

## Genetic variability studies in tomato (*Solanum lycopersicum* L.)

Santosh Kumari and Manish K Sharma

Received : November, 2012 / Accepted : February, 2013

Tomato is one of the most popular and widely grown vegetables in the world. It belongs to the family Solanaceae. It is world's largest vegetable crop after potato. Tomato has become an important vegetable of the world in view of the increasing demand for fresh consumption as well as processing industry. Fresh fruits of tomato are in great demand round the year and throughout the country. Large quantities of tomato are used to produce ketchup, paste, puree, juice and soup. Fruit yield of tomato depends upon the extent and nature of genetic variability present in the population. Genetic variability is the material from which superior genotypes can be evolved after selection. Higher the amount of variability in the population, greater is the scope for its improvement by selection. Knowledge of association of fruit yield with its contributing traits helps in breeding programmes. Wide range of variability provides better scope of selecting desirable genotypes. Effective selection depends upon existence of genetic variability in the population. Therefore, the present experiment was conducted to determine genetic variability, direct and indirect contributing traits towards fruit yield through path coefficient analysis in tomato.

Forty genotypes of tomato were grown in Randomized Block Design with three replications during summer 2008 at Experimental Farm of Vegetable Science, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan. Thirty days old seedlings were transplanted at spacing of 90 x 30 cm in first week of April. Recommended practices given by the university were followed to raise tomato crop. The observations were recorded on characters, days to first flowering, days from anthesis to turning stage, number of fruits per cluster, number of fruits per pant, average fruit weight, fruit yield per plant, fruit shape index, number of seeds per fruit, number of locules per fruit, pericarp thickness,

total soluble solids, ascorbic acid content, plant height and harvest duration. The genotypic coefficient of variation and phenotypic coefficient of variation were estimated as per method suggested by Burton and Devane (1953). Heritability in broad sense and genetic gain were computed according to Johnson *et al.* (1955). Correlation coefficient analysis was done as per Al-Jibouriet *al.* (1958). Path coefficient analysis was estimated according to formulae suggested by Dewey and Lu (1959).

In general, phenotypic coefficient of variation was higher than genotypic coefficient for all the traits under study in the present investigation. This indicated that environmental factors influenced their expression. High genotypic and phenotypic coefficients of variability were recorded for number of fruits per plant (30.13% and 30.80%), average fruit weight (34.23% and 34.97%), fruit yield per plant (30.61% and 31.60%), number of seeds per fruit (33.73% and 36.06%) and plant height (30.25% and 31.75%). This suggested greater phenotypic and genotypic variability in the germplasm and possibility for making further improvement by selection. Mehta and Asati (2008) also reported similar results in tomato.

Heritability estimates provides the assessment of amount of transmissible genetic variation to total variability. High heritability reveals the improvement of that character is possible through selection, whereas low heritability indicates that characters are highly governed by the environment and large population has to be raised for selecting the desirable genotypes. Heritability estimates were recorded high for days from anthesis to turning stage (81.70%), number of fruits per cluster (93.35%), number of fruits per plant (95.72%), average fruit weight (95.80%), fruit yield per plant (93.90%), fruit shape index (85.91%), number of seeds per fruit (87.53%), pericarp thickness (88.83%), ascorbic acid content (80.96%), plant height (90.74%) and harvest duration (86.68%). The genetic gain was high for number of fruits per plant (60.73%), average fruit weight (69.01%), fruit yield per plant (60.53%), number of seeds per fruit (54.68%) and

plant height (58.87%).

Heritability alone does not provide full evidence about the amount of genetic progress. Therefore high heritability along with high genetic gain is more reliable for making selection. High heritability coupled with high genetic gain were observed for number of fruits per plant ( 95.72 % and 60.73 %), average fruit weight (95.80 % and 69.01 %), fruit yield per plant (93.90 % and 60.53 %), number of seeds per fruit (87.53 % and 54.68 %) and plant height ( 90.74 % and 58.87%), which might be assigned to additive gene effect governing their inheritance and phenotypic selection for their improvement could be achieved by simple method like pure line or mass selection or bulk or SSD method following hybridization and selection in early generations.

The genotypic correlations were higher in magnitude than phenotypic values indicating predominant role of

heritable factors. Positive and significant association of fruit yield per plant with number of fruits per plant, average fruit weight and pericarp thickness was observed (Table 1). This suggested that improvement in these traits will result in increased fruit yield. Singh *et al.*, (2007) and Rani *et al.*, (2008) found similar results. Days to first flowering had significant positive correlation with days from anthesis to turning stage, average fruit weight, pericarp thickness, but had significant negative correlation with ascorbic acid content. Days from anthesis to turning stage had significant positive correlation with days to first flowering. Number of fruits per cluster showed positive and significant association with number of fruits per plant and plant height. Positive and significant association of number of fruits per cluster with number of fruits per plant was also reported by Singh *et al.*, (2004). Number of fruits per plant exhibited positive and

**Table 1.** Estimates of Phenotypic (P) and Genotypic (G) correlation coefficients among various horticultural traits in tomato

