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Studies on correlation and path coefficient analysis in tomato (*Solanum lycopersicum* L.)

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Abstract
The present research programme regarding correlation and path coefficient analysis in tomato (*Solanum lycopersicum* L.), was carried out at Hill Millet Research Station, Waghai, The Dangs, NAU. *Rabi* season 2021-22. Fifty genotypes of tomato were evaluated in Randomized Block Design with three replications. In genotypic correlation, yield per plant (kg) posed highly significant and positive correlation with plant height (0.30), total number of fruits per plant (0.29) and vitamin c (0.57) and positive but non-Significant correlation at genotypic level was observed with average fruit weight (0.18) and total soluble solids (0.07). In phenotypic correlation yield per plant observed highly significant and positive correlation with plant height (0.22), average fruit weight (0.30), total number of fruits per plant (0.27) and vitamin C (0.31), while it showed positive but non-significant correlation with TSS (0.10). Therefore, it can be concluded that selection based on these characters would be effective for the breeding Programme towards yield enhancement in tomato.

Keywords: Tomato, (*Solanum lycopersicum* L.), genotypic correlation, phenotypic correlation, path coefficient analysis, direct and indirect effect

Introduction
Tomato (*Solanum lycopersicum* L.) is one of the most important and widely grown vegetable in the worldwide. It is most popular vegetable of Solanaceae family because to its higher adaptability, high yield potential and short duration crop hence area under tomato cultivation is increasing day by day. It is day neutral and mainly self-pollinated, but a certain percentage of cross pollination also occurs. The crop is native to Central and South America (Vavilov, 1951) [16]. In world, it ranks second in importance after potato, but tops the list of processed vegetables (Chaudhary, 1996) [4]. Tomato fruits are good source of total sugar (reducing sugar and non reducing sugar), beta-carotene and lycopene contain which helps to maintain the human health. India is the second largest producer of vegetables next to China with an annual production of 204.83 million tonnes from an area of 11.34 million hectares (NHB, 2022) [3]. In India it is grown almost in every region with an area and production of 840.00 hectares and 20331.00 tonnes, respectively (NHB, 2022) [3]. Tomato is major contributor of antioxidants such as carotenoids (especially, lycopene and β-carotene), phenolics, ascorbic acid and small amount of vitamin E in daily diets (Rai *et al*., 2012) [12]. The correlation studies help in knowing about the type of association between various traits in a given set of germplasm. Estimation of correlation coefficient among the yield contributing characters is necessary to understand the direction of selection and maximize yield in the shortest period (Miller *et al*., 1958) [8]. The path coefficient analysis helps to work out the direct and indirect effect of various traits on the dependent character like yield (Dewey and Lu, 1959) [5]. The correlation coefficient being the result of cause and effect of relationship between different characters may not always provide complete information. Thus, a better understanding of the association between characters is provided by path coefficient analysis.

Materials and Methods
The present experiment was carried out during *Rabi* season, 2021-22 at Rambhas Farm, Hill Millet Research Station, Waghai, Navsari Agricultural University. The experiment was carried out at Randomized Block Design (RBD) with 3 replications. A total 30 genotypes were used in this study. Total experimental area was 973.35 m^2. The spacing was 90 cm and 60 cm between rows and plants respectively and total 12 plants planted in line (10 +2 boarder plant). Fertilizer rate of 150:60:60 NPK kg/ha was applied.

The seeds were grown during the November month and transplanted after 45 days into main field. Random plant selection (five plants) was made from each replication for each genotype to record the data for each parameter. Plant height, average fruit weight, number of fruits per plant, yield per plant (kg/ha), total yield (t/ha). Total soluble solid content was determined with the help of Pocket Refractometer. The vitamin C i.e., ascorbic acid content was determined by Dye method. The analysis of variance for design of experiment was done for partitioning the variance into treatments and replications. The analysis of variance was completed according to the procedure suggested by Panse and Sukhatme (1967) [11] for each of the characters separately. Phenotypic and genotypic correlation coefficients were assessed as per the procedure suggested by Singh and Choudhary (1985) [13]. The direct and indirect effects of the yield contributing factors were estimated through path analysis by Wright, (1921) [18]; Dewey and Lu, (1959) [5].

Results and Discussion

In the study, correlation between seven traits were worked out in all possible combinations at both phenotypic and genotypic level presented in Table 1 and 2. In genotypic correlation, yield per plant (kg) posed highly significant and positive correlation with plant height (0.30), total number of fruits per plant (0.29) and vitamin c (0.57) and positive but non significant correlation at genotypic level was observed with average fruit weight (0.18) and total soluble solids (0.07).

In phenotypic correlation yield per plant observed highly significant and positive correlation with plant height (0.22), average fruit weight (0.30), total number of fruits per plant (0.27) and vitamin C (0.31), while it showed positive but non significant correlation with TSS (0.10). These results are in agreement with the findings of Naveen *et al.* (2017) [10]; Anuradha *et al.* (2018) [1]; Archana *et al.* (2019) [2]; Sushma *et al.* (2020) [14]; Mishra and Nandi (2018) [9]; Kumar *et al.* (2021) [6]; Kumari and Dongra (2021) [7]; Sushma *et al.* (2020) [14]. As per the current experiment regarding inter relationship it can be concluded that for improving in fruit yield per plant of ideal prototype can could be higher plant height, total number of fruits per plant and vitamin C and a greater number of fruits per plant.

