Indian J. Hort. 69(4), December 2012: 540-544

Correlation and path coefficient analysis for quantitative and qualitative traits for fruit yield and seed yield in tomato genotypes

Bhavana Sharma* **and J.P. Singh**
Department of Vegetable Science, Govind Ballabh Pant University of Agriculture & Technology, Pantnagar 263145 Udham Singh Nagar, Uttarakhand

ABSTRACT

One hundred twenty tomato genotypes, introduced from AVRDC, Taipei, Taiwan were evaluated for twenty one quantitative and qualitative traits for fruit yield and seed yield by correlation and path analysis during spring summer at GBPUA&T, Pantnagar. This study revealed that fruit yield was significantly and positively correlated with fruit weight per plant (0.790 and 0.995) followed by days to 50 per cent flowering and non-significantly but positively correlated with average fruit weight, seed yield per plant. Path analysis study shown fruit weight per plant had maximum direct effect on fruit yield (0.875 and 1.0) followed by number of fruits per plant and flower clusters per plant indicating the trait of major importance for yield improvement. Seed vigour index also had maximum direct effect on seed yield. Based on this analysis, at the time of selection of tomato genotypes, one has to put emphasis on the characters like fruit weight per plant, days taken to first harvest, germination, seed vigour index I and II. The seed vigour index can also be considered as an important tool to predict performance of seed lot in the field.

Key words: Correlation, path analysis, seed vigour, *Solanum lycopersicum*.

INTRODUCTION

Tomato (S*olanum lycopersicum* syn. *Lycopersicon esculentum* Mill.), is one of the major fruit vegetable crop in India. It is the most important crop in terms of total vitamins in vegetables available in the Indian diet (Chadha, 2) and use in several ways in food industry and cosmetics. Studies revealed that yield is one of the most important trait and polygenic in nature, influence by several traits. The correlation among these traits gives an idea about the extent of association existing between yield and yield components. Moreover, the information related to the nature and extent of association among various yield attributes and direct and indirect influence of each component traits on yield could prove helpful in formulating effective breeding strategy. Ghosh *et al.* (6) had studied 40 hybrid tomato varieties for twelve characters and demonstrated that fruit yield per plant was significantly and positively correlated with number of fruits per plant, average weight of fruits, number of clusters. Mohanti *et al*. (10) had done correlation observations for 19 tomato genotypes and stated that characters affecting yield such as average fruit weight and days to 50% flowering could be important selection traits to increase fruit yield. Further, the path analysis explores the relative contribution of both direct and indirect effects of yield components on yield. The path analysis in 35 tomato genotypes showed that number of fruits per plant and average fruit weight has positive direct effect on fruit yield (Anjum *et al.*, 1). All these analyses were carried out in limited number of tomato genotypes. In the present study we have evaluated the 120 tomato genotypes for 21 quantitative and qualitative traits for fruit yield by correlation and path analysis. Further, seed characters were correlated with field characters to predict seed performance before sowing.

MATERIALS AND METHODS

One hundred twenty tomato genotypes introduced from AVRDC, Taipei, Taiwan, were evaluated using Augmented Block Design (Federer and Raghavarao, 5) along with four check varieties. Investigations were carried out in spring summer season for two consecutive years at Vegetable Research Centre, Pantnagar. Crop was raised using a spacing of 50 cm × 50 cm in alternate rows. In total 21 traits were observed for growth, quality, yield and seed traits, namely plant height, number of primary branches per plant, days to 50 per cent flowering, number of flowers per cluster, number of flower clusters per plant, days taken to first harvest, days taken to last harvest, average fruit weight, number of locules per fruit, number of fruits per plant, weight of fruits per plant, fruit yield, total soluble solids (TSS), seed yield per plant, test weight, seed viability, germination percent,

*Corresponding author's present address: Plant Breeding and Genetics Laboratory, Graduate School of Agricultural Science, Tohoku University. Amamiya-machi, 1-1 Tsutsumidori, Aoba-ku, Sendai, Miyagi, 981-8555, Japan; E-mail: bhavna.uniyal@gmail.com

seedling length, seedling dry weight, Seed vigour index I (SVI) and Seed vigour index II (SVII).

For calculation of seed yield per plant we extracted seed by fermentation method in every picking until last harvest and divided by number of plant. Weight of 100 seeds in grams was taken as test weight and SVI and SVII were calculated by multiplying germination percentage into seedling length and seedling dry weight, respectively. The mean values were taken to evaluate correlation while path analysis was done according Dewey and Lu (3).

RESULTS AND DISCUSSION

Fruit yield, being a complex polygenic character, requires an improvement through various component characters such as flower cluster, primary branches, days to flower, fruit weight etc. many more. In this study, association patterns revealed that total eleven significant correlations were found in the first, while twelve characters were significantly correlated with each other in the second year. Out of these, five significant characters were common in both years (Table 1).