Traits		Days from anthesis to turning stage	Number of fruits per cluster	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (g)	Fruit shape index	Number of seeds per fruit	Number of locules per fruit	Pericarp thickness (mm)	Total soluble solids ( <sup>o</sup> B)	Ascorbic acid content (mg/100g)	Plant height (cm)	Harvest duration
Days to first flowering	P	0.631*	-0.429	-0.426	0.594*	0.319	-0.253	-0.112	0.045	0.612*	0.005	-0.591*	-0.174	0.115
	G	0.533*	-0.559*	-0.541*	0.647*	0.323	-0.379	-0.175	-0.020	0.647*	-0.094	-0.778**	-0.253	0.054
Days from anthesis to turning stage	P		-0.201	-0.208	0.528	0.467	-0.251	-0.177	0.107	0.504	-0.015	-0.345	0.022	0.104
	G		-0.271	-0.269	0.552*	0.479	-0.348	-0.232	0.060	0.506	-0.098	-0.457	-0.017	0.051
Number of fruits per cluster	P			0.566*	-0.493	0.223	0.370	-0.022	-0.288	-0.437	0.182	0.536	0.572*	-0.043
	G			0.563*	-0.503	0.232	0.362	-0.031	-0.304	-0.454	0.168	0.530	0.567*	-0.058
Number of fruits per plant	P				-0.556*	0.533*	0.175	0.128	-0.069	-0.592*	0.034	0.615*	0.397	0.189
	G				-0.565*	0.537*	0.166	0.123	-0.079	-0.607*	0.021	0.611*	0.392	0.180
Average fruit weight (g)	P					0.645*	-0.314	-0.396	0.121	0.867**	-0.096	-0.844**	-0.141	0.164
	G					0.643*	-0.328	-0.403	0.114	0.867**	-0.110	-0.866**	-0.149	0.156
Fruit yield per plant (g)	P						-0.311	-0.274	0.171	0.560*	0.001	-0.436	0.107	0.287
	G						-0.326	-0.282	0.163	0.556*	-0.013	-0.454	0.101	0.279
Fruit shape index	P						-0.014	-0.055	-0.200	0.119	0.351	0.060	0.132	
	G						-0.025	-0.073	-0.219	0.097	0.337	0.048	0.115	
Number of seeds per fruit	P								-0.067	-0.208	0.304	0.179	0.094	0.210
	G								-0.077	-0.219	0.296	0.169	0.088	0.202
Number of locules per fruit	P									0.053	-0.140	0.027	-0.306	-0.246
	G									0.039	-0.164	0.009	-0.320	-0.267
Pericarp thickness (mm)	P										0.070	-0.788**	-0.209	0.144
	G										0.051	-0.819**	-0.221	0.131
Total soluble solids ( <sup>o</sup> B)	P											0.095	-0.221	0.062
	G											0.072	-0.240	0.040
Ascorbic acid content (mg/100g)	P												0.109	-0.125
	G												0.098	-0.149
Plant height (cm)	P													0.542*
	G													0.538*

\*Significant at 5% level of significance

\*\*Significant at 1% level of significance

significant association with fruit yield per plant, number of fruits per cluster and ascorbic acid content. Singh *et al.*, (2007) also found similar results. Number of fruits per plant also showed significant negative correlation with average fruit weight and pericarp thickness. Average fruit weight showed significant positive correlation with fruit yield per plant, pericarp thickness and days to first flowering and had significant negative correlation with number of fruits per plant and ascorbic acid content. Significant and positive correlation of average fruit weight with fruit yield per plant and pericarp thickness has been reported by Rani *et al.*, (2008). Pericarp thickness had significant positive correlation with average fruit weight, fruit yield per plant, and days to first flowering. Pericarp thickness also exhibited negative correlation with number of fruits per plant and ascorbic acid content. Ascorbic acid content had significant positive correlation with number of fruits per plant, while it had significant negative correlation with average fruit weight, pericarp thickness and days to first flowering. Plant height had significant positive correlation with number of fruits per cluster and harvest duration. Harvest duration had significant positive correlation with plant height. In general, genotypic correlation

coefficients were higher than corresponding phenotypic correlation coefficients. The nature of genotypic correlation was similar to phenotypic correlation. However, in some cases correlation coefficients at genotypic level were significant, while at phenotypic level same were found to be non significant. At genotypic level, days to first flowering had significant negative correlation with number of fruits per cluster and number of fruits per plant, whereas days from anthesis to turning stage had significant positive correlation with average fruit weight.

