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# Correlation coefficient and path analysis studies in tomato (*Solanum lycopersicum* L.)

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## ABSTRACT

*The investigation was carried out at the Horticulture Research Farm of the B.B.A. University, Lucknow (UP), India during rabi season of 2017-18 and 2018-19 to. Study the correlation coefficient and path analysis in tomato (Solanum lycopersicum L.). The twenty genotypes were evaluated in randomized block design with three replication. Genotypic correlation coefficient was indicated that fruit yield (q ha$^{-1}$) exhibited highly significant positive correlations with average fruit weight (1.042), fruits per plant (0.996), branches per plant (0.831) and fruits per cluster (0.749). It also registered significant negative correlation with days to 50 % flowering (-0.835). However, phenotypic correlation coefficient indicated that fruit yield (q ha$^{-1}$) had highly significant positive correlations with fruits per plant (0.977), clusters per plant (0.893), average fruit weight (0.729) whereas, significant negative correlation with days to 50 % flowering (-0.178). Path analysis revealed that the traits like fruit yield kg/plot (1.430) and fruit yield per plant (0.034) exhibited positive direct effects on fruit yield and these traits also recorded positive correlation with yield. This suggested that direct selection based on these traits will be rewarding for crop yield improvement.*

**Key-words:** Tomato, correlation coefficient, path analysis

## INTRODUCTION

The cultivated tomato (*Solanum lycopersicum* L.) belonging to the family Solanaceae, is one of the most consumed vegetable worldwide and a well-studied crop species in terms of genetics, genomics and breeding. It has multipurpose uses in fresh as well as Processed food industries and is one of the most nutritive vegetable rich in Vitamin A, Vitamin C, protein, fat, carbohydrates as well as other essential minerals and food elements (Mahapatra *et al.* 2013). Systematic study and evaluation of germplasm is of great importance for current and future agronomic and genetic improvement of the crop (Reddy *et al.* 2013).Correlation coefficient helps a breeder to select an efficient trait in breeding programme and to allocate appropriate weight age for obtaining optimal results. Path analysis facilitates the partitioning of correlation coefficients into direct and indirect effects of various characters on yield or any other attributes and also permits critical examination of specific factors that provide a given correlation. As yield is a complex character, its direct improvement is difficult. The knowledge of the relationship among yield and other plant characters and their relative contribution to yield is very useful, while formulating the selection scheme with the target to improve yield. Therefore, in order to formulate a sound breeding plan for its improvement, the present experiment was conducted to determine the correlation and direct and indirect effect of various traits on fruit yield of tomato through path coefficient analysis

## MATERIALS AND METHODS

The field experiment was conducted at Babasaheb Bhimrao Ambedkar University, Lucknow (UP), during rabi season of 2017-18 and 2018-19. The experimental site is situated at 26$^0$50 N latitude, 80$^0$52' E longitude and altitude of 111 meter above mean sea level (MSL). The area experiences rainfall from April to October with the many rains from June to early September. The area receives average rainfall between 800-1000 mm with annual and maximum temperature ranging from 15 to 30$^0$C. The experimental materials consisted of twenty genotypes of tomato i.e. LA-3957, Rio-Grande, Punjab Barkha Bahar-2, Kashi Aman, Solan

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Vojr, IIHR-2202, VRT-103-6-1, Kalyanpur type-1, Switizar Land, Pusa Sadabahar, VRT-02 (Pe), TLCV-16, VRT-50, Selection-7, Toleu-32, VRT-01, H-86, KT-8, TLCV-28 and VRT-51. Correlation coefficient analysis was done as per Al-Jibouri *et al.*(1958) and the path coefficient analysis was estimated according to the formulae suggested by Dewey and Lu (1959). The experiment was evaluated in randomized block design with three replication. Recommended dose of N, $P_2O_5$ and $K_2O$ was supplied through urea, single superphosphate and muriate of potash, respectively. Appropriate management practices were adopted to raise the crop. Observations were recorded on plant height, number of branches/plant, days to 50% flowering, number of clusters per plant, number of flower per cluster, number of fruit per plant, average fruit weight, number of locules per fruit, pericarp thickness, fruit length, fruit width, fruit yield per plant, fruit yield (kg/plot), fruit yield (q/ha). All the parameters were collected from randomly selected plants of each treatment. Observations on vegetative parameters were recorded at proper stage and statistically analyzed.

