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# Assessing Prominent Quantitative Traits Significantly Correlated with Fruit Yield Improvement in Tomato (*Solanum lycopersicum* L.) over Seasons

**Hareesh Kumar Maurya [a++], Rubee Lata [a#*], G. C. Yadav [a†], Himanshu Singh [b++], Shyam Sundar [a] and Vikas Kumar [c++]**

[a] *Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, UP - 226025, India.*
[b] *Department of Vegetable Science, College of Horticulture, Banda University of Agriculture and Technology, Banda, UP- 210001, India.*
[c] *Department of Horticulture, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, UP- 224229, India.*

***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## Abstract

Tomato (*Solanum lycopersicum* L.) is an economically important vegetable crop, and fruit yield is a complex quantitative trait influenced by several interrelated characters. The present investigation was undertaken to assess associations among yield and yield-contributing traits and to identify prominent quantitative characters

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[++]*Research Scholar;* [#]*Assistant Professor;* [†]*Professor;*
**Corresponding author: E-mail: rubyhort@gmail.com;*

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related to fruit yield improvement in tomato over seasons. The study used 43 genotypes, comprising 10 lines, 3 testers and 30 $F_1$ hybrids, evaluated in a Randomised Block Design with three replications at the Horticulture Research Farm, Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh, during the Rabi seasons of 2024–25 and 2025–26. Observations were recorded for 16 quantitative traits, and correlation coefficients were estimated using pooled data. At the genotypic level, total fruit yield per plant showed significant positive associations with fruits per plant (0.836**), average fruit weight (0.729**), equatorial diameter (0.495**), locules per fruit (0.455**), pericarp thickness (0.451**), total soluble solids (0.421**), fruits per cluster (0.412**), number of primary branches per plant (0.312**), plant height (0.263**) and polar diameter (0.244**). At the phenotypic level, total fruit yield per plant was positively associated with fruits per plant (0.837**), average fruit weight (0.697**), equatorial diameter (0.421**), total soluble solids (0.360**), pericarp thickness (0.357**), locules per fruit (0.337**), number of primary branches per plant (0.243**), polar diameter (0.184*), fruits per cluster (0.180*) and plant height (0.174*). The comparable pattern of associations at both levels indicates that these traits may serve as useful selection criteria for yield improvement. The negative association of days to 50% flowering with yield also suggests the relevance of early-maturing genotypes in tomato breeding.

*Keywords: Tomato; genotypic correlation; phenotypic correlation; fruit yield; marketable yield; yield components; average fruit weight; fruits per plant; tomato breeding; quantitative traits.*

## 1. Introduction

Tomato is widely regarded as a “protective food” due to its rich nutritional value and is often referred to as the “poor man’s orange” because of its affordability and vitamin content. The fruits are consumed both fresh and after cooking, and are extensively processed into products such as soup, juice, ketchup, puree, paste and powder (Maurya et al., 2025). Tomato is mainly cultivated in open fields and as an off-season crop under greenhouse conditions, making it an important forcing crop. Owing to its high demand and economic returns, it serves as a valuable source of income for small and marginal farmers while also playing a significant role in improving the nutritional security of consumers (Thamburaj & Singh, 2001; Sharma et al., 2019).

Tomato (*Solanum lycopersicum* L.), a member of the family Solanaceae, is a diploid (2n = 24) herbaceous crop widely cultivated across diverse agro-climatic regions due to its adaptability and economic importance. The plant typically develops a well-branched taproot system, although under transplanted conditions it tends to form a fibrous root system with numerous adventitious roots. The stem is soft, green and pubescent at the early stage, becomes semi-woody with age, and exhibits either a determinate or indeterminate growth habit depending on the genotype. Leaves are compound, alternate and pinnately lobed, with glandular hairs that provide a characteristic odour and protective function. The inflorescence is usually cymose and bears yellow, bisexual and actinomorphic flowers, with fused anthers forming a cone around the style, thereby facilitating predominantly self-pollination. The fruit is a fleshy berry that shows considerable variation in size, shape and colour, with pigments such as lycopene contributing to its red colouration. Internally, the fruit consists of the pericarp, locules, placenta and seeds, while the seeds are small, flattened and enclosed in a gelatinous matrix.

