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APPRAISAL OF CHARACTER ASSOCIATION IN TOMATO (*SOLANUM LYCOPERSICUM* L.)

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ABSTRACT

Tomato also known as “Love Apple” or “Apple of Peru” is a highly significant commercial vegetable crop of India. Correlation and path analysis guide breeders to improve yield productivity by identifying key traits influencing yield in selection programs. Therefore, the present investigation was carried out for evaluating correlation and path analysis for fruit yield and its components in 45 diverse genotypes of tomato in Randomized Complete Block Design with three replications at Main Vegetables Research Station, Anand Agricultural University, Anand during *Kharif-Rabi* 2023-24 using twenty parameters. The results revealed that the traits *viz.* number of fruits per plant, average fruit weight, plant height, fruit girth, days to marketable maturity, number of branches per plant, fruit length, and test weight should be given due importance because of their strong positive direct effect and positive correlation with fruit yield per plant. Thus, while undertaking genetic improvement for fruit yield in tomato through selection programs, more emphasis should be given to these traits.

Key words: correlation, path analysis, selection, fruit yield

Introduction

Tomato (*Solanum lycopersicum* L.) is a highly significant vegetable crop which is grown worldwide. It is a self-pollinated cop with chromosome number 2n = 24. Sikder *et al.*, (2013) observed that tomatoes are day-neutral and widely consumed yearly. In the world’s tropics and subtropics, tomatoes are one of the most significant and extensively cultivated vegetable fruits. After potato, it ranks second among the various vegetables produced worldwide and is a member of the *Solanaceae* family, popularly known as the nightshade family. The reason for the widespread cultivation of tomatoes, which are offered both fresh and in various processed forms, is their acceptance in both domestic and international markets. It is originally native to tropical America from Peruvian and Mexican regions (Thompson and Kelly, 1957). Tomato was introduced in India by English traders of the East India Company in 1822 (Kalloo, 1988).

China stands first in the major tomato growing countries followed by India, Turkey, USA, Egypt, Italy, Iran, Spain, Mexico, Brazil and Nigeria (Anonymous, 2023a). Tomato ranks third in priority after potato and onion in India but ranks second after potato in the world. India ranks second in the area (8.64 lakh hectares) and production (211.81 lakh tonnes) in the world. The productivity of tomato in India is 24.31 tonnes per hectare (Anonymous, 2022a). In India, Madhya Pradesh stands first in production (29.70 lakh tonnes) followed by Andhra Pradesh, Karnataka, Tamil Nadu, Odisha and Gujarat. Gujarat ranks sixth in tomato production in India. (Anonymous, 2022b). In Gujarat, tomato is grown in 67.87 thousand hectares with the annual production of 19.22 lakh tons with a productivity of 28.32 tons per hectare. The important tomato growing districts of Gujarat are

Anand, Kheda, Gandhinagar, Dang, Dahod, Narmada, Panchamahal, Banaskantha, Vadodara, Sabarkantha, Valsad and Bhavnagar (Anonymous, 2023b).

Tomato flowers are hypogynous, hermaphrodite, and regular, with six recurved golden yellow petals and a tubular cone of stamens that promote self-pollination, though spontaneous cross-pollination can occur up to five percent (Salunkha *et al.*, 1987).

The red-colored substance known as "lycopene" found in tomatoes is regarded as the "most potent natural antioxidant in the world." Tomatoes and tomato-based products are high in potassium, vitamin C, and folate. Due to the antioxidant properties of lycopene and various other carotenoids, which are abundant in tomatoes, these meals are rich in antioxidant activity.

Understanding trait inter-relationships through phenotypic and genotypic correlations is crucial for crop improvement, as it aids in selecting desirable genotypes, facilitates trait transfer, and predicts the influence of one trait on another by eliminating environmental effects. Path analysis, developed by Wright (1921), partitions the correlation coefficient into direct and indirect effects, helping breeders assess the contribution of independent variables to yield and aiding in precise selection.

