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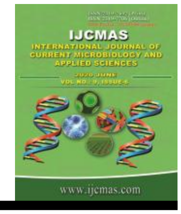

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Correlation and Path Coefficient Analysis in Tomato (*Solanum lycopersicum* L.)

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ABSTRACT

The present investigation was carried out under AICRP on Vegetable Crops at Horticultural Research cum Instructional Farm, Department of Vegetable Science, IGKV, Raipur (C.G.) during rabi 2016-17. The 22 tomato (*Solanum lycopersicum* L.) genotypes were evaluated to estimate the nature and magnitude of associations of different characters with fruit yield (q/ha). The experiment was conducted using Randomized Block Design (RBD) with three replications. An overall observation of correlation coefficient analysis revealed that average fruit wt. (0.792, 0.735), fruit diameter (0.751, 0.705), number of fruits per cluster (0.636, 0.520), number of flowers per cluster (0.620, 0.520), fruit yield per plant (0.584, 0.559), ascorbic acid (0.441, 0.355) and number of fruits per plant (0.415, 0.352), exhibited the significant positive correlation with fruit yield (q/ha). Hence, direct selection for these traits may lead to the development of high yielding genotypes of tomato. In case of path analysis fruit diameter (11.003), fruit yield per plant (5.646), plant height (5.363), days to first fruit harvest (4.913), number of fruits per cluster (3.052), number of branches per plant (1.206) had highest positive direct effect on fruit yield (q/ha) hence, indicating their true positive and significant association with fruit yield (q/ha). This indicated that these traits play important role in yield improvement. This implies that direct selection for these characters might be effective and there is a possibility of improvement in fruit yield.

Keywords

Correlation, Path analysis, Genotypes, Tomato, Yield

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Introduction

Tomato (*Solannum lycopersicum* L.) is one of the most important and popular vegetable crops in the world. Tomato is popular due to its nutritive and medicinal values. Nuez *et al.*, 2004 identified it as the horticultural crop with the highest commercial value. In India; tomato is grown across all agro-ecological zones and occupies an area of about 801 thousand hectares with an annual production of 22.33 million tonnes, respectively (Anon., 2017). Tomato is universally treated as 'Protective Food' since it is very rich in minerals, vitamins, antioxidants, essential amino acids, sugars and dietary fibers which are important ingredients for culinary and table purpose, chutney, pickles, ketchup, soup, juice, puree etc. (Sekhar *et al.*, 2010). Fresh fruit of tomato are in great demand round the year throughout the country.

Hence, there is continuous need to strengthen the crop improvement programmes in tomato and ultimately developing new varieties/hybrids satisfying to the present day needs of farmers and consumers as well. Yield is a complex character and selection for yield and yield components deserves considerable attention. A crop breeding programme, aimed at increasing the plant productivity requires consideration not only of yield but also of its components that have direct or indirect bearing on yield. Association analysis is an important approach in a breeding programme. The estimates of different genetic parameters and the association of different characters are important for better understanding of the nature and the magnitude of genetic variability present in the breeding material. As we know that, the yield is a complex character being influenced by various component factors. Knowledge of interrelationship among these factors is necessary for indirect selection of higher fruit yielding genotypes by giving appropriate emphasis for each of these characters.

Materials and Methods

Twenty two genotypes of tomato collected from different sources were evaluated during 2016-17 under AICRP on Vegetable Crops, Department of Vegetable Science at Horticultural Research and Instructional Farm, IGKV, Raipur (C.G.). The experiment was laid out in Randomized Block Design (RBD) with three replications. All recommended cultural practices were followed. Observations were recorded for eighteen characters viz., days to 50% flowering, number of branches per plant, plant height, number of fruit cluster per plant, number of flowers per cluster, number of fruits per cluster, number of fruits per plant, days to first fruit harvest, fruit yield per plant, fruit length, fruit diameter, average fruit weight, number of locules per fruit, pericarp thickness and fruit yield per hectare (q). Whereas, qualitative characters like, total soluble solids, ascorbic acid content, dry matter % of fruit were recorded and subjected to correlation and path coefficient analysis.

