Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(1): 2078-2082
Received: 04-11-2019
Accepted: 06-12-2019

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Genetic variability and character association analysis for yield and attributing traits in tomato (*Solanum lycopersicum* L.) genotypes for protected cultivation

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DOI: https://doi.org/10.22271/phyto.2020.v9.i1ai.10772

Abstract
The present study was carried out with fourteen genotypes of tomato at Polyhouse Complex, Department of Horticulture (Veg. & Flori.), BAU, Sabour during 2018-2019 to assess the genetic variability and character association for yield and attributing traits in tomato (*Solanum lycopersicum* L.) genotypes for protected conditions. The experiment was laid out in randomized block design with three replications. Data were recorded for sixteen morphological traits and five biochemical traits. The experimental results revealed considerable differences among the genotypes for all the traits except titratable acidity and β-carotene. Higher phenotypic and genotypic coefficients of variation (PCV and GCV) were observed for no. of flowers/truss, no. of locules/fruit, no. of fruits/truss, fruit yield/plant, no. of fruit/plant, average weight of fruit, final plant height, titratable acidity, lycopene, ascorbic acid and β-carotene indicating phenotypic selection for these traits was effective for enhancement. High heritability together with high genetic advance as % of mean was observed in all traits except days to fruit picking. Based upon correlation and path coefficient analysis characters like no. of flower /truss, equatorial diameter, pericarp thickness and no. of fruit /plant could be reliable selection parameters for evolving high yielding genotypes.

Keywords: Tomato, GCV, PCV, correlation, path analysis

Introduction
Tomato (*Solanum lycopersicum* L.) is most liked and versatile vegetable that grown throughout the world. It belongs to the nightshade family having chromosome number is 2n = 24. Tomatoes fruit has high demand in local and national markets throughout the year but in open field condition, round the year production is not possible because it is susceptible to several biotic and abiotic stresses and as a result quality and yield of tomato is reduced as compared to tomato produced under protected conditions. Thus, for overcoming adverse conditions protected farming is best substitute. In greenhouses, indeterminate tomatoes are grown because it utilizes vertical space inside greenhouse, give slow and regular picking of fruit and producing higher fruit yield.
Knowledge about the nature and level of inter-relationship of yield and other components is very valuable because selection based on one trait may directly or indirectly affect the performance of another trait. Therefore, assessment of inter-relationships among a number of component characters is an important requisite to bring improvement in desired direction. Path coefficient analysis partitions correlation coefficient into direct and indirect effect and gives information about the direct and indirect contribution made by different traits towards yield. Keeping all these facts in consideration, the present investigation was carried out.

Materials and methods
Fourteen diverse genotypes of tomato were collected from different sources and used for the investigation. These genotypes were planted in randomized block design under naturally ventilated polyhouse with three replications at Polyhouse Complex, Deptt. of Horticulture (Veg. and Flori.), Bihar Agricultural College, BAU, Sabour, Bhagalpur (Bihar) during Rabi season of 2018. Seedlings of all the genotype were transplanted at 25th Oct. 2018 at a spacing of 60 cm x 60 cm (Double row planting). Recommended package of practices were followed for healthy growth of the crop. Data were recorded for sixteen morphological traits viz., days to first flower initiation, days to fifty percent flowering, node to first flowering etc and five biochemical parameters viz., total soluble solid (o brix), ascorbic acid (mg/100g), titratable acidity (%), lycopene (mg/100g) and β-carotene (mg/100g) and were statistically analyzed as per the standard procedure.

Results and Discussion

Data from analysis of variance shows that mean sum of squares of all genotypes was highly significant for all traits under study except titratable acidity and β-carotene which indicate high amount of variability exist in the genotypes. Thus, there is abundant scope for selection of promising genotypes. Analogous finding were also observed by Hasan *et al.*, (2016) [1], Kumar *et al.*, (2017) [2] and Panchbhaiya *et al.*, (2018) [4].

The estimates of variability showed that PCV were higher in magnitude than their corresponding GCV for all the traits (table 1), indicating variation is due to environmental factors present during the growing season of crop which influences their expression. Thus, selection for these traits might be unpredictable in nature. Panchbhaiya *et al.*, (2018) [4] and Ritonga *et al.*, (2018) [5] also observed high PCV values than the corresponding GCV values.

