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STUDIES ON CORRELATION AND PATH COEFFICIENT ANALYSIS IN TOMATO (*SOLANUM LYCOPERSICUM* L.)

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Abstract

Thirty five genotypes of tomato collected from different location of India and maintained at Department of Vegetable Science were evaluated for thirteen quantitative characters in randomized complete block design with three replications at Main Experiment Station, Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.), India; during *Rabi* 2012-2013. Genotypic correlation coefficients were mostly similar in nature and higher in magnitude than the corresponding phenotypic correlation coefficients. Fruit yield per plant had exhibited highly significant and positive association with average fruit weight. Average fruit weight and number of fruits per plant were identified as most important traits, which contributed considerable positive direct effect on fruit yield per plant.

Key words : Agro-ecology, path coefficient, phenotypic, genotypic, correlation direct and indirect effect.

Introduction

Tomato (*Solanum lycopersicon* L.) is one of the most important solanaceous vegetable crops grown widely all over the world. It is a very versatile vegetable for culinary purposes. Ripe fresh tomato fruits are consumed fresh as salads, cooked vegetable and processed products such as puree, paste, powder, ketchup, sauce, soup and canned whole fruits. Unripe green fruits are used for preparation of pickles and chutney. All the species of tomato are native to Western South America (Rick, 1976). Tomato is important source of lycopene (an antioxidant), ascorbic acid and ß-carotene and valued for their colour and flavour. It is one of the most popular and widely cultivated vegetable throughout the world and ranking second in importance after potato in many countries including India. The total area of world under tomato cultivation is 4.58 m ha with total production of 150.51 m tonnes with productivity of 32.8 tonnes per hectare. Whereas, in India total area is 0.88 m ha and production is 18.23 m tonnes with 20.7 tonnes/ha productivity (Anonymous, 2011-12). Tomato is a typical day neutral plant and is mainly self-pollinated, but a certain percentage of cross-pollination also occurs. It is a warm season crop reasonably resistant to heat and drought and grows under wide range of soil and climatic conditions. Considering the importance and scope of this crop, there is a need to develop tomato varieties suitable to specific agro-ecological conditions and also for specific end use. Study of correlation between different quantitative characters provides an idea of association that could be effectively exploited to formulate selection strategy for improving yield components. For any effective selection programme, it would be desirable to consider the relative magnitude of association of various characters with yield. The path coefficient technique helps in estimating the direct and indirect contribution of various traits out of the total correlation towards yield. On the basis of these strategies, the quantum importance of individual characters is marked to facilitate the selection programme for better gains.

Materials and Methods

Present investigation was conducted at the Main Experimental Station of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.), India during *Rabi* 2012-2013. The experiment was conducted in Randomized Block Design with three replications to evaluate 35 genotypes of tomato. Seeds were sown in nursery bed on 5th October, 2012 and 24 days old healthy seedlings were transplanted in the experimental field on 29th October, 2012 in two row of 4 m length with inter and intra row spacing of 60 and 50 cm, respectively. Three

Table 1 : Estimates of phenotypic correlation coefficients among twelve characters in tomato.

Characters	Plant height (cm)	Primary branches/ Plant	Diameter of fruits (cm)	Pericarp thickness (mm)	Fruit length (cm)	Fruits/ plant	Average fruit weight (g)	TSS %	Locules/ fruit	Un-market-able fruits/ plant	Marketable fruits/ plant	Fruit yield per plant (g.)
Days to 50% flowering	-0.137	0.116	-0.106	-0.128	0.049	0.326	-0.220	-0.292	0.063	0.233	0.319	-0.016
Plant height (cm)		0.013	-0.191	-0.237	-0.208	0.147	0.042	-0.137	-0.028	0.183	0.112	0.056
Primary branches/ plant			0.0261	-0.087	-0.048	0.192	0.186	0.018	-0.008	0.242	0.122	0.281
Diameter of fruits (cm)				0.315	0.461**	-0.288	0.452**	-0.095	0.251	-0.108	-0.330	0.289
Pericarp thickness (mm)					0.055	-0.357*	0.302	-0.042	0.306	-0.299	-0.323	0.100
Fruit length (cm)						-0.017	0.084	-0.034	-0.045	-0.024	-0.018	0.067
Fruits/ plant							-0.400*	-0.076	-0.158	0.705**	0.946**	0.231
Average fruit weight (g)								-0.025	0.392*	-0.356*	-0.355*	0.775**
TSS %									0.1443	-0.315	0.042	-0.026
Locules/ fruit										-0.278	-0.072	0.330
Unmarketable fruits/ plant											0.450**	0.058
Marketable fruits/ plant												0.255