Results and Discussion

Association analysis is an important approach in a breeding programme. It gives an idea about relationship among the various characters and determines the component characters, on which selection can be used for genetic improvement in the fruit yield. The degree of association between independent and dependent variables was first suggested by Galton (1888) its theory was developed by Pearson (1904) and their mathematical utilization at phenotypic, genotypic and environmental levels was described by Searle (1961).

The genotypic and phenotypic correlation for fruit yield and its component in tomato are presented in Table 1 and only significant correlations are discussed here. Fruit yield per hectare (q) expressed a highly significant positive correlation with average fruit wt. (0.792, 0.735), fruit diameter (0.751, 0.705), number of fruits per cluster (0.636, 0.520), number of flowers per cluster (0.620, 0.520), fruit yield per plant (0.584, 0.559), ascorbic acid (0.441, 0.355) and number of fruits per plant (0.415, 0.352), at genotypic and phenotypic level, respectively. While number of fruit cluster per plant (0.341, 0.267) and fruit length (0.323, 0.298) expressed a highly significant positive correlation at genotypic level and significant positive correlation at phenotypic level, respectively. The results are in accordance with Mahapatra *et al.,* (2013), Nagariya *et al.,* (2015), Sridharan *et al.,* (2016), Naveen *et al.,* (2017) and Rawat *et al.,* (2017) reported very high and significant correlation coefficient for above characters with fruit yield.

Highly significant and positive correlation was shown by days to 50% flowering with number of branches per plant (0.480, 0.395) and dry matter % of fruit (0.389, 0.268) at genotypic and phenotypic level, respectively. Number of branches per plant had highly positive and significant correlation with number of fruit cluster per plant (0.781, 0.645), number of fruits per plant (0.699, 0.572), fruit yield per plant (0.370, 0.338) and total soluble solid (0.596, 0.524) at both genotypic and phenotypic levels. Number of fruit cluster per plant showed positive and highly significant correlation with number of fruits per plant (0.830, 0.706) and fruit yield per plant (0.654, 0.517) at genotypic and phenotypic level, respectively. Positive and highly significant correlation was shown by number of flowers per cluster with number of fruits per cluster (0.901, 0.799), fruit diameter (0.569, 0.473) and average fruit wt. (0.469, 0.424) at genotypic and phenotypic level, respectively. Similar results are also observed by Tasisa *et al.,* (2012), Ghosh *et al.,* (2010) and Nagariya *et al.,* (2015).

Number of fruits per cluster exhibited highly significant and positive correlation with fruit diameter (0.589, 0.464), average fruit wt. (0.519, 0.397) and number of locules per fruit (0.450, 0.368) at both genotypic and phenotypic level.

Positive and highly significant correlation was shown by number of fruits per plant with fruit yield per plant (0.507, 0.474) at genotypic and phenotypic level respectively. Days to first fruit harvest exhibited highly significant and negative correlation with fruit yield per plant (-0.628, -0.539), fruit diameter (-0.705, -0.619), average fruit wt. (-0.674, -0.595) and total soluble solid (-0.405, -0.366) at both genotypic and phenotypic level. Fruit yield per plant had highly positive and significant correlation with fruit diameter (0.646, 0.587), average fruit wt. (0.753, 0.692) and total soluble solid (0.400, 0.360) at genotypic and phenotypic level respectively. Fruit length showed highly positive and significant and significant correlation with pericarp thickness (0.338, 0.303) at genotypic and phenotypic level respectively. Similar finding were observed by Khapte and Jansirani (2014) and Singh *et al.,* (2017).

Average fruit wt. showed highly positive and significant correlation with number of locules per fruit (0.419, 0.402) at genotypic and phenotypic level. Number of locules per fruit showed positive and significant correlation with ascorbic acid (0.268) at genotypic level, while dry matter % of fruit (-0.281) showed negative and significant correlation at genotypic level. Pericarp thickness showed positive and highly significant correlation with total soluble solid (0.457, 0.398) and ascorbic acid (0.317, 0.398) at genotypic and phenotypic level respectively. Total soluble solid showed negative and highly significant correlation with dry matter % of fruit (-0.395, -0.351) at genotypic and phenotypic level respectively.