High level of GCV and PCV were recorded in lycopene (52.39%, 52.46%) after that β-carotene (48.80%, 48.92), number of fruit per plant (41.49%, 42.11%), titratable acidity (37.57%, 37.67%), number of locules per fruit (34.04%, 34.61%), fruit yield per plant (33.52%, 34.06%), number of fruit per truss (31.66%, 32.27%), ascorbic acid (27.67%, 27.77%), average fruit weight (27.10%, 27.76%), number of flower per truss (23.90%, 24.06%) and plant height at final harvest (21.40%, 21.88%). These high estimates indicate ample scope for enhancement of these traits through simple selection. High degree for PCV and GCV was reported by Lekshmi and Celine (2017) [3] and Panchbhaiya *et al.*, (2018) [4].

Moderate level of GCV and PCV was seen in plant height at 60 DAT (17.61%, 18.67%), polar diameter of fruit (16.51%, 17.86%), days to first fruiting (15.91%, 16.56%), days to first flowering (15.58%, 16.89%), days to 50% flowering (15.14%, 16.39%), total soluble solid (13.63%, 13.90%), equatorial diameter of fruit (13.00%, 14.16%) and node to first flowering (11.15%, 12.75%). The moderate estimates suggest that direct selection for these traits should be considered cautiously. Moderate estimates for GCV and PCV were reported by Lekshmi and Celine (2017) [3] and Panchbhaiya *et al.*, (2018) [4]. Low level of GCV and PCV was seen in days to first picking (4.49%, 6.81%). Similar finding was also noted by Rai *et al.*, (2016) [5].

High heritability estimates (>60%) were recorded for all the traits except days to first picking. High heritability together with high genetic advance as % of mean was observed in days to fifty percent flowering (85.30%, 28.80%), days to first flowering (85.08%, 29.60%), no. of flowers/truss (94.34%, 47.82%), days to first fruiting (92.39%, 31.51%), no. of fruits/truss (96.27%, 64.00%), plant height at 60 days after transplanting (88.99%, 34.22%), node to first flowering (76.55%, 20.10%), number of locules per fruit (96.72%, 68.96%), polar diameter of fruit (85.43%, 31.43%), equatorial diameter of fruit (84.38%, 24.61%), pericarp thickness (84.01%, 34.91%), total soluble solid (96.16%, 27.53%), titratable acidity (99.47%, 77.18%), ascorbic acid (99.28%, 56.79%), β-carotene (99.51%, 100.28%), lycopene (99.77%, 107.78%), plant height at final harvest (95.72%, 43.14%), average fruit weight (95.30%, 54.49%), no. of fruits/ plant (97.09%, 84.22%), fruit yield per plant (96.86%, 67.95%) indicating strong influence of additive gene action and phenotypic selection is effective for these traits. Analogous observations were found by Lekshmi and Celine (2017) [3] and Ritonga *et al.*, (2018) [6].

The knowledge about the nature and level of inter-relationship of yield and other components is very valuable because selection based on one trait may directly or indirectly affect the performance of another trait. Assessment of inter-relationships among a number of component characters is, therefore, an important requisite to bring improvement. In the present study, in general, the genotypic correlation coefficients were higher in magnitude than the corresponding phenotypic correlation (Table 2a &b). High genotypic correlation coefficients revealed that there was heritable correlation among the traits. Sehgal *et al.*, (2018) [7] and Sharma et *al.*, (2019) [8] also observed same result in their study.

At both genotypic and phenotypic level, no. of fruits /plant (0.745, 0.721), plant height at 60 DAT (0.689, 0.619), number of fruits per truss (0.612, 0.594), number of flowers per truss (0.587, 0.558), β- carotene (0.440, 0.432), equatorial diameter (0.413, 0.386), lycopene (0.410, 0.404) and pericarp thickness (0.362, 0.346) showed positive and significant connection with fruit yield /plant. Selection on the basis of these traits might lead to higher yield. Present study confirms the result of Ritonga *et al.*, (2018) [6] and Sharma et *al.*, (2019) [8]. Whereas association was negative and significant was found in days to first fruiting (-0.460, -0.420), number of locules (-0.448, -0.431) and days to first flower (-0.399, -0.331). Similar result was noted for no. of locules by Sehgal *et al.*, (2018) [7].