Fruit weight per plant had highest correlation with fruit yield, during first year (0.790) and subsequent year (0.995). Second highest correlation was found with days to 50 percent flowering (0.457) in the second year, while it was non-significant but positively correlated (0.162) in the first year (Table 2). Fruit yield was also positively but non-significantly correlated with number of locules per fruit, average fruit weight, number of fruits per plant and total soluble solids (Table 2). These findings are the further confirmation of Golani *et al*. (7), and Manna and Paul (9) studies on tomato. The differences between the values for two years, could be due to interaction of environmental factors.

Yield components are under polygenic control hence any improvement in a positive component of yield in combination of components would result in improvement of yield. The number of fruits per plant was positively and significantly correlated with flower clusters per plant (0.493) in the second year, while non-significantly positively correlated in the first year (0.306). It was highly negatively correlated with average fruit weight (-0.442 and -0.560), while average fruit weight was found to be highly significant and positively associated with number of locules per fruit and fruit weight per plant (Table 1). This shows that there might be an appropriate combination of traits for number of fruits per plant as well as marketable fruit size. Seed vigour II also had positive significant correlation with seedling dry weight, Seed vigour I, viability percent and seed test weight. Dhedhi *et al*.

Table 1. Significant correlation coefficients between various characters.

Character vs. character		1st year	2nd year	Av. value	Character vs character		1st year	2nd year	Av. value
Plant height (cm)	Days to last harvest	0.979**			Fruit wt./plant (kg)	Fruit yield (q/ha)	0.790**	0.995**	0.892
No. of pri. branches	Seedling dry wt. (mg)	-0.586**			No. of fruits per plant	Average fruit weight (g)		-0.560**	
Days to 50% flowering	Fruit wt. per plant (kg)		0.456*		No. of fruits per plant	Total soluble solids	0.469*		
Days to 50% flowering	Fruit yield (q/ha)		0.457*		No. of fruits per plant	Seedling length (cm)		0.489*	
No. of flowers cluster per plant	Plant height (cm)		0.433*		Total soluble solids	Viability (%)	0.440*		
No. of flowers cluster per plant	Av. fruit weight (g)	-0.444*	-0.46*	-0.452	Viability (%)	Germination (%)	0.499*	0.707**	0.603
No. of flowers cluster per plant	Seed yield per plant (g)	0.435*			Seedling length (cm)	No. of flower cluster/ plant		0.441*	
Days to first harvest	Days to last harvest	0.843**	0.832*	0.837	Seedling dry wt. (mg)	Germination (%)		0.486*	
Av. fruit weight (g)	No. of fruits per plant	-0.442*			Seedling dry wt. (mg)	Seed vigour II	0.813**	0.922**	0.867

Table 2. Correlation coefficient for different quantitative and qualitative traits.

