

Genetic Variability and Character Association Analysis in Tomato

Pradeep Kumar Singh, B Singh and Sudhakar Pandey

Indian Institute of Vegetable Research, Varanasi (Uttar Pradesh)

Genetic variability, heritability (h^2), genetic advance, character association and path analysis were carried out in 17 accessions of tomato (*Solanum lycopersicum* Mill.) during 2000-2001. Significant genotypic differences were observed for all characters under study as indicated by the high genotypic coefficient of variation for number of fruits per plant, average fruit weight, number of locules per fruit, acidity percentage, length of fruits and yield of fruits per plant. The characters with high genotypic coefficient of variation had also high heritabilities. This indicates the possibility of genetic improvements for such traits through selection based on phenotype. Association studies indicated that the yield of fruits per plant positively correlated with plant height, number of branches per plant, number of fruits per plant, average fruit weight, fruit length, number of locules, TSS and ascorbic acid content. Pericarp thickness and acidity percentage are negatively correlated with yield. Path coefficient analysis revealed that plant height, number of branches per plant, width of fruit, number of fruits per plant and average fruit weight exhibited the maximum positive direct effect on yield. Thus an increase in selection on these traits may lead to an over all increase in the yield. Quality traits except pericarp thickness and TSS did not play any significant direct and indirect role. Therefore, a genetic improvement of yield can be initiated by putting positive selection pressure on plant height, number of branches per plant, width of fruit, number of fruits per plant and average fruit weight.

Key words: Tomato, Variability, Correlation, Path analysis, Heritability, Yield

Tomato (*Lycopersicon esculentum* Mill.) is one of the important vegetables grown throughout the world. Though the area and production of tomato are increasing annually yet its average yield remains low. Therefore, for improving yield potential there is a need of systemic breeding approach. Hence knowledge of the magnitude and kind of variability existing in the germ pool for yield and its attribute is essentially important. Heritability examines the extent of heritable portion of variability, while study of genetic advance predicts the possible yield through selection. Keeping in view of this, an attempt was made to know the nature and magnitude of genetic variability existing for yield and its contributing characters in the available germplasm of tomato. The fruit yield in tomato as in other field crops is a very complex character and is dependent on a number of yield components. An attributing trait has been of immense practical interest in the field of plant breeding. This among different yield attributes and for predicting yield in correlation between the related variables. Path coefficient analysis allows partitioning the correlation coefficient into direct and indirect effects of the traits contributing towards the dependent attributes. Selection based on suitable selection indices is more efficient than the selection of different attributes individually. Thus, contribution of suitable indices adopting statistical tools is an essential aspect of plant improvement.

Materials and Methods

The present investigation was carried out at the research farm of the Horticulture Allahabad Agricultural Institute, during 2000-2001. Seventeen hybrids consisting of some released/ pre released varieties were taken for the study. Experiment was laid out in randomized block design with three replications. Seedlings were transplanted in the field during September. A spacing of 75 x 60 cm was given and all the recommended agronomic practices were followed. The observations were recorded on three randomly selected plants per replications for each hybrid on twelve important characters. The analysis of variance was carried out as suggested by Panse and Sukhatme (1997) were used for calculating other genetic parameters. Genotypic and Phenotypic coefficient of variation were calculated as per the formula suggested by Burton and Devane (1953).

Results and Discussion

The analysis of variance indicated highly significant differences among genotypes for all the characters (Table 1). The extent of variability present in seventeen hybrids of tomato was measured in term of range, grand mean, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability, (broad sense) and genetic advance. All the varieties differed significantly with respect to different characters studied. There was close relationship between PCV and GCV

Table 1. Analysis of variance

Source of variation	Plant height (cm)	Branches/plant	Fruits/plant	Avg. fruit wt. (gm)	Fruit length (cm)	Fruit width (cm)	Locules/fruit	TSS %	Acidity %	Yield/plant (kg)
Replication	26.37	0.58	9.20	1.49	0.58	0.03	0.07**	0.11**	0.0059**	0.0061
Treatment	426.12**	6.64**	4700.99**	839.74**	2.12**	2.04**	4.47	0.48	0.35**	0.54**
Error	3.86	0.20	1.96	3.55	0.10	0.09	0.03	0.02	0.0057	0.01

* Significant at 5 percent probability level

** Significant at 1% probability level

(Table 1). Data further revealed that of the characters under study exhibited high degree of GCV revealing close relationship between phenotypic and genotypic and these characters are not influenced by environment hence improvement for these characters are difficult which is inconsonance in the present finding.