Table 1: Estimates of GCV % and PCV %, heritability% and genetic advance as % mean for twenty-one characters of fourteen tomato genotypes

Characters	GCV (%)	PCV (%)	Heritability %	GA %
A. Morphological parameters				
Days to first flowering	15.58	16.89	85.08	29.60
Node to first flowering	11.15	12.75	76.55	20.10
Days to 50% flowering	15.14	16.39	85.30	28.80
No. of flowers per truss	23.90	24.60	94.34	47.82
Days to first fruiting	15.91	16.56	92.39	31.51
No. of fruits per truss	31.66	32.27	96.27	64.00
Plant height at 60 DAT (cm)	17.61	18.67	88.99	34.22
Days taken to first picking	4.49	6.81	43.60	6.11
Polar diameter of fruit (cm)	16.51	17.86	85.43	31.43
Equatorial diameter of fruit (cm)	13.00	14.16	84.38	24.61
Pericarp thickness (mm)	18.49	20.17	84.01	34.91
No. of locules per fruit	34.04	34.61	96.72	68.96
No. of fruits per plant	41.49	42.11	97.09	84.22
Average fruit weight (g)	27.10	27.76	95.30	54.49
Fruit yield per plant (Kg)	33.52	34.06	96.86	67.95

Plant height at final harvest (cm)	21.40	21.88	95.72	43.14
B. Biochemical parameters				
Total Soluble Solid (ºBrix)	13.63	13.90	96.16	27.53
Titratable Acidity (%)	37.57	37.67	99.47	77.18
Ascorbic Acid (mg/100g)	27.67	27.77	99.28	56.79
Lycopene (mg/100g)	52.39	52.46	99.75	107.79
β-carotene (mg/100g)	48.80	48.92	99.51	100.28

The path coefficient analysis allows partitions of correlation coefficients into direct and indirect effects of various traits towards dependent variable and thus, helps in forming proficient selection approach. The direct effects obtained at genotypic level were markedly different from those at phenotypic level (Table 3a & 3b). These differences might be due to varying degree of influence of environment on various traits studied. Highest positive direct effects on fruit yield /plant was shown by days to first flower (0.15), equatorial diameter (0.32), pericarp thickness (0.35) and no. of fruit /plant (1.16) which suggests that it may considered as a prime trait for enhancing yield. Ritonga et al., (2018) [6], Sehgal *et al.*, (2018) [7] and Sharma et *al.*, (2019) [8] also reported direct and positive effects of these traits.

Negative and direct effect on fruit yield /plant were shown by days to first fruit set (-1.03), plant height at 60 DAT (-0.40), β- carotene (-0.64) and lycopene (-0.22). At genotypic and phenotypic level, maximum positive indirect effect on fruit yield /plant was exerted by no. of flower /truss via no. of fruit /plant (0.534, 0.375); no. of fruit /truss via no. of fruit /plant (0.498, 0.344); plant height at 60 DAT via no. of fruit /plant (0.525, 0.355); equatorial diameter via average fruit weight (0.418, 0.335); pericarp thickness via average fruit weight (0.322, 0.276); β-carotene via days to first fruit set (0.626, 0.257), no. of fruit /plant (0.47,10.333) and days to fifty percent flowering (0.443,0.281); lycopene via days to first fruit set (0.586, 0.240), no. of fruit /plant (0.461, 0.325) and days to fifty percent flowering (0.412, 0.260); no. of fruit /plant via final plant height (0.338, 0.123).

