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Research Article

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

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ABSTRACT

Correlation and path analysis were carried in thirty genotypes for yield and quality characters. The association studies showed that fruit yield per plant was positively and significantly correlated with number of primary branches per plant, number of flowers per cluster, number of fruits per cluster, fruit length, fruit width and average fruit weight. However, fruit yield per plant was negatively and significantly correlated with days to 50% flowering, peel to pulp ratio, number of locules per fruit and titrable acidity. Path analysis studies done to study the cause and effect relationship revealed that number of primary branches per plant, number of flowers per cluster, number of fruits per cluster, fruit width, average fruit weight, pulp yield, pericarp thickness and lycopene had positive direct effects on fruit yield per plant. Hence, these characters may be simultaneously selected to develop the high yielding with quality rich varieties.

Key words: *Tomato, Correlation, Path analysis, Yield and Quality*

INTRODUCTION

Tomato is the world's largest vegetable crop and known as protective food both because of its special nutritive value and also because of its wide spread production. It is one of the most important vegetable crop cultivated for its fleshy fruits. Tomato is mainly consumed as salad, cooked or processed into several products like ketchup, juice, puree, sauce and whole canned fruit. It is a good source of an antioxidant (lycopene), ascorbic acid and vitamin B. The degree and direction of relationship between two or more variables could be found out through statistical measure of correlation coefficient. It helps to measures the mutual relationship between various plant characters and determines the component characters on which selection could be made for genetic improvement of yield and quality contributing traits while the path analysis partitioning the correlation coefficient into the direct and indirect effect of a set of independent variables on dependent variables.

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Hence, there is pre-requisite for preliminary investigations of characters in the genotypes for the development of superior hybrids in tomato. Thus, keeping above considerations in view, the present research work has been conducted to study the correlation and path coefficient analysis in thirty genotypes (9 parents, 18 F_1 hybrids and 3 commercial checks) on twenty characters of tomato.

MATERIAL AND METHODS

The present investigation was undertaken at an experimental farm of Vegetable Research Station, Dr. Y.S. R. Horticultural University, Rajendranagar, Hyderabad. The experimental material consist of nine parents *viz*; EC-165749, LE-56, LE-62, LE-64, LE-65, LE-67 used as lines (females) and Punjab Chhuhara, Pant T-3 and Pusa Gaurav as testers (males) and mated as per Line x Tester mating model of Kempthorne[1]. Thus a total of 18 hybrids were synthesized by making crosses between lines and the testers during *rabi*, 2010. All the 18 hybrids along with their corresponding nine parents and three standard checks *viz*; Lakshmi, US-618 and Arka vikas were evaluated in a randomized block design in three replications during *kharif*, 2011. The data was subjected to the analysis of variance for randomized block design as suggested by Panse and Sukhatme[2]. Observations were recorded for twenty quantitative and qualitative characters viz., Plant height (cm), Number of primary branches per plant, Days to 50% flowering, Number of flowers per cluster, Number of fruits per cluster, Fruit length (cm), Fruit width (cm), Average fruit weight (g) Fruit yield per plant (kg), Pulp yield (%), Peel to pulp ratio, Number of locules per fruit, Pericarp thickness (mm), Total soluble solids (ºBrix), Titrable acidity (%), Ascorbic acid content (mg/100 g), Total carotenoid content (mg/100 g), Reducing sugars (%), Total sugars (%), Lycopene content (mg/100 g) in F_1s, parents and checks. The phenotypic and genotypic correlation coefficient of yield and quality contributing traits were estimated as per described method Al-Jibouri *et al*.[3]. The direct and indirect effect was estimated as per method of Wright[4] and elaborated by Dewey and Lu[5] respectively.