Trait	Plant height (cm)	No. of pri. branch-es	Days to 50% flower-ing	No. of flowers per cluster	No. of flower clusters per plant	Days to first harvest	Days to last harvest	Av. fruit weight (g)	No. of locule per fruit	Fruit weight per plant (kg)	No. of fruits per plant	Total soluble solids (%)	Test weight (g)	Seed viability (%)	Seed germi-nation (%)	Seed-ling length (cm)	Seed-ling dry wt. (mg)	Seed vigour I	Seed vigour II	Seed yield per plant (g)	Fruit yield (q/ ha)
Plant height (cm)		0.272	0.274	0.351	0.410	0.039	0.979**	-0.205	-0.003	0.005	0.107	0.202	-0.232	0.082	-0.09	0.223	0.097	0.111	0.063	0.247	0.048
No. of pri. branches	0.235		0.186	0.217	0.32	0.015	0.014	0.216	-0.01529	-0.0392	-0.0474	0.074	-0.235	-0.047	0.052	0.099	-0.586**	0.078	-0.055	0.023	0.053
Day to 50% flowering	0.198	0.166		0.183	0.092	0.31	0.209	-0.1	0.08	-0.2	0.007	0.212	-0.199	0.283	0.03	0.203	0.002	0.179	0.009	0.01	0.162
No. of flowers per cluster	0.164	0.253	-0.066		0.307	0.106	0.134	0.233	-0.275	0.128	0.129	0.11	-0.198	0.069	0.115	0.029	-0.068	0.132	-0.013	0.037	-0.154
No. of flower clusters per plant	0.433*	0.176	-0.022	0.25		0.086	0.079	-0.444*	-0.07	0.072	0.306	0.174	-0.182	-0.018	0.247	-0.159	-0.004	-0.04	0.132	0.435*	0.008
First harvest	0.087	0.125	0.13	0.119	-0.02		0.843**	0.064	0.018	-0.224	-0.098	0.113	-0.171	0.145	0.081	-0.142	-0.121	-0.106	-0.059	-0.148	-0.238
Days to last harvest	0.093	0.176	0.173	0.267	0.005	0.832*		0.071	0.064	-0.165	-0.099	-0.213	0.197	0.085	0.077	-0.045	0.005	-0.015	0.048	-0.147	-0.186
Av. fruit weight (g)	-0.219	0.106	0.181	-0.281	-0.46*	0.013	-0.038		0.277	0.124	-0.442*	-0.255	0.166	0.049	-0.278	0.038	0.126	-0.111	-0.068	-0.267	0.153
No. of locules per fruit	0.046	-0.072	0.162	-0.242	-0.162	0.101	0.118	0.374		0.019	-0.059	-0.151	0.201	-0.126	0.02	0.001	0.121	-0.008	0.122	-0.04	0.209
Fruit wt./plant (kg)	0.177	0.024	0.456*	0.119	0.003	-0.066	0.033	0.083	0.196		0.346	0.117	0.245	0.121	0.096	0.086	0.097	-0.037	0.049	0.382	0.790**
No. of fruits/ plant	0.176	0.118	-0.107	0.133	0.493*	-0.055	-0.087	-0.560**	-0.086	0.144		0.469*	0.079	0.12	0.181	-0.109	0.127	-0.009	-0.007	0.328	0.006
Total soluble solids (%)	0.2	0.271	-0.044	0.22	0.271	0.151	0.351	-0.256	-0.054	0.14	0.159		-0.132	0.440*	0.213	-0.037	-0.014	0.043	0.134	0.268	0.027
Test weight (g)	-0.193	-0.123	-0.0168	-0.346	-0.275	-0.16	0.149	0.276	0.199	0.002	-0.163	-0.226		0.023	-0.027	-0.006	0.223	-0.007	0.194	-0.102	0.23
Viability (%)	-0.257	-0.206	-0.186	-0.305	-0.048	-0.026	-0.108	0.111	0.035	-0.127	0.043	-0.036	0.184		0.499*	0.062	0.08	0.242	0.347	0.041	-0.111
Germination (%)	-0.143	-0.159	-0.064	-0.235	0.066	0.122	0.135	-0.172	0.078	-0.009	0.076	0.2	0.17	0.707		-0.136	-0.141	0.376	0.411	0.141	0.135
Seedling length (cm)	0.116	0.002	-0.038	0.05	0.441*	-0.013	-0.069	-0.184	-0.097	0.157	0.489*	0.113	-0.069	0.073	0.061		0.154	0.82	0.015	-0.103	0.102
Seedling dry wt. (mg)	0.208	-0.094	-0.244	-0.179	-0.157	00	-0.079	0.017	00	-0.143	0.09	0.075	0.284	0.171	0.022	-0.085		0.059	0.813**	0.043	0.167
Seed vigour I	-0.067	0.094	0.112	-0.177	-0.048	-0.041	-0.055	-0.074	-0.003	-0.03	-0.056	0.057	0.142	0.39	0.486*	0.011	0.196		0.241	-0.0875	-0.05
Seed vigour II	-0.046	-0.147	0.253	-0.248	-0.15	0.026	-0.046	-0.043	0.035	-0.161	-0.061	-0.021	0.314	0.366	0.33	-0.067	0.922**	0.329		0.128	0.076
Seed yield/ plant (g)	-0.247	0.037	-0.009	0.222	0.29	0.005	0.15	-0.32	-0.04	0.337	0.214	0.336	-0.163	0.04	0.202	-0.067	-0.112	0.089	-0.057		0.312
Fruit yield (q/ ha)	0.118	0.03	0.457*	-0.103	0.02	-0.07	0.028	0.089	0.187	0.995**	0.132	0.135	0.014	-0.128	0.008	-0.154	-0.143	-0.036	0.163	0.346	

*, ** Significant at 1 and 5% levels.

(4) had also observed that seed vigour was positively correlated with germination in pigeon pea, Thus, Seed vigour II can be used as an efficient tool for prediction of seed lot vigour under field conditions before sowing.

