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# Association and Path Coefficient Analysis among $F_2$ Segregating Population of Tomato (*Solanum lycopersicum* L)

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***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 is one of the most important vegetable crop grown by small farmers and commercial growers for both local uses as well as processing industries. So, it is important to increase its productivity along with desirable attributes through its genetic characters. Therefore, present experiment was conducted at the College of Agriculture, Vellayani, to evaluate the $F_2$ segregating population of a tomato cross involving Anagha x IIHR 2896 for correlation and path analysis. Correlation analysis revealed that plant height, number of primary branches, plant spread, number

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of days to first flowering, number of days to first fruit harvest, number of fruits per plant, fruit weight, fruit volume, and number of locules were highly significant and positively correlated with fruit yield per plant. Path analysis revealed that the number of fruits per plant, fruit weight and fruit volume had a high positive direct effect on fruit yield per plant, followed by plant height and plant spread. However, the number of primary branches, the number of days to first flowering, the number of days to first fruit harvest and number of locules had a negative direct effect on fruit yield per plant. Hence, the characters showing positive correlation and direct effect should be given more emphasis in the selection programme for the development of superior varieties.

*Keywords: Correlation; productivity; characters; fruit yield.*

## 1. INTRODUCTION

Vegetables play an important role in nutritional security, and economic viability and fit well into the predominant intensive cropping systems prevailing in different parts of our country. More than 60 kinds of vegetables are grown in India in tropical, subtropical, and temperate agro-climates *(IIVR, Varanasi)*. Tomato (*Solanum lycopersicum* L.) belongs to the large and diverse family Solanaceae, which includes more than 3000 species, and occupies a wide variety of habitats (Knapp, 2002). It is a very important vegetable crop grown throughout the world. In fact, it is the fifth most important cultivated crop after rice, wheat, maize, and potato. The fruits are consumed either raw or cooked or processed into various products like juice, ketchup, sauce, paste, puree, etc. The popularity of tomato is on the rise among consumers, not only because of its good taste but also because it contains high levels of vitamin A, vitamin C, potassium, phosphorus, magnesium, and calcium. It also contains lycopene and carotene, which are antioxidants that promote good health. The high demand for tomatoes makes it a high value crop that can generate much income for farmers [1]. Considering the potentiality of this crop, there is a need for improvement and to develop varieties suited to specific agro-ecological conditions and also for specific end use. A thorough knowledge regarding the amount of genetic variability existing for various characters is essential for initiating the crop improvement programme. With limited variability much cannot be achieved and the breeder will have to enrich the germplasm or he can resort to create greater variability through hybridization, mutation and polyploidy breeding.

Yield is an important character associated with many other characters with varying degrees of influence. It is crucial to understand how various characteristics contribute to yield so that superior lines can be selected with higher yield and quality. Analysing correlations and path coefficients can provide insight into genetic variability within populations. Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for yield improvement. Path analysis splits the correlation coefficients into direct and indirect effects of a set of dependent variables on the independent variable. This aids in the selection of elite genotypes. In self-pollinated crops such as tomatoes, yield, and quality are typically enhanced through the selection of genotypes with desirable character combinations present in nature or through the hybridization process. For any selection program to be effective, it is essential to have information regarding the interrelationships between various characters. Considering the above facts, the present study was conducted to understand the association among the various traits in the $F_2$ tomato segregating population.

## 2. MATERIALS AND METHODS

The experiment was conducted at the College of Agriculture, Vellayani, Thiruvananthapuram, Kerala, from January 2023 to May 2023. The experiment site is located at $8.5^0$ North latitude and $76.9^0$ East longitude, at an altitude of 29.00m above mean sea level. The experimental materials consist of 222 $F_2$ segregating lines, derived from the cross Anagha x IIHR 2896, along with parents, and $F_1$ were planted in an unreplicated trial and evaluated for yield and its attributing traits. Seedlings were transplanted after thirty days of sowing in the main field at a spacing of 60 cm x 65 cm accommodating a plant population of 10 per row. Recommended crop production and protection package of practices were followed to raise a healthy crop. Each plant is labelled for recording ten quantitative characters, which include plant height (cm), number of primary branches, plant spread (cm), number of days to first flowering,

number of days to first fruit harvest, number of fruits per plant, fruit weight, fruit volume, number of locules and fruit yield per plant. Phenotypic correlation coefficients were assessed as per the procedure suggested by Singh and Choudhary [2]. The direct and indirect effects of the yield contributing factors were estimated through path analysis [3,4]. The data were analyzed using R 4.2.2 Software and GenStat.