RESULTS AND DISCUSSION

Simple correlation studies were carried for all the characters studied (Table 1). In general, the genotypic correlation coefficients were considerably higher than the phenotypic ones. Number of primary branches per plant (0.3338 P, 0.4045 G), number of flowers per cluster (0.3075 P, 0.3224 G), number of fruits per cluster (0.3938 P, 0.5603 G), fruit length (0.3813 P, 0.4972G), fruit width (0.3888 P, 0.4449 G) and average fruit weight (0.4575 P, 0.5169 G) had positive significant association with fruit yield per plant at phenotypic and genotypic levels. Similar results was reported by Anjum *et al*.[6] for number of primary branches per plant, Manivannan and Irulappan[7] for number of flowers per cluster and number of fruits per cluster, Susic *et al*.[8] for fruit length and fruit width and Indurani *et al*.[9] for average fruit weight. Among the quality parameters pulp yield (0.5629 P, 0.7459 G), pericarp thickness (0.2802 P, 0.3130 G), total carotenoid content (0.3183 P, 0.3710 G) and lycopene content (0.3953 P, 0.4487 G) had positively significant association with fruit yield per plant at phenotypic and genotypic levels. These results are in conformity with the findings of Indurani *et al*.[9] for pericarp thickness and lycopene and Kumar *et al*.[10] for total carotenoid content. Days to 50% flowering (-0.3448 P, -0.4992 G), peel to pulp ratio (-0.5072 P, -5774 G), number of locules per fruit (-0.2330 P, -0.2778 G) and titrable acidity (-0.3897 P, -0.4898 G) had significant and negative association with fruit yield per plant at phenotypic and genotypic levels. Results are in agreement with the findings of Padma *et al*.[11] for days to 50% flowering and Kumar *et al*.[10] for titrable acidity. These results indicate the importance of these traits in selection for fruit yield per plant. Direct selection based on these traits would result in simultaneous improvement of aforesaid traits and yield in tomato.

The path coefficient studies (Table 2) revealed that lycopene content (0.3181) followed by number of flowers per cluster (0.2799), fruit width (0.2246), number of primary branches per plant(0.2092), pericarp thickness (0.1335) and plant height (0.1309) had maximum direct positive effect on fruit yield per plant at phenotypic level. Number of flowers per cluster (0.7692), plant height (0.5824), days to 50% flowering (0.4952), pulp yield (0.4429), TSS (0.4255) and number of locules per fruit (0.4054) exhibited highest positive direct effect on fruit yield per plant at genotypic level. These results are in accordance with the findings of Haydar *et al*.[12] for number of flowers per cluster, Lakshmikant and Mani[13] for fruit width and number of primary branches per plant and Kumar and Thakur[14] for pericarp thickness. This suggested that direct selection based on these traits will be rewarding for yield improvement in tomato. Peel to pulp ratio (-0.3208), titrable acidity (-0.2702), reducing sugars (-0.1154), days to 50% flowering (-0.1078) and number of locules per fruit (-0.1041) showed maximum negative direct effect on fruit yield at phenotypic level along with negative significant correlation on fruit yield. So, these characters were not used for direct selection in tomato. Fruit length exhibited very high negative direct effect at genotypic level but positive correlation with fruit yield per plant. In this situation, the indirect causal factors are to be considered simultaneously for selection.

Table 1: Phenotypic (P) and genotypic (G) correlation coefficients among twenty yield, yield attributes and quality characters in tomato