Conclusion

On the basis findings, it can be concluded that wide range of genetic variability are exists in present set of genetic material except titratable acidity and β-carotene. Thus, there is abundant scope for selection of promising genotypes. Furthermore, high GCV, heritability and genetic advance as % of mean found in titratable acidity, ascorbic acid, β-carotene, lycopene, plant height at final harvest, mean fruit weight, no. of fruit/plant, fruit yield/plant, no. of flower/truss, no. of fruits/truss and no. of locules/fruit show preponderance of additive gene action thus there is abundant scope for the enhancement of these traits through selection. Days to first flower, equatorial diameter, pericarp thickness and no. of fruit /plant had high positive direct effects on fruit yield/plant which suggests that direct selection for these characters may be effective and may be considered as a prime trait for enhancing yield. So these genotypes can be used for parent for future breeding programme.

Table 2a: Genotypic correlation among yield and yield attributes for twenty-one characters of fourteen genotypes of tomato

Characters	DFF	NNFF	DFPF	NFT	DTFF	NFPT	PH	DFP	NL	PD	ED	PT	TSS	TA	AA	BC	LY	FPH	AFW	NFPP
NNFF	0.370*																			
DFPF	1.008**	0.453**																		
NFT	-0.256	-0.388*	-0.242																	
DTFF	0.850**	0.057	0.833**	-0.073																
NFPT	-0.182	-0.085	-0.090	0.650**	-0.234															
PH	-0.344*	-0.200	-0.274	0.721**	-0.172	0.687**														
DFP	0.624**	-0.297	0.564**	0.008	0.978**	-0.325*	0.051													
NL	0.147	-0.100	0.092	-0.368*	0.275	-0.573**	-0.329*	0.180												
PD	-0.087	-0.281	-0.078	-0.032	0.150	-0.042	-0.120	0.541**	-0.251											
ED	-0.221	-0.019	-0.129	0.099	-0.271	0.331*	0.572**	-0.040	0.248	-0.176										
PT	0.224	-0.582**	0.220	0.447**	0.249	0.376**	0.355*	0.584**	-0.248	0.327*	0.336*									
TSS	0.641**	0.549**	0.683**	-0.295	0.646**	-0.249	-0.303	0.340*	0.152	-0.145	-0.382*	-0.357*								
TA	0.496**	0.117	0.465**	-0.545**	0.313*	-0.323*	-0.571**	0.067	0.124	-0.280	-0.348*	-0.118	0.511**							
AA	0.102	0.347*	0.180	-0.542**	0.053	-0.230	-0.395*	0.074	-0.210	0.278	-0.225	-0.220	0.420**	0.474**						
BC	-0.646**	-0.195	-0.661**	0.197	-0.611**	0.092	0.211	-0.591**	-0.311*	-0.231	-0.110	-0.250	-0.232	0.157	0.090					
LY	-0.600**	-0.156	-0.614**	0.151	-0.572**	0.026	0.146	-0.554**	-0.268	-0.220	-0.122	-0.270	-0.181	0.203	0.136	0.994**				
FPH	-0.011	-0.030	-0.014	0.298	0.165	0.272	0.315*	0.244	-0.584**	0.084	-0.425**	0.051	0.153	0.194	0.079	0.408**	0.379*			
AFW	-0.117	-0.502**	-0.142	-0.102	-0.091	-0.153	-0.081	0.168	0.509**	0.222	0.618**	0.476**	-0.499**	-0.115	-0.122	-0.186	-0.156	-0.646**		
NFPP	0.025	0.330*	0.067	0.462**	-0.179	0.431**	0.454**	-0.363*	-0.479**	-0.438**	-0.018	-0.028	0.130	-0.041	-0.231	0.407**	0.399**	0.411**	-0.501**	
YPP	-0.399**	-0.101	-0.305	0.587**	-0.460**	0.612**	0.689**	-0.305	-0.448**	-0.135	0.413**	0.362*	-0.301	-0.289	-0.217	0.440**	0.410**	0.218	0.008	0.745**

* Significant at $P \leq 0.05$,** Significant at $P \leq 0.01$

Table 2b: Phenotypic correlation among yield and yield attributes for twenty-one characters of fourteen genotypes of tomato