An overall observation of correlation coefficient analysis revealed that average fruit wt., fruit diameter, number of fruits per cluster, number of flowers per cluster, fruit yield per plant, ascorbic acid and number of fruits per plant exhibited the significant positive correlation with fruit yield (quintal per ha). Hence, direct selection for these traits may lead to the development of high yielding genotypes of tomato.

Table.1 Genotypic and phenotypic correlation coefficient analysis between fruit yield and its components in tomato during *rabi* 2016-17

S.No.	Characters		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Days to 50% flowering	G	0.480**	-0.222	0.275*	-0.606**	-0.715**	0.315*	0.191	0.210	0.236	-0.241	-0.273*	-0.540**	-0.184	0.115	-0.428**	0.389**	-0.469**
		P	0.395**	-0.182	0.223	-0.477**	-0.532**	0.238	0.143	0.167	0.203	-0.230	-0.230	-0.497**	-0.131	0.066	-0.364**	0.268*	-0.402**
2	No of branches per plant	G	1.000	0.189	0.781**	-0.083	0.053	0.699**	-0.451**	0.370**	0.112	0.205	0.060	-0.078	-0.151	0.596**	-0.160	-0.395**	-0.041
		P	1.000	0.129	0.645**	-0.078	0.050	0.572**	-0.390**	0.338**	0.103	0.196	0.063	-0.074	-0.141	0.524**	-0.118	-0.310*	-0.031
3	Plant height (cm)	G		1.000	0.359**	0.253*	0.283*	0.337**	-0.275*	-0.072	-0.318**	-0.153	-0.052	0.286*	-0.012	0.257*	0.200	-0.274*	0.250*
		P		1.000	0.301*	0.255*	0.239	0.301*	-0.230	-0.063	-0.286*	-0.140	-0.039	0.286*	-0.019	0.211	0.147	-0.213	0.239
4	Number of fruit cluster per plant	G			1.000	0.124	0.243*	0.830**	-0.482**	0.654**	0.263*	0.319**	0.285*	0.136	0.046	0.415**	-0.060	-0.260*	0.341**
		P			1.000	0.061	0.160	0.706**	-0.358**	0.517**	0.253*	0.265*	0.218	0.089	0.026	0.301*	-0.039	-0.207	0.267*
5	Number of flowers per cluster	G				1.000	0.901**	0.245*	-0.417**	0.265*	0.021	0.569**	0.469**	0.227	0.199	0.281*	0.363**	-0.261*	0.620**
		P				1.000	0.799**	0.170	-0.325**	0.223	0.029	0.473**	0.424**	0.210	0.179	0.222	0.309*	-0.185	0.520**
6	Number of fuits per cluster	G					1.000	0.334**	-0.563**	0.358**	-0.071	0.589**	0.519**	0.450**	0.120	0.384**	0.370**	-0.409**	0.636**
		P					1.000	0.182	-0.400**	0.240	-0.037	0.464**	0.397**	0.368**	0.161	0.281*	0.237	-0.263*	0.520**
7	Number of fuits per plant	G						1.000	-0.532**	0.507**	0.340**	0.324**	0.205	-0.242	-0.025	0.305*	0.063	-0.228	0.415**
		P						1.000	-0.423**	0.474**	0.305*	0.256*	0.195	-0.180	-0.080	0.213	0.037	-0.176	0.352**
8	Days to first fruit harvest	G							1.000	-0.628**	0.122	-0.705**	-0.674**	-0.336**	0.086	-0.405**	-0.050	0.147	-0.574**
		P							1.000	-0.539**	0.141	-0.619**	-0.595**	-0.297*	0.090	-0.366**	-0.033	0.111	-0.498**
9	Fruit yield per plant (kg)	G								1.000	0.337**	0.646**	0.753**	0.111	0.099	0.400**	-0.073	0.113	0.584**
		P								1.000	0.309*	0.587**	0.692**	0.112	0.082	0.360**	-0.046	0.100	0.559**
10	Fruit length (cm)	G									1.000	0.268*	0.233	-0.408**	0.338**	0.069	0.144	0.089	0.323**
		P									1.000	0.239	0.217	-0.356**	0.303*	0.078	0.137	0.079	0.298*
11	Fruit diameter (cm)	G										1.000	0.895**	0.370**	0.067	0.236	0.178	-0.152	0.751**
		P										1.000	0.833**	0.353**	0.041	0.233	0.123	-0.134	0.705**
12	Average fruit wt. (g)	G											1.000	0.419**	0.153	0.289*	0.075	-0.107	0.792**
		P											1.000	0.402**	0.113	0.253*	0.083	-0.074	0.735**
13	Number of locules per fruit	G												1.000	-0.117	0.003	0.268*	-0.281*	0.307*
		P												1.000	-0.093	0.024	0.240	-0.206	0.288*
14	Pericarp thickness (mm)	G													1.000	0.457**	0.317**	-0.033	0.212
		P													1.000	0.398**	0.398**	0.398**	0.398**
15	Total soluble solid (°Brix)	G														1.000	0.199	-0.395**	0.190
		P														1.000	0.190	-0.351**	0.148
16	Ascorbic acid (mg/100g)	G															1.000	-0.371**	0.441**
		P															1.000	-0.254*	0.355**
17	Dry matter % of fruit	G																1.000	-0.163
		P																1.000	-0.151
18	Fruit yield per hectare (q)	G																	1.000
		P																	1.000