S. No.		Plant height (cm) (1)	Number of Primary branches per plant (2)	Days to 50% flowering (3)	No. of flowers per cluster (4)	No. of fruits per cluster (5)	Fruit length (cm) (6)	Fruit width (cm) (7)	Average fruit weight (g) (8)	Pulp yield (%) (9)	Peel to pulp ratio (10)	No. of locules per fruit (11)	Pericarp thickness (mm) (12)	TSS (°Brix) (13)	Titrable acidity (%) (14)	Ascorbic acid content (mg/100 g) (15)	Total carotenoid content (mg/100 g) (16)	Reducing sugars (%) (17)	Total sugars (%) (18)	Lycopene content (mg/100 g) (19)	Fruit yield per plant (kg) (20)
(1)	P	**1.000**	0.1632	0.0761	0.0241	-0.0645	-0.2580*	0.1049	0.0448	0.1240	0.1980	-0.1726	-0.0584	0.1578	0.1282	-0.1630	-0.0971	0.1532	0.1041	-0.1236	0.0583
	G	**1.000**	0.2331*	0.1728	-0.0342	-0.0547	-0.3039**	0.1316	0.0752	0.2045	0.2775**	-0.2715**	-0.0393	0.2615*	0.1753	-0.2206*	-0.0562	0.2087*	0.1579	-0.1365	0.0631
(2)	P		**1.000**	0.0812	-0.0698	-0.1311	0.0195	0.1338	0.1609	0.1309	-0.1649	-0.1372	-0.1373	0.1025	0.0791	-0.2196*	0.3372**	0.1276	0.1480	0.3416**	0.3338**
	G		**1.000**	0.0949	-0.0629	-0.2217*	-0.0164	0.2358*	0.1946	0.2101*	-0.1590	-0.1712	-0.1894	0.1201	0.0867	-0.2900**	0.3808**	0.1660	0.1921	0.4138**	0.4045**
(3)	P			**1.0000**	-0.2574*	-0.2768**	-0.0790	-0.0442	-0.2041	-0.1104	0.1743	-0.0012	-0.1373	-0.0321	0.3960**	-0.1903	0.1398	-0.1171	-0.0059	0.0757	-0.3448**
	G			**1.0000**	-0.3681**	-0.5191**	-0.0757	-0.0535	-0.3081**	-0.2125*	0.1775	-0.0544	-0.1825	-0.0286	0.6556**	-0.3174**	0.2093*	-0.0556	0.0251	0.0898	-0.4992**
(4)	P				**1.0000**	0.1449	0.0153	0.1645	0.1453	0.0066	0.1419	0.4043**	0.2847**	0.2137*	-0.0221	0.0307	0.0090	0.2042	0.0540	0.0829	0.3075**
	G				**1.0000**	0.3023**	0.0426	0.2312*	0.2027	-0.0041	0.1526	0.5590**	0.3252**	0.2278*	-0.1213	0.0459	0.0369	0.2951**	0.1202	0.1379	0.3224**
(5)	P					**1.0000**	0.1965	0.0828	0.2081*	0.3133**	-0.3176**	-0.3612**	0.0148	-0.0067	-0.3582**	0.3262**	0.2150*	-0.0041	-0.0090	0.1718	0.3938**
	G					**1.0000**	0.2459*	0.1431	0.2479*	0.4146**	-0.3560**	-0.5155**	0.0704	-0.0140	-0.5537**	0.4083**	0.1961	-0.0292	-0.0083	0.1857	0.5603**
(6)	P						**1.0000**	-0.0557	0.1462	0.6233**	-0.4655**	-0.3484**	0.4043**	-0.0942	-0.2709**	0.2992**	0.2685*	0.0142	-0.0117	0.3448**	0.3813**
	G						**1.0000**	-0.0729	0.1672	0.7466**	-0.5556**	-0.3609**	0.4987**	-0.1288	-0.4367**	0.3582**	0.3307**	-0.0416	-0.0239	0.4134**	0.4972**
(7)	P							**1.0000**	0.4387**	0.3334**	-0.1861	0.0654	0.1431	-0.0092	0.0356	-0.1847	-0.1401	0.0277	-0.0204	-0.0936	0.3888**
	G							**1.0000**	0.5130**	0.4244**	-0.2313*	0.0500	0.1893	-0.0258	0.0709	-0.1993	-0.1417	0.0316	-0.0251	-0.0938	0.4449**
(8)	P								**1.0000**	0.4012**	-0.2881**	-0.0235	0.0752	-0.0609	-0.2977**	-0.0910	-0.1395	-0.0768	-0.0656	-0.0417	0.4575**