## RESULTS AND DISCUSSION

*Correlation coefficient*

The correlation coefficients among different characters were worked out in all possible combinationsn at genotypic and phenotypic levels (Table 1&2). In general, the correlation coefficient at genotypic level were higher in magnitude than the corresponding values of phenotypic correlations. The nature of genotypic correlations was more or less similar to phenotypic correlations. Genotypic correlation coefficient indicated that fruit yield (q $ha^{-1}$) recorded positive and significant correlations with fruits per plant (0.996) followed by branches per plant (0.831) and fruits per cluster (0.749). It also registered significant negative correlation with days to 50% flowering (-0.835) and pericarp thickness (-0.069). Fruit yield (kg/plot) had positive and significant correlation with cluster per plant (0.975) followed by plant height (0.937) and negative and significant correlation with days to 50 % flowering (-0.835) followed by pericarp thickness (-0.068). Fruit yield per plant had positive and significant correlation with number of fruits per plant (0.996) followed by cluster per plant (0.975), negatively and significantly correlation with day to 50 % flowering (-0.835). Pericarp thickness had positive and significantly correlation with average fruit weight (0.667) followed by number of fruits per cluster (0.298). Locules per fruit was positively and significantly correlated with average fruit weight (0.846) followed by plant height (0.340) at genotypic level. Average fruit weight positive and significantly correlation with flowers per cluster (0.945) and negative and significant correlation with days to 50 % flowering (-0.592). Fruit per plant recorded positive and significant correlations with clusters per plant (0.987) followed by flowers per cluster (0.934) whereas, negatively and significantly correlation with day to 50 % flowering (-0.843). Fruits per cluster had positive and significantly correlation with plant height (0.848) however negative and significant correlation with day to 50 % flowering (-0.689).

The correlation coefficient indicated that fruit yield (q $ha^{-1}$) was found to have positive and significant correlation with number of fruits per plant (0.977) followed by clusters per plant (0.893) and negative and significant one with days to 50% flowering (-0.178). Fruit yield (kg/plot) had positive and significant correlation with cluster per plant (0.893) followed by fruits per cluster (0.816). Fruit yield per plant was positively and significant ly correlated with average fruit weight (0.976), and negatively and significantly with days to 50 % flowering (-0.178). Pericarp thickness had positive and significant correlation with fruits per cluster (0.587) and negative and significant with branches per plant (-0.117). Locules per fruit also had positive and significant correlation with average fruit weight (0.903) followed by clusters per plant (0.677). Average fruit weight had positive and significant correlation with clusters per plant (0.918) followed by flowers per cluster (0.605). Fruits per plant recorded positive and significant correlations with clusters per plant (0.627) and negative and significant with days to 50 % flowering (-0.208). Fruits per cluster was observed to have positive and significant correlation with cluster per plant (0.856). The influence of each character on yield could be

Table 1: Genotypic correlation coefficient for different pairs of characters in 20 parents of tomato