Keeping the above facts in focus, present investigation aims to elucidate the genotypic and phenotypic correlation and direct- indirect effects among agro economic traits and some others related to biochemical in some selected species of Tomato.

Material and Methods

The experiment was conducted at the Main Vegetable Research Station, Anand Agricultural University, Anand, during *Kharif-Rabi* 2023–2024. The experimental material for the present investigation comprised 45 genotypes of tomato (*Solanum lycopersicum* L.) obtained from Main Vegetable Research Station, AAU, Anand. The genotypes were evaluated using a Randomized Complete Block Design with three replications. Each genotype was sown in a single row of 4.5 meters length and keeping row to row distance 90 cm. All recommended package of practices were followed to raise good and healthy crop.

Observations were recorded from five randomly selected competitive plants for fruit yield and its attributing characters *viz.*, plant height (cm), branches per plant, average fruit weight, fruit length (cm), fruit girth (cm), pericarp thickness (mm), locules per fruit, seeds per fruit, shelf life (days), fruits per plant, test weight (g), total soluble solids (ºBrix), total soluble sugars (%), lycopene content (mg/100g), acidity (%), ascorbic acid content (mg/100g) and â-carotene content (mg/100g). For days to 50% flowering and days to marketable maturity observations were recorded on plot basis. For biochemical analysis samples collected from each genotype were crushed to make their pulp which was then used for estimation of various biochemical parameters according to the standard analytical procedure. Genotypic and phenotypic correlation coefficients were estimated as suggested by Hazel (1943). The path coefficient analysis was carried-out according to the method suggested by Wright (1921) and used by Dewey and Lu (1959).

Results and Discussion

Analysis of Variance

The investigation revealed that, for each of the 20 characters under study, the mean square resulting from 45 genotypes were highly significant, suggesting that there was ample amount of variability among the genotypes which can be exploited in future for improvement of respective traits (Table 1).

Correlation Analysis

Character association analysis was used in the

Table 1: Analysis of variance (mean sum of squares) for different characters in tomato.

S. No.	Source of variation / Characters	Mean Sum of Squares		
		R	G	E
		df		
1.	Days to 50% flowering	3.33	32.95**	3.75
2.	Days to marketable maturity	0.31	52.88**	12.85
3.	Plant height	187.94	636.09**	68.33
4.	Branches per plant	1.37	6.61**	1.36
5.	Average fruit weight	69.43	1075.01**	56.16
6.	Fruit length	0.04	1.39**	0.11
7.	Fruit girth	2.58	36.77**	2.90
8.	Pericarp thickness	0.31	7.84**	0.37
9.	Locules per fruit	0.02	3.92**	0.04
10.	Seeds per fruit	8.15	180.83**	12.03
11.	Shelf life	0.63	3.89**	0.31
12.	Fruits per plant	5.87	89.64**	6.60
13.	Fruit yield per plant	0.03	0.29**	0.02
14.	Test weight	0.001	0.44**	0.01
15.	Total soluble solids	1.29**	1.31**	0.04
16.	Total soluble sugar	0.003	0.38**	0.001
17.	Lycopene content	0.001	0.364**	0.001
18.	Acidity	0.002	0.06**	0.001
19.	Ascorbic acid content	0.61	117.16**	0.35
20.	β-carotene content	0.01	4.29**	0.01

R: Replications; **G:** Genotypes; **E:** Error
Note: *, ** Significant at 5% and 1% level, respectively

Table 2: Genotypic correlation coefficients among different characters in tomato.