Path coefficient analysis explains the direct and indirect causes of association. In present study, path coefficient analysis was done by considering fruit yield as dependent variable and others as independent variables. Maximum positive direct effect towards fruit yield per plant was contributed by average fruit weight (0.754) followed by number of fruits per plant (0.744), pericarp thickness (0.417) and number of fruits per cluster (0.440)(Table 2). The other characters which showed positive direct effects but in small magnitude were ascorbic acid content, number of locules per fruit, days to first flowering, total soluble solids, days from anthesis

**Table 2.** Estimates of direct and indirect effects on yield per plant of different horticultural traits under study in tomato

Traits	Days to first flowering	Days from anthesis to turning stage	Number of fruits per cluster	Number of fruits per plant	Average fruit weight (g)	Fruit shape index	Number of seeds per fruit	Number of locules per fruit	Pericarp thickness (mm)	Total soluble solids (°B)	Ascorbic acid content (mg/100g)	Plant height (cm)	Harvest duration	Genotypic correlation coefficient
Days to first flowering	<u>0.094</u>	0.027	-0.058	-0.403	0.488	0.058	0.000	-0.003	0.269	-0.006	-0.134	-0.011	0.002	0.323
Days from anthesis to turning stage	0.050	<u>0.051</u>	-0.028	-0.200	0.416	0.053	-0.001	0.010	0.211	-0.007	-0.078	-0.001	0.002	0.479
Number of fruits per cluster	-0.053	-0.014	<u>0.440</u>	0.419	-0.379	-0.056	0.000	-0.052	-0.189	0.011	0.091	0.016	-0.002	0.232
Number of fruits per plant	-0.051	-0.014	0.306	<u>0.744</u>	-0.284	-0.026	0.000	-0.014	-0.253	0.001	0.105	0.017	0.006	0.537
Average fruit weight (g)	0.061	0.028	-0.052	-0.420	<u>0.754</u>	0.050	-0.001	0.019	0.361	-0.008	-0.149	-0.006	0.005	0.643
Fruit shape index	-0.036	-0.018	0.038	0.124	-0.247	<u>-0.154</u>	0.000	-0.013	-0.091	0.007	0.058	0.002	0.004	-0.326
Number of seeds per fruit	-0.016	-0.012	-0.003	0.091	-0.304	0.004	<u>0.002</u>	-0.013	-0.091	0.020	0.029	0.004	0.007	-0.282
Number of locules per fruit	-0.002	0.003	-0.032	-0.059	0.086	0.011	0.000	<u>0.171</u>	0.016	-0.011	0.001	-0.014	-0.009	0.163
Pericarp thickness (mm)	0.061	0.026	-0.047	-0.452	0.653	0.034	-0.001	0.007	<u>0.417</u>	0.004	-0.140	-0.009	0.004	0.556
Total soluble solids (°B)	-0.009	-0.005	0.017	0.015	-0.083	-0.015	0.001	-0.028	0.021	<u>0.068</u>	0.0012	-0.010	0.001	-0.013
Ascorbic acid content (mg/100g)	-0.073	-0.023	0.055	0.455	-0.653	-0.052	0.000	0.001	-0.341	0.005	<u>0.172</u>	0.004	-0.005	-0.454
Plant height (cm)	-0.024	-0.001	0.038	0.292	-0.112	-0.007	0.000	-0.055	-0.092	-0.016	0.017	<u>0.043</u>	0.018	0.101
Harvest duration (days)	0.005	0.003	-0.006	0.134	0.118	-0.018	0.000	-0.046	0.054	0.003	-0.026	0.023	<u>0.034</u>	0.279

Residual effect= 0.1156

to turning stage, plant height, harvest duration and number of seeds per fruit, however fruit shape index showed negative direct effect on fruit yield per plant. At genotypic level, the residual effect was recorded to be 0.1156.

Thus, the present study suggests that number of fruits per plant, average fruit weight, fruit yield per plant, number of seed per fruit and plant height are important characters for bringing the improvement through selection. Therefore, more emphasis should be given in selection for these traits.

### References

- Al-Jibouri HA, Miller PA and Robinson HF (1958). Genotypic and environmental variances and covariances in an upland cotton cross of interspecific origin. *Agronomy Journal* 50(10): 633-636.
- Burton GW and Devane EH (1953) Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. *Agronomy Journal* 45: 478-481.
- Dewey DR and Lu KH (1959) A correlation and path coefficient analysis of crested wheat grass seed production. *Agronomy Journal* 51: 515-518.
- Johnson HW, Robinson EH and Comstock RE (1955) Estimates of genetic and environmental variability in soybean. *Agronomy Journal* 47: 314-318.
- Mehta N and Asati BS (2008) Genetic relationship of growth and development traits with fruit yield in tomato (*Lycopersicon esculentum* Mill.). *Karnataka Journal of Agricultural Sciences* 21(1): 92-96.
- Rani CI, Veeraragavathatham D and Sanjutha S (2008) Studies on correlation and path coefficient analysis on yield attributes in root knot nematode resistant  $F_1$  hybrids in tomato. *Journal of Applied Sciences* 4(3): 287-295.
- Singh AK and Narayan R (2004) Variability studies in tomato under cold arid conditions of Ladakh. *The Horticultural Journal* 17(1): 67-72.
- Singh AK, Sharma JP and Kumar S (2007) Variability, correlation and path studies in harvest index and yield components in tomato (*Lycopersicon esculentum* Mill.). *The Horticultural Journal* 20(1): 25-29.