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Assessment of Correlation and Path coefficient Analysis for Yield and Yield Contributing Traits among Tomato (*Solanum Lycopersicum* L.) Genotypes

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ABSTRACT: For twenty yield-contributing traits, correlations and path coefficients were examined in seven tomato (*Solanum lycopersicum* L.) genotypes. The interrelationship between the analysed features was discovered using the correlation coefficients. Average fruit weight, fruit yield per plant, equatorial fruit diameter, polar fruit diameter, total phenolic content, and days to 50% flowering all showed strong positive correlations with total fruit yield. However, the first day of fruit set was very significantly negatively correlated with total fruit yield. Whereas, lycopene content had high significant and positive correlation with total phenolics content, TSS content and total antioxidant capacity but negative correlation with titrable acidity. The total fruit yield had the highest positive direct effect in the path coefficient analysis, followed by the number of fruit per plant, the number of locules per fruit, the days to 50% flowering, and the number of primary branches per plant, all of which both positively correlated with and directly affected the yield.

Keywords: Genotypic, Phenotypic, Correlation, Path, Fruit yield.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most economically important vegetables in India and in the world. The fruit has multiple uses in human nutrition and is eaten raw, cooked, and processed into a variety of products. It is grown throughout the country due to its adaptability to a wide variety of soils and climates (Ahmed, 1976). It is a commonly used vegetable crop in both the fresh fruit market and the processed food business around the world. It is grown in a farm and kitchen garden for cooked vegetables, soup, sauce, and ketchup *etc*. (Nagariya *et al*., 2015). Tomato is a significant source of vitamin A, B, C and other nutrient element (Khapte and Jansirani 2014).

An understanding of the genetic diversity found in populations can be gained through correlation and path coefficient analyses. The component traits on which selection might be based for an increase in yield are determined by correlation coefficient analysis, which assesses the relationship between various plant characteristics (Hasan *et al*., 2016). Path analysis helps in the selection of an elite genotype by dividing the correlation coefficients into the direct and indirect impacts of a group of dependent variables on the independent variable (Tsagaye *et al*., 2022). As yield is a complex character, its direct improvement is difficult. (Islam *et al*., 2010). When creating a selection strategy with the goal of increasing yield, understanding the link between yield and other plant characteristics as well as their proportional contributions to yield is highly helpful.

MATERIALS AND METHOD

The research was carried out between 2015 and 2017 at the Bihar Agriculture College Sabour, Department of Vegetable and Floriculture, BAU, Bhagalpur. The material for the present study comprised of 7 genotypes of tomato *viz*., H-86, Pusa Rohini, Arka Abha, Arka Vikash, Arka Ahuti, CLNB and *S. Pimpennilifolium*. 30 day-old tomato seedlings were transplanted with a 60 × 60 cm spacing in the main field. Three replications of the experiment were done using a Randomized Block Design (RBD). To raise a productive harvest, the advised cultural techniques were used. To record the observations on 20 characters, five competing plants were chosen at random from each row in each replication. Using the formulas provided by Johnson *et al*. (1955); Al-Jibouri *et al*. (1958), single correlation coefficients between two characters were calculated at the genotypic and phenotypic levels. The direct and indirect effect was estimated as per the method of Wright (1921) and elaborated by Dewey and Lu (1959) respectively.

RESULT AND DISCUSSION

For future development of a complex polygenic character through selection, it is critical to understand the relationships between numerous characters associated to yield. According to the current study, genotypic correlation coefficients were typically greater than phenotypic ones. Fruit yield cannot be genetically improved without also improving the yield component traits. It is evident that it is impractical to include all of the component characters in a selection scheme, so in these cases, understanding the relationships between various qualities and the fruit production and quality metrics will be very helpful in creating an effective and efficient selection.