| Character | Branches per plant | Days to 50% flowering | Clusters per plant | Flowers per cluster | Fruits per cluster | Fruits per plant | Average fruit weight | Locules per fruit | Pericarp thickness | Fruit yield per plant | Fruit yield (kg/plot) | Fruit yield (q/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant height (cm) | 0.892 | -0.795 | 0.968 | 0.927** | 0.848** | 0.930 | 1.109 | 0.340** | -0.047 | 0.937 | 0.937** | 0.937 |
| Branches per plant | | -0.848** | 0.820 | 0.870 | 0.733 | 0.842 | 1.113 | 0.024 | -0.224 | 0.831 | 0.832 | 0.831** |
| Days to 50% flowering | | | -0.936** | -0.935 | -0.689** | -0.843** | -0.592** | -0.256 | 0.153 | -0.835** | -0.835** | -0.835*** |
| Clusters per plant | | | | 0.988** | 0.770 | 0.987** | 0.902 | 0.264 | -0.204 | 0.975** | 0.975** | 0.975 |
| Flowers per cluster | | | | | 0.778 | 0.934** | 0.945** | 0.233 | -0.230 | 0.928 | 0.928 | 0.928 |
| Fruits per cluster | | | | | | 0.768 | 1.160 | 0.096 | 0.298* | 0.751 | 0.750 | 0.749** |
| Fruits per plant | | | | | | | 1.010 | 0.230 | -0.110 | 0.996** | 0.996 | 0.996** |
| Average fruit weight | | | | | | | | 0.846** | 0.667** | 1.042 | 1.045 | 1.042** |
| Locules per fruit | | | | | | | | | 0.493 | 0.273 | 0.274 | 0.272 |
| Pericarp thickness | | | | | | | | | | -0.066* | -0.068 | -0.069 |
| Fruit yield per plant | | | | | | | | | | | 1.000 | 1.000 |
| Fruit yield (kg/plot) | | | | | | | | | | | | 1.000 |
| Fruit yield (q/ha) | | | | | | | | | | | | 1.000 |

Table 2. Phenotypic correlation coefficient for different pairs of characters in 20 parents of tomato

| Character | Branches per plant | Days to 50% flowering | Clusters per plant | Flowers per cluster | Fruits per cluster | Fruits per plant | Average fruit weight | Locules per fruit | Pericarp thickness | Fruit yield per plant | Fruit yield (kg/plot) | Fruit yield (q/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant height (cm) | 0.307 | -0.357 | 0.372 | 0.532** | 0.436 | 0.387 | 0.539 | 0.157 | -0.025 | 0.528 | 0.529 | 0.529 |
| Branches per plant | | -0.392* | 0.348** | 0.513 | 0.411 | 0.434 | 0.576 | 0.022 | -0.117* | 0.517 | 0.517 | 0.517 |
| Days to 50% flowering | | | 0.157 | -0.421 | 0.037 | -0.208** | 0.149 | 0.331 | 0.519 | -0.178* | -0.178 | -0.178* |
| Clusters per plant | | | | 0.532 | 0.856** | 0.627** | 0.918** | 0.677** | 0.457 | 0.893 | 0.893** | 0.893** |
| Flowers per cluster | | | | | 0.534 | 0.502 | 0.605** | 0.200 | -0.08 | 0.685 | 0.685 | 0.685 |
| Fruits per cluster | | | | | | 0.585 | 1.067 | 0.488 | 0.587** | 0.816 | 0.816** | 0.816 |
| Fruits per plant | | | | | | | 0.717 | 0.318 | 0.143 | 0.729 | 0.729 | 0.977* |
| Average fruit weight | | | | | | | | 0.903** | 0.813 | 0.976** | 0.978 | 0.729** |
| Locules per fruit | | | | | | | | | 0.731 | 0.509 | 0.510 | 0.509 |
| Pericarp thickness | | | | | | | | | | 0.284 | 0.283 | 0.283 |
| Fruit yield per plant | | | | | | | | | | | 1.000 | 1.000 |
| Fruit yield (kg/plot) | | | | | | | | | | | | 1.000 |
| Fruit yield (q/ha) | | | | | | | | | | | | 1.000 |

Table 3. Genotypic path coefficient analysis (direct and indirect effect) of yield contributing of characters of tomato