## 3. RESULTS AND DISCUSSION

### 3.1 Correlation Analysis

In this investigation, correlation coefficients were worked out on all possible combinations of yield and yield attributing traits in 222 F2 segregants of cross Anagha × IIHR 2896 and presented in Table 1. Correlation results indicated that fruit yield per plant expressed significantly positive correlation with all the characters under the study *i.e.,* plant height (0.69), number of primary branches (0.40), plant spread (0.75), number of days to first flowering (0.34), number of days to first fruit harvest (0.32), number of fruits per plant (0.21), fruit weight (0.94), fruit volume (0.93) and number of locules (0.16). The results were in accordance with Lekshmi and Celine [5]; Kumar et al*.* [6] and Nevani et al*.* [7] for the characters such as plant height, number of primary branches, number of fruits per plant, and fruit weight. However, Rahman et al*.* [8] reported a negative correlation with fruit weight.

Plant height had a positive and significant correlation with all the characters except the number of fruits per plant (0.02) and the number of locules (0.05). Similar results were also obtained by Mayavel et al*.* [9]; Akhtar and Najnine [10]. Fruit weight along with fruit volume showed a positive and significant correlation with plant height (0.67, 0.69), number of primary branches (0.38, 0.39), plant spread (0.70, 0.72), number of days to first flowering (0.33, 0.33), number of days to first fruit harvest (0.30, 0.32) and number of locules (0.17, 0.19), respectively. Similar findings were reported by Mayavel [9], Ravindra et al. [11] and Lakshmi et al*.* [12] for fruit yield per plant and plant height.

The number of primary branches exhibited a positive correlation with all characters. The number of fruits per plant showed a negative correlation with fruit weight (-0.11), fruit volume (-0.10) and number of locules (-0.02). However, it showed a positive association with plant height (0.02), number of primary branches (0.05), plant spread (0.10), number of days to first flowering (0.038) and number of days to first fruit harvest (0.04). Number of locules showed a negative correlation with number of days to first flowering (-0.04), number of days to first fruit harvest (-0.01) and number of fruits per plant (-0.02), whereas it showed a positive correlation with remaining characters i.e., plant height (0.05), number of primary branches (0.12), plant spread (0.14), fruit weight (0.17) and fruit yield (0.19). The above results are in line with the finding of Madhurina and Paul [13], Maurya et al*.* [14], Ara et al*.* [15], Kumar et al. [16] and Singh [17]. The correlation plot of all the characters is depicted in Fig. 1.

**Table 1. Phenotypic correlation coefficient for different pairs of characters in F2 population of tomato**

| | PH | NPB | PS | NDFF | NDFFH | NFPP | FW | FV | NL | FY |
|---|---|---|---|---|---|---|---|---|---|---|
| PH | 1 | | | | | | | | | |
| NPB | 0.52** | 1 | | | | | | | | |
| PS | 0.83** | 0.57** | 1 | | | | | | | |
| NDFF | 0.53** | 0.28** | 0.42** | 1 | | | | | | |
| NDFFH | 0.46** | 0.29** | 0.39** | 0.77** | 1 | | | | | |
| NFPP | 0.02 | 0.06 | 0.10 | 0.04 | 0.04 | 1 | | | | |
| FW | 0.67** | 0.38** | 0.70** | 0.33** | 0.30** | -0.11 | 1 | | | |
| FV | 0.69** | 0.39** | 0.72** | 0.33** | 0.32** | -0.10 | 0.98** | 1 | | |
| NL | 0.05 | 0.12 | 0.14* | -0.04 | -0.01 | -0.02 | 0.17* | 0.19* | 1 | |
| FY | 0.69** | 0.40** | 0.75** | 0.34** | 0.32** | 0.21** | 0.94** | 0.93** | 0.16* | 1 |

