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Genetic diversity and path analysis in tomato (*Solanum lycopersicum* L.)

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Tomato (*Solanum lycopersicum* L.) occupies the prime position among different vegetables and is an important vegetable cultivated in India. The present trend in crop improvement programmes is the development of hybrid cultivars to boost the productivity and profitability of farmers. To meet all the requirements of successful hybrids, it is neccessary to be familiar with the detailed genetic makeup of the selected material to be used in hybrid breeding. Genetic variability among the parents is a prerequisite to develop new cultivar and select better segregants for various economic characters. Knowledge of correlations is equally important for simultaneous and/ or indirect improvement of characters that are difficult to quantify especially for those traits, which exhibit low heritability. Therefore, it is essential to make preliminary investigation of the characters of the lines to be used for the development of superior hybrids/varieties. In the view of above, present investigation were undertaken to study the genetic variability, correlation among different quantitative and qualitative traits and path analysis in tomato genotypes to facilitate the selection of suitable superior genotypes for development of new varieties/ hybrids using standard breeding programme.

The experimental material consisting of 40 genotypes of tomato collected from different sources were evaluated during kharif, 2009 in the Department of Vegetable Science, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan (HP). The crop was grown in randomized block design with three replications at spacing of 90x30 cm. Five randomly chosen plants were labelled and used for recording the observations. The statistical analysis was done according to the methods for genetic coefficients of variation for heritability in broad sense and Johnson *et al.* (1955) for genetic advance. Correlation coefficients were calculated by the method described by Al-jibouri *et al.* (1958) and path coefficients worked out according to Wright (1921).

The analysis of variance revealed highly significant differences among the genotypes for all the characters studied. In general, phenotypic coefficients of variation were higher than genotypic coefficients of variation indicating that the genotypic influence is lessened under the influence of given environment. However, a close correspondence between GCV and PCV in respect of all the characters indicated that environment has very little influence on the expression of the characters under study. The estimates of heritability (broad sense) for most of the characters were high indicating that the genotypes under study have a great scope for the selection based on these characters. High values of GCV and heritability estimates supplemented with greater gains also revealed role of additive gene effects regulating the inheritance of such traits (Narayan *et al.,* 1996). The high GCV values for number of fruits per plant, average fruit weight, yield per plant, pericarp thickness and thousand seed weight with high heritability indicating that there is ample scope for selection. Further, estimates of heritability and genetic advance provide information about the heritable portion of variance and genetic gain expected in the next generation; hence it is desirable to consider these estimates.

High heritability with high genetic gain was observed for number of fruits per plant, average fruit weight, yield per plant and pericarp thickness indicating that most likely the heritability is due to additive gene effects and selection may be effective. Johson *et al.* (1955) has also suggested that characters having high heritability coupled with high genetic gain would respond to selection better than those with high heritability accompanying low genetic gain. These findings are in accordance with the results of Joshi and Singh (2003) and Singh and Narayan (2004) in tomato. High GCV accompanied with high heritability and high genetic gain were noticed for number of fruits

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per plant, average fruit weight, yield per plant, pericarp thickness, and number of seeds per fruit. The high GCV couples with high heritability and high genetic gain offers the most effective condition for selection. Thus direct selection for these characters could be effective in the crop improvement of tomato.

Coefficients of correlation were also worked out at phenotypic and genotypic level for fourteen characters in the present investigation (Table 1). In general, genotypic correlation was higher than the phenotypic correlation coefficients indicating that there is strong association between two characters genetically, but the phenotypic correlation value is lessened by the significant interaction of environment. Yield per plant expressed a highly significant positive correlation with pericarp thickness, shelf life, TSS and fruit shape index. Number of fruits per plant was positively and significantly correlated with yield per plant, while negatively but

Table 1. Phenotypic (P) and genotypic (G) coefficients of correlation among different characters in tomato genotypes