S. No.		Plant height (cm) (1)	Number of Primary branches per plant (2)	Days to 50% flowering (3)	No. of flowers per cluster (4)	No. of fruits per cluster (5)	Fruit length (cm) (6)	Fruit width (cm) (7)	Average fruit weight (g) (8)	Pulp yield (%) (9)	Peel to pulp ratio (10)	No. of locules per fruit (11)	Pericarp thickness (mm) (12)	TSS (°Brix) (13)	Titrable acidity (%) (14)	Ascorbic acid content (mg/100 g) (15)	Total carotenoid content (mg/100 g) (16)	Reducing sugars (%) (17)	Total sugars (%) (18)	Lycopene content (mg/100 g) (19)	Fruit yield per plant (kg) (20)
	G								**1.0000**	0.5449**	-0.3304**	-0.0119	0.0835	-0.1494	-0.4283**	-0.0880	-0.1335	-0.0831	-0.0667	-0.0622	0.5169**
(9)	P									**1.0000**	-0.4408**	-0.5119**	0.3888**	-0.0358	-0.3037**	0.1310	0.1532	0.0386	0.0691	0.2130*	0.5629**
	G									**1.0000**	-0.6204**	-0.5824**	0.5127**	-0.0367	-0.4528**	0.1651	0.1924	0.0225	0.0531	0.2790**	0.7459**
(10)	P										**1.0000**	0.3572**	-0.0786	-0.0199	0.0791	-0.1379	-0.2881**	-0.1186	-0.1495	-0.2823**	-0.5072**
	G										**1.0000**	0.4480**	-0.0953	-0.0539	0.1378	-0.1525	-0.3285**	-0.1103	-0.1826	-0.3400**	-0.5774**
(11)	P											**1.0000**	0.0315	0.0179	0.1819	-0.1934	-0.1698	0.0223	-0.0477	-0.0922	-0.2330*
	G											**1.0000**	0.0390	0.0073	0.2839**	-0.2649*	-0.2117*	0.0891	-0.0764	-0.1000	-0.2778**
(12)	P												**1.0000**	-0.2805**	-0.0413	0.0274	-0.0555	-0.1986	-0.2558*	-0.0110	0.2802**
	G												**1.0000**	-0.3208**	-0.0946	0.0406	-0.0431	-0.1988	-0.3094**	-0.0080	0.3130**
(13)	P													**1.0000**	-0.0431	-0.0242	0.2620*	0.8378**	0.8226**	0.3037**	0.0741
	G													**1.0000**	-0.0656	-0.0019	0.3220**	1.0259**	1.0331**	0.3517**	0.0774
(14)	P														**1.0000**	-0.2957**	-0.0181	-0.0378	-0.1138	-0.0805	-0.3897**
	G														**1.0000**	-0.3857**	0.0720	-0.0384	-0.1066	-0.0566	-0.4898**
(15)	P															**1.0000**	0.0864	0.0224	0.0421	0.0573	0.1223
	G															**1.0000**	0.1155	0.0538	0.0473	0.0409	0.1198
(16)	P																**1.0000**	0.2722**	0.3583**	0.9065**	0.3183**
	G																**1.0000**	0.3328**	0.4407**	0.9919**	0.3710**
(17)	P																	**1.0000**	0.8211**	0.3501**	0.1283
	G																	**1.0000**	1.0058**	0.3945**	0.1651
(18)	P																		**1.0000**	0.4038**	0.1289
	G																		**1.0000**	0.4785**	0.1634
(19)	P																			**1.0000**	0.3953**
	G																			**1.0000**	0.4487**
(20)																					**1.0000**
																					1.0000

***significant at 5% LOS ** significant at 1 % LOS**

(1) = Plant height (cm) ; (2) = Number of primary branches per plant ; (3) = Days to 50% flowering ; (4) = Number of flowers per cluster; (5) = Number of fruits per cluster;

(6) = Fruit length (cm) ; (7) = Fruit width (cm) ; (8) = Average fruit weight (g); (9) = Pulp yield (%);

(10) = Peel to pulp ratio; (11) = Number of locules per fruit; (12) = Pericarp thickness (mm) ; (13) = Total soluble solids (ºBrix); (14) = Titrable acidity (%); (15) = Ascorbic Acid (mg/100 g); (16) = Total carotenoids (mg/100 g); (17) = Reducing sugars (%); (18) = Total sugars (%); (19) = Lycopene (mg/100 g); (20) = Fruit yield per plant (kg)

Table 2: Direct and indirect effects of various yield, yield attributes & quality characters on fruit yield in thirty genotypes of tomato

