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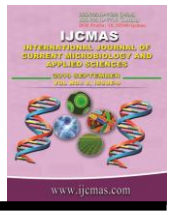

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Correlation and Path Analysis Studies for Yield in Tomato (*Solanum lycopersicum* L.)

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A B S T R A C T

Correlation and path analysis were carried out in forty-five tomato hybrids along with ten parents for yield. The association studies showed that fruit yield per plant was positively and significantly correlated with average fruit weight. However, fruit yield per plant was negatively correlated with number of cluster per plant, length of fruits, total number of branches per plant, TSS and ascorbic acid content of fruit. Path analysis studies done to study the cause and effect relationship revealed that number of flowers per cluster, number of fruits per cluster, number of fruits per plant, number of locules per fruit and average fruit weight had high positive direct effects on fruit yield per plant. Hence, direct selection for these traits is done for improving fruit yield per plant.

Introduction

Tomato (*Solanum lycopersicum* L.) is a member of the family solanaceae and significant warm season fruit vegetable crop of special economic importance in the horticultural industry worldwide (He *et al.*, 2003). Tomato is a native of Peru Equador region (Rick, 1969) and having chromosome number 2n=24. Tomato is the most important vegetable crop next only to potato because of its high yielding potential, wider adaptability and multipurpose uses. It is widely consumed vegetable crop throughout the world both for fresh fruit market and the processed food industry. It is grown at farm and kitchen garden for slice, soup, sauce, ketchup, cooked vegetable etc. It is a rich source of vitamins A, B and C. Tomato is grown as an annual or short lived perennial herbaceous plants. It has taproot and growth habit of the plant is determinate, semi-determinate and

indeterminate. 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 effect on yield.

Correlation and path coefficient analysis give an insight into the genetic variability present in populations. Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for improvement in yield. Path analysis splits the correlation coefficients into direct and indirect effects of a set of dependent variables on the independent variable thereby aids in selection of elite genotype. An improvement in yield in self pollinated crop like tomato is normally achieved by selecting the genotypes with desirable character combinations existing in nature or by hybridization. Information on the nature and extent of variability present in genetic stocks, heritability, genetic advance and interrelationship among various characters is a prerequisite for framing any selection program. The present study was carried out to get the information for character association for yield in fifty-five genotypes of tomato.

Materials and Methods

Fifty-five genotypes of tomato consisting of 45 F_1 hybrids and 10 parents were evaluated in a randomized block design with two replications at Department of Vegetable Science, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar. Seeds sowing in the nursery beds was carried out on October 9th and transplanting was done on 8th November, 2016. All recommended cultural practices were followed to raise good crop stand and growth of the plants. The observation were recorded on five randomly selected plants per replication for each germplasm on eighteen different characters: days to 1st flowering, days to 50% flowering, number of cluster per plant, number of flowers per cluster, number of fruits per cluster, number of fruits per plant, length of fruits, diameter of fruits, pericarp thickness, number of locules per fruit, plant height, total number of branches, average fruit weight, yield per plant, total yield per plot, TSS, acidity content of fruit and ascorbic acid content of fruit. The correlations of coefficients among yield and quality attributes were calculated as suggested by Panse and Sukhatme (1985). Path coefficient analysis was carried out according to Dewey and Lu (1959).

Results and Discussion

The mean value for yield per plant of the genotypes revealed that the highest value being shown by BT-22-4-1 (2.565) followed by BT-22-4-1 X BT-3 (2.495), BT-22-4-1 X BT-17-2 (2.405), BT-19-1-1-1 X BT-22-4-1 (2.105) and the lowest value possess by BT-1 X BT-22-4-1 (0.165) followed by Utkal Kumari X BT-19-1-1-1 (0.570), BT-1 (0.740) and BT-1 X Utkal Kumari (0.750) (Table 1). The range for yield per plant of tomato genotypes under study is (0.165-2.565).

