Character Association and Path Coefficient Studies in Tomato

M. Behera¹*, P. N. Jagadev¹, S. Das¹, K. Pradhan² and B. B. Sahoo²

¹Department of Plant Breeding and Genetics, Odisha University of Agriculture and Technology, Bhubaneswar-751003, India
²Regional Research and Technology Transfer Station, Semiliguda, Koraput, OUAT, Bhubaneswar-751003, India

*Corresponding author

A B S T R A C T

The present investigation was conducted at Regional Research Technology Transfer Station, Semiliguda, Koraput during kharif, 2017 in 40 advance lines of tomato to find out the degree of association of component characters with yield and the direct and indirect effects of the traits on fruit yield. The results revealed that the estimates of correlation at phenotypic and genotypic levels was positively significantly highest between fruit yield and number of fruits per plant followed by number of flower clusters per plant, number of fruits per cluster, number of flowers per cluster and root volume. Path coefficient studies at phenotypic level showed that the highest direct contribution to fruit yield was observed through number of fruits per plant followed by number of flower clusters per plant and average fruit weight. Hence for increasing the fruit yield, selection should be based on plants bearing more number of fruits, flower clusters and flowers per cluster.

Keywords
Character association, Correlation, Path coefficient analysis, Tomato

Introduction

Tomato (Solanum lycopersicum L.) is one of the important and widely popular vegetable crops grown in India. India ranks 2nd in both area and production in world and ranks 5th among the vegetables in antioxidant activity assays. Selection based on yield alone is not reliable as influenced by the environment. Therefore indirect selections through component characters became important in a breeding programme for yield improvement. Studies on character association and path analysis not only help in understanding the physical linkage but also give useful information about the direction of selection.

Keeping this in view, the present investigation was undertaken to find out the nature and magnitude of correlations among the characters for selecting the character combinations and path analysis has been used to organize the relationships between the predicted and responsible variables to understand the direct and indirect effects of each of the characters on the fruit yield for increasing the productivity.
Materials and Methods

The experiment was conducted at Regional Research Technology Transfer Station, Semiliguda, Koraput during kharif, 2017 with 40 advance lines of tomato in a Randomized Block Design with two replications maintaining a spacing of 60 x 40 cm. The plot size was 3.0 m x 2.8m. Recommended cultural practices were followed. Observations on 15 morpho-physiological traits (Table 1) were taken from five competitive plants selected on random from middle rows of each plot. The mean data were used for analysis of variance and covariance (Panse and Sukhatme, 1967). From the covariance components, the correlation coefficients at genotypic and phenotypic levels were estimated (Miller et al., 1958) and these were used for path coefficient analysis (Dewey and Lu, 1959).

Results and Discussion

Correlation studies (Table 1) showed that for most character pairs, genotypic and phenotypic associations were in the same directions and the genotypic estimates were higher than the phenotypic ones, indicating an inherent association between the characters. High significant positive association between flower clusters/plant and number of fruits/plant was observed both at genotypic and phenotypic levels, indicated that increase in number of flower clusters had direct bearing on more production of fruits. Further, total fruit yield, the most important economic trait, exhibited the highest positive association with number of fruits per plant followed by number of clusters per plant and number of fruits per cluster, number of flowers per cluster and root volume. The highest estimates of genotypic correlation was between fruit yield and number of clusters per plant, followed by number of fruits per plant and number of fruits per cluster. The rest characters showed non-significant correlations with total fruit yield.

When other characters considered (other than yield), plant height had a significant positive correlation at phenotypic level with number of branches per plant and at genotypic level, it had a significant correlation with number of branches per plant (0.466) at 5% level. Number of branches per plant showed positive significant association with LAI at genotypic level (0.330). Number of clusters per plant had significant positive correlation with number of fruits per plant, followed by number of fruit per cluster and root volume both at genotypic and phenotypic levels. The negative correlation of number of fruits/plant with fruit girth, fruit weight, LAI and total chlorophyll content indicated that an increase in fruit girth, fruit weight, LAI and chlorophyll content would result in reduction of number of fruits production/plant.

From the Table 1, it was revealed that the highest estimates of correlation at phenotypic level was between fruit yield and number of fruits per plant (0.890), followed by number of clusters per plant (0.868), number of fruits per cluster (0.549), number of flowers per cluster (0.536) and root volume (0.403). The highest estimates of genotypic correlation was between fruit yield and number of clusters per plant, followed by number of fruits per plant (0.972), number of fruits per cluster (0.914), number of fruits per cluster (0.866), number of flowers per cluster (0.867) and root volume (0.410). The rest characters showed non-significant correlations with total fruit yield.
Table 1: Phenotypic ($r_p$) and genotypic ($r_g$) correlation co-efficient among various characters for 40 tomato genotypes