Cha.	DFF	DMM	PH	BPP	AFW	FL	FG	PT	LPF	SPF	SL	FPP	TW	TSS	TSG	LC	Acidity	AAC	BC	FYP
DFF	1																			
DMM	0.483**	1																		
PH	-0.222	-0.163	1																	
BPP	0.091	0.053	-0.162	1																
AFW	-0.431**	-0.299*	0.706**	-0.205	1															
FL	-0.170	-0.220	0.156	-0.117	-0.124	1														
FG	-0.379*	-0.046	0.573**	0.110	0.788**	-0.046	1													
PT	-0.071	0.040	0.182	0.088	0.077	0.187	0.174	1												
LPF	-0.189	-0.155	-0.009	-0.235	0.096	-0.201	0.082	-0.073	1											
SPF	-0.170	-0.119	0.071	-0.083	0.056	-0.039	0.042	0.079	0.746**	1										
SL	-0.091	-0.115	-0.142	0.018	-0.058	0.159	0.006	0.868**	-0.017	0.046	1									
FPP	-0.147	-0.168	0.580**	-0.407**	0.565**	0.256	0.303*	0.348*	0.011	-0.050	0.259	1								
TW	0.092	0.134	-0.073	0.143	-0.089	-0.031	0.026	0.060	0.240	0.334*	0.159	-0.103	1							
TSS	-0.002	0.216	0.063	-0.255	0.077	-0.145	-0.084	-0.091	0.154	0.126	-0.101	0.130	0.190	1						
TSG	-0.132	0.037	0.112	-0.045	-0.001	-0.232	-0.135	0.021	0.112	0.081	-0.063	-0.104	-0.116	0.323*	1					
LC	-0.215	0.190	-0.049	-0.172	-0.040	0.188	0.101	0.046	0.002	-0.221	0.094	0.049	-0.037	-0.058	-0.198	1				
Acidity	-0.087	0.035	0.009	0.152	-0.123	0.001	0.014	-0.194	0.253	0.307*	-0.155	-0.264	0.072	-0.187	-0.007	0.074	1			
AAC	0.034	-0.239	-0.086	0.120	-0.123	0.278	-0.036	0.159	-0.197	-0.266	0.294*	-0.177	-0.022	-0.170	-0.134	-0.181	-0.013	1		
BC	-0.178	-0.092	0.238	0.020	0.200	0.304*	0.311*	0.269	-0.199	-0.021	0.115	0.185	-0.327*	-0.239	0.035	0.035	0.090	-0.108	1	
FYP	-0.199	-0.252	0.666**	-0.251	0.636**	0.195	0.287*	0.234	-0.024	-0.072	0.116	0.906**	-0.035	0.073	-0.012	-0.089	-0.179	-0.126	0.127	1

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

DFF - Days to 50% flowering, **DMM** - Days to marketable maturity, **PH** - Plant height, **BPP** - Number of branches per plant, **AFW** - Average fruit weight, **FL** - Fruit length, **FG** - Fruit girth, **PT** - Pericarp thickness, **LPF** - Number of locules per fruit, **SPF** - Number of seeds per fruit, **SL** - Shelf life, **FPP** - Number of fruits per plant, **TW** - Test weight, **TSS** - Total soluble solids, **TSG** - Total soluble sugar, **LC** - Lycopene content, **AAC** - Ascorbic acid content, **BC** - β-carotene content, **FYP** - Fruit yield per plant, **Cha.** - Characters

current study to determine the characters that are associated with yield and how they relate to it. At the genotypic and phenotypic levels, the correlation coefficients between the fruit yield per plant and its component traits as well as between them were evaluated. In the current study of character association, it was observed that genotypic correlation coefficients were relatively higher than phenotypic correlation coefficients for majority traits, which indicated that there was a strong inherent association between characters studied and its phenotypic expression. In some of the characters, phenotypic correlation coefficients were higher than genotypic correlation coefficients, it indicates suppressing effect of the environment which modified the expression of the characters at phenotypic levels. The results of genotypic and phenotypic correlation for 20 yield and its contributing traits among 45 genotypes of tomato are presented in Table 2 and 3, respectively.

