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***RESEARCH PAPER***

# Path co-efficient analysis of yield component in tomato

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**Abstract :** Thirty four genotypes of tomato were evaluated during *Rabi* season of 2006 - 2007 to estimate the nature and magnitude of genetic variability based on days to first harvest, number of pickings, plant height, number of fruits per plant, fruit weight plant, fruit size, single fruit weight, number of locules, pericarp thickness and TSS. A wide range of variation was observed among the characters studied which have a great interest for tomato breeders. Single fruit weight gave the highest heritability during 2006; however, it was at maximum for days to first harvest during 2007. Fruit weight plant showed high and positive genotypic and phenotypic correlation with number of picking and with number of fruits per plant, thus indicating that these traits were the most important yield components. On the basis of performance and keeping in view the selection criteria observed in the present study, 14 genotypes were identified through path analysis for future testing under wide range of environments.

**Key Words :** Tomato, Correlation, Path-co-efficient, Fruit yield

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## INTRODUCTION

Tomato, *Lycopersicon esculentum* Mill. which belongs to the nightshade family, Solanaceae, the world's largest vegetable crop after potato and sweet potato and it tops the list of canned vegetables. Low productivity of tomato in India is mainly due to cultivation of unimproved types or/and un adapted types, cultivation in low priority area, poor crop management, inadequate plant protection measures, and non-availability of well-adapted and high yielding varieties for various agro-climatic regions. The non-availability of superior genotypes and low efficiency in utilizing the existing variability in plant breeding programmes has resulted in low space of crop improvement. Therefore, an alternative would be to go for indirect selection considering correlated traits with high heritability. In the present investigation, germplasm lines have been obtained from different agro-climatic regions of India.

## MATERIALS AND METHODS

The field experiment was conducted during the *Rabi* season on farmers field, under the supervision of Institute of Agriculture, Palli Siksha Bhavan, Visva Bharati University. The field is situated under sub-humid, sub-tropical belt of West Bengal. Thirty-four tomato genotypes were sown in seedbed during *Rabi* season on 2006 and 2007. The experiment was laid out according to Randomized Block Design (RBD) with three replications. Each genotype was planted in three rows of 5m length with a spacing of 75 x 60cm. All recommended package of practices were followed during the crop season for raising a healthy crop. Five randomly selected plants from each plot per replication were scored for recording the observations. The data have been recorded in 50 per cent flowering, plant height (cm), number of primary branch per plant, number of secondary branches per plant, number of flowers per cluster, number of fruits per plant, average fruit weight (g), fruit yield per plant (g), fruit yield per picking per plant (g), fruit length (mm), fruit diameter (mm), fruit firmness, locules per fruit, pericarp thickness (mm), total soluble solids (TSS, $^{o}$Brix), total acid content (%).

## RESULTS AND DISCUSSION

Path co-efficient analysis splits the correlation co-

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efficients into the measures of direct and indirect effect. Path co-efficients are simply standardized partial regression co-efficients and measure the direct and indirect contributions of independent variables on dependent variable. In the present investigation, fruit yield per plant was taken as dependent variable on nine other characters, which were independent variables for determining fruit yield. Shrivastava and Sharma (1976) suggested that the only direct yield components should be used for path analysis. Therefore, overlapping traits and derived traits such as L: B ratio, fruit yield per picking, days to fist and full flowering were not included in the path analysis (Table 3).

The low value of residual effect (0.1846) indicated that the nine characters included in this study explain high percentage of variation in yield in this population. Moreover, majority of the values of path co-efficients are less than unity indicating that inflation due to multicolinearity is minimal (Table 2).

Weight per fruit had the highest (1.983) direct effect followed by pericarp thickness (0.961), number of primary branches (0.431) and fruits per plant (0.317). Firmness exhibited lowest positive direct effect (0.110) on fruit yield. However, fruit length (-1.317), fruit diameter (-1.024) and days to 50% flowering (-0.225) displayed high negative indirect effect. Though the total acid also showed negative direct effects, its magnitude was very small (-0.007).