*, **, Significant at 5% and 1% probability respectively.

Table-2: Estimates of genotypic correlation coefficients among thirteen characters in tomato

Characters	Plant height (cm)	Primary branches/ Plant	Diameter of fruits (cm)	Pericarp thickness (mm)	Fruit length (cm)	Fruits/ plant	Average fruit weight (g)	TSS %	Locules/ fruit	Un-market-able fruits/ plant	Marketable fruits/ plant	Fruit yield per plant (g.)
Days to 50% Flowering	-0.147	0.121	-0.111	-0.173	0.055	0.351	-0.236	-0.321	0.055	0.259	0.349	-0.021
Plant height (cm)		0.013	-0.196	-0.268	-0.211	0.147	0.042	-0.146	-0.028	0.193	0.112	0.057
Primary branches/ plant			0.033	-0.063	-0.038	0.215	0.198	0.002	-0.012	0.272	0.137	0.302
Diameter of fruits (cm)				0.363	0.470	-0.300	0.466	-0.079	0.265	-0.104	-0.353	0.301
Pericarp thickness (mm)					0.072	-0.398	0.335	-0.081	0.376	-0.352	-0.366	0.111
Fruit length (cm)						-0.017	0.087	-0.028	-0.052	-0.026	-0.019	0.068
Fruits/ plant							-0.401	-0.093	-0.166	0.731	0.958	0.232
Average fruit weight (g)								-0.017	0.415	-0.371	-0.358	0.778
TSS (%)									0.174	-0.365	0.032	-0.028
Locules/ fruit										-0.307	-0.076	0.349
Unmarketable fruits/ plant											0.505	0.060
Marketable fruits/ plant												0.256

*, **, Significant at 5% and 1% probability respectively.

Table 3 : Direct and indirect effects of twelve quantitative traits on fruit yield/ plant (g) at phenotypic level in tomato.

Characters	Days to 50 % flowering	Plant height (cm)	Primary branches/ plant	Diameter of fruits (cm)	Pericarp thickness (mm)	Fruit length (cm)	Fruits/ plant	Average fruit weight (g)	TSS %	Locules/ fruit	Unmark-Etable fruits/ plant	Marketa-ble fruits/ plant	Correlation with fruit yield per plant(g)
Days to50 per cent flowering	**0.009**	0.012	-0.005	-0.001	0.003	-0.001	0.256	-0.231	-0.010	0.001	-0.010	-0.025	**-0.016**
Plant height (cm)	-0.001	**0.086**	-0.006	-0.002	0.005	0.007	0.116	0.044	-0.004	-0.004	-0.008	-0.009	**0.056**
No. of primary branches per plant	0.001	-0.001	**0.047**	0.003	0.002	0.001	0.151	0.196	0.001	-0.001	-0.011	-0.009	**0.320**
Diameter of fruit (cm)	-0.001	0.016	-0.001	**0.012**	-0.007	-0.015	-0.227	0.476	-0.003	0.003	0.004	0.026	**0.289**
Pericarp thickness (mm)	-0.001	0.020	0.004	0.003	**-0.002**	-0.001	-0.281	0.316	-0.001	0.003	0.013	0.025	**0.100**
Fruit length (cm)	0.000	0.018	0.002	0.004	-0.001	**-0.033**	-0.013	0.088	-0.001	-0.001	0.001	0.001	**0.066**
Fruit per plant	0.003	-0.013	-0.009	-0.001	0.008	0.000	**0.787**	-0.421	-0.002	-0.002	-0.032	-0.075	**0.231**
Average fruit weight (g)	-0.002	-0.004	-0.008	0.004	-0.007	-0.002	-0.315	**1.053**	-0.001	0.005	0.016	0.028	**0.775**
Total Soluble Solids (TSS)	-0.003	0.012	-0.001	-0.001	0.001	0.001	-0.060	-0.025	**0.035**	0.002	0.014	-0.003	**-0.026**
No. of locules per fruit	0.001	0.002	0.004	0.003	-0.007	0.001	-0.125	0.412	0.005	**0.012**	0.012	0.005	**0.330**
Unmarketable fruit/plant	0.002	-0.016	-0.011	-0.001	0.007	0.001	0.555	-0.374	-0.011	-0.003	**-0.045**	-0.035	**0.058**
Marketable fruit/plant	0.003	-0.009	-0.006	-0.003	0.007	0.001	0.745	-0.374	0.001	-0.001	-0.020	**-0.079**	**0.254**