Correlation between yield and yield component traits

Fruit yield per plant had highly significant and positive correlation with plant height, number of fruits per plant and fruit weight at both genotypic and phenotypic levels and significant and positive association with fruit girth at both the levels. While it has positive and significant association with fruit length and pericarp thickness at phenotypic level only. It also showed negative and significant correlation with number of branches per plant at phenotypic level only. For other characters it showed non-significant association. The findings suggest that, fruit yield can be improved in these tomato genotypes by using these traits as selection criteria in succeeding generations. A tall plant with more number of fruits having higher girth and weight ultimately leads to higher fruit yield per plant. Therefore, these traits should be given more attention while improving fruit yield. Positive association of fruit yield per plant with number of fruits per plant, average fruit weight and fruit girth was reported by Patel and Kumar (2021) and Nevani and Sridevi (2021) and positive association of fruit yield per plant with plant height was earlier reported by Maurya *et al.*, (2020) and Kumar *et al.*, (2021).

Inter correlation among yield component traits

The trait days to 50% flowering was highly

Table 3: Phenotypic correlation coefficients among different characters in tomato.

Cha.	DFF	DMM	PH	BPP	AFW	FL	FG	PT	LPF	SPF	SL	FPP	TW	TSS	TSG	LC	Acidity	AAC	BC	FYP
DFF	1																			
DMM	0.282**	1																		
PH	-0.137	-0.081	1																	
BPP	0.038	0.031	-0.129	1																
AFW	-0.368**	-0.176*	0.573**	-0.139	1															
FL	-0.150	-0.168	0.105	-0.061	-0.065	1														
FG	-0.273**	-0.023	0.449**	0.072	0.648**	-0.031	1													
PT	-0.079	0.014	0.145	0.051	0.070	0.159	0.146	1												
LPF	-0.167	-0.112	-0.012	-0.154	0.081	-0.178*	0.078	-0.076	1											
SPF	-0.133	-0.092	0.028	-0.050	0.068	-0.056	0.001	0.061	0.656**	1										
SL	-0.061	-0.039	-0.087	0.048	-0.075	0.104	0.048	0.734**	0.004	0.012	1									
FPP	-0.128	-0.109	0.452**	-0.252**	0.466**	0.198*	0.234**	0.286**	0.011	-0.061	0.221**	1								
TW	0.076	0.043	-0.065	0.080	-0.084	-0.018	0.026	0.064	0.230**	0.279**	0.127	-0.115	1							
TSS	0.010	0.130	0.039	-0.176*	0.056	-0.119	-0.076	-0.055	0.146	0.093	-0.063	0.089	0.173*	1						
TSG	-0.109	0.04	0.094	-0.021	-0.001	-0.196*	-0.120	0.015	0.109	0.069	-0.050	-0.090	-0.114	0.301**	1					
LC	-0.175*	0.141	-0.050	-0.132	-0.035	0.145	0.083	0.042	-0.001	-0.208*	0.081	0.059	-0.042	-0.047	-0.193*	1				
Acidity	-0.063	0.060	0.001	0.114	-0.104	-0.003	0.024	-0.179*	0.244**	0.279**	-0.137	-0.236**	0.083	-0.172*	-0.007	0.077	1			
AAC	0.020	-0.176*	-0.067	0.090	-0.113	0.239**	-0.03	0.154	-0.197*	-0.235**	0.259**	-0.161	-0.027	-0.155	-0.134	-0.175*	-0.017	1		
BC	-0.15	-0.069	0.201*	0.026	0.187*	0.278*	0.269**	0.242**	-0.194*	-0.015	0.101	0.177*	-0.314**	-0.232**	0.035	0.031	0.087	-0.107	1	
FYP	-0.188	-0.170	0.544**	-0.185*	0.528**	0.174*	0.202*	0.174*	-0.020	-0.068	0.092	0.753**	-0.031	0.054	-0.011	-0.086	-0.164	-0.115	0.116	1