S.No		Plant height (cm) (1)	No. of primary branches per plant (2)	Days to 50 per cent flowering (3)	No. of flowers per cluster (4)	No of fruits per cluster (5)	Fruit length (cm) (6)	Fruit width (cm) (7)	Average fruit weight (g) (8)	Pulp yield (%) (9)	Peel to pulp ratio (10)	No. of locules per fruit (11)	Pericarp thickness (mm) (12)	TSS (ºBrix) (13)	Titrable acidity (%) (14)	Ascorbic acid content (mg/100g) (15)	Total carotenoid content (mg/100g) (16)	Reducing sugars (%) (17)	Total sugars (%) (18)	Lycopene content (mg/100g) (19)	Fruit yield per plant (kg)
(1)	P	**0.1309**	0.0341	-0.0082	0.0067	-0.0019	0.0118	0.0236	0.0026	0.0044	-0.0635	0.0180	-0.0079	0.0007	-0.0346	-0.0078	0.0058	-0.0177	0.0008	-0.0393	0.0583
	G	**0.5824**	0.0404	0.0856	-0.0263	0.0266	0.3253	0.0274	-0.0555	0.0906	-0.4117	-0.1101	-0.0067	0.1113	-0.2640	0.0531	-0.0027	-0.2390	-0.0034	-0.0540	0.0631
(2)	P	0.0214	**0.2092**	-0.0087	-0.0195	-0.0040	-0.0009	0.0300	0.0094	0.0047	0.0529	0.0143	-0.0186	0.0004	-0.0214	-0.0105	-0.0200	-0.0147	0.0011	0.1086	0.3338
	G	0.1357	**0.1735**	0.0470	-0.0484	0.1078	0.0175	0.0491	-0.1436	0.0931	0.2359	-0.0694	-0.0322	0.0511	-0.1306	-0.0698	0.0184	-0.1901	-0.0041	0.1636	0.4045
(3)	P	0.0100	0.0170	**-0.1078**	-0.0720	-0.0083	0.0036	-0.0099	-0.0120	-0.0040	-0.0559	0.0001	-0.0186	-0.0001	-0.1070	-0.0091	-0.0083	0.0135	0.0000	0.0241	-0.3448
	G	0.1006	0.0165	**0.4952**	-0.2831	0.2523	0.0810	-0.0111	0.2274	-0.0941	-0.2633	-0.0220	-0.0310	-0.0122	-0.9876	-0.0764	0.0101	0.0636	-0.0005	0.0355	-0.499
(4)	P	0.0031	-0.0146	0.0277	**0.2799**	0.0044	-0.0007	0.0370	0.0085	0.0002	-0.0455	-0.0421	0.0386	0.0009	0.0060	0.0015	-0.0005	-0.0236	0.0004	0.0264	0.3075
	G	-0.0199	-0.0109	-0.1822	**0.7692**	-0.1469	-0.0456	0.0481	-0.1496	-0.0018	-0.2263	0.2266	0.0553	0.0969	0.1828	0.0110	0.0018	-0.3380	-0.0026	0.0545	0.3224
(5)	P	-0.0084	-0.0274	0.0298	0.0406	**0.0301**	-0.0090	0.0186	0.0122	0.0112	0.1019	0.0376	0.0020	0.0000	0.0968	0.0156	-0.0127	0.0005	-0.0001	0.0546	0.3938
	G	-0.0318	-0.0385	-0.2571	0.2325	**-0.4861**	-0.2632	0.0298	-0.1830	0.1836	0.5280	-0.2089	0.0120	-0.0060	0.8341	0.0982	0.0095	0.0335	0.0002	0.0735	0.5603