In biological system where all variables are interdependent, path coefficient analysis has proved very significant and is used as a tool to position the observed correlation coefficients into series of direct and indirect effects of yield components on yield, thus revealing specific forces, which are acting to build up a given correlation. In present study, data analysis revealed that in the first year fruit weight per plant had maximum positive direct effect (0.875) on fruit yield (Table 3) followed by number of fruits per plant (0.392). Average fruit weight had positive indirect effects on yield *via* flower clusters per plant, locules per fruit, fruit weight per plant, and number of fruits per plant (data not shown). Most of the characters have showed positive direct effect except days to 50 percent flowering (-0.004) and days to first harvest (-0.046), which are very low. Tiwari *et al*. (12) had also found such observations using nineteen tomato genotypes. In the second year the maximum direct effect was shown by fruit weight per plant (1.0) followed by number and fruit weight per plant (0.280), average fruit weight (0.012), flower clusters per plant (0.025) and flower per cluster (0.025) (Table 3). Fruit yield had positive indirect effects through locules per fruit and number of fruits per plant. These results are in confirmation with the findings of Kant and Mani (8). Maximum direct negative effect was exhibited by Seed vigour I (-0.01), days to last harvest (-0.02), days to 50 percent flowering (-0.001) and total soluble solids (0.009).

On the basis of above studies in large number of tomato genotypes for twenty one traits for two successive year data analysis, we concluded that fruit weight per plant is an important character for improvement of fruit yield in tomato. Other characters such as number of fruits per plant, average fruit weight and flower cluster per plant can also be consider during breeding programme, while these characters should be in proper combination to attain ideal marketable size fruit and other fruit qualities. Above characters can observe during selection to obtain outstanding lines for breeding.

Table 3. Direct effect of different characters on yield.

Character	Plant height (cm)	No. of primary branches	Days to 50 % flowering	No. of flower per cluster	No. of flower cluster per plant	Days to first harvest	Days to last harvest	Av. fruit weight (g)	No. of locules per fruit	Fruit wt. per plant (kg)	No. of fruits per plant	Total soluble solids	Test weight (g)	Viability (%)	Germi-nation (%)	Seedling length (cm)	Seedling dry weight (mg)	Seed vigour I	Seed vigour II	Seed yield/ plant (g)
1st year	0.052	0.067	-0.004	0.015	0.040	-0.046	-0.013	0.011	0.153	0.875	0.392	0.076	0.063	0.059	0.199	0.032	0.343	-0.092	0.385	0.059
2nd year	0.01	0.005	-0.001	0.024	0.025	0.011	-0.02	0.012	0.009	1	0.280	-0.009	0.02	0.002	0.009	0.005	0.005	-0.01	0.008	0.012
Average	0.031	0.04	0.00	0.02	0.03	-0.02	-0.02	0.01	0.08	0.94	0.34	0.03	0.04	0.03	0.10	0.02	0.17	-0.05	0.20	0.04

REFERENCES

1. Anjum, A., Raj, N., Nazeer, A. and Khan, S.H. 2009. Genetic variability and selection parameters for yield and quality attributes in tomato. *Indian J. Hort.* **66**: 73-78.

2. Chadha, K.L. 2001. *Handbook of Horticulture*. Directorate of Information and Publications of Agriculture, ICAR, New Delhi, pp. 8.

3. Dewey, D.R. and Lu, K.H. 1959. Correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J*. **51**: 515-18.

4. Dhedhi, K.K., Zaveri, P.P. and Tikka, S.B.S. 1997. Correlation and path analysis of pigeon pea over environments. *Indian J. Pulses Res*. **10**:104-6.

5. Federer, W.T. and Raghavarao, D. 1975. An augmented design. *Biometrics*, **31**: 29-35.

6. Ghosh, K.P., Islam, A.K.M.A., Mian, M.A.K. and Hossain, M.M. 2010. Genetic diversity in F_2 segregation population of different commercial hybrids of tomato (*Solanum lycopersicum* L.). *J. Genet. Evol.* **3**: 15-23.

7. Golani, I.J., Mehta, D.r., Purohit, V.L., Pandya, G.H. and Kanjzariya, M.V. 2007. Genetic Variability, correlation and path coefficient studies in tomato. *Indian J. Agric. Res*. **41**: 146-49.

8. Kant, L. and Mani, V.P. 2004. Association and contribution of different characters towards fruit yield in tomato (*Lycopersicon esculentum* Mill.). *Indian J. Hort.* **61**: 327-30.

9. Manna, M. and Paul, A. 2012. Studies of genetic variability and character association of fruit quality parameters in tomato. *Hort Flora Res. Spectrum*, **1**: 110-16.

10. Mohanti, B.K. 2003. Genetic Variability, correlation and path coefficient studies in tomato. *Indian J. Agric. Res.* **37**: 68-71.

11. Prasad, V.S.R.K., Rai, Mathura and Rai, M. 1999. Genetic variation, component association and direct and indirect selections in some exotic tomato germplasm. *Indian J. Hort*. **56**: 262-66.

12. Tiwari, J.K. and Upadhyay, D. 2011**.** Correlation and path coefficient studies in tomato (*Lycopersicon esculentum* Mill.). *Res. J. Agric. Sci.* **2**: 63-68.

Received : March, 2011; Revised : April, 2012;
Accepted : May, 2012