**, ** Significant at 5% and 1% levels, respectively*

*PH – Plant height (cm); NPB- Number of primary branches; PS- Plant spread (cm); NDFF- Number of days to first flowering; NDFFH- Number of days to first fruit harvest; NFPP- Number of fruits per plant; FW- Fruit weight (g); FV- Fruit Volume (ml); NL – Number of locules; FY – Fruit yield per plant*

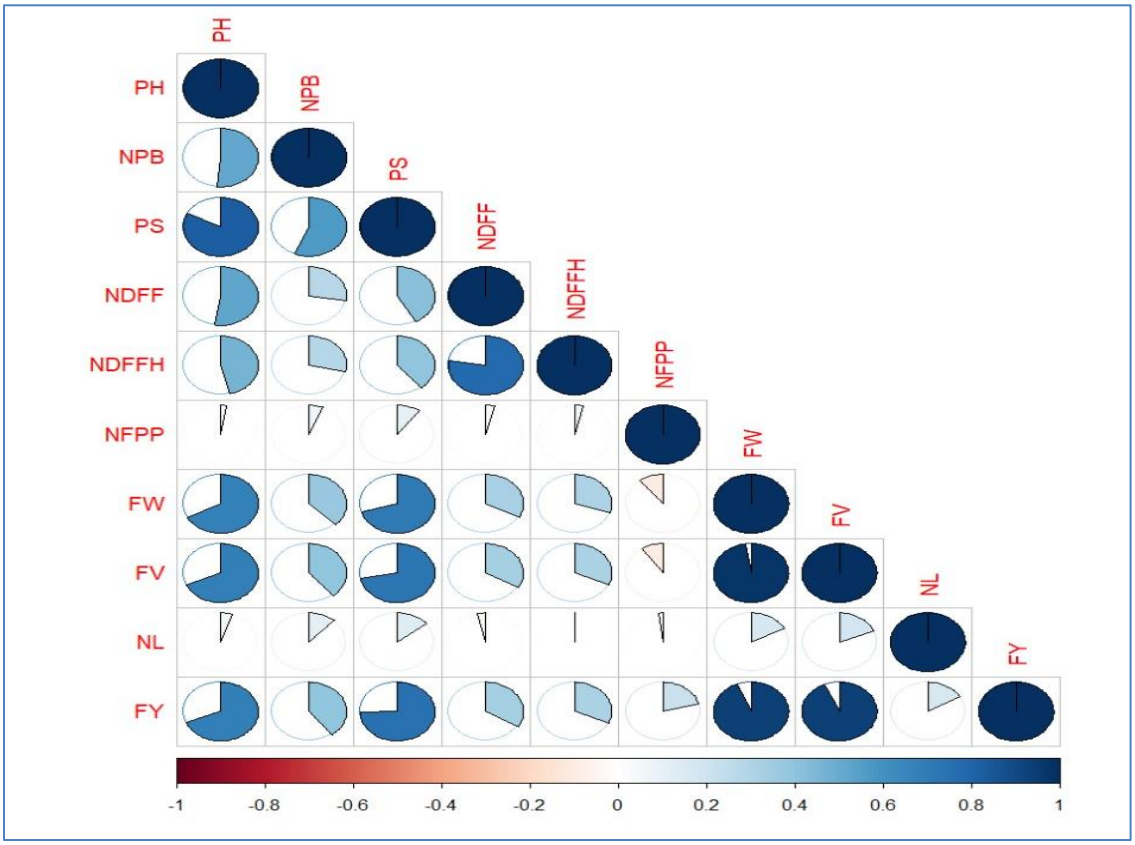


**Fig. 1. Correlation diagram showing the correlation analysis between traits in segregating F2 population of tomato**

Correlation studies indicated that plant height, number of primary branches, plant spread, fruit volume, and fruit weight deserve greater weightage during selection for fruit yield in tomato. With increased fruit weight, fruit volume, plant spread, number of branches per plant and plant height, fruit yield per plant increases because of the presence of a greater number of branches and increased individual fruit mass. Therefore, selection for these traits would be rewarding as it shows a direct association with fruit yield per plant.