| Characters                  | Days to 50% flowering | Plant height | No. of branch/ plant | No. of cluster/ plant | No. of flower/ cluster | No. of fruit/ plant | Polar diameter of plant | Equitorial diameter of plant | Pericarp thickness | Average fruit weight | Root volume | Leaf area index | Total chlorophyll content |
|-----------------------------|------------------------|--------------|----------------------|-----------------------|------------------------|---------------------|------------------------|-----------------------------|-------------------|---------------------|-------------|----------------|-------------------------|
| Plant height                | $r_p$ -0.138            |              |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
|                            | $r_g$ -0.285            |              |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
| No. of branch/plant         | $r_p$ -0.393 0.466**    | $r_g$ -0.882 0.507** |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
| No. of cluster/plant        | $r_p$ -0.057 -0.050 0.052 | $r_g$ 0.010 -0.054 0.047 |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
| No. of flower/cluster       | $r_p$ -0.074 0.061 -0.010 0.739** | $r_g$ -0.143 -0.057 0.013 0.756** |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
| No. of fruit/cluster        | $r_p$ -0.005 -0.125 -0.133 0.746** 0.782** | $r_g$ -0.047 -0.119 -0.124 0.775** 0.810** |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
| No. of fruit/ plant         | $r_p$ -0.154 -0.194 0.126 0.777** 0.572** 0.583** | $r_g$ -0.217 -0.197 0.128 0.861** 0.619** 0.634** |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
| Polar diameter of fruit     | $r_p$ 0.030 0.147 -0.026 0.177 0.096 0.070 0.122 | $r_g$ 0.206 0.160 -0.017 0.173 0.086 0.088 0.126 |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
| Equitorial diameter of fruit| $r_p$ -0.041 0.108 -0.167 0.098 0.082 0.065 -0.139 0.331 | $r_g$ -0.158 0.109 -0.182 0.103 0.081 0.086 -0.139 0.330 |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
| Pericarp thickness          | $r_p$ -0.122 0.283 0.196 0.216 0.059 0.072 0.184 0.413** -0.127 | $r_g$ -0.213 0.287 0.231 0.256 0.076 0.097 0.195 0.444** -0.150 |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
| Average fruit weight        | $r_p$ 0.182 0.001 0.016 0.241 -0.004 -0.006 -0.164 0.157 0.415** 0.071 | $r_g$ 0.224 0.001 0.099 0.306 0.012 -0.006 -0.131 0.204 0.448** 0.070 |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
| Root volume                 | $r_p$ 0.123 0.222 0.003 0.308 -0.001 -0.018 0.188 0.198 0.337** 0.137 0.420** | $r_g$ 0.260 0.220 0.220 0.336* 0.001 -0.013 0.191 0.211 0.348* 0.141 0.455** |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
| Leaf area index             | $r_p$ 0.220 0.251 0.161 0.021 -0.022 -0.050 -0.100 0.168 -0.066 0.380* 0.255 0.054 | $r_g$ 0.629* 0.330* 0.330* -0.021 -0.092 -0.108 -0.127 0.174 -0.121 0.463** 0.336* 0.065 |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
| Total chlorophyll content   | $r_p$ 0.211 0.013 -0.056 0.147 0.069 0.259 -0.003 0.092 0.176 0.165 0.207 0.109 0.249 | $r_g$ 0.427** 0.014 0.014 0.173 0.081 0.289 -0.006 0.101 0.181 0.169 0.222 0.108 0.308 |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |
| Fruit yield                 | $r_p$ -0.077 -0.127 0.138 0.868** 0.536** 0.549** 0.890** 0.190 0.064 0.188 0.225 0.403** -0.016 0.051 | $r_g$ -0.187 -0.135 -0.135 0.972** 0.567** 0.586** 0.914** 0.214 0.063 0.190 0.242 0.410** 0.002 0.051 |                      |                       |                        |                     |                        |                              |                   |                     |             |                |                         |

$r \geq 0.312$ sig at 5% level $* r \geq 0.403$ sig at 1% level $^{**}$

$r_p$ = correlation at phenotypic level, $r_g$ = correlation at genotypic level
Table 2 Direct (diagonal) and indirect effects of component traits on yield at phenotypic level for 40 tomato advance lines

