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Research Note

Study of correlation for yield and quality characters in tomato (*Lycopersicon esculentum* Mill.)

Manoj Kumar* and Dudi B.S.
Department of Vegetable Science, Haryana Agricultural University, Hisar, India
*Email:drvermamanoj@gmail.com

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Abstract:
The present investigation was carried out at Research Farm and the laboratories of Department of Vegetable Science, CCS HAU, Hisar during spring-summer season (January to May, 2004). The experimental material for the present studies comprised 12 parents and their 66 F_1 crosses and the experiment was laid out in Randomized block design with three replications. Correlation and path analysis revealed that due weightage is to be given for number of fruits per plant and fruit weight (g), therefore, fruit weight as an important character which may be included in selection criterion for improvement in fruit yield per plant. The correlation analysis revealed that total fruit yield (kg) per plant was correlated significantly and positively with number of fruits per plant, fruit weight and total sugar. The study of path coefficient analysis showed that highest positive direct effect was exerted by number of fruits per plant. The correlation of yield with most of the quality traits indicated that simultaneous improvement of yield and quality traits was not possible because of negative correlation of yield with such quality traits. Therefore, a simultaneous improvement of yield and quality traits with negative correlation necessitates some sacrifices both in yield and biochemical constituents.

Key words: Tomato, *Lycopersicon esculentum*, Correlation, Path-coefficient, Fruit yield, Fruit quality

Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular vegetables grown all over the world with an estimated annual production of 152.9 million tonnes grown in an area of 4.39 million hectares (FAOSTAT Database, 2011). In India tomato is grown in 5.9 lakh ha producing 11.15 million tonnes with a productivity of 16.3 t/ha, while in Haryana tomato is grown in 9000 ha producing 1.995 lakh tones with a productivity of 22.2 t/ha. To increase the yield potential, maximum utilization of the desirable characters for developing any ideal genotypes is essential. Fruit yield is a quantitative character, which is influenced by a number of yield contributing characters. Selection for higher yield, the complex interrelationship between the yield contributing characters usually show a complex chain of interacting relationship.. In tomato yield is the cumulative effect of many component characters individually contributing towards yield. As yield and quality are the main objective of a breeder, it is important to know the relationship between various characters that have direct and indirect effect on yield and quality. The degree of relationship for association of these characters with yield and quality can be ascertained by correlation studies. This would aid in formulating an efficient breeding program for improving the yield potential and quality via its components. A study was, therefore, conducted on the character associations and path coefficient analysis between yield, quality and yield contributing characters of tomato. Tomato (*Lycopersicon esculentum* Mill.) is one of the most widely grown vegetable in India. Efforts are being made to increase its productivity by developing superior varieties. However, yield being a complex character; its direct improvement is difficult. Knowledge in respect of the nature and magnitude of associations of yield with various component characters is a pre-requisite to bring improvement in the desired direction. A crop breeding programme, aimed at increasing the plant productivity requires consideration not only of yield but also of its components that have a direct or indirect bearing on yield. The coefficient of correlation describes the degree of association between independent and dependent variables. Path coefficient analysis measures the direct influence of one variable upon another and permits the separation of correlation coefficient into components of direct and indirect effects.

The material for the present studies comprised 12 parents (EC 31767, H 36, Pusa Ruby, Punjab Chhuhara, Yashwant –A-2-8, LA 1420, Merrol, Sel-7 (Hisar Arun), New Wonder, Sel-15, Sioux and Cul 29) and their 66 F_1 crosses. The seeds of diallel set of crosses attempted, and selfed parental lines during February to March, 2003 and harvested in May, 2003 were sown in nursery beds

on 20th November, 2003. The 40 days old seedlings were transplanted in the field on 10.01.2004. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Plot size was 60 cm spaced single rows of 3.15 m length for each genotype accommodating 7 plants spaced 45 cm from each other. All other recommended cultural practices for the crop were followed. Five randomly selected competitive plants from each row in each replication were tagged for the purpose of recording of the observations on different characters *viz*. days to 50% flowering, plant height (cm), number of branches per plant, number of flower clusters per plant, number of fruits per truss, number of fruits per plant, fruit size (length/breadth ratio), fruit weight (g), early fruit yield of first two pickings (kg), total fruit yield (kg), number of locules per fruit, pericarp thickness (mm), number of seeds per fruit, dry matter content (%), Juice : pulp ratio, seed : pulp ratio, total soluble solids (%), total sugars (%), reducing sugars (%), titrable acidity (g of citric acid/100 ml of juice), ascorbic acid (mg/100 g of fruit), total carotenoides(mg/100 g of fruit) and lycopene content (mg/100 g of fruit).