Simple correlation studies were carried for all the characters studied. The degree of association between fruit yield and its contribution can be estimated by correlation coefficient at genotypic and phenotypic levels. All possible phenotypic and genotypic correlation coefficient between fruit yield and its components was calculated and is given in (Tables 2 and 3). For most of the characters genotypic correlation coefficient was found higher than phenotypic correlation coefficient indicating a strong inherent association among various characters. Similar findings were observed by Mohanty (2003) and Singh

(2009). Average fruit weight had significant positive correlation with fruit yield per plant. The results are in accordance with Kumar *et al.,* (2006) for average fruit weight. The genotypic association of days to 50% flowering showed significant positive association with length of fruits. Similarly a significant and positive correlation of number of flowers per cluster was found with number of fruits per cluster, number of locules per fruit, plant height and average fruit weight while diameter of fruits was found to be in positive and significant association with number of locules per fruit. Results are in accordance with Singh (2009) and Ara *et al.,* (2009). Days to first flowering and days to 50% flowering showed significant negative association with number of flowers per cluster. Similarly number of cluster per plant exhibited negative significant association with average fruit weight and positively correlated with number of flowers per cluster, number of fruits per plant, number of locules per fruit, total number of branches per plant, TSS and ascorbic acid content while number of flowers per cluster had negative significant correlation with diameter of fruits and positive association with length of fruits, pericarp thickness, total number of branches per plant, TSS, ascorbic acid and acidity content. Number of fruits per plant showed significant negative association with plant height while positively correlated with length and diameter of fruits, pericarp thickness, total number of branches per plant, TSS and ascorbic acid content. Same observations were made by Singh *et al.,* (2007) and Singh (2009) for number of fruits per plant. The phenotypic association of days to 50% flowering exhibited significant positive correlation with days to 50% flowering while number of flowers per cluster showed the same with number of fruits per cluster. The results observed are similar to the findings of Dhankar and Dhankar (2006).

Yield per plant had positive association with days to first flowering, days to 50% flowering, number of flowers per cluster, number of fruits per cluster, number of fruits per plant, diameter of fruits, pericarp thickness, number of locules per fruit, plant height and acidity content while had negative association with number of cluster per plant, length of fruits, total number of branches per plant, TSS and ascorbic acid content. Similar results for some characters are also observed by Prashanth *et al.,* (2008). Average fruit weight had positive association with days to first flowering, days to 50% flowering number of fruits per cluster, plant height, TSS and acidity content while had negative association with ascorbic acid acid content, fruit length and pericarp thickness. Results are in accordance with Kumar and Dudi (2011). TSS had positive association acidity content while negatively correlated with ascorbic acid content. Ascorbic acid had negative association with TSS. Results are in accordance with Kumar and Dudi (2011) for fruit weight, TSS, acidity.

The path coefficient studies (Table 4) revealed that plant number of fruits per cluster, number of flowers per cluster, number of fruits per plant, average fruit weight and number of locules per fruit had high positive direct effects on fruit yield per plant while days to first flowering, days to 50% flowering, fruit diameter, pericarp thickness and plant height had moderate direct positive effects on fruit yield per plant. High negative direct effects on fruit yield per plant had been observed for number of cluster per plant, fruit length, total number of branches per plant, TSS, ascorbic acid and acidity content. The results are in accordance with the findings of Asati *et al.,* (2008) for plant height, number of primary branches per plant, days to 50% flowering and fruit weight, Kumar and Thakur (2007) for number of fruits per plant, fruit length and fruit width.