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

DFF - Days to 50% flowering, **DMM** - Days to marketable maturity, **PH** - Plant height, **BPP** - Number of branches per plant, **AFW** - Average fruit weight, **FL** - Fruit length, **FG** - Fruit girth, **PT** - Pericarp thickness, **LPF** - Number of locules per fruit, **SPF** - Number of seeds per fruit, **SL** - Shelf life, **FPP** - Number of fruits per plant, **TW** - Test weight, **TSS** - Total soluble solids, **TSG** - Total soluble sugar, **LC** - Lycopene content, **AAC** - Ascorbic acid content, **BC** - β-carotene content, **FYP** - Fruit yield per plant, **Cha**. - Characters

significantly and positively correlated with days to marketable maturity at both genotypic and phenotypic levels. On the contrary it was negatively and highly significantly correlated with fruit weight at both genotypic and phenotypic levels and it was negatively and significantly correlated with fruit gith at genotypic level and negatively and highly significantly at phenotypic level. With lycopene content it showed negative and significant association at phenotypic level only. Sushma *et al.*, (2020) and Nevani and Sridevi (2021) also reported positive association between days to 50% flowering and days to marketable maturity. Plant height exhibited highly significant and positive correlation with traits like number of fruits per plant, fruit girth, average fruit weight and fruit yield per plant both at genotypic and phenotypic levels. This inferred that increase in plant height leads to simultaneous improvement in the above mention traits. Maurya *et al.*, (2020) and Kumar *et al.*, (2021) also reported positive association of plant height with number of fruits per plant. Positive association of plant height with fruit yield per plant was reported by Namdev and Dongre (2018) and Vijaylaxmi *et al.*, (2021). The character number of branches per plant showed negative and highly significant association with the character number of fruits per plant at both genotypic and phenotypic levels and for the traits fruit yield per plant and total soluble solids it showed negative and significant association at phenotypic level only. Kumar and Dudi (2011) reported negative association between number of branches per plant and number of fruits per plant and Namdev and Dongre (2018) reported negative correlation between number of branches per plant and fruit yield per plant. There was highly significant and positive correlation of fruit weight with traits like fruit girth, fruit yield per plant and number of fruits per plant at both genotypic and phenotypic levels. Therefore, selection of genotypes with higher fruit weight and more number of fruits is crucial for yield improvement. Present findings were showing confirmation with results reported by Mishra *et al.*, (2019), Maurya *et al.*, (2020) and Kumar *et al.*, (2021). Pericarp thickness was highly significantly and positively correlated with shelf life at both genotypic and phenotypic levels. It also showed positive and significant association with number of fruits per plant at genotypic level and with same trait highly significant and positive

Table 4: Genotypic path coefficient analysis showing direct and indirect effects of different characters on fruit yield per plant in tomato