The relationship between the characters in the hybrids depends upon the association existing in the parents. The genotypic and phenotypic correlation coefficients estimated between yield, its components and quality traits and inter-correlation among the different yield components are furnished in Table 1 and only significant correlations are discussed here. In general, the magnitude of genotypic correlation coefficient was higher than the corresponding phenotypic coefficient indicating thereby a strong inherent association between various traits under study.

In the present investigation total fruit yield (kg) per plant was correlated significantly and positively with number of fruits per plant (0.507), fruit weight (0.439), total sugar (0.279) and number of seeds per fruit (0.234), while non-significant positive association was noticed with early fruit yield of first two pickings (0.196), number of locules per fruits (0.125), reducing sugar (0.112), pericarp thickness (0.092), number of flower cluster per plant (0.076), number of branches per plant (0.068), total carotenoides (0.056), lycopene content (0.056) and seed: pulp ratio (-0.029). It showed non-significant negative association with dry matter content (-0.208), number of fruits per truss (-0.155), ascorbic acid (-0.117), plant height (-0.077), fruit size (length: breadth ratio) (-0.044), total soluble solids (-0.032), titrable acidity (-0.029), days to 50% flowering (-0.025) and juice: pulp ratio (-0.012). Days to 50% flowering showed highly significant and positive phenotypic correlation with total soluble solids (0.310), number of branches per plant (0.249) and non significant positive correlation with number of flower cluster per plant (0.159), number of fruits per cluster (0.156), plant height (0.068) and fruit size (0.056). Number of flower cluster per plant showed significant and positive phenotypic correlation with fruit weight (0.333), total sugar (0.242) and dry matter content (0.242). It showed non-significant and positive phenotypic correlation with number of seeds per fruit (0.164), number of locules per fruit (0.161), total soluble solids (0.097), early yield of first two pickings (0.054), pericarp thickness (0.046) and reducing sugars (%) (0.002). Number of fruits per truss showed significant and positive association with fruit size (0.288) and dry matter content (0.212), while significant negative phenotypic correlation with total sugar (%) (-0.356), total carotenoides (-0.301), lycopene content (-0.301), number of seeds per fruit (-0.294) and pericarp thickness (-0.248). Fruit weight (g) showed significant and positive phenotypic correlation with number of seeds per fruit (0.267), early yield of first two pickings (0.230), pericarp thickness (0.215), while it showed non-significant positive correlation with total carotenoides (0.160), lycopene content (0.160), total sugars (0.143), number of locules per fruit (0.137), ascorbic acid (0.085), reducing sugars (0.054), total soluble solids (0.046) and dry matter content (0.044).

Pericarp thickness (mm) showed significant and positive phenotypic correlation with total carotenoides (0.330) and Lycopene content (0.330) and number of seeds per fruit (0.250). Total soluble solids (%) showed highly non-significant and positive phenotypic correlation with total carotenoides (0.061) and lycopene content (0.061). Total sugar (%) showed highly significant and positive phenotypic correlation with total carotenoides (0.486) and lycopene content (0.486). It showed non-significant and positive phenotypic correlation with reducing sugars (%) (0.146). Reducing sugars (%) showed non-significant and positive phenotypic correlation with carotenoides (0.164), lycopene content (0.164). ascorbic acid (0.118). Titrable acidity (g of citric acid/100 ml of juice) showed highly non-significant and positive phenotypic correlation with total carotenoides (0.188) and lycopene content (0.188). Ascorbic acid (mg/100 g of fruit) showed highly significant and positive phenotypic correlation with total carotenoides (0.306) and lycopene content (0.306).

The result of present study indicated that due weightage is to be given for number of fruits per plant and fruit weight (g). The present results are in agreement with the observations of earlier workers *viz*., number of fruits positively correlated with

yield (Parsad and Parsad, 1971; Singh and Singh, 1980; Manivannan, 1985; Sidhu and Singh, 1989; Kanthaswami *et al.*, 1994 and Wang *et al.*, 1998); total yield positively correlated with early yield, fruit number per plant, fruit weight (Dudi and Kalloo, 1982); number of primary branches and number of secondary branches per plant, plant height and number of fruit per truss positively correlated with yield under stress condition (Anand *et al.*, 1986) and normal condition (Manivannan, 1985), total soluble solids positively correlated with acidity and T.S.S.: acid ratio whereas T.S.S.: acid ratio negatively correlated with acidity and number of locules (Padda *et al.*, 1971). Fruit firmness was positively correlated with total sugar content and dry matter content (Markovic *et al*., 1997). The correlation of yield with most of the quality traits indicated that simultaneous improvement of yield and quality traits was not possible because of negative correlation of yield with such quality traits. Therefore, a simultaneous improvement of yield and quality traits with negative correlation necessitates some sacrifices both in yield and biochemical constituents.