Tomato is one of the most extensively grown vegetable crops worldwide and ranks second in importance after potato in many countries, including India. Globally, tomato was cultivated over an area of about 4.9 million hectares in 2022, with total production of approximately 186 million tonnes and an average productivity of 37.1 tonnes per hectare (Food and Agriculture Organization of the United Nations, 2022). In India, the crop occupied around 0.873 million hectares, producing 21.23 million tonnes, with an average yield ranging from 24.3 to 25.0 tonnes per hectare (Directorate of Economics and Statistics, 2024). This productivity is comparatively lower than the global average. The major tomato-producing states in India include Madhya Pradesh, Karnataka, Andhra Pradesh, Uttar Pradesh and Odisha. Botanically, all cultivated tomato species are believed to have originated from the western regions of South America.

Fruit yield in tomato is a complex quantitative trait governed by several genes and is highly influenced by environmental conditions. It is not determined by a single character but results from the interaction of multiple yield-contributing traits, such as days to first fruit harvest, plant height, number of branches per plant, days to 50% flowering, fruits per plant, fruits per cluster and average fruit weight. Therefore, understanding the nature and magnitude of association among these traits is essential for effective selection and yield improvement (Singh & Chaudhary, 1985).

Correlation analysis is a statistical tool widely used in plant breeding to measure the degree and direction of association between different traits. It helps to identify characters that have a significant influence on yield and can be used as indirect selection criteria. Positive correlations between yield and its component traits facilitate simultaneous improvement, whereas negative correlations may hinder selection efficiency (Falconer & Mackay, 1996). However, early traits showing a negative correlation are also important for yield improvement and net returns, as they may support earlier produce availability in the market and help obtain higher prices per unit of produce. Hence, the study of correlations among yield components is crucial for developing high-yielding tomato varieties.

In tomato breeding, germplasm evaluation plays a critical role in identifying superior genotypes with desirable agronomic and yield-related traits. Germplasm collections provide a valuable source of genetic variability that can be utilised for crop improvement. The assessment of correlations among yield-contributing characters in diverse tomato germplasm assists breeders in selecting promising parental lines and developing high-yielding cultivars. Such studies also contribute to a better understanding of trait interactions and the genetic architecture underlying yield performance.

Correlation coefficient analysis helps to explain the magnitude and direction of association among different quantitative traits and fruit yield in tomato. Knowledge of these relationships enables breeders to identify important yield-contributing characters and formulate effective selection strategies for the development of high-yielding tomato cultivars.

Although correlations between yield and its component traits have been studied in tomato, the strength and direction of trait associations can vary with genotype, season and environment. Information on the consistency of genotypic and phenotypic associations across seasons is therefore required for identifying dependable selection criteria. In the present set of tomato lines, testers and $F_1$ hybrids, limited pooled seasonal information was available on the traits most strongly associated with fruit yield under the experimental conditions of Lucknow. This gap justified the evaluation of quantitative trait associations using pooled data from two consecutive Rabi seasons. These findings highlight the importance of correlation studies in understanding trait relationships and improving selection strategies (Dewey & Lu, 1959). Therefore, the present investigation on correlation and association studies of yield components in tomato germplasm aimed to evaluate the interrelationships among important quantitative traits and to identify key characters contributing to yield improvement (Searle, 1961).

## 2. Materials and Methods

The study was conducted at the Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh, India, during the Rabi season. Correlation coefficient analysis was performed using pooled data from two consecutive years (2024–25 and 2025–26) to identify important yield-contributing traits in tomato, with row-to-row spacing of 60 cm and plant-to-plant spacing of 50 cm. Each experimental plot consisted of two rows, each 3 m long. The experiment was laid out in a Randomised Block Design (RBD) with three replications for each treatment to identify the prominent quantitative traits correlated with enhanced fruit yield in tomato. The data were subjected to correlation coefficient analysis using the formula suggested by Searle (1961).

## 2.1 Experiment Site

The experiment was carried out at the Main Experiment Station, Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh, India. The experimental site is located in a humid subtropical agro-climatic zone. Geographically, it is located in the Gangetic alluvial plains of eastern Uttar Pradesh, between 24.47° and 26.56° N latitude and 82.12° and 83.98° E longitude, at an elevation of approximately 113 metres above mean sea level. The soil of the experimental field was sandy loam in texture, with moderate fertility and a pH range of 6.5 to 7.2.