At genotypic and phenotypic level fruit yield per plant had highly significant positive correlation with total fruit yield. Moreover, average fruit weight had highly significant positive correlation with fruit yield per plant and total fruit yield. Similar findings in tomato were also reported by Ara *et al*. (2009); Tewari and Upadhyay (2011); Hasan *et al*. (2016). Plant height showed high significant and positive correlation with primary branches per plant, number of fruit per plant, and it had high significant but negative correlation with ascorbic acid, lycopene and total phenolic contents. Similar findings in tomato for these traits was reported by Ahirwar *et al*. (2013); Tsagaye *et al*. (2022). Number of locules per fruit high significant and positive correlation with total phenolics content and it had highly significant but negative correlation with number of fruits per plant. Total soluble solids had highly significant positive correlation with number of fruits per plant. It had high significant but negative correlation with average fruit weight. Singh *et al*. (2004) reported a similar finding. Days to first flowering showed high significant positive correlation with days to 50% flowering, days to first fruit set, however it had high significant but negative correlation with number of fruits per plant, fruit yield per plant and total fruit yield and total antioxidant capacity. Bernousi *et al.* (2011) also reported similar findings.

Polar fruit diameter showed highly significant positive correlation with pericarp thickness (Table 1 & 2). Similar results were noticed by Srinivasulu *et al*. (2020). Hence for improvement of tomato yield, selection should be based on higher plant height, number of primary branches, fruit number. However, higher yield might lead to sacrifice of the fruit biochemical quality, hence selection for moderation may be the key to maintaining the balance between yield and quality.

According to Table 3 path coefficient analysis, there was a significant positive direct effect for total fruit yield (0.9962) followed by number of fruit per plant (0.0070), Number of locules per fruit (0.0055), days to 50% flowering (0.0055) and primary branches per plant (0.0035). Similar results were observed by Khapte and Jansirani (2014). It was also observed that the high negative direct effect was exerted by days to first flowering (-0.0035), titrable acidity (-0.0030) and total soluble solids (-0.0034). Similar finding was observed by Rani *et al*. (2010) and Nagariya *et al*. (2015). Present research findings indicate that direct selection of average fruit weight and number of fruits per plant can be used as basis of selection for improvement in tomato in respect of yield.

Table 1: Association of different characters in tomato (Genotypic Correlation).

Character	D50%F	DFFS	NLPF	PH	PBPP	PFD	EFD	PT	AA	TCC	LC	TAC	TA	TPC	TSS	AFW	NFPP	FYPP	TFY
FF	.993**	0.996**	-0.019	0.114	-0.095	0.227*	0.250*	-0.109	-0.003	0.216*	0.065	-0.454**	-0.201	-0.472**	-0.044	-0.192	-0.331**	-0.387**	-0.389**
D50%F		0.992**	-0.016	0.155	-0.119	0.121	0.107	-0.075	-0.109	0.062	0.013	-0.469**	-0.113	-0.394**	-0.117	-0.190	-0.190	-0.311**	-0.313**
DFFS			-0.044	0.186	-0.025	0.150	0.091	-0.117	-0.160	0.069	-0.051	-0.427**	-0.101	-0.396**	-0.146	-0.117	-0.332**	-0.303**	-0.305**
NLPF				0.035	0.076	-0.097	0.027	-0.210	-0.161	-0.141	-0.250*	-0.104	0.137	-0.030	-0.237*	0.180	-0.303**	0.033	0.032
PH					0.480**	-0.260*	-0.166	0.006	-0.352**	0.021	-0.365**	-0.011	0.073	-0.577**	-0.072	-0.016	0.292**	0.127	0.127
PBPP						-0.196	-0.404**	-0.120	-0.096	-0.293**	-0.381**	0.214*	0.085	-0.280**	-0.138	0.219*	-0.190	0.116	0.116
PFD							0.643**	0.381**	0.154	0.277**	0.041	-0.133	0.130	0.131	-0.022	0.396**	-0.163	0.379**	0.380**
EFD								0.228*	0.182	0.759**	0.246*	-0.020	-0.220*	-0.010	0.029	0.257*	-0.013	0.312**	0.312**
PT									0.059	0.236*	0.181	-0.009	0.115	0.143	-0.050	0.040	0.036	0.080	0.082
AA										0.185	0.398**	0.457**	-0.063	0.119	0.404**	-0.078	-0.019	-0.113	-0.113
TCC											0.391**	0.101	-0.290**	-0.001	0.036	0.185	-0.032	0.220*	0.220*
LC												0.229*	-0.211*	0.322**	0.304**	-0.045	0.018	-0.012	-0.012
TAC													0.024	0.089	-0.047	0.095	-0.148	0.014	0.013
TA														0.111	0.063	-0.043	0.166	0.002	0.002
TPC															0.195	0.355**	-0.105	0.369**	0.369**
TSS																-0.359**	0.547**	-0.148	-0.149
AFW																	-0.503**	0.892**	0.892**
NFPP																		-0.065	-0.065
FYPP																			1.000**
TFY																			-0.547**

