
The material for the present study consisted of 16 genotypes of tomato (*Solanum lycopersicum*) were bought from the ICAR Indian Institute of Vegetable Research, Jakhani, Varanasi. The name of 16 genotypes of tomato used in the investigation are given below.

**Table 1:** List of genotypes used in the trial work

| Sr. No. | Name of Cultivar | Symbols used | Source of genotypes |
|---|---|---|---|
| 1 | Cherry TLCVAR-1 | L1 | IIVR, VARANASI |
| 2 | EC-62050 | L2 | -do- |
| 3 | EC-62017 | L3 | -do- |
| 4 | EC-62025 | L4 | -do- |
| 5 | EC-620501 | L5 | -do- |
| 6 | EC-620507 | L6 | -do- |
| 7 | CherryTLCVAR-6 | L7 | -do- |
| 8 | EC-620518 | L8 | -do- |
| 9 | EC-620522 | L9 | -do- |
| 10 | EC-620523 | L10 | -do- |
| 11 | EC-620528 | L11 | -do- |
| 12 | EC-520029 | L12 | -do- |
| 13 | CherryTLCVAR-4 | L13 | -do- |
| 14 | EC-620530 | L14 | -do- |
| 15 | EC-620537 | L15 | -do- |
| 16 | EC-620538 | L16 | -do- |

The experiment was laid out in Randomized Block Design (RBD) with three replications having a plot size of 3 x 3 $m^2$. Plants of each genotype were planted at a spacing of 60 x 60 cm. A total of 16 genotypes were included to raise the commercial crop of tomato for conducting the experiment in the present studies the experimental filed was given repeated ploughing with disc plough and the cultivars followed by planking. The required tilth was obtained before transplanting. Plots were made under marked area. Basal dose of fertilizer is given

**Result and Discussion**

In general, correlation coefficients were high at genotypic level than phenotypic level. Results also indicated that fruit yield (q/ ha) had positive and significant association with average fruit weight, fruit width, fruit length, number of primary branches per plant and number of seeds per fruit. However, it showed significant positive genotypic correlation with days to 50% flowering and number of locules per fruit. Phenotypic correlation indicated that fruit yield (q/ha) showed significant positive correlation with average fruit weight, fruit width, fruit length and

Fruit yield (q/ha) showed significant positive correlation with average fruit weight, fruit width, fruit length, number of locules per fruit and number of seeds per fruit. The nature of genotypic correlation was similar to phenotypic correlation. However, in some cases, correlation coefficients at genotypic level were significant while at phenotypic level some were found to be non-significant. Yield (q/ha) showed highly significant positive correlation with average fruit weight and total soluble solids, fruit width, fruit length, number of locules per plot and number of seeds per fruit. Similar findings were also reported by Joshi *et al*. (2004) [10]; Singh *et al*. (2006) [24]; Sharma (2008) [22]; Rani *et al*. (2010) [19]; Dar *et al*. (2011) [4, 5]; Kumar and Dudi (2011) [13]; Buckseth *et al*. (2012) [1]; Mann and Paul (2012) [15]; Chernet *et al*. (2013) [2]; Kumar *et al*. (2013) [12], Reddy *et al*. (2013) [20], Sherpa *et al*. (2014) [23], Nalla *et al*. (2015) [18], Meena and Bahadur (2015) [16] and Meena *et al.* (2018) [17], Sharma *et al.* (2019).

Phenotypic path coefficient analysis revealed that maximum positive direct effect towards fruit yield (q/ha) was contributed by average fruit weight followed by number of fruits per plant, number of primary branches per plant, plant height and total soluble solids. However, negative direct effect towards fruit yield per plant was reported by fruit length and pericarp thickness.

Genotypic path coefficient analysis revealed that maximum positive direct effect towards fruit yield (q/ha) was contributed by average fruit weight followed by number of fruits per plant, number of seeds per fruit, number of primary branches per plant, plant height and days to first flowering. However, negative direct effect towards fruit yield per plant was contributed by fruit width, fruit length, pericarp thickness.