With the help of GCV alone, it is not possible to determine the amount of variation that is heritable. Heritable variation can be finding out with greater degree of accuracy when heritability is studied in conjunction with genetic advance. The heritability estimates of fruit length and fruit width (0.86) to number of fruits per plant (0.99). High heritability accompanied with high genetic advance 152.36 for number of fruits per plant, 71.08 per cent Avg. fruit wt. 69.02 per cent number of locules per fruit and 61.22 per cent acidity indicating that most likely the heritability is due to additive gene effects and selection may effective this confirm the findings of the Dudi et al. (1983) and Mittal et al. (1996). If heritability was mainly owing to non-additive gene action, the genetic advance could be expected. It was clear from table 1 that the characters like plant height, average fruit weight, fruit length, fruit width, pericarp thickness, locules per fruit, TSS %, acidity %, ascorbic acid possessing high GCV, heritability and genetic advance could be effectively used in selection as it has been suggested by Sahu and Mishra (1995) and Pujari et al., (2000) that characters with high heritability coupled with high genetic advance would respond to selection better than those with high heritability and low genetic advance values observed in other characters namely plant height 29.91 %, number of branches per plant 35.18 %, yield per plant 39.03 %, fruit length 36.09 %, fruit width 31.53 %, pericarp thickness 42.83 %, TSS 16.48 % and ascorbic acid 33.00 % indicated that the expression of these characters was governed by non – additive gene action. As suggested by Mittal et al. (1996) and Pujari et al. (1995), the high heritability is being estimated due to favorable influence

of environment rather than genotype and selection for such traits may not be rewarding.

Genotypic and Phenotypic correlation studies are essential in evaluating the possibility of simultaneous improvement for many characters and also the impact of selection for one trait on the other related ones. In the present investigation, yield per plant was positively correlated with number of fruits, average fruit weight, number of branches and plant height. Positive correlation between yield per plant and average fruit weight was in accordance with the results of Singh and Mittal (1976), Sidhu and Singh (1989), Yadav and Singh (1998) and Prasad *et al.* (1998). It is revealed from the association studies that in addition to the direct selection pressure for yield, selection for more branches, taller plants will lead to a rapid genetic improvement for yield per plant. The TSS and ascorbic acid showed positive correlation while pericarp thickness and acidity percentage showed negative correlation with yield. Therefore, simultaneous improvement of yield and quality traits necessitates some sacrifices both in yield and biochemical constituents. Similar results were also reported by Bhattacharya (1977).

The direct and indirect effects of different traits on total yield are given by phenotypic path coefficient. Plant height contributed directly to yield and through number of branches per plant, width of fruits, pericarp thickness and TSS positive direct effect on yield have also been recorded for number of branches per plant, number of fruits per plant, average fruit weight, length of fruit, width of fruit, number of locules and acidity percentage whereas, negative indirect effect via plant height, number of fruits per plant, width of fruits, pericarp thickness and TSS did not show any considerable direct or indirect effect on yield. Residual variation left to be determined for yield was only 0.4521. Correlation studies reveal only the general relationship between any two variables without unfolding any possible cause of such associations. Path coefficient analysis allows partitioning the correlation

Table 2. Range, mean, variability, heritability and genetic advance

Characters	Range		(GM) Grand mean (x)	PCV (%)	GCV (%)	Broad sense heritability (%)	Genetic advance in percent of mean
	Min.	Max.					
Plant height (cm)	56.82	97.55	80.60	14.92	14.72	0.97	29.91
Branches/ plant	6.27	11.36	8.20	18.63	17.86	0.91	35.18
Fruits/ plant	24.88	199.75	53.47	74.05	74.00	0.99	152.36
Avg. fruit wt. (gm)	9.94	85.88	48.07	34.94	34.72	0.98	71.08
Fruit length (cm)	2.43	6.23	4.36	20.17	18.80	0.86	36.09
Fruit width (cm)	2.66	6.00	4.90	17.63	16.43	0.85	31.53
Locules / fruit	2.00	6.00	3.58	34.31	33.94	0.97	69.02
TSS %	2.78	7.73	5.30	22.75	21.75	0.91	42.83
Acidity %	0.28	1.55	1.11	31.19	30.44	0.95	61.22
Yield/ plant (kg)	1.45	2.92	2.12	20.75	19.83	0.91	39.03

Table 3. Estimates of genotypic and phenotypic correlation coefficients

Characters		Branches/ plant	Fruits/ plant	Avg.fruit wt. (gm)	Fruit length (cm)	Fruit width (cm)	Pericarp thickness (mm)	Locules/ fruit	TSS %	Acidity %	Ascorbic acid (mg/ 100gm)
Plant height (cm)	P	0.43	0.45	-0.62**	-0.51*	0.16	-0.17	0.04	0.03	0.26	0.24
	G	0.44	0.45	-0.64	-0.55	0.15	-0.19	0.03	0.02	0.28	0.25
Branches/ plant	P		0.64**	-0.54	-0.51*	-0.34	-0.45	0.25	0.09	0.10	0.33
	G		0.67	-0.57	-0.56	-0.40	-0.52	0.27	0.10	0.12	0.37
Fruits/ plant	P			-0.72**	-0.65**	0.07	-0.17	-0.11	0.15	0.25	0.53*
	G			-0.73	-0.69	0.08	-0.18	-0.11	0.16	0.25	0.57
Avg. fruit wt. (gm)	P				0.61**	-0.15	0.13	0.30	0.02	-0.48*	-0.31
	G				0.66	-0.16	0.13	0.31	0.02	-0.50	-0.33
Fruit length (cm)	P					-0.05	0.29	-0.21	-0.10	-0.37	-0.12
	G					-0.04	0.36	-0.22	-0.10	-0.41	-0.13
Fruit width (cm)	P						0.62**	-0.49*	0.15	0.35	-0.05
	G						0.67	-0.55	0.20	0.41	-0.02
Pericarp thickness (mm)	P							-0.59*	0.36	0.01	0.02
	G							-0.63	0.44	0.014	0.010
Locules / fruit	P								0.08	-0.34	-0.25
	G								0.08	-0.35	-0.26
TSS %	P									-0.07	0.19
	G									-0.13	0.21
Acidity %	P										0.15
	G										0.17