Characters: Days to first flowering (DFF), Days to 50% flowering (D50%F),Days to first fruit set (DFFS), Number of locules per fruit (NLPF), Plant height (PH),Primary branches per branch (PB/P), Polar fruit diameter (PFD),), Equatorial fruit diameter (EFD).Pericarp thickness (PT), Ascorbic acid content (AA),Total carotenoids content(TCC),lycopene content (LC), Total antioxidant capacity (TAC),Titrable acidity (TA), Total phenol content (TPC), Total soluble solid (TSS), Average fruit weight (AFW), Number of fruit per plant (NFPP), Fruit yield per plant (FYPP) and Total fruit yield (TFY).

Table 2: Association of different characters in tomato (Phenotypic Correlation).

Character	D50%F	DFFS	NLPF	PH	PBPP	PFD	EFD	PT	AA	TCC	LC	TAC	TA	TPC	TSS	AFW	NFPP	FYPP	TFY
FF	0.781**	0.788**	0.002	0.078	-0.073	0.133	0.175	-0.066	0.015	0.132	0.065	-0.283**	-0.130	-0.267	-0.048	-0.094	-0.111	-0.179	-0.179
D50%F		0.780**	-0.002	0.151	-0.079	0.065	0.087	-0.034	-0.047	0.049	0.006	-0.322**	-0.081	-0.240*	-0.070	-0.107	-0.016	-0.132	-0.131
DFFS			-0.019	0.137	-0.051	0.092	0.064	-0.083	-0.075	0.044	-0.032	-0.280**	-0.077	-0.206	-0.096	-0.083	-0.064	-0.144	-0.144
NLPF				0.033	0.080	-0.094	0.022	-0.206	-0.156	-0.139	-0.243*	-0.103	0.135	-0.024	-0.224	0.185	-0.238*	0.035	0.034
PH					0.450**	-0.242*	-0.164	0.014	-0.308**	0.007	-0.340**	-0.010	0.067	-0.515**	-0.057	-0.015	0.224*	0.110	0.110
PBPP						-0.180	-0.380**	-0.116	-0.083	-0.275*	-0.355**	0.204	0.080	-0.254*	-0.103	0.203	-0.152	0.086	0.086
PFD							0.620**	0.371**	0.142	0.26*5	0.038	-0.132	0.126	0.130	-0.018	0.370**	-0.114	0.333**	0.334**
EFD								0.225*	0.174	0.734**	0.240*	-0.020	-0.217*	-0.026	0.034	0.254*	-0.020	0.279*	0.279*
PT									0.055	0.231*	0.175	-0.010	0.113	0.140	-0.049	0.040	0.023	0.071	0.072
AA										0.166	0.384**	0.448**	-0.061	0.101	0.367**	-0.071	0.003	-0.091	-0.091
TCC											0.382**	0.099	-0.283**	-0.002	0.037	0.176	-0.044	0.181	0.182
LC												0.226*	-0.202	0.299**	0.275*	-0.048	0.010	-0.017	-0.017
TAC													0.024	0.084	-0.047	0.095	-0.113	0.013	0.013
TA														0.103	0.054	-0.041	0.128	0.006	0.006
TPC															0.130	0.319**	-0.042	0.326**	0.325**
TSS																-0.344**	0.449**	-0.112	-0.113
AFW																	-0.404**	0.813**	0.813**
NFPP																		0.191	0.191
FYPP																			-0.442**
TFY																			0.968**