Table 1: Genotypic correlation coefficients for yield and yield attributing traits in Tomato

	Plant height (cm)	Average fruit weight (g)	Total number of fruits per plant	Total soluble solids (^{0}Brix)	Vitamin C	Yield per plant (kg/ha)
Plant height (cm)	1					
Average fruit weight (g)	0.20*	1				
Total number of fruits plant	-0.072	-0.73**	1			
Total soluble solids (^{0}Brix)	0.13	0.84**	-0.49*	1		
Vitamin C	0.28*	0.04	0.38**	0.27*	1	
Yield per plant (kg/ha)	0.30*	0.18	0.28*	0.07	0.57**	1

Table 2: Phenotypic correlation coefficients for yield and yield attributing traits in Tomato

	Plant height (cm)	Average fruit weight (g)	Total number of fruits per plant	Total soluble solids (^{0}Brix)	Vitamin C	Yield per plant (kg/ha)
Plant height (cm)	1					
Average fruit weight (g)	0.18*	1				
Total number of fruits plant	-0.07	-0.66**	1			
Total soluble solids (^{0}Brix)	0.1	0.75**	-0.46**	1		
Vitamin C	0.22*	-0.01	0.31*	0.23*	1	
Yield per plant (kg/ha)	0.22*	0.30*	0.27*	0.10	0.31*	1

Significance at 1% and 5% probability level by F test

The path coefficient analysis indicates that the association of the independent character with depended variable is due to their direct effect on it or is a consequence of their direct effect through other characters. The estimation of correlation coefficients indicates only extent nature of association between yield and its components, but does not show the direct and indirect effects of different yield attributes on yield. Fruit yield per plant is depended on several characters which are mutually associated; these will turn impair the true association between independent variable and yield per plant. A change in any one component has two paths of actions *viz.*, the direct influence on fruit yield, indirect effect through components which are revealed from correlation studies. Path analysis partitions the correlation into direct and indirect effects and permits a critical look to recognize the specific forces acting to produce a given correlation and measure the relative importance of each causal factor.

Table 3: Estimation of direct and indirect effects of different yield attributing traits on fruit yield of tomato

Traits	PH	AFW	TNFP	TSS	VC	Correlation with YPP
PH	0.04	0.31	-0.054	-0.126	0.136	0.305*
AFW	0.008	1.51	-0.55	-0.81	0.023	0.185
TNFP	-0.003	-1.118	0.749	0.481	0.181	0.29*
TSS	0.005	1.27	-0.37	-0.96	0.12	0.073
VC	0.012	0.074	0.29	-0.265	0.46	0.579**

Residual effect = 0.288

Bold diagonal figures are the direct effects and non diagonal figures are indirect effects

PH= Plant height (cm) TSS = Total soluble solids
VC= Vitamin C

AFW = Average fruit weight (g)
TNFP = Total number of fruits per plant
YPP = Yield per plant (kg)

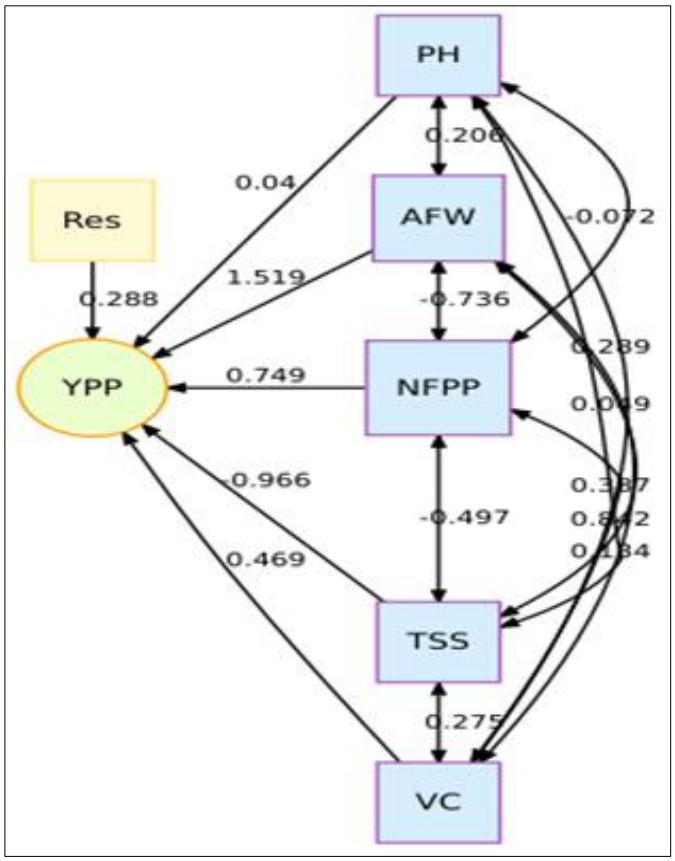

Fig 1: Genotypic path diagram representing direct and indirect effects of yield attributing traits on yield per plant in tomato

In genotypic path analysis, all the characters except total soluble solids (-0.96) recorded positive direct effect on yield. Highest positive direct effects were recorded by average fruit weight (1.51), total number of fruits per plant (0.74), vitamin c (0.46) and plant height (0.04). Therefore, Similar results were observed by Vijayalaxmi *et al*. (2021) [17]; Shalini *et al*. (2021) [15] and Kumari and Dongra (2021) [7]. Therefore, it can be concluded that selection based on these characters would be effective for the breeding programme towards yield enhancement in tomato. However, traits like total soluble solids showed negative direct effect with fruit yield per plant. This may be due to energy directed towards reproductive growth and increasing the yield.

Conclusion

The study revealed that yield per plant (kg) exhibited high significant positive association at genotypic and phenotypic level plant height, average fruit weight, total number of fruits, and vitamin C content. In path analysis average fruit weight and number of fruits per plant exhibited high and positive direct effect on fruits yield per plant. Therefore, these characters should be the selection criteria in further breeding programme. Direct selection based on these traits could result in simultaneous improvement of traits and fruit yield in tomato.

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