## 3.2 Path Analysis

The association between yield and its component traits may be positive or negative; but it is the net result of the direct effect of that particular trait and indirect effects via other traits. Hence, it is necessary to determine the path coefficients that partition the observed correlation into direct and indirect effects and also reveal the cause and effect relationship between yield and its related traits. The path coefficients were computed and the results are presented in Table 2 and path diagram of all the characters is depicted in Fig. 2.

The path analysis results revealed that a high positive direct effect was shown by fruit weight (0.7307), fruit volume (0.2077), and number of fruits per plant (0.3053) followed by plant height (0.0261) and plant spread (0.041) on fruit yield per plant. These characters showing positive direct effect are very much useful in the selection of superior plants for yield. However, number of primary branches (-0.0114), number of days to first flowering (-0.0068), number of days to first fruit harvest (-0.0023), and number of locules (-0.0005) showed a negative direct effect on fruit yield per plant. The characters showing negative direct effect will not be much useful in the selection of genotypes. The high positive indirect effect was shown by fruit weight through plant height (0.4902), number of primary branches (0.2746), plant spread (0.5142), number of days to first flowering (0.238), number of days to first fruit harvest (0.2209), fruit volume (0.714) and number of locules (0.1251) on fruit yield per plant. Fruit volume also expressed a positive indirect effect on fruit yield per plant through plant height (0.1425), number of primary branches (0.0811), plant spread (0.1499), number of days to first flowering (0.069), number

of days to first fruit harvest (0.0661), fruit weight (0.203) and number of locules (0.0386). These findings are in accordance with Reddy et al. [18] for plant height and number of fruits per plant, Asati et al. [19] for plant height, number of primary branches, number of days to first flowering and fruit weight, Nevani et al, [7] for number of fruits per plant and fruit weight, Joshi et al. [20], Ghosh et al. [21] and Monamodi et al. [22] for fruit weight. The characters with high positive correlation and high direct effects are amenable for selection. Hence, path analysis studies of the present investigation reveal that fruit weight, fruit volume, number of fruits per plant, plant height and plant spread were important yield components having positive and direct effect on improvement for fruit yield per plant in tomato. The residual effect (0.12) obtained suggests that the characters selected are the major contributing characters for the fruit yield of tomato; also, small amounts of contribution were from the characters that were not considered in the study.

**Table 2. Path coefficient for different pairs of characters in F2 population of tomato**

| | PH | NPB | PS | NDFF | NDFFH | NFPP | FW | FV | NL |
|---|---|---|---|---|---|---|---|---|---|
| PH | **0.0261** | 0.0135 | 0.021 | 0.0138 | 0.012 | 0.0006 | 0.0175 | 0.0179 | 0.0013 |
| NPB | -0.0059 | **-0.0114** | -0.0064 | -0.0031 | -0.0033 | -0.0006 | -0.0043 | -0.0044 | -0.0013 |
| PS | 0.0340 | 0.0232 | **0.041** | 0.0171 | 0.016 | 0.0041 | 0.0288 | 0.0296 | 0.0057 |
| NDFF | -0.0036 | -0.0019 | -0.0028 | **-0.0068** | -0.0052 | -0.0003 | -0.0022 | -0.0023 | 0.0003 |
| NDFFH | -0.0011 | -0.0007 | -0.0009 | -0.0018 | **-0.0023** | -0.0001 | -0.0007 | -0.0007 | 0.0000 |
| NFPP | 0.0068 | 0.0174 | 0.0308 | 0.0117 | 0.0123 | **0.3053** | -0.0329 | -0.0292 | -0.0054 |
| FW | 0.4902 | 0.2746 | 0.5142 | 0.238 | 0.2209 | -0.0788 | **0.7307** | 0.714 | 0.1251 |
| FV | 0.1425 | 0.0811 | 0.1499 | 0.069 | 0.0661 | -0.0199 | 0.203 | **0.2077** | 0.0386 |
| NL | 0.0000 | -0.0001 | -0.0001 | 0.0000 | 0.0000 | 0.0000 | -0.0001 | -0.0001 | **-0.0005** |