Cha.	DFF	DMM	PH	BPP	AFW	FL	FG	PT	LPF	SPF	SL	FPP	TW	TSS	TSG	LC	Acidity	AAC	BC	rg
DFF	**-0.167**	0.151	-0.077	0.029	-0.340	-0.031	0.297	0.02	-0.06	0.057	-0.028	-0.092	0.011	0	0.005	0.039	0.000	-0.002	-0.01	-0.199
DMM	-0.081	**0.313**	-0.057	0.017	-0.237	-0.041	0.036	-0.012	-0.05	0.04	-0.035	-0.104	0.015	-0.029	-0.001	-0.034	0.000	0.011	-0.005	-0.252
PH	0.037	-0.051	**0.349**	-0.051	0.558	0.029	-0.446	-0.052	-0.003	-0.024	-0.043	0.361	-0.008	-0.009	-0.004	0.009	0.000	0.004	0.013	0.666**
BPP	-0.015	0.017	-0.057	**0.315**	-0.162	-0.022	-0.087	-0.025	-0.075	0.028	0.006	-0.254	0.016	0.035	0.002	0.031	0.001	-0.006	0.001	-0.251
AFW	0.072	-0.094	0.247	-0.065	**0.789**	-0.023	-0.617	-0.022	0.031	-0.019	-0.018	0.352	-0.01	-0.01	0.000	0.007	-0.001	0.006	0.011	0.636**
FL	0.029	-0.069	0.055	-0.037	-0.099	**0.184**	0.036	-0.054	-0.064	0.013	0.049	0.159	-0.004	0.02	0.009	-0.034	0.000	-0.013	0.017	0.195
FG	0.063	-0.014	0.199	0.035	0.622	-0.008	**-0.782**	-0.05	0.026	-0.014	0.002	0.189	0.003	0.011	0.005	-0.018	0.000	0.002	0.017	0.287*
PT	0.012	0.013	0.064	0.028	0.061	0.034	-0.137	**-0.287**	-0.023	-0.027	0.264	0.216	0.007	0.012	-0.001	-0.008	-0.001	-0.008	0.015	0.234
LPF	0.032	-0.049	-0.003	-0.074	0.076	-0.037	-0.064	0.021	**0.319**	-0.249	-0.005	0.007	0.027	-0.021	-0.004	0.000	0.001	0.009	-0.011	-0.024
SPF	0.028	-0.037	0.025	-0.026	0.045	-0.007	-0.033	-0.023	0.237	**-0.334**	0.014	-0.032	0.038	-0.017	-0.003	0.04	0.001	0.013	-0.001	-0.072
SL	0.015	-0.036	-0.05	0.006	-0.046	0.029	-0.005	-0.249	-0.006	-0.016	**0.304**	0.162	0.018	0.014	0.002	-0.017	-0.001	-0.014	0.006	0.116
FPP	0.025	-0.053	0.202	-0.129	0.446	0.047	-0.238	-0.1	0.004	0.017	0.079	**0.622**	-0.012	-0.018	0.004	-0.009	-0.001	0.009	0.01	0.906**
TW	-0.015	0.042	-0.026	0.045	-0.070	-0.006	-0.021	-0.017	0.077	-0.112	0.049	-0.064	**0.114**	-0.026	0.004	0.007	0.000	0.001	-0.018	-0.035
TSS	0	0.068	0.022	-0.081	0.061	-0.027	0.066	0.026	0.049	-0.042	-0.031	0.081	0.022	**-0.135**	-0.012	0.01	-0.001	0.008	-0.013	0.073
TSG	0.022	0.012	0.039	-0.014	-0.001	-0.043	0.106	-0.006	0.036	-0.027	-0.019	-0.065	-0.013	-0.044	**-0.038**	0.036	0.000	0.006	0.002	-0.012
LC	0.036	0.06	-0.017	-0.054	-0.032	0.035	-0.080	-0.013	0.001	0.074	0.029	0.031	0.001	0.008	0.008	**-0.179**	0.000	0.009	0.002	-0.089
Acidity	0.015	0.011	0.003	0.048	-0.097	0.000	-0.012	0.056	0.081	-0.103	-0.047	-0.165	0.008	0.025	0.000	-0.013	**0.004**	0.001	0.005	-0.179
AAC	-0.006	-0.075	-0.03	0.038	-0.097	0.051	0.028	-0.046	-0.063	0.089	0.09	-0.110	-0.003	0.023	0.005	0.033	0.000	**-0.048**	-0.006	-0.126
BC	0.03	-0.029	0.083	0.007	0.158	0.056	-0.244	-0.077	-0.064	0.007	0.035	0.115	-0.037	0.032	-0.001	-0.006	0.000	0.005	**0.054**	0.124

Note: Residual effect = 0.016, diagonal values are direct effects, Cha.-Characters, *,** Significant at 5 and 1% level, respectively
DFF - Days to 50% flowering, **DMM -** Days to marketable maturity, **PH -** Plant height, **BPP -** Number of branches per plant, **AFW -** Average fruit weight, **FL -** Fruit length, **FG -** Fruit girth, **PT -** Pericarp thickness, **LPF -** Number of locules per fruit, **SPF -** Number of seeds per fruit, **SL -** Shelf life, **FPP -** Number of fruits per plant, **TW -** Test weight, **TSS -** Total soluble solids, **TSG -** Total soluble sugar, **LC -** Lycopene content, **AAC -** Ascorbic acid content, **BC -** β-carotene content, **FYP –** Fruit yield per plant, **Cha**. – Characters, **rg- rg with FYP**