The study of path coefficient analysis (Table 2) showed that highest positive direct effect was exerted by number of fruit per plant (1.056) followed by juice-pulp ratio (1.007), fruit weight (0.822), number of fruit per truss (0.384), total sugars (%) (0.299), number of branches per plant (0.218), total soluble solids (%) (0.210), number of seeds per fruit (0.196), plant height (cm) (0.156), total carotenoides (0.101), pericarp thickness (0.069), titrable acidity (0.064) and reducing sugar (0.008) whereas, highest negative direct effect was exerted by seed : pulp ratio (-1.057) followed by lycopene content (-0.310), ascorbic acid (-0.179), number of flower cluster per plant (-0.144), fruit size (-0.115), number of locules per fruit (-0.050), dry matter content (-0.038) and early fruit yield of first two pickings (-0.019). The result of earlier worker has revealed that number of fruits per plant (Nandpuri *et al.*, 1977), early yield per plant, number of fruits and weight of fruits exhibited high positive direct effect for yield (Dudi and Kalloo, 1982).

Furthermore, highest direct contributions were made by total number of fruits per plant and dry matter content towards total yield (Bhutani and Kalloo, 1989). Study of indirect effects showed that days to 50% flowering influenced total yield per plant (kg) indirectly, positively through total soluble solids (0.073), number of branches per plant (0.064), number of fruits per cluster (0.06), lycopene content (0.026), ascorbic acid (mg/100 g of fruit) (0.015), number of fruits per plant (0.003) and seed: pulp ratio (0.026). Plant height (cm) influenced total yield per plant (kg) indirectly, positively through juice-pulp ratio (0.128), number of fruit per plant (0.117), number of locules per fruit (0.114), number of fruits per cluster (0.11), lycopene content (0.027), number of clusters per plant (0.026), dry matter content (%) (0.004), number of branches per plant (0.0033), early yield of first two pickings (0.0016) and reducing sugars (%) (0.001). Number of branches per plant influenced total yield per plant (kg) indirectly, positively through seed: pulp ratio (0.146), number of fruit per cluster (0.07), fruit weight (0.049), lycopene content (0.045), number of locules per fruit (0.005), total soluble solids (%) (0.001) and reducing sugars (%) (0.001). Number of flower clusters per plant influenced total yield per plant (kg) indirectly, positively through, seed: pulp ratio (0.21), total sugars (%) (0.096), number of seeds per fruit (0.036), total soluble solids (%) (0.021), pericarp thickness (mm) (0.003), ascorbic acid (mg/100 g of fruit) (0.002), lycopene content (0.001) and reducing sugars (%) (0.001). Number of fruits per truss, influenced total yield per plant (kg) indirectly, positively through, lycopene content (0.126), number of locules per fruit (0.009), total soluble solids (%) (0.005) and reducing sugars (%) (0.001). Number of fruit per plant, influenced total yield per plant (kg) indirectly, positively through, juice: pulp ratio (0.11), total sugars (%) (0.04), ascorbic acid (mg/100 g of fruit) (0.009), dry matter content (%) (0.009), number of seeds per fruit (0.004), titrable acidity (g of citric acid/100 ml of juice) (0.001), lycopene content (0.001), reducing sugars (%) (0.001) and early yield of first two pickings (0.001). Fruit size (length/breadth ratio) influenced total yield per plant (kg) indirectly, positively through number of fruit per cluster (0.125), number of fruit per plant (0.102), seed: pulp ratio (0.092), number of clusters per plant (0.038), number of locules per fruit (0.019), lycopene content (0.017), pericarp thickness (mm) (0.009) and reducing sugars (%) (0.001). Fruit weight (g) influenced total yield per plant (kg) indirectly, positively through seed: pulp ratio (0.27), number of seeds per fruit (0.054), total Sugars (%) (0.046), total carotenoides (0.020), pericarp thickness (mm) (0.016), total soluble solids (%) (0.009) and reducing sugars (%) (0.001). Early yield of first two pickings, influenced total yield per plant (kg) indirectly, positively through, seed: pulp ratio (0.064), total sugars (%) (0.061), ascorbic acid (mg/100 g of fruit) (0.012), number of seeds per fruit (0.001), total carotenoides (0.006), pericarp thickness (mm) (0.003), number of locules per fruit (0.001) and reducing sugars (%) (0.001). Nandpuri *et al.*, (1977) observed positive indirect effect via fruit size and plant height for yield. Number of locules per fruit, influenced total yield per plant (kg) indirectly, positively through, juice: pulp ratio (0.22), total sugars (%) (0.09), number of seeds per fruit (0.073), total