Table.1 Mean of 45 F_1 hybrids and 10 parent

	GENOTYPES	YIELD PLANT^{-1}
V1	Bt-1 x Utkal Dipti	1.045
V2	BT-1 x Utkal Kumari	0.750
V3	BT-1 x BT-19-1-1-1	1.095
V4	BT-1 x BT-317	0.965
V5	BT-1 x BT-22-4-1	0.165
V6	BT-1 x BT-3	1.495
V7	BT-1 x BT-17-2	1.450
V8	BT-1 x BT-507-2-2	1.195
V9	BT-1 x BT-21	1.310
V10	Utkal Dipti x Utkal Kumari	0.850
V11	Utkal Dipti x BT-19-1-1-1	1.185
V12	Utkal Dipti x BT-317	1.060
V13	Utkal Dipti x BT-22-4-1	2.050
V14	Utkal Dipti x BT-3	1.350
V15	Utkal Dipti x BT-17-2	1.295
V16	Utkal Dipti x BT-507-2-2	1.030
V17	Utkal Dipti x BT-21	1.085
V18	Utkal Kumari x Bt-19-1-1-1	0.570
V19	Utkal Kumari x BT-317	0.840
V20	Utkal Kumari x BT-22-4-1	1.490
V21	Utkal Kumari x BT-3	1.160
V22	Utkal Kumari x BT-17-2	1.095
V23	Utkal Kumari x BT-507-2-2	1.000
V24	Utkal Kumari x BT-21	1.180
V25	BT-19-1-1-1 x Bt-317	0.840
V26	BT-19-1-1-1 x BT-22-4-1	2.105
V27	BT-19-1-1-1 x BT-3	1.205
V28	BT-19-1-1-1 x BT-17-2	1.295
V29	BT-19-1-1-1 x BT-507-2-2	1.385
V30	BT-19-1-1-1 x BT-21	1.170
V31	BT-317 x BT-22-4-1	1.215
V32	BT-317 x BT-3	1.685
V33	BT-317 x BT-17-2	1.410
V34	BT-317 x BT-507-2-2	1.340
V35	BT-317 x BT-21	1.015
V36	BT-22-4-1 x BT-3	2.495
V37	BT-22-4-1 x BT-17-2	2.405
V38	BT-22-4-1 x BT-507-2-2	2.060
V39	BT-22-4-1 x BT-21	2.030
V40	BT-3 x BT-17-2	1.470
V41	BT-3 x BT-507-2-2	1.380
V42	BT-3 x BT-21	1.255
V43	BT-17-2 x Bt-507-2-2	1.370
V44	BT-17-2 x BT-21	1.310
V45	BT-507-2-2 x Bt-21	1.190
V46	BT-1	0.740
V47	Utkal Dipti	0.935
V48	Utkal Kumari	0.645
V49	BT-19-1-1-1	1.095
V50	BT-317	0.920
V51	BT-22-4-1	2.565
V52	BT-3	1.640
V53	BT-17-2	1.485
V54	BT-507-2-2	1.305
V55	BT-21	1.245
SED		0.129
CD		0.259

Table.2 Genotypic correlation co-efficient (r_g) between all pairs of 17 characters in tomato

Characters		Days to 50% flowering	No. of cluster/ plant	No. of flowers/ cluster	No. of fruits/ cluster	No. of fruits/ plant	Length of fruits	Diameter of fruits	Pericarp thickness of fruit	No. of locules/ fruit	Plant height	Total no. of branches/plant	Average fruit weight	TSS of fruit	Ascorbic acid content	Acidity content of fruit	Yield/plant
Days to 1st flowering	r_g	-1.13902	-0.13042	-0.55081*	-0.12662	-0.12649	0.18004	0.14443	0.15133	0.24604	-0.14160	-0.23246	0.07171	-0.10335	0.10602	-0.00138	0.07610
Days to 50% flowering	r_g		-0.12566	-0.53999*	-0.36075	-0.23321	0.43270*	-0.26021	0.31008	0.21120	0.12395	0.03145	0.17267	0.15076	0.28786	0.00796	0.03787
No. of cluster/plant	r_g			0.05652	-0.23688	0.31040	-0.38789	-0.03499	-0.11355	0.13793	-0.08923	0.34211	-0.56164**	0.02640	0.22117	-0.08670	-0.15970
No. of flowers/cluster	r_g				0.94951**	-0.11423	0.21809	-0.42677*	0.14487	0.47090*	0.44999*	0.03456	0.43973*	0.02791	0.31150	0.33475	0.00829
No. of fruits/cluster	r_g					0.10521	0.08859	0.07006	0.20141	0.24927	0.14150	0.11603	0.31234	0.14567	0.18517	0.16359	0.08529
No. of fruits/plant	r_g						0.00243	0.31796	0.08001	-0.23759	-0.44357*	0.16651	-0.24369	0.35606	0.10862	-0.37518	0.06112
Length of fruits	r_g							0.04681	0.03726	0.19970	0.12739	0.23145	-0.11100	-0.06624	0.02345	-0.23074	-0.21288
Diameter of fruits	r_g								0.37177	0.44738*	0.02603	-0.26310	0.15640	0.32378	-0.05490	0.28049	0.15579
Pericarp thickness of fruit	r_g									0.20180	0.09222	-0.17705	-0.05846	0.06433	0.21047	-0.04285	0.04832
No. of locules/fruit	r_g										-0.13084	0.08563	0.16743	0.17371	0.20413	0.16727	0.08167
Plant height	r_g											-0.00519	0.12786	0.04462	-0.13453	0.02455	0.05085
Total no. of branches/plant	r_g												-0.36245	0.19290	-0.15940	-0.35047	-0.40893
Average fruit weight	r_g													-0.04071	-0.13416	0.22108	0.64190**
TSS of fruit	r_g														-0.23596	0.15194	-0.02976
Ascorbic acid content	r_g															-0.05970	-0.33896
Acidity content of fruit	r_g																0.13356