Healthy seedlings were transplanted into the main field on 17 October 2024 and 22 October 2025 during the respective Rabi seasons. The crop was raised following the prescribed agronomic and intercultural practices for tomato cultivation. Manure was applied at 25 tonnes/ha, and the fertiliser dose was 120 N:100 P:60 K kg/ha. The full doses of phosphorus and potassium and half of the nitrogen were applied at transplanting, while the remaining nitrogen was applied in split doses during crop growth. Irrigation was provided at 12–15-day intervals according to crop requirements and weather conditions. Standard crop management practices, such as weeding, hoeing, staking and earthing-up, were carried out as required to ensure proper crop growth and development. Disease management was carried out using carbendazim + mancozeb according to recommendations, while imidacloprid and malathion were used to control insect pests. Fruits were harvested at regular intervals at the red-ripe stage, and observations were recorded on selected plants according to the experimental methodology.

**Table 1. Details of the genotypes included in the experiment are presented below**

| S. No. | Symbol | Genotypes |
|---|---|---|
| **Lines (L)** | | |
| 1 | L1 | NDT-6 |
| 2 | L2 | Punjab Upma |
| 3 | L3 | Punjab Sartaj |
| 4 | L4 | Pusa Gaurav |
| 5 | L5 | Kashi Adarsh |
| 6 | L6 | Kashi Amrit |
| 7 | L7 | Kashi Hemant |
| 8 | L8 | NDT-7 |
| 9 | L9 | Kashi Amul |
| 10 | L10 | Kashi Sharad |
| **Testers (T)** | | |
| 1 | T1 | NDT-5 |
| 2 | T2 | Kashi Aman |
| 3 | T3 | Hisar Arun |
| **F1 Hybrids** | | |
| 1 | L1 x T1 | NDT-6 x NDT-5 |
| 2 | L1 x T2 | NDT-6 x Kashi Aman |
| 3 | L1 x T3 | NDT-6 x Hisar Arun |
| 4 | L2 x T1 | Punjab Upma x NDT-5 |
| 5 | L2 x T2 | Punjab Upma x Kashi Aman |
| 6 | L2 x T3 | Punjab Upma x Hisar Arun |
| 7 | L3 x T1 | Punjab Sartaj x NDT-5 |
| 8 | L3 x T2 | Punjab Sartaj x Kashi Aman |
| 9 | L3 x T3 | Punjab Sartaj x Hisar Arun |
| 10 | L4 x T1 | Pusa Gaurav x NDT-5 |
| 11 | L4 x T2 | Pusa Gaurav x Kashi Aman |
| 12 | L4 x T3 | Pusa Gaurav x Hisar Arun |
| 13 | L5 x T1 | Kashi Adarsh x NDT-5 |
| 14 | L5 x T2 | Kashi Adarsh x Kashi Aman |
| 15 | L5 x T3 | Kashi Adarsh x Hisar Arun |
| 16 | L6 x T1 | Kashi Amrit x NDT-5 |
| 17 | L6 x T2 | Kashi Amrit x Kashi Aman |
| 18 | L6 x T3 | Kashi Amrit x Hisar Arun |
| 19 | L7 x T1 | Kashi Hemant x NDT-5 |
| 20 | L7 x T2 | Kashi Hemant x Kashi Aman |
| 21 | L7 x T3 | Kashi Hemant x Hisar Arun |
| 22 | L8 x T1 | NDT-7 x NDT-5 |
| 23 | L8 x T2 | NDT-7 x Kashi Aman |
| 24 | L8 x T3 | NDT-7 x Hisar Arun |
| 25 | L9 x T1 | Kashi Amul x NDT-5 |
| 26 | L9 x T2 | Kashi Amul x Kashi Aman |

| S. No. | Symbol | Genotypes |
|---|---|---|
| 27 | L9 x T3 | Kashi Amul x Hisar Arun |
| 28 | L10 x T1 | Kashi Sharad x NDT-5 |
| 29 | L10 x T2 | Kashi Sharad x Kashi Aman |
| 30 | L10 x T3 | Kashi Sharad x Hisar Arun |

## 2.2 Observations Recorded

To evaluate the performance of the different genotypes, observations were recorded for sixteen quantitative traits. Data on quantitative traits were collected from five randomly selected plants in each plot for each replication. The observations included days to 50% flowering, days to first fruit harvest, plant height (cm), number of branches per plant, fruits per cluster, fruits per plant, average fruit weight (g), pericarp thickness (mm), locules per fruit, polar diameter (cm), equatorial diameter (cm), total soluble solids, ascorbic acid (mg/100 g), total sugar (mg/100 g), total fruit yield per plant (kg) and marketable fruit yield per plant.