Characters: Days to first flowering (DFF), Days to 50% flowering (D50%F),Days to first fruit set (DFFS), Number of locules per fruit (NLPF), Plant height (PH),Primary branches per branch (PB/P), Polar fruit diameter (PFD),),Equatorial fruit diameter (EFD).Pericarp thickness (PT), Ascorbic acid content (AA),Total carotenoids content(TCC),lycopene content (LC), Total antioxidant capacity (TAC),Titrable acidity (TA), Total phenol content (TPC), Total soluble solid (TSS), Average fruit weight (AFW), Number of fruit per plant (NFPP), Fruit yield per plant (FYPP) and Total fruit yield (TFY).

Table 3: Direct and indirect effect of component characters on fruit yield in tomato.

Traits	FF	D50% F	DFFS	NLPF	PH	PBPP	PFD	EFD	PT	AA	TCC	LC	TAC	TA	TPC	TSS	AFW	NFPP	TFY
FF	**-0.0035**	-0.0038	-0.0037	0.0001	-0.0004	0.0003	-0.0008	-0.0009	0.0004	0.0000	-0.0007	-0.0002	0.0016	0.0007	0.0016	0.0002	0.0007	0.0011	0.0013
D50% F	0.0009	**0.0009**	0.0010	0.0000	0.0001	-0.0001	0.0001	0.0001	-0.0001	-0.0001	0.0001	0.0000	-0.0004	-0.0001	-0.0003	-0.0001	-0.0002	-0.0002	-0.0003
DFFS	0.0059	0.0063	**0.0055**	-0.0002	0.0010	-0.0001	0.0008	0.0005	-0.0006	-0.0009	0.0004	-0.0003	-0.0024	-0.0006	-0.0022	-0.0008	-0.0006	-0.0018	-0.0017
NLPF	-0.0001	-0.0001	-0.0002	**0.0055**	0.0002	0.0004	-0.0005	0.0001	-0.0011	-0.0009	-0.0008	-0.0014	-0.0006	0.0007	-0.0002	-0.0013	0.0010	-0.0017	0.0002
PH	-0.0001	-0.0001	-0.0001	0.0000	**-0.0005**	-0.0002	0.0001	0.0001	0.0000	0.0002	0.0000	0.0002	0.0000	0.0000	0.0003	0.0000	0.0000	-0.0001	-0.0001
PBPP	-0.0003	-0.0004	-0.0001	0.0003	0.0017	**0.0035**	-0.0007	-0.0014	-0.0004	-0.0003	-0.0010	-0.0013	0.0007	0.0003	-0.0010	-0.0005	0.0008	-0.0007	0.0004
PFD	0.0006	0.0003	0.0004	-0.0002	-0.0007	-0.0005	**0.0026**	0.0017	0.0010	0.0004	0.0007	0.0001	-0.0003	0.0003	0.0003	-0.0001	0.0010	-0.0004	0.0010
EFD	0.0003	0.0001	0.0001	0.0000	-0.0002	-0.0005	0.0008	**0.0013**	0.0003	0.0002	0.0010	0.0003	0.0000	-0.0003	0.0000	0.0000	0.0003	0.0000	0.0004
PT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0001	-0.0001	**-0.0002**	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AA	0.0000	-0.0003	-0.0004	-0.0004	-0.0010	-0.0003	0.0004	0.0005	0.0002	**0.0027**	0.0005	0.0011	0.0012	-0.0002	0.0003	0.0011	-0.0002	-0.0001	-0.0003
TCC	0.0002	0.0001	0.0001	-0.0002	0.0000	-0.0003	0.0003	0.0009	0.0003	0.0002	**0.0012**	0.0005	0.0001	-0.0003	0.0000	0.0000	0.0002	0.0000	0.0003
LC	-0.0001	0.0000	0.0001	0.0005	0.0008	0.0008	-0.0001	-0.0005	-0.0004	-0.0009	-0.0008	**-0.0021**	-0.0005	0.0004	-0.0007	-0.0007	0.0001	0.0000	0.0000
TAC	-0.0007	-0.0008	-0.0007	-0.0002	0.0000	0.0004	-0.0002	0.0000	0.0000	0.0008	0.0002	0.0004	**0.0016**	0.0000	0.0001	-0.0001	0.0002	-0.0002	0.0000
TA	0.0006	0.0003	0.0003	-0.0004	-0.0002	-0.0003	-0.0004	0.0007	-0.0003	0.0002	0.0009	0.0006	-0.0001	**-0.0030**	-0.0003	-0.0002	0.0001	-0.0005	0.0000
TPC	-0.0019	-0.0016	-0.0016	-0.0001	-0.0024	-0.0012	0.0005	0.0000	0.0006	0.0005	0.0000	0.0013	0.0004	0.0005	**0.0041**	0.0008	0.0015	-0.0004	0.0015
TSS	0.0002	0.0004	0.0005	0.0008	0.0002	0.0005	0.0001	-0.0001	0.0002	-0.0014	-0.0001	-0.0010	0.0002	-0.0002	-0.0007	**-0.0034**	0.0012	-0.0019	0.0005
AFW	-0.0006	-0.0006	-0.0004	0.0006	-0.0001	0.0007	0.0013	0.0008	0.0001	-0.0002	0.0006	-0.0001	0.0003	-0.0001	0.0011	-0.0011	**0.0032**	-0.0016	0.0028
NFPP	-0.0023	-0.0013	-0.0023	-0.0021	0.0020	-0.0013	-0.0011	-0.0001	0.0003	-0.0001	-0.0002	0.0001	-0.0010	0.0012	-0.0007	0.0038	-0.0035	**0.0070**	-0.0005
TFY	-0.3873	-0.3119	-0.3036	0.0316	0.1263	0.1158	0.3785	0.3106	0.0816	-0.1124	0.2191	-0.0122	0.0133	0.0024	0.3673	-0.1484	0.8889	-0.0650	**0.9962**
GFYPP	**-0.3870**	**-0.3114**	**-0.3032**	**0.0329**	**0.1270**	**0.1164**	**0.3794**	**0.3122**	**0.0804**	**-0.1128**	**0.2196**	**-0.0121**	**0.0136**	**0.0020**	**0.3690**	**-0.1483**	**0.8924**	**-0.0655**	**1.0000**