(6)	P	-0.0338	0.0041	0.0085	0.0043	0.0059	**-0.0456**	-0.0125	0.0086	0.0223	0.1493	0.0363	0.0548	-0.0004	0.0732	0.0143	-0.0159	-0.0016	-0.0001	0.1097	0.3813
	G	-0.1770	-0.0028	-0.0375	0.0328	-0.1196	**-1.0703**	-0.0152	-0.1234	0.3307	0.8241	-0.1463	0.0848	-0.0548	0.6579	0.0862	0.0160	0.0476	0.0005	0.1635	0.4972
(7)	P	0.0137	0.0280	0.0048	0.0461	0.0025	0.0025	**0.2246**	0.0257	0.0120	0.0597	-0.0068	0.0194	0.0000	-0.0096	-0.0088	0.0083	-0.0032	-0.0001	-0.0298	0.3888
	G	0.0766	0.0409	-0.0265	0.1778	-0.0696	0.0781	**0.2081**	-0.3786	0.1880	0.3431	0.0203	0.0322	-0.0110	-0.1068	-0.0480	-0.0069	-0.0362	0.0005	-0.0371	0.4449
(8)	P	0.0059	0.0337	0.0220	0.0407	0.0063	-0.0067	0.0985	**0.0586**	0.0144	0.0924	0.0024	0.0102	-0.0003	0.0804	-0.0043	0.0083	0.0089	-0.0005	-0.0133	0.4575
	G	0.0438	0.0338	-0.1526	0.1559	-0.1205	-0.1789	0.1067	**-0.7381**	0.2413	0.4900	-0.0048	0.0142	-0.0636	0.6453	-0.0212	-0.0065	0.0952	0.0014	-0.0246	0.5169
(9)	P	0.0162	0.0274	0.0119	0.0019	0.0094	-0.0284	0.0749	0.0235	**0.0358**	0.1414	0.533	0.0527	-0.0002	0.0821	0.0063	-0.0091	-0.0045	0.0005	0.0677	0.5629
	G	0.1191	0.0365	-0.1052	-0.0031	-0.2015	-0.7991	0.0883	-0.4022	**0.4429**	0.9203	-0.2361	0.0872	-0.0156	0.6821	0.0397	0.0093	-0.0258	-0.0011	0.1104	0.7459
(10)	P	0.0259	-0.0345	-0.0188	0.0397	-0.0096	0.0212	-0.0418	-0.0169	-0.0158	**-0.3208**	-0.0372	-0.0107	-0.0001	-0.0214	-0.0066	0.0171	0.0137	-0.0011	-0.0898	-0.5072
	G	0.1616	-0.0276	0.0879	0.1174	0.1730	0.5946	-0.0481	0.2438	-0.2748	**-1.4834**	0.1816	-0.0162	-0.0229	-0.2076	-0.0367	-0.0159	0.1263	0.0039	-0.1345	-0.5774
(11)	P	-0.0226	--0.0287	0.0001	0.1132	-0.0109	0.0159	0.0147	-0.0014	-0.0184	-0.1146	**-0.1041**	0.0043	0.0001	-0.0491	-0.0092	0.0101	-0.0026	-0.0004	-0.0293	-0.2330
	G	-0.1582	-0.0297	-0.0269	0.4300	0.2506	0.3863	0.0104	0.0088	-0.2579	-0.6646	**0.4054**	0.0066	0.0031	-0.4276	-0.0638	-0.0102	-0.1021	0.0016	-0.0395	-0.2778
(12)	P	-0.0076	-0.0287	0.0148	0.0797	0.0004	-0.0184	0.0321	0.0044	0.0139	0.0252	-0.0033	**0.1355**	-0.0012	0.0112	0.0013	0.0033	0.0229	-0.0019	-0.0035	0.2802