|                          | Days to 50% flowering | Plant height | No. of branches/plant | No. of cluster/cluster | No. of flower/cluster | No. of fruit/cluster | Polar diameter of plant | Equatorial diameter of plant | Pericarp thickness | Average fruit weight | Root volume | Leaf area index | Total chlorophyll content | Fruit yield |
|--------------------------|------------------------|--------------|-----------------------|------------------------|-----------------------|----------------------|------------------------|--------------------------|----------------------|----------------------|--------------|----------------|-------------------------|-------------|
| Days to 50% flowering    | 0.019                  | -0.002       | -0.011                | -0.015                 | 0.007                 | 0.001                | -0.123                 | -0.001                   | -0.001               | 0.004                | 0.047        | 0.006          | -0.001                 | -0.007      |
| Plant height             | -0.003                 | 0.016        | 0.013                 | -0.013                 | 0.006                 | 0.003                | -0.154                 | 0.001                    | 0.004                | -0.010               | 0.001        | 0.011          | -0.001                 | 0.001       |
| No. of branch/plant      | -0.007                 | 0.007        | 0.028                 | 0.014                  | 0.001                 | 0.003                | 0.099                  | 0.001                    | -0.006               | -0.007               | 0.004        | 0.001          | -0.001                 | 0.002       |
| No. of cluster/cluster   | -0.001                 | -0.001       | 0.001                 | 0.266                  | -0.067                | -0.019               | 0.618**                | 0.002                    | 0.003                | -0.007               | 0.063        | 0.016          | 0.001                   | -0.005      |
| No. of flower/cluster    | -0.001                 | -0.001       | 0.000                 | 0.196                  | -0.091                | -0.020               | 0.455**                | 0.001                    | 0.003                | -0.002               | -0.001       | 0.001          | 0.001                   | -0.002      |
| No. of fruit/cluster     | 0.001                  | -0.002       | -0.003                | 0.198                  | -0.071                | -0.026               | 0.464**                | 0.001                    | 0.002                | -0.002               | -0.002       | -0.001        | 0.001                   | -0.009      |
| No. of fruit/cluster     | -0.003                 | -0.003       | 0.003                 | 0.206                  | -0.052                | -0.015               | 0.796**                | 0.001                    | -0.005               | -0.006               | -0.043       | 0.010          | 0.001                   | 0.890**     |
| Polar diameter of fruit  | 0.001                  | 0.002        | -0.001                | 0.047                  | -0.009                | -0.002               | 0.097                  | 0.010                    | 0.011                | -0.014               | 0.041        | 0.010          | -0.001                 | -0.003      |
| Equatorial diameter of fruit | -0.001              | 0.002        | -0.005                | 0.026                  | -0.007                | -0.002               | -0.111                 | 0.003                    | 0.034                | 0.004                | 0.108        | 0.017          | 0.001                   | -0.006      |
| Pericarp thickness       | -0.002                 | 0.005        | 0.005                 | 0.057                  | -0.005                | -0.002               | 0.146                  | 0.004                    | -0.004               | -0.036               | 0.019        | 0.007          | -0.002                 | -0.006      |
| Average fruit weight     | 0.003                  | 0.001        | 0.001                 | 0.064                  | 0.001                 | 0.001                | -0.130                 | 0.002                    | 0.014                | -0.002               | 0.261        | 0.021          | -0.001                 | -0.007      |
| Root volume              | 0.022                  | 0.044        | 0.001                 | 0.082                  | 0.001                 | 0.001                | 0.0150                 | 0.002                    | 0.012                | -0.005               | 0.110        | 0.051          | 0.001                   | -0.004      |
| Leaf area index          | 0.004                  | 0.004        | 0.004                 | 0.006                  | 0.002                 | 0.001                | -0.080                 | 0.002                    | -0.002               | -0.013               | 0.067        | 0.003          | -0.005                 | -0.009      |
| Total chlorophyll content| 0.04                   | 0.001        | -0.002                | 0.039                  | -0.006                | -0.007               | -0.002                 | 0.001                    | 0.006                | -0.006               | 0.054        | 0.006          | -0.001                 | -0.035      |

Sig at 5% level* sig at 1% level**
Polar diameter of fruit had positive significant correlation with average fruit weight ($r_p = 0.415$, $r_g = 0.444$). Equatorial diameter of fruit had significant positive correlation with average fruit weight ($r_p = 0.415$, $r_g = 0.448$) followed by root volume ($r_p = 0.337$, $r_g = 0.348$). Pericarp thickness had positive significant correlation with leaf area index ($r_p = 0.380$, $r_g = 0.463$). Average fruit weight had positive significant correlation with root volume ($r_p = 0.420$, $r_g = 0.455$). Similar type of results were also obtained by Mahapatra et al., (2013), Kumar (2014) and Khan and Samadia (2018).

The path coefficient analysis was done for clear understanding of the phenotypic correlation coefficient of fruit yield with contributing component traits. The phenotypic correlation coefficient was partitioned into direct and indirect effects of different traits on fruit yield (Table 2).

The results revealed that the highest direct effect to fruit yield was observed through number of fruits per plant (0.796) followed by number of flower clusters per plant (0.266) and average fruit weight (0.261). It was also revealed that the direct effect of number of fruits/plant was further intensified with the indirect effect of number of flower clusters/plant (0.206). Similar type of results were also obtained by Saleem et al., (2013), Kumar et al., (2013), Meena and Bahadur (2015) and Prajapati et al., (2015).

Thus the association and cause effect studies showed that total fruit yield/plant was significantly and positively correlated with number of fruits/plant and number of flower clusters/plant. High direct effects were also observed for these characters. Hence for increasing the fruit yield, selection should be based on plants bearing more number of fruits, flower clusters and flowers per cluster.

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