Path coefficient analysis indicated highest positive direct effect towards yield *via*. days to 50% flowering followed by fruit width, total soluble solids and average fruit weight. Similar findings were also reported by Harer *et al*. (2002); Kant and Mani (2004); Joshi and Kohli (2005) [5]; Dhankhar and Dhankhar (2006) []; Singh *et al*. (2006) [24]; Anjum *et al*. (2009); Dar *et al*. (2011) [4, 5]; Kumar and Dudi (2011) [13]; Buckseth *et al*. (2012) [1]; Mann and paul (2012) [15]; Sharma and Singh (2012) [21]; Tasisa *et al*. (2012); Kumar *et al*. (2013) [12] and Reddy *et al*. (2013) [20] Meena and Bahadur (2015) [16] and Meena *et al.* (2018) [17], Sharma *et al.* (2019).

Therefore, selection on the basis of traits *viz*., average fruit weight, fruit length, fruit width, number of locules per fruit, number of seeds per fruit would be effective in view of the direct and indirect contribution of component traits towards fruit yield.

**Table 2:** Estimates of phenotypic correlation in tomato for various traits

| Traits | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 1st Flowering | 1.00 | 0.89** | 0.24 | -0.01 | -0.13 | -0.11 | 0.10 | 0.128 | 0.03 | 0.41** | 0.12 | -0.003 | -0.04 | 0.14 |
| Days to 50% flowering | | 1.00 | 0.27 | -0.05 | -0.09 | -0.10 | 0.26 | 0.11 | 0.01 | 0.45** | 0.22 | 0.02 | -0.07 | 0.22 |
| Plant height (cm) | | | 1.00 | -0.05 | 0.48** | 0.51** | -0.35* | -0.13 | -0.243 | 0.19 | -0.36* | 0.60** | -0.32* | 0.14 |
| .Number of primary branches per plant | | | | 1.00 | 0.29* | 0.28 | -0.03 | 0.16 | 0.19 | -0.01 | -0.07 | 0.04 | 0.07 | 0.22 |
| .Number of fruits per cluster | | | | | 1.00 | 0.85** | -0.45** | -0.33* | -0.16 | -0.28* | -0.53** | 0.57** | -0.55** | 0.04 |
| Number of fruits per plant | | | | | | 1.00 | -0.57** | -0.33* | -0.21 | -0.26 | -0.66** | 0.60** | -0.41** | -0.01 |
| Fruit length (cm) | | | | | | | 1.00 | 0.13 | 0.16 | 0.25 | 0.87** | -0.21 | -0.55** | 0.47** |
| Fruit width (cm) | | | | | | | | 1.00 | 0.78** | 0.01 | 0.45** | -0.62** | -0.41** | 0.51** |
| Number of locules per fruit | | | | | | | | | 1.00 | -0.05 | 0.40** | -0.48** | 0.64** | 0.43** |
| Pericarp thickness (mm) | | | | | | | | | | 1.00 | 0.14 | 0.09 | -0.15 | -0.02 |
| Average fruit weight (g) | | | | | | | | | | | 1.00 | -0.49** | 0.39** | 0.63** |
| Total soluble solids (°B) | | | | | | | | | | | | 1.00 | -0.60** | 0.63** |
| Number of seeds per fruit | | | | | | | | | | | | | 1.00 | 0.31* |
| Yield (q/ha) | | | | | | | | | | | | | | 1.00 |