# 3. Results and Discussion

Correlation coefficient analysis was carried out to assess the nature and magnitude of associations among quantitative traits and their contribution to yield. Correlations among pairs of characters may result from genetic linkage or pleiotropic effects (Yadav et al., 2022). As a result, selection for one trait may affect another trait; therefore, correlation studies are important in plant breeding programmes because they support effective selection. The nature and magnitude of the relationship between yield and its component traits are critical for effective selection in advanced generations (Sharma et al., 2021). The magnitude of the correlation coefficient may also vary with the population evaluated and the observations recorded.

## 3.1 Genotypic Correlation Coefficient

Correlation among different characters arises due to the linkage or pleiotropic effects of genes and plays an important role in determining the efficiency of selection in breeding programmes. The genotypic correlation coefficients among sixteen characters, based on pooled data, were computed and are presented in Table 2.

The important trait marketable fruit yield per plant exhibited the highest and almost perfect positive association with total fruit yield per plant (0.999**), followed by fruits per plant (0.830**), average fruit weight (0.735**), equatorial diameter (0.487**), locules per fruit (0.470**), pericarp thickness (0.439**), total soluble solids (0.413**), fruits per cluster (0.401**), number of primary branches per plant (0.302**), plant height (0.267**) and polar diameter (0.229**). Similar results were also reported by Singh et al. (2018) and Sengar et al. (2025).

The important trait total fruit yield per plant exhibited a significant positive association, in decreasing order, with fruits per plant (0.836**), average fruit weight (0.729**), equatorial diameter (0.495**), locules per fruit (0.455**), pericarp thickness (0.451**), total soluble solids (0.421**), fruits per cluster (0.412**), number of primary branches per plant (0.312**), plant height (0.263**) and polar diameter (0.244**). Similar results were also reported by Limbani et al. (2020), Basavaraj et al. (2021) and Vijaylaxmi et al. (2021).

Average fruit weight exhibited a highly significant and positive correlation with fruits per cluster (0.257**), followed by fruits per plant (0.240**) and days to first fruit harvest (0.223**). Fruits per plant exhibited a highly significant and positive correlation with fruits per cluster (0.398**), followed by number of primary branches per plant (0.302**) and plant height (0.258**), whereas it showed a highly significant negative correlation with days to 50% flowering (-0.240**). Fruits per cluster exhibited a highly significant and positive correlation with number of primary branches (0.594**), followed by days to 50% flowering (0.351**). Similar results were also found by Kumar and Singh (2018), Doddamani et al. (2019), Limbani et al. (2020) and Kumar et al. (2021).

## 3.2 Phenotypic Correlation Coefficient

The phenotypic correlation coefficients among sixteen characters, based on pooled data, were computed and are presented in Table 3. The magnitude of phenotypic correlations was comparatively lower than that of genotypic correlations, indicating the masking effect of environmental factors on the expression of these traits.