Number of primary branches per plant, though had positive direct effect, its negative indirect effects via days to 50% flowering, firmness, total acid(%), pericarp thickness, fruits per plant and average fruit weight seemed to be the cause of significant negative correlation with fruit yield. The main traits, which exerted negative indirect effects, were average fruit weight and pericarp thickness, which exerted high indirect effects.

Fruit length possessed negative direct effect (-1.317) on fruit yield, and its indirect effect via primary branches per

**Table 1: Showing the best genotypes and their quantitative performance**

| Genotypes | Fruits per plant | Fruit yield per plant (g) | Average fruit weight (g) | Fruit length (mm) | Fruit diameter (mm) | Locules per fruit | Pericarp thickness (mm) | TSS ($^0$Brix) | Total acid (%) |
|---|---|---|---|---|---|---|---|---|---|
| Ojas | 17.25 | 2694 | 155.3 | 64.81 | 63.65 | 3.50 | 8.02 | 6.33 | 0.38 |
| Arka Abha | 21.88 | 2425 | 114.6 | 54.50 | 70.54 | 7.00 | 6.90 | 5.87 | 0.64 |
| RCMT -2 | 30.00 | 2331 | 77.4 | 46.71 | 46.46 | 2.00 | 6.44 | 5.83 | 0.77 |
| Sel -8 | 15.63 | 1888 | 124.7 | 55.47 | 64.90 | 5.00 | 7.89 | 6.47 | 0.64 |
| Laxmi (NP-5005) | 25.13 | 1831 | 73.8 | 45.83 | 54.68 | 3.17 | 6.43 | 6.13 | 0.86 |
| Manilima | 24.50 | 1806 | 74.0 | 43.48 | 55.24 | 3.17 | 6.68 | 5.87 | 0.77 |
| Prolific F1 hybrid | 19.88 | 1788 | 89.0 | 57.20 | 54.02 | 3.00 | 6.68 | 5.77 | 0.54 |
| RCMT -1 | 17.75 | 1781 | 102.7 | 63.00 | 55.39 | 2.83 | 8.72 | 6.03 | 0.39 |
| Megha tomato -2 | 17.50 | 1725 | 98.5 | 53.08 | 50.30 | 3.83 | 5.98 | 6.30 | 0.58 |
| Manikham | 29.25 | 1700 | 59.9 | 49.76 | 47.25 | 2.00 | 6.93 | 6.20 | 0.53 |
| C.D. at 5% | 9.48 | 408.77 | 36.18 | 9.17 | 5.52 | 1.24 | 5.52 | 0.20 | 0.06 |
| C.D. at 1% | 12.74 | 549.11 | 48.61 | 12.32 | 7.41 | 1.66 | 7.41 | 0.27 | 0.09 |

**Table 2 : Genotypic path coefficient of fruit yield with nine independent variable in tomato**

| Characters | | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | Correlation with fruit yield |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 50% flowering | ( $X_1$ ) | **-0.225** | 0.181 | 0.059 | -0.054 | -0.250 | 0.130 | 0.185 | -0.103 | -0.481 | -0.56 ** |
| Primary branch | ( $X_2$ ) | -0.094 | **0.431** | -0.071 | -0.097 | -0.198 | 0.026 | 0.245 | -0.051 | -0.283 | -0.39 ** |
| Firmness | ( $X_3$ ) | -0.007 | 0.054 | **0.110** | 0.142 | 0.008 | -0.002 | 0.011 | -0.035 | 0.101 | 0.38 ** |
| Total acid (%) | ( $X_4$ ) | 0.047 | -0.067 | 0.001 | **-0.007** | -0.034 | -0.003 | -0.003 | -0.288 | -0.110 | -0.41 ** |
| Pericarp thickness | ( $X_5$ ) | 0.058 | -0.089 | 0.071 | 0.013 | **0.961** | -0.844 | -0.617 | -0.037 | 1.283 | 0.72 ** |
| Fruit length | ( $X_6$ ) | 0.022 | -0.008 | 0.145 | -0.016 | 0.616 | **-1.317** | -0.587 | -0.133 | 1.714 | 0.47 ** |
| Fruit diameter | ( $X_7$ ) | 0.041 | -0.103 | 0.053 | 0.150 | 0.579 | -0.755 | **-1.024** | -0.080 | 1.591 | 0.64 ** |
| Fruits per plant | ( $X_8$ ) | 0.107 | -0.101 | 0.192 | -0.013 | -0.166 | 0.811 | 0.380 | **0.317** | -1.155 | 0.37 * |
| Average fruit weight | ( $X_9$ ) | 0.055 | -0.061 | -0.049 | 0.040 | 0.622 | -1.139 | -0.822 | -0.126 | **1.983** | 0.60 ** |