**Table 3:** Estimates of genotypic correlation in tomato for various traits

| Traits | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 1st Flowering | 1 | 0.86** | 0.32* | -0.05 | -0.32* | -0.15 | 0.14 | 0.19 | 0.04 | 0.61** | 0.19 | -0.02 | -0.09 | 0.25 |
| Days to 50% flowering | | 1 | 0.42** | -0.12 | -0.25 | -0.13 | 0.39** | 0.19 | 0.04 | 0.72** | 0.36* | 0.01 | -0.13 | 0.41** |
| Plant height (cm) | | | 1 | -0.06 | 0.51** | 0.53** | -0.36* | -0.14 | -0.27 | 0.19 | 0.52** | 0.62** | -0.34* | 0.09 |
| Number of primary branches per plant | | | | 1 | -0.12 | 0.28 | -0.03 | 0.17 | 0.2 | -0.02 | -0.07 | 0.04 | 0.07 | 0.45* |
| Number of fruits per cluster | | | | | 1 | 0.88** | -0.47** | -0.34* | -0.17 | -0.29* | -0.55** | 0.60** | -0.57** | 0.05 |
| Number of fruits per plant | | | | | | 1 | -0.47** | -0.27 | -0.22 | -0.26 | -0.67** | 0.62** | -0.41** | -0.024 |
| Fruit length (cm) | | | | | | | 1 | 0.14 | 0.17 | -0.27 | 0.87** | -0.22 | 0.14 | 0.50** |
| Fruit width (cm) | | | | | | | | 1 | 0.80** | 0.01 | 0.46** | -0.63** | 0.85** | 0.55** |
| Number of locules per fruit | | | | | | | | | 1 | -0.06 | 0.41** | -0.49** | 0.65** | 0.47** |
| Pericarp thickness (mm) | | | | | | | | | | 1 | 0.14 | 0.09 | -0.16 | -0.03 |
| Average fruit weight | | | | | | | | | | | 1 | -0.49** | 0.40** | 0.67** |
| Total soluble solids (°B) | | | | | | | | | | | | 1 | -0.61** | -0.13 |

**Table 4:** Phenotypic path Coefficient effect in tomato for various traits

| Character | Days to 1st flowering | Plant height (cm) | Number of primary branches per plant | Number of fruits per plant | Fruit length (cm) | Fruit width (cm) | Number of locules per fruit | Pericarp thickness (mm) | Average fruit weight (g) | Total soluble solids (°B) | Number of seeds per fruit | Correlation of yield (q/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 1st flowering | 0.05 | 0.01 | -0.01 | -0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | -0.01 | -0.01 | 0.15 |
| Plant height (cm) | 0.05 | 0.21 | -0.01 | 0.11 | -0.07 | -0.03 | -0.05 | 0.04 | -0.06 | 0.15 | -0.07 | 0.08 |
| Number of primary branches per plant | -0.01 | -0.02 | 0.39 | 0.11 | -0.01 | 0.07 | 0.08 | -0.01 | -0.03 | 0.03 | 0.03 | 0.42 |
| Number of fruits per plant | -0.04 | 0.2 | 0.11 | 0.39 | -0.23 | -0.1 | -0.08 | -0.1 | -0.26 | 0.24 | -0.16 | -0.02 |
| Fruit length (cm) | -0.04 | 0.12 | 0.01 | 0.19 | -0.33 | -0.04 | -0.05 | -0.08 | -0.29 | 0.07 | -0.04 | 0.47 |
| Fruit width (cm) | 0.01 | -0.01 | 0.01 | -0.01 | 0.01 | 0.04 | 0.03 | 0.01 | 0.02 | -0.02 | 0.03 | 0.52 |
| Number of locules per fruit | 0.01 | -0.01 | 0.01 | -0.01 | 0.01 | 0.01 | 0.01 | -0.01 | 0.01 | -0.01 | 0.01 | 0.44 |
| Pericarp thickness (mm) | -0.03 | -0.02 | 0.01 | 0.02 | -0.02 | -0.01 | 0.01 | -0.08 | -0.01 | -0.02 | 0.01 | -0.03 |
| Average fruit weight (g) | 0.16 | -0.48 | -0.1 | -0.88 | 1.15 | 0.6 | 0.53 | 0.19 | 1.32 | -0.64 | 0.52 | 0.63 |
| Total soluble solids (°B) | -0.01 | 0.09 | 0.01 | 0.09 | -0.03 | -0.1 | -0.07 | 0.01 | -0.07 | 0.15 | -0.09 | -0.13 |
| Number of seeds per fruit | -0.01 | -0.03 | 0.01 | -0.04 | 0.01 | 0.08 | 0.06 | -0.01 | 0.04 | -0.05 | 0.09 | 0.32 |