Traits		PH	DFF	NFP	AFW	YPP	DMM	PT	TSS	SL	LC	FSI	NSF	TSW	BRI
PH	p	1.000	0.273	0.098	0.402*	0.458**	0.383*	0.542**	0.325*	0.476**	0.051	0.449**	-0.075	0.134	0.052
	G	1.000	0.428**	0.109	0.448**	0.496**	0.464**	0.622**	0.373*	0.554**	0.056	0.502**	-0.075	0.189	0.041
DFF	P		1.000	0.083	0.048	0.115	0.165	0.094	0.123	0.080	-0.097	0.115	0.005	-0.052	0.083
	G		1.000	0.138	0.043	0.180	0.437**	0.216	0.195	0.163	-0.126	0.316*	-0.019	-0.118	0.138
NFP	P			1.000	-0.468**	0.475**	-0.212	-0.013	0.236	0.104	0.032	-0.117	0.208	0.055	-0.259
	G			1.000	-0.449**	0.486**	-0.277	-0.013	0.302	0.136	0.026	-0.144	0.229	0.062	-0.295
AFW	P				1.000	0.508**	0.376*	0.631**	0.342*	0.478**	-0.012	0.594**	0.094	0.094	0.010
	G				1.000	0.536**	0.458**	0.672**	0.410**	0.539**	-0.008	0.669**	0.130	0.130	0.003
YPP	P					1.000	0.145	0.544**	0.566**	0.491**	-0.068	0.444**	0.169	0.169	-0.286
	G					1.000	0.171	0.568**	0.661**	0.554**	-0.068	0.486**	0.193	0.193	-0.313*
DMM	P						1.000	0.152	0.132	0.082	-0.069	0.320*	-0.089	-0.089	0.174
	G						1.000	0.169	0.172	0.085	-0.081	0.356*	-0.117	-0.117	0.235
PT	P							1.000	0.460**	0.875**	0.089	0.554**	0.130	0.130	-0.071
	G							1.000	0.547**	0.972**	0.092	0.625**	0.162	0.162	-0.085
TSS	P								1.000	0.433**	0.045	0.358*	0.209	0.209	-0.206
	G								1.000	0.608**	0.064	0.462**	0.247	0.247	-0.250
SL	P									1.000	0.126	0.546**	0.127	0.127	-0.130
	G									1.000	0.140	0.658**	0.184	0.184	-0.130
LC	P										1.000	0.034	0.200	0.200	-0.124
	G										1.000	0.025	0.240	0.240	-0.138
FSI	P											1.000	0.210	0.210	-0.103
	G											1.000	0.278	0.278	-0.107
NSF	P												1.000	0.238	-0.037
	G												1.000	0.291	-0.046
TSW	P													1.000	-0.154
	G													1.000	-0.171
BRI	P														1.000
	G														1.000

*Significant at 5 % level of significance

** Significant at 1 % level of significance

Where, PH= Plant height, DFF= Days to first flowering, NFP= No. of fruits per plant, AFW= Average fruit weight, YPP= Yield per plant, DMM= Days to marketable maturity, PT= Pericarp thickness, TSS= total soluble solids, SL=Shelf life, LC= Lycopene content, FSI= Fruit shape index, NSF= No. of seeds per fruit, TSW= Thousand seed weight, BRI= Buckeye rot incidence

Table 2. Estimates of direct and indirect effects of significant traits on yield per plant in tomato

Traits	Plant height	No. of fruits per plant	A/v fruit weight	Pericarp thickness	Total soluble solids	Shelf life	Fruit shape index	Genotypic correlation coeffecients
Plant height	0.488	0.079	0.927	-2.687	-0.095	2.202	-0.419	0.495*
No. of fruits per plant	0.053	0.725	-0.929	0.055	-0.077	0.539	0.120	0.486*
A/v fruit weight	0.219	-0.326	2.068	-2.906	-0.104	2.142	-0.558	0.535*
Pericarp thickness	0.304	-0.009	1.390	-4.322	-0.139	3.866	-0.522	0.568*
Total soluble solids	0.182	0.219	0.847	-2.365	-0.254	2.418	-0.386	0.661*
Shelf life	0.270	0.098	1.114	-4.202	-0.154	3.977	-0.549	0.554*
Fruit shape index	0.245	-0.104	1.383	-2.701	-0.117	2.615	-0.835	0.486*

significantly correlated with average fruit weight. Pericarp thickness showed significant positive correlation with shelf life, TSS and fruit shape index, which is in agreement with the findings of Ghosh and Syamal (1994). Similarly, positive correlation of pericarp thickness and yield as reported by Prashanth *et al.* (2008) are similar to the present findings. Path coefficient analysis of different characters contributing toward yield per plant revealed (Table 2) that shelf life had maximum direct effect followed by average fruit weight and number of fruits per plant, indicating that these are the real independent characters and have maximum contribution towards increase in fruit yield. Among the negative direct effects, pericarp thickness showed highest negative direct effect on yield per plant followed by fruit shape index, whereas lowest negative direct effect on yield per plant was observed for total soluble solids. Similar findings were also obtained by Prashanth *et al.* (2008) and Asati *et al.* (2008). The study indicates that direct selection of shelf life, average fruit weight and number of fruits per plant can be used as selection criteria for improvement in tomato. Residual effect was low, indicating negligible contribution of the characters not included in the study.

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