Residual effect = 0.196, $R^2 = 0.961$

check varieties (H-86 as determinate and NDT-4 and Pusa Rubi as indeterminate) and 31 genotypes were planted in two rows, keeping 8 plants in each row. All recommended cultural practices were followed to raise good crop stand and growth of the plants. Data were recorded for thirteen characters *viz.,* days to 50 per cent flowering, plant height (cm), number of primary branches per plant, fruit diameter (cm), fruit length (cm), number of locules per fruit, pericarp thickness (mm), average fruit weight (g), total soluble solids, number of fruits per plant, number of marketable fruits per plant, number of unmarketable fruits per plant and fruit yield per plant (g). The data were analyzed as per methods suggested by Searle (1961) for correlation coefficient and Dewey and Lu (1959) for path coefficient analysis.

Results and Discussion

The knowledge of nature and magnitude of association between yield and its component traits is necessary for effective selection in advance generations. Correlations between pairs of characters are either due to linkage of genes or due to pleiotropic gene action.

In the present study, correlations between thirteen characters were worked out in all possible combinations at phenotypic and genotypic levels (tables 1 and 2). In general, the magnitude of genotypic correlation coefficients were higher than the corresponding values of the phenotypic correlation coefficients. This indicated a strong genetic association between these traits. The present study also suggested that both genotypic and phenotypic correlations were similar in direction. Kumar *et al.* (2003) also reported higher estimates of genotypic correlation than the corresponding phenotypic correlation coefficients between yield and yield components. A perusal of data (tables 1 and 2) revealed

Table 4 : Direct and indirect effects of twelve quantitative traits on fruit yield/ plant (g) at genotypic level in tomato.

Characters	Days to 50 % flowering	Plant height (cm)	Primary branches /plant	Diameter of fruits (cm)	Pericarp thickness (mm)	Fruit length (cm)	Fruits/ plant	Average fruit weight (g)	TSS %	Locules/ fruit	Un marketable fruits/ plant	Marketable fruits /plant	Correlation with fruit yield per plant (g)
Days to50 per cent flowering	**-0.017**	0.013	-0.004	-0.004	-0.001	-0.002	-0.123	-0.249	-0.012	-0.001	0.086	0.294	**-0.021**
Plant height (cm)	0.002	**0.090**	-0.005	-0.007	-0.002	0.009	-0.051	0.044	-0.005	0.001	0.064	0.094	**0.056**
No. of primary branches per plant	-0.002	-0.001	**0.038**	0.001	-0.005	0.001	-0.074	0.209	0.001	0.001	0.090	0.115	**0.331**
Diameter of fruit (cm)	0.002	0.017	-0.001	**0.039**	0.003	-0.020	0.105	0.492	-0.003	-0.001	-0.034	-0.297	**0.301**
Pericarp thickness (mm)	0.002	0.024	0.002	0.014	**0.008**	-0.003	0.139	0.354	-0.003	-0.002	-0.118	-0.308	**0.111**
Fruit length (cm)	-0.001	0.019	0.001	0.018	0.006	**-0.042**	0.006	0.092	-0.001	0.001	-0.008	-0.016	**0.068**
Fruit per plant	-0.005	-0.013	-0.008	-0.011	-0.003	0.001	**-0.350**	-0.424	-0.003	0.001	0.244	0.805	**0.231**
Average fruit weight (g)	0.004	-0.003	-0.007	0.018	0.002	-0.003	0.140	**1.056**	-0.001	-0.002	-0.124	-0.301	**0.778**
Total Soluble Solids (TSS)	0.005	0.013	-0.001	-0.003	-0.007	0.001	0.032	-0.020	**0.039**	-0.001	-0.122	0.027	**-0.028**
No. of locules per fruit	-0.001	0.002	0.005	0.010	0.003	0.002	0.058	0.438	0.006	**-0.006**	-0.101	-0.063	**0.349**
Unmarketable fruit/plant	-0.004	-0.017	-0.010	-0.004	-0.002	0.001	-0.256	-0.392	-0.014	0.002	**0.334**	0.424	**0.060**
Marketable fruit/plant	-0.005	-0.010	-0.005	-0.013	-0.003	0.001	-0.336	-0.379	0.001	0.005	0.169	**0.840**	**0.258**