**Table 5:** Genotypic path Coefficient effect in tomato for various traits

| Character | Days to 1st flowering | Plant height (cm) | Number of primary branches per plant | Number of fruits per plant | Fruit length (cm) | Fruit width (cm) | Number of locules per fruit | Pericarp thickness (mm) | Average fruit weight (g) | Total soluble solids (°B) | Number of seeds per fruit | Correlation of yield (q/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 1st Flowering | 0.24 | 0.08 | -0.01 | -0.03 | 0.03 | 0.05 | 0.01 | 0.14 | 0.04 | -0.01 | -0.02 | 0.25 |
| Plant height (cm) | 0.11 | 0.33 | -0.02 | 0.18 | -0.12 | -0.04 | -0.09 | 0.07 | -0.12 | 0.2 | -0.11 | 0.1 |
| Number of primary branches per plant | -0.02 | -0.03 | 0.44 | 0.13 | -0.01 | 0.08 | 0.09 | -0.01 | -0.03 | 0.02 | 0.03 | 0.45 |
| Number of fruits per plant | -0.08 | 0.28 | 0.15 | 0.53 | -0.31 | -0.14 | -0.12 | -0.14 | -0.36 | 0.33 | -0.22 | -0.02 |
| Fruit length (cm) | -0.04 | 0.1 | 0.01 | 0.16 | -0.27 | -0.04 | -0.04 | -0.07 | -0.24 | 0.06 | -0.04 | 0.5 |
| Fruit width (cm) | -0.09 | 0.06 | -0.08 | 0.13 | -0.06 | -0.47 | -0.38 | -0.01 | -0.22 | 0.3 | -0.4 | 0.55 |
| Number of locules per fruit | 0.01 | -0.04 | 0.03 | -0.03 | 0.03 | 0.12 | 0.15 | -0.01 | 0.06 | -0.07 | 0.09 | 0.47 |
| Pericarp thickness (mm) | -0.08 | -0.03 | 0.01 | 0.04 | -0.04 | -0.01 | 0.01 | -0.14 | -0.02 | -0.01 | 0.02 | -0.03 |
| Average fruit weight (g) | 0.25 | -0.51 | -0.1 | -0.93 | 1.2 | 0.63 | 0.56 | 0.2 | 1.37 | -0.68 | 0.55 | 0.66 |
| Total soluble solids (°B) | -0.01 | 0.01 | 0.01 | 0.01 | -0.01 | -0.01 | -0.01 | 0.01 | -0.01 | 0.01 | -0.01 | -0.13 |
| Number of seeds per fruit | -0.04 | -0.15 | 0.03 | -0.19 | 0.06 | 0.38 | 0.29 | -0.07 | 0.18 | -0.27 | 0.45 | 0.35 |

## Conclusion

Based on the above investigation, it can be concluded that genotypes were having wide diversity and variability for most of the traits. In general, correlation coefficients were high at genotypic level than phenotypic level. Results also indicated that fruit yield (q/ ha) had positive and significant association with average fruit weight, fruit width, fruit length, number of primary branches per plant and number of seeds per fruit. However, it showed significant positive genotypic correlation with days to 50% flowering and number of locules per fruit. Phenotypic correlation indicated that fruit yield (q/ha) showed significant positive correlation with average fruit weight, fruit width, fruit length and number of locules per fruit. Path coefficient analysis also indicated that days to 50% flowering had the maximum direct contribution towards yield (q/ha) followed by fruit width, total soluble solids and average fruit weight. These traits may be given more emphasis for direct selection of high yielding tomato genotypes in future tomato breeding programmes. Hence, there is ample scope of selection for these traits.

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