* Significant at 5% probability level

** Significant at 1% probability level

coefficient into direct and indirect path effects. In the present investigation path-coefficient analysis of yield and yield components revealed that number of branches, number of fruit, average fruit weight, fruit length and width of fruits were the most important traits contributing to yield. Quality traits did not play any significant direct and indirect role. Further residual variation indicated that a little portion of the variation in yield remain unaccounted for in this path analysis. These findings are

in the agreement with those of Bhattacharya (1977), Supe and Kale (1992) and Yadav and Singh (1998).

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Table 4. Direct (diagonal) and indifferent effects of different traits on yield (phenotypic & genotypic)

Characters		Plant height (cm)	Branches/ plant	Fruits/ plant	Avg. fruit wt. (gm)	Fruit length (cm)	Fruit width (cm)	Pericarp thickness (mm)	Locules/ fruit	TSS %	Acidity %	Ascorbic acid (mg/100gm)
Plant height (cm)	P	0.645	0.136	0.069	-0.546	-0.063	0.005	0.095	-0.025	0.018	-0.059	-0.010
	G	0.800	0.145	0.004	-0.782	-0.037	0.022	0.281	-0.052	0.030	-0.079	-0.043
Branches/ plant	P	0.281	0.313	0.098	-0.473	-0.063	-0.010	0.246	-0.150	0.041	-0.023	-0.014
	G	0.353	0.329	0.006	-0.698	-0.038	-0.055	0.749	-0.371	0.104	-0.034	-0.065
Fruits/ plant	P	0.290	0.201	0.153	-0.632	-0.079	0.002	0.096	0.064	0.069	-0.055	-0.022
	G	0.366	0.221	0.009	-0.892	-0.047	0.011	0.270	0.151	0.169	-0.072	-0.092
Avg. fruit wt. (gm)	P	-0.405	-0.170	-0.111	0.870	0.075	-0.004	-0.073	-0.176	0.012	0.107	0.013
	G	-0.513	-0.189	-0.006	1.219	0.045	-0.022	-0.196	-0.425	0.027	0.138	0.057
Fruit length (cm)	P	-0.332	-0.161	-0.099	0.532	0.122	-0.001	-0.161	0.123	-0.045	0.082	0.005
	G	-0.446	-0.187	-0.006	0.815	0.067	-0.006	-0.527	0.308	-0.102	0.115	0.022
Fruit width (cm)	P	0.103	-0.109	0.012	-0.132	-0.006	0.029	-0.341	0.290	0.69	-0.079	0.002
	G	0.126	-0.132	0.001	-0.200	-0.003	0.137	-0.972	0.754	0.204	-0.113	0.004
Pericarp thickness (mm)	P	0.113	-0.142	-0.027	0.116	0.036	0.018	-0.543	0.347	0.166	-0.002	0.001
	G	-0.157	-0.172	-0.002	0.167	0.025	0.093	-1.432	0.866	0.450	-0.004	-0.002
Locules/ fruit	P	0.028	0.081	-0.017	0.264	-0.026	-0.015	0.324	-0.581	0.037	0.075	0.010
	G	0.030	0.090	-0.001	0.380	-0.015	-0.076	0.910	-1.363	0.090	0.098	0.046
TSS %	P	0.025	0.029	0.023	0.024	-0.012	0.005	-0.200	-0.048	0.451	0.017	-0.008
	G	0.024	0.034	0.001	0.033	-0.007	0.027	-0.633	-0.120	1.018	0.037	-0.037
Acidity %	P	0.173	0.033	0.039	-0.424	-0.046	0.011	0.006	0.198	-0.035	-0.222	-0.006
	G	0.229	0.040	0.002	-0.611	-0.028	0.056	-0.020	0.484	-0.136	-0.276	-0.029
Ascorbic acid (mg/100gm)	P	0.156	0.103	0.082	-0.273	-0.016	-0.002	0.001	0.146	0.088	-0.033	-0.042
	G	0.124	0.124	0.005	-0.405	-0.009	-0.009	-0.014	0.366	0.220	-0.047	-0.173

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