Residual effect: 0.0072

Characters: Days to first flowering (DFF), Days to 50% flowering (D50%F),Days to first fruit set (DFFS), Number of locules per fruit (NLPF), Plant height (PH),Primary branches per branch (PB/P), Polar fruit diameter (PFD),),Equatorial fruit diameter (EFD).Pericarp thickness (PT), Ascorbic acid content (AA),Total carotenoids content(TCC),lycopene content (LC), Total antioxidant capacity (TAC),Titrable acidity (TA), Total phenol content (TPC), Total soluble solid (TSS), Average fruit weight (AFW), Number of fruit per plant (NFPP), Total fruit yield (TFY) and Genotypic Fruit yield per plant (GFYPP)

CONCLUSIONS

The link between average fruit weight, fruit output per plant, equatorial fruit diameter, polar fruit diameter, and total phenolic content was significantly positive, as were the days to 50% flowering, while days to first fruit set have a strong, negative relationship with overall fruit production. On the other hand, lycopene content has high significant and positive correlation with total phenolics content, TSS content and total antioxidant capacity but negative correlation with titrable acidity. In path coefficient analysis the highest positive direct effect was noted in total fruit yield followed by number of fruit per plant, number of locules per fruit, days to 50% flowering and primary branches per plant both had a favourable association with yield and a direct impact on it. Thus, these characteristics can be employed as selection indices in tomato breeding to increase yield.

FUTURE SCOPE

The character's link between fruit yield, earliness with quality traits and positive direct effects on plant yield could be used either for selection of parents for effecting new crosses or hybrids for recombination breeding.

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