*and ** indicates significant at 5 and 1 percent level, respectively

Table.3 Phenotypic correlation co-efficient (r_p) between all pairs of 17 characters in tomato

Characters		Days to 50% flowering	No. of cluster/plant	No. of flowers/ cluster	No. of fruits/ cluster	No. of fruits/ plant	Length of fruits	Diameter of fruits	Pericarp thickness of fruit	No. of locules/ fruit	Plant height	Total no. of branches/plant	Average fruit weight	TSS of fruit	Ascorbic acid content	Acidity content of fruit	Yield/plant
Days to 1st flowering	r_p	0.594**	-0.081	0.099	0.148	0.107	-0.163	-0.047	0.091	-0.003	-0.008	-0.291	0.056	-0.094	0.066	0.046	0.104
Days to 50% flowering	r_p		-0.104	0.226	0.158	0.109	-0.093	-0.016	0.182	-0.100	-0.017	-0.130	0.097	0.048	0.150	-0.003	0.040
No. of cluster/plant	r_p			-0.054	-0.105	0.218	-0.164	-0.094	-0.040	0.091	-0.052	0.208	-0.401	0.053	0.163	-0.092	-0.084
No. of flowers/cluster	r_p				0.818**	-0.025	0.081	0.123	0.069	-0.183	0.056	-0.007	0.127	0.035	0.089	0.036	0.010
No. of fruits/cluster	r_p					0.041	0.047	0.198	0.048	-0.106	0.101	0.072	0.178	0.100	0.103	0.067	0.049
No. of fruits/plant	r_p						-0.066	0.143	0.035	-0.082	-0.232	0.104	-0.150	0.285	0.088	-0.313	0.082
Length of fruits	r_p							-0.004	0.036	0.069	-0.008	0.139	-0.133	-0.017	0.012	-0.139	-0.184
Diameter of fruits	r_p								0.172	0.090	-0.069	-0.069	0.021	0.156	-0.022	0.170	0.052
Pericarp thickness of fruit	r_p									0.062	-0.019	-0.166	-0.049	0.063	0.172	-0.040	0.039
No. of locules/fruit	r_p										-0.006	0.062	0.120	0.120	0.140	0.153	0.065
Plant height	r_p											0.034	0.102	0.014	-0.102	0.050	0.005
Total no. of branches/plant	r_p												-0.262	0.141	-0.122	-0.253	-0.281
Average fruit weight	r_p													0.038	-0.128	0.175	0.600**
TSS of fruit	r_p														0.230	-0.148	-0.022
Ascorbic acid content	r_p															-0.056	-0.326
Acidity content of fruit	r_p																0.098

*and ** indicates significant at 5 and 1 percent level, respectively

Table.4 Estimate of direct (diagonal) and indirect effect of component characters on yield in tomato