| Character | Branches per plant | Days to 50% flowering | Clusters per plant | Flowers per cluster | Fruits per cluster | Fruits per plant | Average fruit weight | Locules per fruit | Pericarp thickness | Fruit yield per plant | Fruit yield (kg/plot) | Fruit yield (q/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant height (cm) | **-0.199** | -0.071 | 0.040 | -0.032 | 0.028 | 0.032 | 0.007 | 0.030 | 0.003 | 0.007 | -0.264 | 1.340 |
| Branches per plant | -0.178 | **-0.079** | 0.042 | -0.027 | 0.027 | 0.028 | 0.006 | 0.030 | 0.000 | 0.008 | -0.234 | 1.189 |
| Days to 50% flowering | 0.158 | 0.067 | **-0.050** | 0.031 | -0.029 | -0.026 | -0.006 | -0.016 | -0.002 | -0.006 | 0.235 | -1.194 |
| Clusters per plant | -0.193 | -0.065 | 0.047 | **-0.033** | 0.030 | 0.029 | 0.008 | 0.025 | 0.002 | 0.002 | -0.275 | 1.394 |
| Flowers per cluster | -0.184 | -0.069 | 0.047 | -0.032 | **0.031** | 0.029 | 0.007 | 0.026 | 0.002 | 0.006 | -0.261 | 1.327 |
| Fruits per cluster | -0.169 | -0.058 | 0.034 | -0.025 | 0.024 | **0.038** | 0.006 | 0.032 | 0.001 | 0.012 | -0.211 | 1.073 |
| Fruits per plant | -0.185 | -0.067 | 0.042 | -0.032 | 0.029 | 0.029 | **0.008** | 0.028 | 0.002 | 0.005 | -0.281 | 1.424 |
| Average fruit weight | -0.221 | -0.088 | 0.029 | -0.030 | 0.029 | 0.044 | 0.008 | **0.027** | 0.008 | 0.021 | -0.293 | 1.494 |
| Locules per fruit | -0.068 | -0.002 | 0.013 | -0.009 | 0.007 | 0.004 | 0.002 | 0.023 | **0.009** | 0.018 | -0.077 | 0.391 |
| Pericarp thickness | 0.009 | 0.018 | -0.008 | 0.007 | -0.007 | 0.011 | -0.001 | 0.018 | 0.005 | **0.014** | 0.019 | -0.098 |
| Fruit yield per plant | -0.013 | 0.032 | -0.002 | -1.002 | 0.456 | -0.043 | -0.008 | 0.022 | -0.009 | -0.027 | **0.034** | -1.102 |
| Fruit yield (kg/plot) | -0.187 | -0.066 | 0.042 | -0.032 | 0.028 | 0.028 | 0.008 | 0.028 | 0.003 | 0.005 | -0.282 | **1.430** |
| Fruit yield (q/ha) | **-0.187** | **-0.066** | **0.042** | **-0.032** | **0.028** | **0.028** | **0.008** | **0.028** | **0.003** | **0.005** | **-0.282** | **1.430** |

Table 4. Phenotypic path coefficient analysis (direct and indirect effect) of yield contributing of characters of tomato

| Character | Branches per plant | Days to 50% flowering | Clusters per plant | Flowers per cluster | Fruits per cluster | Fruits per plant | Average fruit weight | Locules per fruit | Pericarp thickness | Fruit yield per plant | Fruit yield (kg/plot) | Fruit yield (q/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant height (cm) | **-0.003** | -0.001 | 0.000 | -0.018 | 0.000 | 0.003 | 0.000 | 0.004 | 0.002 | 0.001 | 0.264 | 0.281 |
| Branches per plant | -0.001 | **-0.004** | 0.000 | -0.017 | 0.000 | 0.003 | 0.000 | 0.004 | 0.000 | 0.000 | 0.258 | 0.275 |
| Days to 50% flowering | 0.001 | 0.002 | **0.000** | -0.008 | 0.000 | 0.000 | 0.000 | 0.001 | 0.003 | 0.000 | -0.089 | -0.094 |
| Clusters per plant | -0.001 | -0.001 | 0.000 | **-0.050** | 0.000 | 0.007 | 0.000 | 0.007 | 0.007 | 0.000 | 0.445 | 0.474 |
| Flowers per cluster | -0.001 | -0.002 | 0.000 | -0.026 | **-0.001** | 0.004 | 0.000 | 0.004 | 0.002 | -0.001 | 0.342 | 0.363 |
| Fruits per cluster | -0.001 | -0.002 | 0.000 | -0.042 | 0.000 | **0.008** | 0.000 | 0.008 | 0.005 | -0.001 | 0.407 | 0.433 |
| Fruits per plant | -0.001 | -0.002 | 0.000 | -0.031 | 0.000 | 0.004 | **0.018** | 0.005 | 0.003 | -0.001 | 0.364 | 0.387 |
| Average fruit weight | -0.001 | -0.002 | 0.000 | -0.046 | 0.000 | 0.008 | 0.001 | **0.007** | 0.009 | -0.001 | 0.487 | 0.519 |
| Locules per fruit | 0.000 | 0.000 | 0.000 | -0.034 | 0.000 | 0.004 | 0.000 | 0.007 | **0.010** | -0.001 | 0.254 | 0.271 |
| Pericarp thickness | 0.000 | 0.000 | 0.000 | -0.023 | 0.000 | 0.004 | 0.000 | 0.006 | 0.007 | **-0.001** | 0.142 | 0.150 |
| Fruit yield per plant | 0.000 | 0.000 | 0.000 | 0.002 | 0.000 | -0.001 | 0.000 | -0.002 | -0.003 | 0.005 | **0.049** | -0.053 |
| Fruit yield (kg/plot) | -0.001 | -0.002 | 0.000 | -0.044 | 0.000 | 0.006 | 0.001 | 0.007 | 0.005 | 0.000 | 0.499 | **0.531** |
| Fruit yield (q/ha) | **-0.001** | **-0.002** | **0.000** | **-0.044** | **0.000** | **0.006** | **0.001** | **0.007** | **0.005** | **0.000** | **0.499** | **0.531** |