Residual = 0.1846 *and ** Indicate significane of value at P=0.05 and 0.01, respectively, Bold faced values on the diagonal are direct effects plant, pericarp thickness and average fruit were positive and indirect effects through fruit diameter and fruits per plant were negative. However, correlation of this character with fruit yield was positive and highly significant due to very high indirect effects already mentioned above.

Days to 50 per cent flowering had negative direct effect and had high negative indirect effect via average fruit weight and pericarp thickness and hence, exhibited significant negative correlation with fruit yield. Therefore, while selecting for high yield, days to 50 per cent flowering should not be considered as a criterion. However, it is a fact that earliness is an important trait in any crop improvement programme. Therefore, efforts should be made to break undesirable genetic correlation to combine earliness with high yield. Similar situation was observed in case of total acid (%).

Though number of primary branches showed positive direct effect (0.431) and positive indirect effect via fruit diameter, it was significantly and negatively correlated with fruit yield. This was due to the high negative indirect effects exerted by other traits on fruit yield.

Fruit length and diameter recorded high direct negative effects. The positive significant correlation of these traits with fruit yield seemed to be due to high positive indirect effect exerted *via* average fruit weight and pericarp thickness. However, low to moderate negative indirect effects exerted by some other traits further reduced magnitude of association of this character with fruit yield.

Fruits per plant had high positive direct effect and exerted high positive indirect effects *via* fruit length (0.811), fruit diameter (0.380) and pericarp thickness. This resulted in significantly positive correlation of this trait with fruit yield, despite of its very high negative indirect effects via average fruit weight.

Similar observation was also noticed in case of average fruit weight, which had positive and significant correlation with fruit yield despite exerting high negative indirect effects through fruit length and fruit diameter. This was due to very high positive direct effect and high positive indirect effect *via* pericarp thickness. The perusal of genotypic path co-efficients revealed that average fruit weight exerted very high positive indirect effects in the path of pericarp thickness, fruit length and fruit diameter. The character firmness of the fruits exerted positive indirect effects in the path of all the traits except in the path of number of primary branches and average fruit weight while number of fruits per plant exerted negative indirect effects in the path of all other characters. However, in both the above cases indirect effects on majority of the traits was small.

These results of the present investigation are in conformity with the findings of Singh *et al.* (1997) for plant height; Padma *et al.* (2002) and Singh and Roy (2004) for fruit length; Singh and Roy (2004) for primary branches per plant and fruits per plant; Dhaliwal *et al*. (2004) for average fruit weight and number of fruits. However, reports on the path co-efficients of firmness and pericarp thickness are scarce in the literature.

Path co-efficient analysis is very efficient in deciphering the degree of influence of one variable on the other in quantitative terms (Dewey and Lu, 1959). Path analysis is a special type of multivariate analysis, which deals with the closed system of variables (each variable in the system is either a linear combination of some other variables in the system or is one of the basic factors of the system). In other words system is formally complete, including all the basic factors (causes) and their resultant variables (effects). Grafius (1959) opined that there may not be gene governing yield *per se*; rather there could be genes which govern the component characters. Therefore, rapid increase in yield is expected to result if selection is practiced for component characters. In the present investigation, three component traits, *viz.*, average fruit weight, number of fruits per plant and pericarp thickness, which have high degree of influence on the fruit yield, due to their high positive direct effects and significant positive correlation with yield, have been (Table 2).