S.No		Plant height (cm) (1)	No. of primary branches per plant (2)	Days to 50 per cent flowering (3)	No. of flowers per cluster (4)	No of fruits per cluster (5)	Fruit length (cm) (6)	Fruit width (cm) (7)	Average fruit weight (g) (8)	Pulp yield (%) (9)	Peel to pulp ratio (10)	No. of locules per fruit (11)	Pericarp thickness (mm) (12)	TSS (°Brix) (13)	Titrable acidity (%) (14)	Ascorbic acid content (mg/100g) (15)	Total carotenoid content (mg/100g) (16)	Reducing sugars (%) (17)	Total sugars (%) (18)	Lycopene content (mg/100g) (19)	Fruit yield per plant (kg)
	G	-0.0229	-0.0329	-0.0904	0.2502	-0.0342	-0.5337	0.0394	-0.0616	0.2271	0.1414	0.0158	**0.1700**	-0.1365	0.1425	0.0098	-0.0021	0.2277	0.0066	-0.0032	0.3130
(13)	P	0.0207	0.0214	0.0035	0.0598	-0.0002	0.0043	-0.0021	-0.0036	-0.0013	0.0064	-0.0019	-0.0380	**0.0042**	0.0116	-0.0012	-0.0155	-0.0967	0.0060	0.0966	0.0741
	G	0.1523	0.0208	-0.0142	0.1752	0.0068	0.1378	-0.0054	0.1103	-0.0163	0.0800	0.0030	-0.0545	**0.4255**	0.0988	-0.0005	0.0156	-1.1750	-0.0219	0.1391	0.0774
(14)	P	0.0168	0.0165	-0.0427	-0.0062	-0.0108	0.0124	0.0080	-0.0174	-0.0109	-0.0254	-0.0189	-0.0056	-0.0002	**-0.2702**	-0.0141	0.0011	0.0044	-0.0008	-0.0256	-0.3897
	G	0.1021	0.0150	0.3246	-0.0933	0.2692	0.4674	0.0147	0.3162	-0.2006	-0.2044	0.1151	-0.0161	-0.0279	**-1.5064**	-0.0928	0.0035	0.0440	0.0023	-0.0224	-0.4898
(15)	P	-0.0213	-0.0459	0.0205	0.0086	0.0098	-0.0136	-0.0415	-0.0053	0.0047	0.0442	0.0201	0.0037	-0.0001	0.0799	**0.0477**	-0.0051	-0.0026	0.0003	0.0182	0.1223
	G	-0.1285	-0.0503	-0.1571	0.0353	-0.1985	-0.3834	-0.0415	0.0650	0.0731	0.2262	-0.1074	0.0069	-0.0008	0.5810	**0.2406**	0.0056	-0.0616	-0.0010	0.0162	0.1198
(16)	P	-0.0127	0.0705	-0.0151	0.0025	0.0065	-0.0122	-0.0315	-0.0082	0.0055	0.0924	0.0177	-0.0075	0.0011	0.0049	0.0041	**-0.0593**	-0.0314	0.0026	0.2883	0.3183
	G	-0.0328	0.0661	0.1036	0.0284	-0.0953	-0.3540	-0.0295	0.0985	0.0852	0.4873	-0.0858	-0.0073	0.1370	-0.1085	0.0278	**0.0484**	-0.3812	-0.0094	0.3923	0.3710
(17)	P	0.0201	0.0267	0.0126	0.0572	-0.0001	-0.0006	0.0062	-0.0045	0.0014	0.0380	-0.0023	-0.0269	0.0035	0.0102	0.0011	-0.0161	**-0.1154**	0.0060	0.1113	0.1283
	G	0.1215	0.0288	-0.0275	0.2270	0.0142	0.0445	0.0066	0.0614	0.0100	0.1636	0.0361	-0.0338	0.4365	0.578	0.0129	0.0161	**-1.1453**	-0.0214	0.1560	0.1651
(18)	P	0.0136	0.0310	0.0006	0.0151	-0.0003	0.0005	-0.0046	-0.0038	0.0025	0.0479	0.0050	-0.0347	0.0035	0.0307	0.0020	-0.0212	-0.0948	**0.0073**	0.1284	0.1289
	G	0.0920	0.0333	0.0124	0.0925	0.0040	0.0255	-0.0052	0.0492	0.0235	0.2708	-0.0310	-0.0526	0.4396	0.1606	0.0114	0.0213	-1.1520	**-0.0212**	0.1892	0.1634
((19)	P	-0.0162	0.0715	-0.0082	0.0232	0.0052	-0.0157	-0.0210	-0.0024	0.0076	0.0906	0.0096	-0.0015	0.0013	0.0218	0.0027	-0.0537	-0.0404	0.0030	**0.3181**	0.3953
	G	-0.0795	0.0718	0.0445	0.1061	-0.0903	-0.4424	-0.0195	0.0459	0.1236	0.5043	-0.0405	-0.0014	0.1497	0.0853	0.0098	0.0480	-0.4519	-0.0102	**0.3955**	0.4487

Phenotypic Residual effect = 0.49; Genotypic Residual effect= 0.24; Diagonal (under lined) values indicate direct effects

(1) = Plant height (cm) ; (2) = Number of primary branches per plant ; (3) = Days to 50% flowering ; (4) = Number of flowers per cluster; (5) = Number of fruits per cluster; (6) = Fruit length (cm) ; (7) = Fruit width (cm) ; (8) = Average fruit weight (g); (9) = Pulp yield (%); (10) = Peel to pulp ratio; (11) = Number of locules per fruit; (12) = Pericarp thickness (mm) ; (13) = Total soluble solids (°Brix); (14) = Titrable acidity (%); (15) = Ascorbic Acid (mg/100 g); (16) = Total carotenoids (mg/100 g); (17) = Reducing sugars (%); (18) = Total sugars (%); (19) = Lycopene (mg/100 g); (20) = Fruit yield per plant (kg)

CONCLUSION

It can be concluded that number of primary branches per plant, number of flowers per cluster, number of fruits per cluster, fruit width, average fruit weight, pericarp thickness and lycopene can be put to direct selection pressure to increase both yield along with the quality simultaneously in tomato because these characters exerted direct effect on yield and quality in tomato.

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