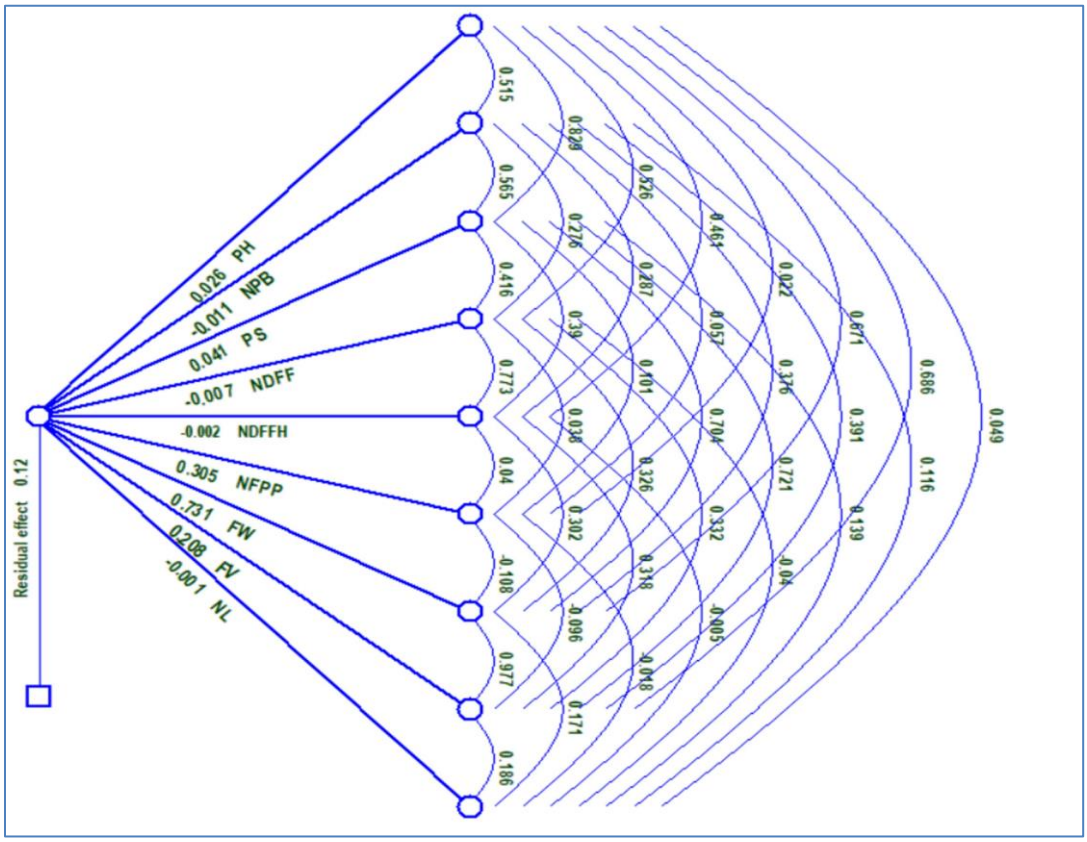


**Fig. 2. Path diagram showing the direct and indirect effects on fruit yield per plant in segregating $F_2$ population of tomato**

## 4. CONCLUSION

The outcome of the results indicated that all the characters studied show a positive correlation with fruit yield per plant. In path analysis, a high positive direct effect was exhibited by fruit weight, fruit volume, and the number of fruits per plant. A high indirect effect was shown by fruit weight and fruit volume through all other characters except the number of fruits per plant. Therefore, improvement in the yield can be brought about by selecting the characters such as fruit weight, fruit volume and fruit yield per plant.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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