carotenoides (0.04), total soluble solids (%), (0.020), titrable acidity (g of citric acid/100 ml of juice) (0.019), pericarp thickness (mm) (0.011) and, dry matter content (%) (0.003). Pericarp thickness (mm), influenced total yield per plant (kg) indirectly, positively through, seed: pulp ratio (0.215), lycopene content (-0.128), total sugars (%) (0.068), number of seeds per fruit (0.052), ascorbic acid (mg/100 g of fruit) (0.009), titrable acidity (g of citric acid/100 ml of juice) (0.006), and total carotenoides (0.004). Number of seeds per fruit, influenced total yield per plant (kg) indirectly, positively through, juice: pulp ratio (0.197), total sugars (%) (0.114), total carotenoides (0.038), titrable acidity (g of citric acid/100 ml of juice) (0.006) and dry matter content (%) (0.0034).Dry matter content (%), influenced total yield per plant (kg) indirectly, positively through, ascorbic acid (mg/100 g of fruit) (0.071), lycopene content (0.047), seed: pulp ratio (0.039) and total sugars (%) (0.026). Juice: pulp ratio, influenced total yield per plant (kg) indirectly, positively through, lycopene content (0.005) and titrable acidity (g of citric acid/100 ml of juice) (0.003). Seed: pulp ratio, influenced total yield per plant (kg) indirectly, positively through, lycopene content (0.028) and titrable acidity (g of citric acid/100 ml of juice) (0.003). Titrable acidity (g of citric acid/100 ml of juice), influenced total yield per plant (kg) indirectly, positively through, total sugars (%) (0.044), total carotenoides (0.027), total soluble solids (%) (0.014) and reducing sugars (%) (0.001). Total Sugars (%), influenced total yield per plant (kg) indirectly, positively through, total carotenoides (0.058), ascorbic acid (mg/100 g of fruit) (0.002) and reducing sugars (%) (0.001). Total soluble solids (%), influenced total yield per plant (kg) indirectly, positively through, total carotenoides (0.006) and ascorbic acid (mg/100 g of fruit) (0.002). Reducing sugars (%), influenced total yield per plant (kg) indirectly, positively through, total carotenoides (0.020). Ascorbic acid (mg/100 g of fruit), influenced total yield per plant (kg) indirectly, positively through, total carotenoides (0.037). Total carotenoides influenced total yield per plant (kg) indirectly, negatively through lycopene content (-0.31).

The effect of residual factor (0.1118) on fruit yield per hectare was negligible, thereby, suggested that no other major yield component is left over. In present investigation, fruit number, juice-pulp ratio, fruit weight, number of fruit per truss, total sugars (%), number of branches per plant and total soluble solids (%)showed high positive and direct effect had significant positive correlation with fruit yield per plant. Therefore, the plant with more number of fruits and fruits with higher weight, juice-pulp ratio and high TSS should be considered in selection criteria for increasing fruit yield per plant. Directly or indirectly all characters showed positive effect on fruit yield per plant, which is in confirmation to the finding of Hidaytullah *et al*. (2008) who also reported that number of fruit per plant, average fruit weight and number of primary branches per plant exhibited positive as well as high direct effect. Bodende (2002) also reported that plant height, fruit diameter and fruit length were directly responsible for the determination of fruit yield in tomato. Hayder *et al*. (2007) also observed that fruit weight exerted high positive and direct effect on fruit yield per plant. Similar results were obtained by Lakshmi and Mani (2004), Singh and Cheema (2005), Prasad and Mathur (1999).

Similarly, the results of earlier worker have showed that fruit number per plant was among the characters having high direct effect on yield. Number of fruits per plant, number of clusters per plant and fruit weight were the prime contributing factors for the realization of high yield. Number of fruits per plant, total soluble solids and acidity had positive and direct influence on yield, while number of laterals per plant, number of fruits per cluster and flesh thickness had negative direct effect on yield. The narrow difference between genotypic and phenotypic values suggested less environmental influence controlling relationship between the traits.