Characters	DFF	NNFF	DFPF	NFT	DTFF	NFPT	PH	DFP	NL	PD	ED	PT	TSS	TA	AA	BC	LY	FPH	AFW	NFPP
NNFF	0.261																			
DFPF	0.942**	0.322*																		
NFT	-0.255	-0.337*	-0.245																	
DTFF	0.794**	-0.004	0.756**	-0.086																
NFPT	-0.156	-0.062	-0.061	0.619**	-0.228															
PH	-0.380*	-0.139	-0.292	0.673**	-0.187	0.650**														
DFP	0.365*	-0.179	0.401**	-0.018	0.598**	-0.227	0.075													
NL	0.131	-0.085	0.074	-0.366*	0.267	-0.554**	-0.313*	0.114												
PD	-0.034	-0.253	-0.011	-0.019	0.155	-0.031	-0.126	0.310*	-0.245											
ED	-0.161	0.006	-0.090	0.056	-0.200	0.285	0.471**	-0.020	0.252	-0.116										
PT	0.165	-0.426**	0.202	0.409**	0.179	0.348*	0.312*	0.422**	-0.227	0.278	0.297									
TSS	0.588**	0.451**	0.619**	-0.293	0.647**	-0.246	-0.279	0.173	0.147	-0.119	-0.335*	-0.361*								
TA	0.453**	0.108	0.422**	-0.536**	0.304	-0.317*	-0.533**	0.045	0.124	-0.267	-0.314*	-0.107	0.503**							
AA	0.095	0.301	0.168	-0.520**	0.046	-0.219	-0.371*	0.031	-0.207	0.259	-0.207	-0.190	0.408**	0.470**						
BC	-0.593**	-0.175	-0.606**	0.193	-0.585**	0.089	0.198	-0.358*	-0.307	-0.215	-0.100	-0.224	-0.230	0.155	0.089					
LY	-0.545**	-0.135	-0.561**	0.145	-0.546**	0.026	0.132	-0.360*	-0.263	-0.196	-0.110	-0.249	-0.176	0.202	0.135	0.991**				
FPH	-0.025	-0.041	-0.012	0.286	0.133	0.267	0.314*	0.186	-0.554**	0.060	-0.388*	0.047	0.144	0.191	0.078	0.397**	0.369*			
AFW	-0.101	-0.397*	-0.103	-0.085	-0.107	-0.152	-0.102	0.114	0.482**	0.202	0.549**	0.451**	-0.495**	-0.117	-0.117	-0.179	-0.151	-0.623**		
NFPP	-0.010	0.284	0.043	0.450**	-0.175	0.413**	0.426**	-0.221	-0.450**	-0.399**	0.003	-0.002	0.118	-0.043	-0.224	0.400**	0.390*	0.400**	-0.485**	
YPP	-0.331*	-0.100	-0.254	0.558**	-0.420**	0.594**	0.619**	-0.198	-0.431**	-0.118	0.386*	0.346*	-0.293	-0.283	-0.210	0.432**	0.404**	0.205	0.018	0.721**

* Significant at $P \leq 0.05$, ** Significant at $P \leq 0.01$

Table 3a: Direct and indirect effects of different trait on yield per plant of fourteen genotypes of tomato at genotypic level