**Table 2. Estimates of Genotypic correlation coefficients among sixteen characters in tomato**

| Character | Days to 50% flowering | Days to first fruit harvest | Plant height | Primary branches | Fruits/cluster | Fruits/plant | Avg fruit weight | Pericarp thickness | Locules/fruit | Polar diameter | Equatorial diameter | TSS | Ascorbic acid | Total sugar | Total fruit yield/plant | Marketable fruit yield/plant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Days to 50% flowering** | 1.000 | -0.442** | -0.203* | -0.164 | 0.351** | -0.240** | -0.074 | 0.221* | -0.050 | 0.133 | 0.081 | -0.099 | 0.001 | -0.083 | -0.217* | -0.241** |
| **Days to first fruit harvest** | | | 0.220* | -0.253** | -0.656** | -0.153 | 0.223* | -0.366** | -0.295** | 0.197* | -0.184* | -0.187* | 0.104 | 0.278** | 0.016 | 0.027 |
| **Plant height** | | | | -0.468** | -0.207* | 0.258** | 0.166 | 0.330** | 0.335** | 0.097 | 0.555** | 0.039 | 0.043 | -0.098 | 0.263** | 0.267** |
| **Primary branches** | | | | | 0.594** | 0.302** | 0.150 | 0.059 | 0.147 | 0.253** | 0.004 | 0.179* | 0.125 | 0.006 | 0.312** | 0.302** |
| **Fruits/cluster** | | | | | | 0.398** | 0.257** | 0.534** | 0.248** | 0.237** | 0.244** | 0.409** | -0.398** | -0.117 | 0.412** | 0.401** |
| **Fruits/plant** | | | | | | | 0.240** | 0.335** | 0.407** | 0.026 | 0.367** | 0.259** | 0.221* | -0.061 | 0.836** | 0.830** |
| **Avg fruit weight** | | | | | | | | 0.395** | 0.298** | 0.388** | 0.425** | 0.415** | -0.154 | 0.192* | 0.729** | 0.735** |
| **Pericarp thickness** | | | | | | | | | 0.106 | 0.038 | 0.465** | 0.325** | 0.117 | -0.117 | 0.451** | 0.439** |
| **Locules/fruit** | | | | | | | | | | 0.110 | 0.333** | 0.411** | -0.020 | -0.038 | 0.455** | 0.470** |
| **Polar diameter** | | | | | | | | | | | 0.064 | 0.208* | 0.016 | -0.412** | 0.244** | 0.229** |
| **Equatorial diameter** | | | | | | | | | | | | 0.334** | 0.002 | -0.076 | 0.495** | 0.487** |
| **TSS** | | | | | | | | | | | | | -0.087 | -0.040 | 0.421** | 0.413** |
| **Ascorbic acid** | | | | | | | | | | | | | | -0.417** | 0.034 | 0.026 |
| **Total sugar** | | | | | | | | | | | | | | | 0.077 | 0.096 |
| **Total fruit yield/plant** | | | | | | | | | | | | | | | | 0.999** |
| **Marketable fruit yield/plant** | | | | | | | | | | | | | | | | 1.000 |

**, ** significant at 5% and 1% level, respectively*

**Table 3. Estimates of phenotypic correlation coefficients among sixteen characters in tomato**

| Character | Days to 50% flowering | Days to first fruit harvest | Plant height | Primary branches | Fruits/cluster | Fruits/plant | Avg fruit weight | Pericarp thickness | Locules/fruit | Polar diameter | Equatorial diameter | TSS | Ascorbic acid | Total sugar | Total fruit yield/plant | Marketable fruit yield/ plant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Days to 50% flowering** | 1.000 | -0.282** | -0.091 | -0.159 | 0.127 | -0.098 | 0.028 | 0.124 | -0.069 | -0.018 | 0.036 | -0.055 | 0.037 | -0.080 | -0.060 | -0.063 |
| **Days to first fruit harvest** | | | 0.150 | -0.195* | -0.247** | -0.045 | 0.120 | -0.242** | -0.222* | 0.106 | -0.165 | -0.128 | 0.042 | 0.044 | 0.034 | 0.035 |
| **Plant height** | | | | -0.383** | -0.132 | 0.151 | 0.129 | 0.258** | 0.298** | 0.035 | 0.468** | 0.051 | 0.020 | -0.022 | 0.174* | 0.188* |
| **Primary branches** | | | | | 0.355** | 0.226* | 0.126 | 0.101 | 0.170 | 0.247** | -0.006 | 0.180* | 0.035 | 0.036 | 0.243** | 0.240** |
| **Fruits/cluster** | | | | | | 0.159 | 0.117 | 0.289** | 0.151 | 0.108 | 0.106 | 0.243** | 0.044 | 0.031 | 0.180* | 0.176* |
| **Fruits/plant** | | | | | | | 0.201* | 0.294** | 0.286** | 0.036 | 0.311** | 0.206* | 0.075 | -0.057 | 0.837** | 0.825** |
| **Avg fruit weight** | | | | | | | | 0.265** | 0.224* | 0.274** | 0.353** | 0.379** | -0.089 | 0.055 | 0.697** | 0.701** |
| **Pericarp thickness** | | | | | | | | | 0.116 | 0.078 | 0.384** | 0.238** | 0.040 | -0.089 | 0.357** | 0.357** |
| **Locules/fruit** | | | | | | | | | | 0.132 | 0.286** | 0.252** | -0.015 | -0.018 | 0.337** | 0.355** |
| **Polar diameter** | | | | | | | | | | | 0.019 | 0.125 | -0.020 | -0.089 | 0.184* | 0.169 |
| **Equatorial diameter** | | | | | | | | | | | | 0.211* | -0.011 | -0.001 | 0.421** | 0.419** |
| **TSS** | | | | | | | | | | | | | -0.136 | -0.078 | 0.360** | 0.354** |
| **Ascorbic acid** | | | | | | | | | | | | | | -0.022 | -0.010 | -0.016 |
| **Total sugar** | | | | | | | | | | | | | | | -0.001 | 0.001 |
| **Total fruit yield/plant** | | | | | | | | | | | | | | | | 0.993** |
| **Marketable fruit yield/ plant** | | | | | | | | | | | | | | | | 1.000 |