association at phenotypic level. Therefore, selection of genotypes with higher pericarp thickness with good shelf life and higher number of fruits is highly desirable. Similar results of pericarp thickness for shelf life was also reported by Kumar *et al.*, (2021) and Nevani and Sridevi (2021). The character number of fruits per plant had significant and positive association with the trait fruit yield plant. This inferred that selection of genotypes with higher number of fruits per plant helps in overall improvement of yield. Positive association of number of fruits per plant with fruit yield was reported by Namdev and Dongre (2018), Nevani and Sridevi (2021). Lycopene content had negative and significant association with number of seeds per fruit, days to 50% flowering and ascorbic acid content at phenotypic level only. Nevani and Sridevi (2021) reported negative association of lycopene content with days to 50% flowering and acidity. Therefore, selection of genotypes which are early maturing and high in lycopene content is highly desirable. The character ascorbic acid content had positive and significant association with shelf life at genotypic level and with the same trait plus fruit length positive and highly significant association at phenotypic level. Negative association of ascorbic acid content with number of locules per fruit was also reported by Patel and Kumar (2021).

Path coefficient analysis

Path analysis was carried out at genotypic level considering fruit yield per plant as dependent variable and its attributes *viz.*, days to 50% flowering, days to marketable maturity, plant height, number of branches per plant, fruit weight, fruit length, fruit girth, pericarp thickness, number of locules per fruit, number of seeds per fruit, shelf life, fruits per plant, test weight, total soluble solids, total soluble sugar, lycopene content, acidity, ascorbic acid content and â-carotene content as independent variables. Each component has two kinds of effects in path analysis *viz.*, direct effect on fruit yield per plant and indirect effect through other components which are not explained by correlation studies. The results of genotypic path coefficient analysis are presented in Table 4. The path coefficient analysis revealed the cause-and-effect relationship which is shown at genotypic level. Highest direct positive effect on fruit yield per plant was registered by fruit weight (0.789), followed by number of fruits per plant (0.622),

plant height (0.349), number of locules per fruit (0.319), number of branches per plant (0.315), days to marketable maturity (0.313), shelf life (0.304), fruit length (0.184) and test weight (0.114). Fruit girth indirectly and positively influenced fruit yield per plant through fruit weight (0.622). These traits can be considered as primary selection criteria in breeding programs for improvement of fruit yield in tomato. The remaining character *viz*. days to 50% flowering, fruit girth, pericarp thickness, seeds per fruit, total soluble solids, total soluble sugars, lycopene content and ascorbic acid content showed negative direct effect on fruit yield per plant. Similar results were obtained by Mishra *et al*., (2019) and Maurya *et al*., (2020) for fruit weight, Ritonga *et al.*, (2018) and Namdev and Dongre (2018) for fruits per plant, Vijyalaxmi *et al.*, (2021) and Patel and Kumar (2021) for plant height, Kumar and Dudi (2011) for branches per plant, days to 50% flowering and lycopene content, Kumar *et al.*, (2021) for locules per fruit, Sushma *et al.*, (2020) for days to marketable maturity and total soluble solids, Nevani and Sridevi (2021) for fruit length and shelf life, Mahmood *et al.*, (2008) for test weight and seeds per fruit, Khapte and Jansirani (2014) for fruit girth, Maurya *et al.*, (2020) for pericarp thickness and Mishra *et al.*, (2019) for ascorbic acid content. The residual effect at genotypic level was observed to be low (0.016) through various characters which are not considered under study, it indicates that there were no considerable effects *via* such traits which are not considered under investigation.

The path coefficient analysis revealed that fruit weight, number of fruits per plant, plant height and fruit girth could be considered as major yield components and should be given due consideration while exercising selection for improvement in terms of fruit yield as they had positive direct effect as well as positive correlation with fruit yield per plant.

Conclusion

The above showed that in order to increase fruit yield, it is important to consider the fruits per plant, fruit weight, plant height and fruit girth. The days to marketable maturity, branches per plant, fruit length, and test weight were also found to be significant yield components by path coefficient analysis. As a result of their strong positive direct effect and positive correlation with fruit yield, these factors should be given appropriate consideration when selecting.

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