In the present investigation, significant differences among the genotypes have been observed for various characters through analysis of variance technique. Besides, the perusal of the data and results from the analysis of genetic

**Table 3 : Showing the estimates of range, variance, PCV, GCV, heritability and genetic advance and per cent of mean according to fruit characters in tomato**

| Characters | Range | | Grand mean | Phenotypic variance | Genotypic variance | PCV (%) | GCV (%) | Herit-ability | Genetic advance | GA as % of mean |
|---|---|---|---|---|---|---|---|---|---|---|
| Locules per fruit | 2.00 | 7.00 | 3.46 | 1.86 | 1.56 | 39.46 | 36.14 | 83.87 | 2.36 | 68.18 |
| Pericarp thickness (mm) | 1.32 | 8.72 | 5.84 | 1.70 | 1.50 | 22.31 | 20.96 | 88.24 | 2.37 | 40.56 |
| Fruit length (mm) | 13.73 | 72.94 | 47.00 | 137.10 | 116..80 | 24.91 | 22.99 | 85.19 | 20.55 | 43.72 |
| Fruit diameter (mm) | 12.99 | 70.54 | 50.30 | 90.22 | 82.87 | 18.88 | 18.10 | 91.85 | 17.97 | 35.73 |
| TSS ($^{o}$Brix) | 5.70 | 6.50 | 6.11 | 0.05 | 0.04 | 3.66 | 3.27 | 80.00 | 0.37 | 6.03 |
| Firmness | 1.00 | 3.00 | 2.04 | 0.48 | 0.44 | 33.97 | 32.53 | 91.67 | 1.31 | 64.16 |
| Total acid (%) | 0.38 | 0.89 | 0.66 | 0.02 | 0.01 | 18.95 | 18.32 | 93.55 | 0.24 | 36.51 |
| Average fruit weight (g) | 9.41 | 155.27 | 78.24 | 991..09 | 675.24 | 40.24 | 33.21 | 68.13 | 44.18 | 56.48 |

variability, heritability and genetic advance revealed that selection for primary and secondary branches, plant height, fruits per plant, number of locules per fruit, fruit length, fruit diameter and fruit weight would be effective in improvement of fruit yield, whereas, selection for pericarp thickness, total acid content, firmness, locules per fruit as well as the fruit weight would be effective for improving the quality.

In the course of investigation, we could identify some of the top performing genotypes based on fruit yield per plant and other characters. Top ten genotypes from among the 34 evaluated in the study have been presented in the Table 1 and Fig. 1. The data revealed that none of the genotype was superior for all the traits. However, Ojas topped the list with highest yield, early flowering, highest average fruit weight, thick Pericarp, high TSS, firm fruits and low acidity. The genotype, Arka Abha was statistically at par with Ojas with respects to fruit yield and earliness but produced softer fruits compared to Ojas. RCMT-2 ranked third in fruit weight while Sel-8 ranked second in average fruit weight in top-ten list (however, Aruna ranked second in average fruit weight with 150 g among 34 genotypes). Different genotypes were superior in one or few desirable traits. Hence, there is a scope for further improvement in these genotypes. Further, these promising genotypes have to be tested over seasons and years to evaluate their stability, suitability and adaptation to this region

The character association studies through correlation and path analysis revealed that the correlation co-efficient between any causal factor and the effect was not equal to its direct effect in any character, indicating that selection criteria and selection for component traits based on correlation co-efficients would not be very much effective. However, in the present material, selection criteria based on the characters like average fruit weight, number of fruits per plant and pericarp thickness would be rewarding. For the characters like fruit length and fruit diameter for which correlation co-efficients were positive, but the direct effects were negative, the indirect causal factors are to be considered simultaneously for selection, since indirect effects seem to be the cause of negative correlation. For the character like primary branch for which correlation co-efficients were negative but the direct effects were positive, a restricted simultaneous selection model is to be followed, *i.e.* restrictions are to be imposed to nullify the undesirable indirect effects in order to make use of the direct effect.