*Significant at 0.05, ** significant at 0.01

Table.2 Genotypic path coefficient analysis for fruit yield and its components in tomato during *rabi* 2016-17

Characters	Days to 50% flowering	No. of branches per plant	Plant height (cm)	No. of fruit cluster per plant	No. of flowers per cluster	No. of fuits per cluster	No. of fuits per plant	Days to first fruit harvest	Fruit yield per plant	Fruit length (cm)	Fruit diameter (cm)	Average fruit wt. (g)	No. of Locules per fruit	Pericarp thickness (mm)	TSS	Ascorbic acid (mg/100g)	Dry matter % of fruit	Fruit yield per hectare (q)
1	**-3.629**	-1.741	0.804	-0.999	2.198	2.595	-1.142	-0.693	-0.761	-0.857	0.873	0.992	1.959	0.668	-0.416	1.554	-1.412	**-0.469****
2	0.579	**1.206**	0.228	0.942	-0.100	0.064	0.842	-0.544	0.446	0.136	0.247	0.073	-0.094	-0.182	0.719	-0.193	-0.477	**-0.041**
3	-1.188	1.012	**5.363**	1.926	1.358	1.518	1.806	-1.474	-0.387	-1.707	-0.820	-0.277	1.534	-0.062	1.378	1.070	-1.472	**0.250***
4	-0.186	-0.529	-0.243	**-0.676**	-0.084	-0.165	-0.562	0.326	-0.442	-0.178	-0.216	-0.193	-0.092	-0.031	-0.280	0.040	0.176	**0.341****
5	3.932	0.540	-1.644	-0.804	**-6.493**	-5.851	-1.590	2.707	-1.718	-0.137	-3.692	-3.045	-1.476	-1.293	-1.825	-2.360	1.692	**0.620****
6	-2.183	0.163	0.864	0.743	2.750	**3.052**	1.019	-1.718	1.093	-0.218	1.799	1.583	1.375	0.366	1.173	1.128	-1.247	**0.636****
7	-0.903	-2.005	-0.967	-2.383	-0.703	-0.958	**-2.871**	1.526	-1.454	-0.975	-0.930	-0.588	0.695	0.071	-0.874	-0.181	0.654	**0.415****
8	0.938	-2.218	-1.350	-2.367	-2.048	-2.765	-2.611	**4.913**	-3.084	0.597	-3.465	-3.311	-1.650	0.421	-1.990	-0.247	0.724	**-0.574****
9	1.184	2.090	-0.407	3.690	1.494	2.022	2.860	-3.544	**5.646**	1.904	3.649	4.249	0.626	0.559	2.257	-0.410	0.639	**0.584****
10	-0.468	-0.223	0.631	-0.521	-0.042	0.141	-0.673	-0.241	-0.668	**-1.981**	-0.531	-0.462	0.808	-0.670	-0.136	-0.285	-0.175	**0.323****
11	-2.648	2.254	-1.683	3.512	6.255	6.485	3.565	-7.761	7.112	2.950	**11.003**	9.843	4.076	0.736	2.595	1.954	-1.673	**0.751****
12	1.573	-0.348	0.297	-1.640	-2.698	-2.984	-1.179	3.877	-4.330	-1.341	-5.146	**-5.753**	-2.413	-0.882	-1.665	-0.434	0.614	**0.792****
13	2.727	0.394	-1.445	-0.687	-1.148	-2.276	1.223	1.696	-0.560	2.059	-1.872	-2.119	**-5.052**	0.592	-0.014	-1.354	1.418	**0.307***
14	-0.036	-0.029	-0.002	0.009	0.038	0.023	-0.005	0.017	0.019	0.065	0.013	0.030	-0.023	**0.193**	0.088	0.061	-0.006	**0.212**
15	-0.093	-0.483	-0.208	-0.336	-0.228	-0.312	-0.247	0.329	-0.324	-0.056	-0.191	-0.235	-0.002	-0.371	**-0.811**	-0.161	0.320	**0.190**
16	-0.139	-0.052	0.065	-0.019	0.118	0.120	0.020	-0.016	-0.024	0.047	0.058	0.024	0.087	0.103	0.065	**0.325**	-0.120	**0.441****
17	0.071	-0.072	-0.050	-0.047	-0.047	-0.074	-0.041	0.027	0.021	0.016	-0.028	-0.019	-0.051	-0.006	-0.072	-0.067	**0.182**	**-0.163**