	DFF	NNFF	DFPF	NFT	DTFF	NFPT	PH	DFP	NL	PD	ED	PT	TSS	TA	AA	BC	LY	FPH	AFW	NFPP	r YPP
DFF	0.15	-0.18	-0.68	-0.00	-0.87	0.00	0.14	0.04	0.00	0.02	-0.07	0.08	0.64	-0.18	0.03	0.42	0.13	-0.01	-0.08	0.03	- 0.40**
NNFF	0.05	-0.50	-0.30	-0.01	-0.06	0.00	0.08	-0.02	-0.00	0.07	-0.01	-0.20	0.55	-0.04	0.10	0.13	0.04	-0.03	-0.34	0.38	-0.10
DFPF	0.15	-0.22	-0.67	-0.00	-0.85	0.00	0.11	0.03	0.00	0.02	-0.04	0.08	0.68	-0.16	0.05	0.43	0.14	-0.01	-0.10	0.08	-0.31
NFT	-0.04	0.19	0.16	0.02	0.07	-0.01	-0.29	0.00	-0.00	0.01	0.03	0.16	-0.29	0.19	-0.16	-0.13	-0.03	0.25	-0.07	0.53	0.587**
DTFF	0.13	-0.03	-0.56	-0.00	-1.03	0.00	0.07	0.07	0.00	-0.04	-0.09	0.09	0.64	-0.11	0.02	0.40	0.13	0.14	-0.06	-0.21	- 0.46**
NFPT	-0.03	0.04	0.06	0.01	0.24	-0.01	-0.28	-0.02	-0.01	0.01	0.11	0.13	-0.25	0.11	-0.07	-0.06	-0.01	0.22	-0.10	0.50	0.61**
PH	-0.05	0.10	0.18	0.01	0.18	-0.01	-0.40	0.00	-0.00	0.03	0.19	0.12	-0.30	0.20	-0.12	-0.14	-0.03	0.26	-0.06	0.53	0.69**
DFP	0.09	0.15	-0.38	0.00	-1.00	0.00	-0.02	0.06	0.00	-0.13	-0.01	0.20	0.34	-0.02	0.02	0.38	0.12	0.20	0.11	-0.42	-0.31
NL	0.02	0.05	-0.06	-0.01	-0.28	0.01	0.13	0.01	0.01	0.06	0.08	-0.09	0.15	-0.04	-0.06	0.20	0.06	-0.48	0.34	-0.55	- 0.45**
PD	-0.01	0.14	0.05	-0.00	-0.15	0.00	0.05	0.03	-0.00	-0.24	-0.06	0.11	-0.14	0.10	0.08	0.15	0.05	0.07	0.15	-0.51	-0.13
ED	-0.03	0.01	0.09	0.00	0.28	-0.00	-0.23	-0.00	0.00	0.04	0.32	0.18	-0.38	0.12	-0.07	0.07	0.03	-0.35	0.42	-0.02	0.41**
PT	0.03	0.29	-0.15	0.01	-0.26	-0.00	-0.14	0.03	-0.00	-0.08	0.11	0.35	-0.35	0.04	-0.07	0.16	0.06	0.04	0.32	-0.03	0.36**
TSS	0.09	-0.27	-0.46	-0.01	-0.66	0.00	0.12	0.02	0.00	0.04	-0.12	-0.12	0.99	-0.18	0.13	0.15	0.04	0.13	-0.34	0.15	-0.30
TA	0.07	-0.06	-0.31	-0.01	-0.32	0.00	0.23	0.00	0.00	0.07	-0.11	-0.04	0.51	-0.35	0.14	-0.10	-0.05	0.16	-0.08	-0.05	-0.29
AA	0.02	-0.17	-0.12	-0.01	-0.06	0.00	0.16	0.00	-0.00	-0.07	-0.07	-0.08	0.42	-0.17	0.30	-0.06	-0.03	0.07	-0.08	-0.27	-0.22
BC	-0.10	0.10	0.44	0.00	0.63	-0.00	-0.09	-0.03	-0.00	0.06	-0.04	-0.09	-0.23	-0.06	0.03	-0.64	-0.22	0.34	-0.13	0.47	0.44**
LY	-0.09	0.08	0.41	0.00	0.59	0.00	-0.06	-0.03	-0.00	0.05	-0.04	-0.09	-0.18	-0.07	0.04	-0.64	-0.22	0.31	-0.11	0.46	0.41**
FPH	-0.00	0.02	0.01	0.01	-0.17	-0.00	-0.13	0.01	-0.08	-0.02	-0.14	0.02	0.15	-0.07	0.02	-0.26	-0.08	0.82	-0.44	0.48	0.22
AFW	-0.02	0.25	0.10	-0.0	0.09	0.00	0.03	0.01	0.07	-0.05	0.20	0.17	-0.50	0.04	-0.04	0.12	0.04	-0.53	0.68	-0.58	0.01
NFPP	0.00	-0.16	-0.05	0.01	0.18	-0.01	-0.18	-0.02	-0.01	0.11	-0.01	-0.01	0.13	0.01	-0.07	-0.26	-0.09	0.34	-0.34	1.16	0.75**