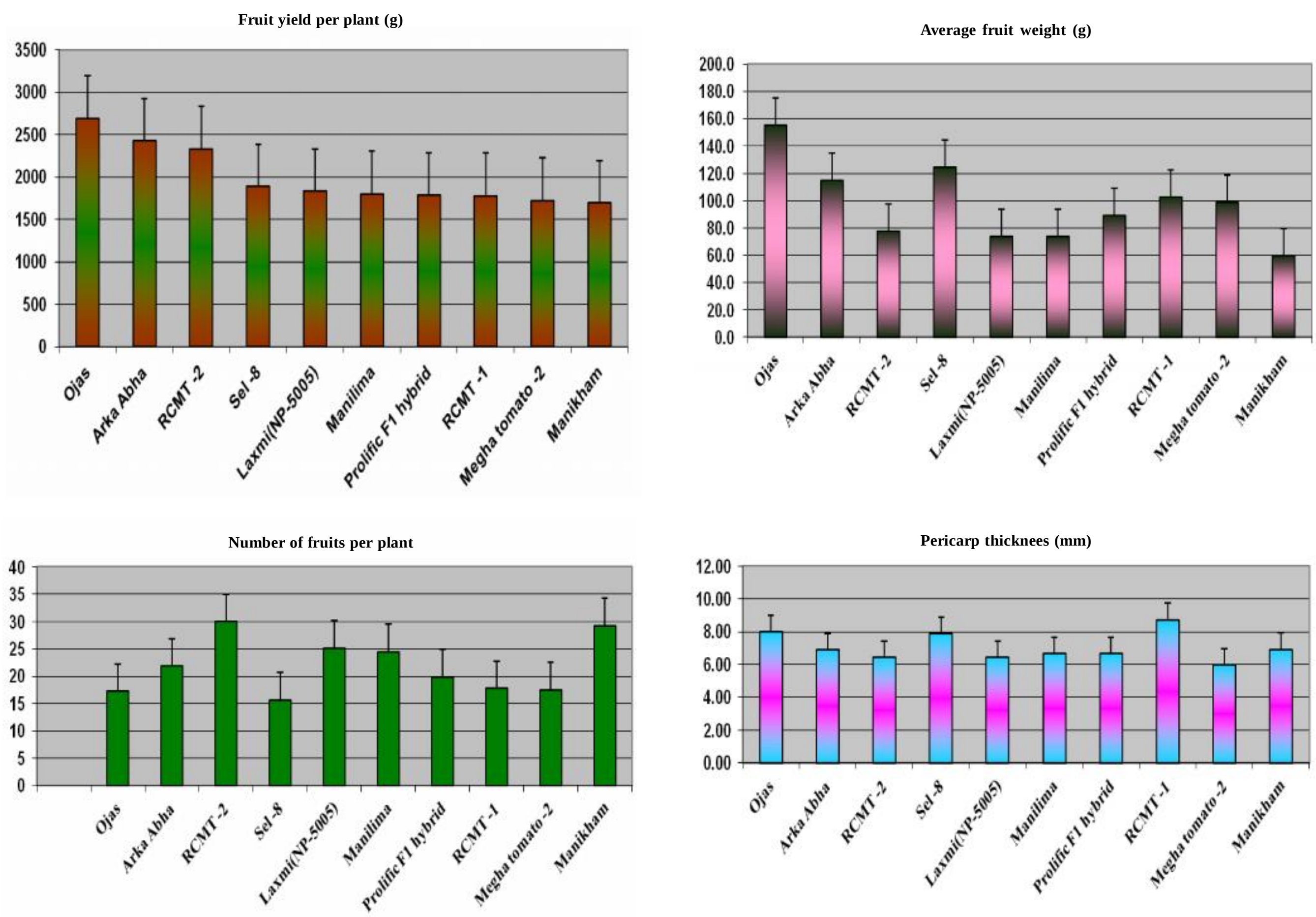


**Fig. 1: Graphs showing best genotypes depends on different fruit characters**

**Conclusion :**

The results of the path analysis has identified three major fruit yield component traits, *viz.*, average fruit weight, number of fruits per plant and pericarp thickness, which have high degree of influence on the fruit yield, due to their high positive direct effects on yield and significant positive correlation with yield. However, traits like primary branches had high positive direct effect and negative correlation with yield while days to 50 per cent flowering had negative direct effect and negative correlation with yield.

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