Improvement in yield could be managed by selection for number of flowers per cluster, flower clusters at first picking, number of fruits per cluster, weight per fruit and total sugar.

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Table 1: Phenotypic (above diagonal) and genotypic (below diagonal) correlations coefficients between different characters in tomato

Characters	1	2	3	4	5	6	7	8	9	10	11	12
1	**1.000**	0.068	0.249*	0.159	0.156	0.007	0.056	-0.096	0.024	-0.025	0.063	-0.092
2	0.072	**1.000**	0.009	-0.139	0.249*	0.106	0.340**	-0.228*	-0.072	-0.077	-0.227*	-0.205
3	0.293	0.015	**1.000**	0.210*	0.111	0.006	0.070	0.060	0.124	0.068	-0.073	-0.071
4	0.197	-0.184	0.249	**1.000**	0.158	-0.238*	-0.239*	0.333**	0.054	0.076	0.161	0.046
5	0.168	0.296	0.190	0.222	**1.000**	-0.031	0.288**	-0.088	0.013	-0.155	-0.189	-0.248*
6	0.003	0.111	-0.010	0.274	-0.035	**1.000**	0.092	-0.429**	0.006	0.507**	0.040	-0.091
7	0.063	0.357	0.067	-0.267	0.325	0.096	**1.000**	-0.124	0.077	-0.044	-0.393**	0.126
8	-0.117	-0.244	0.060	0.392	0.118	-0.449	-0.134	**1.000**	0.230*	0.439**	0.137	0.215*
9	0.042	-0.080	0.140	0.110	0.018	-0.007	0.104	0.286	**1.000**	0.196	-0.013	0.033
10	-0.040	-0.142	0.067	0.090	-0.189	0.506	-0.047	0.433	0.237	**1.000**	0.125	0.092
11	0.069	-0.245	-0.105	0.163	-0.206	0.043	-0.406	0.140	-0.017	0.131	**1.000**	0.145
12	-0.096	-0.218	-0.081	0.040	-0.286	-0.095	0.133	0.231	0.043	0.101	0.152	**1.000**
13	-0.043	-0.227	-0.089	0.183	-0.348	0.021	-0.237	0.276	0.04	0.243	0.370	0.263
14	0.064	-0.098	0.072	0.250	0.245	-0.235	0.127	0.048	0.295	-0.218	-0.090	0.131
15	-0.071	0.127	-0.269	-0.252	-0.206	0.108	-0.169	-0.139	-0.037	-0.018	0.220	-0.113
16	-0.024	0.245	-0.137	-0.199	0.0874	0.323	-0.087	-0.253	-0.061	0.040	0.193	-0.203
17	0.348	-0.028	0.004	0.100	0.025	-0.167	-0.068	0.044	-0.207	-0.034	0.096	-0.084
18	-0.007	-0.179	-0.167	0.320	-0.434	0.144	-0.119	0.155	0.203	0.290	0.294	0.226
19	-0.187	0.159	0.008	0.002	0.032	0.048	0.186	0.064	0.023	0.117	-0.059	-0.116
20	-0.138	-0.198	–0.223	-0.295	-0.267	0.016	-0.155	-0.015	-0.137	-0.030	0.294	0.106
21	-0.084	0.141	0.098	-0.012	0.002	-0.054	0.013	0.091	-0.067	-0.119	0.070	-0.050
22	-0.085	-0.089	-0.146	-0.001	-0.407	-0.002	-0.056	0.198	0.065	0.069	0.380	0.415
23	-0.085	-0.089	-0.146	-0.001	-0.407	-0.002	-0.056	0.198	0.065	0.069	0.380	0.415

*Significant at P≤0.05 and ** P≤0.01 level of significance.

Characters

1. **Days to 50% flowering**
2. **Plant height (cm)**
3. **Number of branches per plant**
4. **Number of flower clusters per plant**
5. **Number of fruit per truss**
6. **Number of fruits per plant**
7. **Fruit size (length/breadth ratio)**
8. **Fruit weight (g)**
9. **Early fruit yield (Kg)**
10. **Total fruit yield (Kg)**
11. **Number of locules per fruit**
12. **Pericarp thickness (mm)**
13. **Number of seeds per fruit**
14. **Dry matter content (%)**
15. **Juice : pulp ratio**
16. **Seed : pulp ratio**
17. **Total soluble solids (%)**
18. **Total Sugars (%)**
19. **Reducing sugars (%)**
20. **Titrable acidity (g of citric acid/100 ml of juice)**
21. **Ascorbic acid (mg/100 g of fruit)**
22. **Total carotenoides (mg/100 g of fruit)**
23. **Lycopene content (mg/100 g of fruit)**

Continued.....