known through correlation studies with a view to determine the extent and nature of relationships prevailing among yield and yield attributing characters. Direct selection based on these traits would result in simultaneous improvement of traits and yield per se in tomato. Similar results were reported by Ara *et al.* (2009), Ghosh *et al.* (2010) and Ullah *et al*. (2015). Similarly, Rani *et al.* (2010), Dar *et al.* (2011) and Tiwari *et al*. (2013) also reported that average fruit weight exerted positive direct effect on fruit yield.

*Path coefficient analysis***:** Path coefficient analysis gives an idea about the contribution of each independent character on the dependent character. Since the mutual relationship of component characters might vary both in magnitude and direction, it may tend to vitiate the association of fruit yield with other attributes. Therefore, it is necessary to partition the correlation into direct and indirect effects of each other. The highest positive (direct and indirect) effect on fruit yield (q $ha^{-1}$) was exhibited by fruit yield kg/plot (1.430), fruits per cluster (0.038), fruit yield per plant (0.034), flowers per cluster (0.031), average fruit weight (0.027), pericarp thickness (0.014), locules per fruit (0.009) and fruits per plant (0.008). Further, the maximum negative (direct and indirect) effect towards fruit yield (q $ha^{-1}$) was exhibited by plant height (-0.199), branches per plant (-0.079), days to 50 % flowering (-0.050), and clusters per fruit (-0.033). The maximum positive phenotypic path coefficient analysis (direct and indirect) effect on fruit yield (q $ha^{-1}$) was exhibited by fruit yield (kg/plot) (0.531), fruit yield per plant (g) (0.049), fruits per plant (0.018), pericarp thickness (0.010) and locules per fruit (0.007). However, the highest negative (direct and indirect) effect on fruit yield (q $ha^{-1}$) was exhibited by clusters per plant (-0.050), branches per plant (-0.004), plant height (-0.003) and flowers per plant (-0.001). Results of the path coefficient analysis revealed the improvement of yield by improving the characters like days to first flowering, fruits per plant and weight of fruit. Similarly Kumar *et al.* (2013) reported that yield can be improved directly by improving fruit weight. The traits like fruits per plant and average fruit weight exhibited positive direct effects on fruit yield and these traits also recorded positive correlation with yield. This suggested that direct selection based on these traits will be rewarding for crop yield improvement. Similar results were also reported in tomato by Singh and Narayan (2004) and Rawat *et al.* (2017). In this study, yield per plant of tomato can also been increased indirectly through number of primary branches, days to fruit set and also through number of fruits per plant and average weight of fruit.

The results revealed the occurrence of considerable positive as well as negative direct and indirect effects by various characters on the fruit yield of tomato through one or other characters. Path analysis revealed that the traits like fruit yield (kg/plot), fruit yield per plant (g) and fruits per plant exhibited positive direct effects on fruit yield and these traits also recorded positive correlation with yield. Thus, it can be concluded that the characters mentioned above should be duly considered at the time of formulation of selection strategy to develop high yielding varieties in tomato.

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