Characters	Days to 1st flowering	Days to 50% flowering	No.of cluster/ plant	No.of flowers/ cluster	No.of fruits/ cluster	No.of fruits/ plant	Length of fruits	Diameter of fruits	Pericarp thickness of fruit	No. of locules/ fruit	Plant height	Total no. of branches/plant	Average fruit weight	TSS of fruit	Ascorbic acid content	Acidity content of fruit	Genotypic correlation with Yield /plant
Days to 1st flowering	0.04121	0.21097	0.06469	-0.33001	0.10759	-0.07398	-0.07424	0.00176	0.01547	0.08842	-0.00604	0.01598	0.02811	0.01482	-0.02873	0.00007	0.07610
Days to 50% flowering	0.04694	0.18522	0.06233	-0.32352	0.30653	-0.13640	-0.17842	-0.00318	0.03171	0.07590	0.00529	-0.00216	0.06767	-0.02161	-0.07800	-0.00043	0.03787
No.of cluster/plant	0.00537	0.02328	-0.49602	0.03386	0.20128	0.18154	0.15994	-0.00043	-0.01161	0.04957	-0.00381	-0.02352	-0.22013	-0.00378	-0.05993	0.00470	-0.15970
No.of flowers/cluster	0.02270	0.10002	-0.02804	0.59913	-0.80681	-0.06681	-0.08993	-0.00521	0.01481	0.16922	0.01920	-0.00238	0.17235	-0.00400	-0.08441	-0.01814	0.00829
No.of fruits/cluster	0.00522	0.06682	0.11750	0.56888	0.84971	0.06154	-0.03653	0.00086	0.02060	0.08958	0.00604	-0.00798	0.12242	-0.02088	-0.05018	-0.00886	0.08529
No.of fruits/plant	0.00521	0.04320	-0.15397	-0.06844	-0.08940	0.58487	-0.00100	0.00388	0.00818	-0.08538	-0.01893	-0.01145	-0.09551	-0.05104	-0.02943	0.02033	0.06112
Length of fruits	-0.00742	-0.08014	0.19240	0.13066	-0.07528	0.00142	-0.41234	0.00057	0.00381	0.07176	0.00544	-0.01591	-0.04351	0.00949	-0.00635	0.01250	-0.21288
Diameter of fruits	-0.00595	0.04820	0.01736	-0.25569	-0.05953	0.18596	-0.01930	0.01221	0.03802	0.16077	0.00111	0.01809	0.06130	-0.04641	0.01488	-0.01520	0.15579
Pericarp thickness of fruit	-0.00624	-0.05743	0.05632	0.08680	-0.17114	0.04679	-0.01536	0.00454	0.10226	0.07252	0.00394	0.01217	-0.02291	-0.00922	-0.05703	0.00232	0.04832
No.of locules/fruit	-0.01014	-0.03912	-0.06841	0.28213	-0.21181	-0.13896	-0.08235	0.00546	0.02063	0.35936	-0.00558	-0.00589	0.06562	-0.02490	-0.05531	-0.00906	0.08167
Plant height	0.00584	-0.02296	0.04426	0.26960	-0.12023	-0.25943	-0.05253	0.00032	0.00943	-0.04702	0.04267	0.00036	0.05011	-0.00640	0.03645	-0.00133	0.05085
Total no.of branches/plant	0.00958	-0.00583	-0.16970	0.02070	-0.09859	0.09738	-0.09543	-0.00321	-0.01810	0.03077	-0.00022	-0.06876	-0.14206	-0.02765	0.04319	0.01899	-0.40893
Average fruit weight	-0.00296	-0.03198	0.27859	0.26346	-0.26540	-0.14252	0.04577	0.00191	-0.00598	0.06017	0.00546	0.02492	0.39194	-0.00584	0.03635	-0.01198	0.64190
TSS of fruit	0.00426	-0.02792	-0.01310	0.01672	-0.12378	0.20825	0.02731	0.00395	0.00658	0.06242	0.00190	-0.01326	0.01596	-0.14335	-0.06394	0.00823	-0.02976
Ascorbic acid content	-0.00437	-0.05332	-0.10971	0.18663	-0.15734	0.06353	-0.00967	-0.00067	0.02152	0.07336	-0.00574	0.01096	-0.05258	-0.03382	-0.27098	0.00324	-0.33896
Acidity content of fruit	0.00006	-0.00147	0.04300	0.20056	-0.13901	-0.21943	0.09514	0.00342	-0.00438	0.06011	0.00105	0.02410	0.08665	0.02178	0.01618	-0.05419	0.13356

Residual effect = 0.6944423

Figures underlined denoted the Direct Effect

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