Residual effect = 0.176 R^2 = 0.969

that most important trait *i.e.* fruit yield per plant had highly significant and positive association with average fruit weight at phenotypic level. Thus, these characters emerged as most important associates of fruit yield in tomato. The available literature has also indicated positive correlation between average fruit weight, fruit yield per plant and number of fruit per plant, number of primary branches per plant, plant height, pericarp thickness, and diameter of fruit in tomato (Kumar *et al.*, 2003; Kumar *et al.*, 2004; Makesh *et al.*, 2006; Maurya *et al.*, 2011; Madhurima and Paul, 2012). Number of marketable as well as unmarketable fruits per plant had highly significant and positive association with number of fruits per plant and unmarketable fruits per plant and negative and significantly correlation with average fruit weight. Number of locules per fruit had significant and positive association with average fruit weight. Average fruit weight had highly significant and positive association with diameter of fruits and fruit yield per plant while, negative significant correlation with marketable and unmarketable fruits per plant. Number of fruits per plant was found negatively and significantly correlated with pericarp thickness. Fruit length had highly significant and positive correlation with diameter of fruits. These results are in consonance with the finding of Madhurima and Paul (2012), Maurya *et al.* (2011), Ara *et al.* (2009) and Singh (2007). Thus, on the basis of above discussion it can be concluded that selection for average fruit weight followed by fruit diameter, length of fruit, locules per fruit and fruits per plant would be effective for yield improvement. Emphasis for selection of these traits in desired direction for higher yield had also been suggested by earlier workers (Singh, 2007; Madhurima and Paul, 2012; Narolia *et al.*, 2012).

Path coefficient analysis is a tool to partition the observed correlation

coefficient of yield components on yield into direct and indirect effects to provide clear picture of character associations for formulating effective selection strategy. Path analysis differs from simple correlation in that it points out the causes and their relative importance whereas, the later measures simply the mutual association ignoring the causation. In present study, the path coefficient analysis was carried out at phenotypic as well as genotypic levels (tables 3 and 4). High positive direct effects were exerted by average fruit weight and number of fruits per plant on fruit yield per plant. This indicates that, direct selection for average fruit weight and number of fruits per plant in desired direction would be very effective for yield improvement. These results are in accordance with the findings of Singh *et al*. (2004), Makesh *et al.* (2006), Madhurima and Paul (2012) and Narolia *et al.* (2012). The research also revealed the facts that important direct and indirect component exhibited substantial positive effect *via* some characters along with considerable negative effect *via* some other traits. The occurrence of negative as well as positive direct and indirect effects by yield components on fruit yield *via* one or other characters simultaneously presents a complex situation, where a compromise is required to attain a proper balance of different yield components for determining the ideotype for high fruit yield in tomato. The character mentioned above, merit due consideration at the time of formulation of selection strategy aimed at developing high yielding varieties in tomato.

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