Unexplained variation = -0.722

Table 3b: Direct and indirect effects of different trait on yield per plant of fourteen genotypes of tomato at phenotypic level

	DFF	NNFF	DFPF	NFT	DTFF	NFPT	PH	DFP	NL	PD	ED	PT	TSS	TA	AA	BC	LY	FPH	AFW	NFPP	rYPP
DFF	0.27	-0.09	-0.44	0.07	-0.35	-0.04	0.04	0.01	-0.02	0.00	-0.02	0.04	0.40	-0.19	0.01	0.08	-0.03	-0.01	-0.06	-0.01	-0.33**
NNFF	0.07	-0.32	-0.15	0.09	0.00	-0.01	0.02	-0.01	0.01	0.03	0.00	-0.10	0.31	-0.05	0.02	0.02	-0.01	-0.01	-0.24	0.24	-0.10
DFPF	0.25	-0.11	-0.46	0.06	-0.33	-0.01	0.03	0.01	-0.01	0.00	-0.01	0.05	0.42	-0.18	0.01	0.08	-0.03	-0.00	-0.06	0.04	-0.25
NFT	-0.06	0.11	0.11	-0.24	0.04	0.14	-0.08	-0.00	0.06	0.00	0.01	0.10	-0.20	0.22	-0.03	-0.03	0.01	0.09	-0.05	0.38	0.56**
DTFF	0.21	0.00	-0.35	0.02	-0.44	-0.05	0.02	0.02	-0.05	-0.02	-0.03	0.04	0.44	-0.13	0.00	0.08	-0.03	0.04	-0.07	-0.15	-0.42**
NFPT	-0.04	0.02	0.03	-0.16	0.10	0.23	-0.07	-0.01	0.09	0.00	0.04	0.08	-0.17	0.13	-0.01	-0.01	0.00	0.08	-0.09	0.34	0.59**
PH	-0.10	0.05	0.14	-0.17	0.08	0.15	-0.11	0.00	0.05	0.02	0.07	0.07	-0.19	0.22	-0.02	-0.03	0.01	0.10	-0.06	0.36	0.62**
DFP	0.10	0.06	-0.19	0.01	-0.26	-0.05	-0.01	0.04	-0.02	-0.04	-0.00	0.10	0.12	-0.02	0.00	0.05	-0.02	0.06	0.07	-0.18	-0.20
NL	0.04	0.03	-0.04	0.09	-0.12	-0.13	0.05	0.00	-0.17	0.03	0.04	-0.05	0.10	-0.05	-0.01	0.04	-0.02	-0.17	0.30	-0.38	-0.43**
PD	-0.01	0.08	0.01	0.01	-0.07	-0.01	0.04	0.01	0.04	-0.12	-0.02	0.07	-0.08	0.11	0.01	0.03	-0.01	0.02	0.12	-0.33	-0.12
ED	-0.04	-0.00	0.04	-0.01	0.09	0.07	-0.05	-0.00	-0.04	0.01	0.15	0.07	-0.23	0.13	-0.01	0.01	-0.01	-0.12	0.34	0.00	0.39**
PT	0.05	0.14	-0.09	-0.10	-0.078	0.08	-0.04	0.02	0.04	-0.03	0.04	0.24	-0.24	0.05	-0.01	0.03	-0.01	0.02	0.28	-0.00	0.35**
TSS	0.16	-0.15	-0.29	0.07	-0.28	-0.06	0.03	0.01	-0.03	0.01	-0.05	-0.09	0.68	-0.21	0.03	0.032	-0.01	0.04	-0.30	0.10	-0.29
TA	0.12	-0.04	-0.20	0.14	-0.13	-0.07	0.06	0.00	-0.02	0.03	-0.05	-0.03	0.34	-0.42	0.03	-0.02	0.01	0.06	-0.07	-0.04	-0.28
AA	0.03	-0.10	-0.08	0.13	-0.02	-0.05	0.041	0.00	0.04	-0.03	-0.03	-0.05	0.28	-0.20	0.07	-0.01	0.01	0.02	-0.07	-0.19	-0.21
BC	-0.16	0.06	0.28	-0.05	0.26	0.02	-0.02	-0.01	0.05	0.03	-0.02	-0.05	-0.16	-0.07	0.01	-0.14	0.06	0.12	-0.11	0.33	0.43**
LY	-0.15	0.04	0.26	-0.04	0.24	0.01	-0.02	-0.01	0.04	0.02	-0.02	-0.06	-0.12	-0.09	0.01	-0.14	0.06	0.11	-0.09	0.33	0.40**
FPH	-0.01	0.01	0.01	-0.07	-0.06	0.06	-0.04	0.01	0.09	-0.01	-0.06	0.01	0.10	-0.08	0.01	-0.05	0.02	0.31	-0.38	0.33	0.21
AFW	-0.03	0.13	0.05	0.02	0.05	-0.04	0.01	0.00	-0.08	-0.02	0.08	0.11	-0.34	0.05	-0.01	0.02	-0.01	-0.19	0.61	-0.40	0.02
NFPP	-0.00	-0.09	-0.02	-0.11	0.08	0.10	-0.05	-0.01	0.08	0.05	0.00	0.00	0.08	0.02	-0.02	-0.06	0.02	0.12	-0.30	0.83	0.72**