Residual effect = 0.480, **Significant at 0.01, *Significant at 0.05.
Bold value show direct effect on fruit yield per hectare (q)

The present findings are in conformity with Dar *et al.,* (2011) who reported that yield per hactare had strong positive association with number of fruits per plant, fruit yield per plant and average fruit weight. Similar results were also reported by Prasanna *et al.,* (2005), Ramana, *et al.*, (2007), Ahirwar *et al.*, (2013), Nagariya *et al.,* (2015) and Rawat *et al.,* (2017).

The path coefficient analysis which splits total correlation coefficient of different characters into direct and indirect effects on fruit yield per hectare in such a manner that the sum of direct and indirect effects is equal to total genotypic correlation as presented in Table 2. The data revealed that fruit diameter showed the highest positive direct effect (11.003) on fruit yield followed by fruit yield per plant (5.646), plant height (5.363), days to first fruit harvest (4.913), number of fruits per cluster (3.052), number of branches per plant (1.206), ascorbic acid (0.325), pericarp thickness (0.193) and dry matter % of fruit (0.182) whereas, number of flowers per cluster (-6.493), average fruit wt. (-5.753), number of locules per fruit (-5.052), days to 50% flowering (-3.629), number of fruits per plant (-2.871), fruit length (-1.981), total soluble solid (-0.811) and number of fruit cluster per plant (-0.676) showed negative direct effects on fruit yield (quintal per ha). These findings were in agreement with the results of Ara *et al.,* (2009), Ahirwar *et al.,* (2013) and Naveen *et al.*, (2017) in tomato.

In present investigation, fruit diameter, fruit yield per plant, number of fruits per cluster and number of branches per plant showed highly positive and direct significant effect with fruit yield (q/ha). Therefore, plant having more number of fruits per cluster, more number of branches, fruit yield per plant should be considered in selection criteria for increasing fruit yield. Directly or indirectly all characters showed positive effect on fruit yield per plant, which is in confirmation to the finding of Verma and Sarnaik (2000) and Bodende (2002) reported that fruit yield per plant, number of fruits per cluster and number of branches per plant had maximum direct effect on fruit yield. Similar results were obtained by Ara *et al.,* (2009), Tasisa *et al.,* (2012), Ahirwar *et al.,* (2013), Bajpai *et al.,* (2017) and Joshi and Sridevi (2018).

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