**, ** significant at 5% and 1% level, respectively*

The important trait marketable fruit yield per plant showed the highest positive association with total fruit yield per plant (0.993**), followed in descending order by fruits per plant (0.825**), average fruit weight (0.701**), equatorial diameter (0.419**), pericarp thickness (0.357**), locules per fruit (0.355**), total soluble solids (0.354**), number of primary branches per plant (0.240**), plant height (0.188*) and fruits per cluster (0.176*). The important trait total fruit yield per plant exhibited a positive association, in decreasing order, with fruits per plant (0.837**), average fruit weight (0.697**), equatorial diameter (0.421**), total soluble solids (0.360**), pericarp thickness (0.357**), locules per fruit (0.337**), number of primary branches per plant (0.243**), polar diameter (0.184*), fruits per cluster (0.180*) and plant height (0.174*), indicating that these traits contribute directly to yield improvement. Similar results were also reported by Tiwari and Upadhyay (2011), Badge et al. (2021) and Teli et al. (2022).

Pericarp thickness exhibited a highly significant and positive correlation with fruits per plant (0.294**) and fruits per cluster (0.289**), followed by average fruit weight (0.265**) and plant height (0.258**), whereas it showed a highly significant negative correlation with days to first fruit harvest (-0.242**). Average fruit weight exhibited a highly significant and positive correlation with fruits per plant (0.201*). Fruits per plant exhibited a highly significant and positive correlation with number of primary branches per plant (0.226*). Fruits per cluster exhibited a highly significant and positive correlation with number of primary branches (0.355**). Similar results were also reported by Kumar et al. (2014), Kumar et al. (2020), Lekshmi and Celine (2020), Kumari and Dogra (2021).

The significance of trait associations is important for establishing an appropriate breeding strategy for the selection of high-yielding tomato genotypes. In this respect, correlation analysis based on pooled data is a valid method for identifying the traits that contribute directly or indirectly to yield improvement. The pooled correlation analysis indicated greater genotypic correlation coefficients than the respective phenotypic correlations, demonstrating substantial genetic associations among variables with partial environmental effects. Marketable fruit yield per plant was highly and positively correlated with total fruit yield, fruits per plant and average fruit weight at both genotypic and phenotypic levels, implying that these variables contribute significantly to overall productivity. The favourable correlations of yield with fruit size traits and fruit number may be due to their contribution to fruit biomass and total yield. Such associations may also be due to favourable genetic linkages or common genetic control for these characters. From a breeding point of view, these traits can be exploited as selection criteria for the development of high-yielding tomato cultivars. Hence, simultaneous improvement of these positively related traits is expected to increase the effectiveness of selection and genetic gain in tomato breeding programmes.

## 4. Conclusions

The pooled correlation analysis showed that genotypic correlation coefficients were generally higher than the corresponding phenotypic correlations, indicating that the associations among traits were largely influenced by genetic factors, with partial masking by the environment. Total fruit yield per plant and marketable fruit yield per plant were strongly and positively associated with fruits per plant and average fruit weight at both genotypic and phenotypic levels. Positive associations were also observed with equatorial diameter, pericarp thickness, locules per fruit, total soluble solids, fruits per cluster, number of primary branches per plant, plant height and polar diameter. These relationships indicate that fruit number, fruit weight and selected fruit-size and plant-growth traits are important contributors to yield expression in the evaluated tomato genotypes. Days to 50% flowering showed a negative association with yield at the genotypic level, suggesting that earliness may be considered during selection where early production is desirable. Based on the present findings, simultaneous selection for fruits per plant, average fruit weight and associated yield-contributing traits may improve the efficiency of breeding programmes aimed at developing high-yielding tomato genotypes. These traits can be used to support parental selection and population improvement strategies for yield enhancement in tomato.