Unexplained variation=0.667

DFF- Days to First Flower, NNFF- Number Node to First Flower, DFPF- Days to Fifty Percent Flowering, NFT- Number of Flowers/Truss, DTFF- Days to First Fruiting, NFPT- Number of Fruits/Truss, PH- Plant Height at 60 DAT, DFP- Days to First Picking, NL- Number of Locules, PD- Polar Diameter, ED-Equatorial Diameter, PT- Pericarp Thickness, TSS- Total Soluble Solid, TA- Titratable Acidity, AA- Ascorbic Acid, BC- β- Carotene, LY- Lycopene, FPH- Final Plant Height, AFW- Average Fruit Weight, NFPP- No. of Fruits/Plant, YPP- Yield/Plant.

References

1. Hasan MM, Bari MAA, Hossain MA. Genetic variability and traits association analysis of tomato (*Lycopersicon esculentum* L.) genotypes for yield and quality attributes. Universal Journal of Plant Science. 2016; 4(3):23-34.
2. Kumar M, Yadav RK, Arora A, Kumar M, Talukdar A. Evaluation of genetic parameters for physiological and biochemical traits in tomato (*Solanum lycopersicum* L.). nternational Journal of Current Microbiology and Applied Sciences. 2017; 6(3):1332-1338.

3. Lekshmi SL, Celine VA. Genetic variability studies of tomato (*Solanum lycopersicum* L.) under protected conditions of Kerala. The Asian Journal of Horticulture. 2017; 12(1):106-110.
4. Panchbhaiya A, Singh DK, Verma P, Mallesh S. Assessment of genetic variability in tomato (*Solanum lycopersicum* L.) under polyhouse condition for fruit quality and biochemical traits. International Journal of Chemical Studies. 2018; 6(6):245-248.
5. Rai AK, Vikram A, Pandav A. Genetic Variability Studies in Tomato (*Solanum lycopersicum* L.) for yield and quality traits. International Journal of Agriculture Environment and Biotechnology. 2016; 9(5):739-744.
6. Ritonga AW, Chozin MA, Syukur M, Maharijaya A, Sobir. Genetic variability, heritability, correlation, and path analysis in tomato (*Solanum lycopersicum*) under shading condition. Biodiversitas. 2018; 19(4):1527-1531.
7. Sehgal N, Chadha S, Kumar N, Kaur M, Kanwar S. Correlation and Path Coefficient Analysis for Fruit Yield and Its Component Traits among Bacterial Wilt Resistant F4 Progenies of Tomato (*Solanum lycopersicum* L.). International Journal of Current Microbiology and Applied Sciences. 2018; 7(2):1052-1059.
8. Sharma P, Dhillon NS, Kumar V, Kumar P. Correlation and path analysis for yield and its contributing traits in tomato (*Solanum lycopersicum* L.) under the protected environment. Journal of Pharmacognosy and Phytochemistry. 2019; 1:447-450.