## 5. Limitations

The present study has some limitations that should be considered when interpreting the findings. The experiment was conducted at a single location, although data were pooled over two Rabi seasons. Therefore, the observed associations may be influenced by the agro-climatic conditions of the experimental site, including soil type, management practices and seasonal environmental variation. The study included 43 tomato genotypes, which provided useful information on trait associations, but the results may not represent the full genetic diversity available in cultivated tomato germplasm. The analysis was restricted to correlation coefficients; therefore, causal relationships among traits cannot be confirmed from the present results alone. In addition, the relationships reported here should be validated across multiple locations, seasons and wider genetic backgrounds before they are applied broadly in selection programmes. Multi-environment testing would strengthen the reliability of the identified yield-contributing traits for practical tomato improvement in future breeding programmes under comparable production conditions.

## Declaration of AI Use

This manuscript was prepared through the combined contributions of all author(s), including contributions to the study design, data, content development, results, interpretation, and related scholarly work. The author(s) acknowledge the use of Grammarly and ChatGPT to assist with grammar checking, language refinement, reference formatting. These AI-assisted tools were not used as authors and did not replace the intellectual contributions or scholarly judgment of the author(s). All AI-assisted outputs, including content, references, and interpretations, were carefully reviewed, revised, verified, and approved by the author(s). The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

## Competing Interests

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

## References

Badge, S., Parate, S. R., & Ganvir, G. B. (2021). Correlation and path analysis studies for yield and quality traits in tomato (*Solanum lycopersicum* L.). *International Journal of Current Microbiology and Applied Sciences, 10*(6), 144–151. https://doi.org/10.20546/ijcmas.2021.1006.015

Basavaraj, P. B., Ambresh, Ganiger, V. M., Hongal, S., Mahesh, Y. S., & Patil, B. B. (2021). Correlation and path coefficient analysis in superior recombinant inbred lines of tomato (*Solanum lycopersicum* L.). *International Journal of Current Microbiology and Applied Sciences*. https://doi.org/10.20546/ijcmas.2021.1001.049

Dewey, D. R., & Lu, K. H. (1959). A correlation and path-coefficient analysis of components of crested wheatgrass seed production. *Agronomy Journal, 51*(9), 515–518. https://doi.org/10.2134/agronj1959.00021962005100090002x

Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare. (2024). *Agricultural statistics at a glance*. Ministry of Agriculture and Farmers Welfare, Government of India. https://desagri.gov.in/publication-category/agricultural-statistics-at-a-glance/

Doddamani, M. B., Jagadeesha, R. C., Baby, R., & Prakash, G. (2019). Correlation and path analysis for growth, yield and quality traits in F3 population of cherry tomato (*Solanum lycopersicum* L. var. *cerasiforme*). *International Journal of Chemical Studies*. https://www.chemijournal.com/archives/2019/vol7issue3/PartBG/7-3-544-143.pdf

Falconer, D. S. & Mackay, T. F. C. (1996). *Introduction to quantitative genetics* (4th ed.). Longman.

Food and Agriculture Organization of the United Nations. (2022). *FAOSTAT statistical database*. https://www.fao.org/faostat/en/#home

Kumar, C., & Singh, D. (2018). A correlation and path analysis studies of quantitative and qualitative traits in tomato. *International Journal of Current Microbiology and Applied Sciences, 7*(4), 2230–2238. https://doi.org/10.20546/ijcmas.2018.704.254

Kumar, J., Singh, N., Dixit, P. S., Yadav, L., Singh, B. P., & Tomar, S. (2021). Correlation and path coefficient analysis in tomato (*Solanum lycopersicum* L.). *International Journal of Chemical Studies, 9*(1), 3158–3160. https://doi.org/10.22271/chemi.2021.v9.i1ar.11714

Kumar, K., Sharma, D., Singh, J., & Thakur, P. (2020). Correlation and path coefficient analysis in tomato (*Solanum lycopersicum* L.). *International Journal of Current Microbiology and Applied Sciences*. https://doi.org/10.20546/ijcmas.2020.906.240

Kumar, R., Ram, C. N., Yadav, G. C., Deo, C., Vimal, S. C., & Bhartiya, H. D. (2014). Studies on correlation and path coefficient analysis in tomato (*Solanum lycopersicon* L.). *Plant Archives*. http://www.plantarchives.org/vol14-1.html

Kumari, S., & Dogra, B. S. (2021). Correlation and path analysis studies for yield and its attributes in tomato. *International Journal of Current Microbiology and Applied Sciences, 10*(2), 1376–1383. https://doi.org/10.20546/ijcmas.2021.1002.164

Lekshmi, S. L., & Celine, V. A. (2020). Correlation and path analysis of tomato crop (*Solanum lycopersicum* L.) under protected conditions. *The Journal of Research ANGRAU, 48*(4), 53–58. https://epubs.icar.org.in/index.php/TJRA/article/view/133597

Limbani, H., Makati, J. P., & Patel, J. A. (2020). Correlation and path analysis for yield and quality traits in tomato (*Solanum lycopersicum* L.). *International Journal of Chemical Studies, 8*(3), 664–667. https://doi.org/10.22271/chemi.2020.v8.i3h.9283

Maurya, H. K., Lata, R., Sundar, S., Mitra, D. S., Singh, H., & Yadav, G. C. (2025). Scientific advances in tomato (*Solanum lycopersicum* L.) cultivation, agronomic innovation and genetic improvement: A comprehensive review. *Journal of Advances in Biology & Biotechnology, 28*(10), 781–803. https://doi.org/10.9734/jabb/2025/v28i103103

Searle, S. R. (1961). Phenotypic, genetic and environmental correlations. *Biometrics*. https://doi.org/10.2307/2527838

Sengar, A. S., Kumar, J., Silas, V. J., & Kumar, D. (2025). Estimate of genotypic and phenotypic correlation and path coefficients in tomato (*Solanum lycopersicum* L.). *International Journal of Advanced Biochemistry Research*. https://doi.org/10.33545/26174693.2025.v9.i6n.4682

Sharma, A., Pandey, S. K., & Nair, R. (2021). Correlation and path co-efficient analysis for yield and its contributing traits in tomato (*Solanum lycopersicum* L.). *The Pharma Innovation Journal, 10*(3), 616–622. https://doi.org/10.22271/tpi.2021.v10.i3i.5837

Sharma, P., Dhillon, N. S., Kumar, V., & Kumar, P. (2019). Correlation and path analysis for yield and its contributing traits in tomato (*Solanum lycopersicum* L.) under the protected environment. *Journal of Pharmacognosy and Phytochemistry*. https://www.phytojournal.com/archives/2019/vol8issue1S/PartG/SP-8-1-104-243.pdf

Singh, A. K., Solankey, S. S., Akhtar, S., Kumari, P., & Chaurasiya, J. (2018). Correlation and path coefficient analysis in tomato (*Solanum lycopersicum* L.). *International Journal of Current Microbiology and Applied Sciences*. https://www.ijcmas.com/special-issue-7.php

Singh, R. K., & Chaudhary, B. D. (1985). *Biometrical methods in quantitative genetic analysis*. Kalyani Publishers. https://www.worldcat.org/title/biometrical-methods-in-quantitative-genetic-analysis/oclc/15641447

Teli, A. R., Gangaprasad, S., & Mallikarjuna, H. B. (2022). Correlation and path coefficient analysis in segregating population (F2) of cherry tomato (*Solanum lycopersicum* var. *cerasiforme*). *The Pharma Innovation Journal, 11*(2), 2718–2721. https://doi.org/10.22271/tpi.2022.v11.i2aj.11068

Thamburaj, S., & Singh, N. (Eds.). (2001). *Textbook of vegetables, tubercrops and spices*. Indian Council of Agricultural Research. https://icar.org.in/content/textbook-vegetable-tuber-crops-and-spices

Tiwari, J. K., & Upadhyay, D. (2011). Correlation and path-coefficient studies in tomato (*Lycopersicon esculentum* Mill.). *Research Journal of Agricultural Sciences, 2*(1), 63–68. https://www.rjas.org/

Vijaylaxmi, S. K., Rathod, V., Evoor, S., Kantharaju, V., Tatagar, M. H., & Laksmidevamma, T. N. (2021). Correlation and path coefficient analysis in cherry tomato (*Solanum lycopersicum* var. *cerasiforme*). *Journal of Pharmacognosy and Phytochemistry, 10*(2), 1136–1140. https://www.phytojournal.com/archives/2021/vol10issue2/PartP/10-2-136-782.pdf

Yadav, L., Yadav, G. C., Yadav, S., Yadav, A., & Chaturvedi, V. D. (2022). Assessment of correlation coefficients among the yield related traits in tomato (*Solanum lycopersicum* L.) germplasm. *Biological Forum – An International Journal, 14*(4), 1195–1198.



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