Table 1 Continued.....

Characters	13	14	15	16	17	18	19	20	21	22	23
1	-0.039	0.052	0.033	0.010	0.310**	-0.009	-0.154	-0.113	-0.079	-0.059	-0.059
2	-0.085	-0.090	0.096	0.182	-0.019	-0.159	0.147	-0.187	0.138	-0.077	-0.077
3	-0.085	0.070	-0.228*	-0.133	0.004	-0.122	-0.019	-0.178	0.088	-0.074	-0.074
4	0.164	0.228*	-0.239*	-0.171	0.097	0.242*	0.002	-0.234*	-0.012	-0.006	-0.006
5	-0.294**	0.212*	-0.121	0.064	0.009	-0.356**	0.027	-0.201	0.002	-0.301	-0.301**
6	0.023	-0.223*	0.093	0.243*	-0.162	0.142	0.052	0.023	-0.051	-0.008	-0.008
7	-0.233*	0.119	-0.137	-0.062	-0.071	-0.115	0.167	-0.143	0.014	-0.048	-0.048
8	0.267*	0.044	-0.120	-0.191	0.046	0.143	0.054	-0.021	0.085	0.160	0.160
9	0.035	0.251*	-0.017	-0.078	-0.178	0.176	0.015	-0.128	-0.050	0.061	0.061
10	0.234*	-0.208	-0.012	0.029	-0.032	0.279*	0.112	-0.029	-0.117	0.056	0.056
11	0.359**	-0.082	0.175	0.115	0.095	0.265 *	-0.059	0.269*	0.069	0.321**	0.321**
12	0.250*	0.122	-0.101	-0.125	-0.078	0.203	-0.112	0.092	-0.047	0.330**	0.330* *
13	**1.000**	-0.085	0.174	0.139	-0.149	0.348**	-0.091	0.088	0.201	0.313**	0.313* *
14	0.088	**1.000**	-0.096	-0.039	-0.095	0.003	-0.105	-0.076	-0.386**	-0.120	-0.120
15	0.196	-0.116	**1.000**	0.769 **	-0.158	-0.006	-0.022	0.036	0.080	-0.039	-0.039
16	0.187	-0.037	0.893	**1.000**	-0.121	-0.042	-0.027	0.056	0.055	-0.106	-0.106
17	-0.152	-0.104	-0.172	-0.149	**1.000**	-0.072	-0.024	0.057	-0.009	0.061	0.061
18	0.382	0.009	-0.001	-0.028	-0.074	**1.000**	0.146	0.123	-0.011	0.486**	0.486**
19	-0.106	-0.109	-0.001	-0.025	-0.030	0.172	**1.000**	0.066	0.181	0.164	0.164
20	0.095	-0.088	0.041	0.043	0.064	0.149	0.066	**1.000**	0.005	0.188	0.188
21	0.204	-0.397	0.091	0.067	-0.010	-0.009	0.192	0.005	**1.000**	0.306**	0.306**
22	0.375	-0.151	-0.017	-0.090	0.061	0.577	0.204	0.271	0.365	**1.000**	1.000**
23	0.375	-0.151	-0.017	-0.090	0.061	0.577	0.204	0.271	0.365	1.000	**1.000**

*Significant at P≤0.05 and ** P≤0.01 level of significance.

Characters

1. **Days to 50% flowering**
2. **Plant height (cm)**
3. **Number of branches per plant**
4. **Number of flower clusters per plant**
5. **Number of fruit per truss**
6. **Number of fruits per plant**
7. **Fruit size (length/breadth ratio)**
8. **Fruit weight (g)**
9. **Early fruit yield (Kg)**
10. **Total fruit yield (Kg)**
11. **Number of locules per fruit**
12. **Pericarp thickness (mm)**
13. **Number of seeds per fruit**
14. **Dry matter content (%)**
15. **Juice : pulp ratio**
16. **Seed : pulp ratio**
17. **Total soluble solids (%)**
18. **Total Sugars (%)**
19. **Reducing sugars (%)**
20. **Titrable acidity (g of citric acid/100 ml of juice)**
21. **Ascorbic acid (mg/100 g of fruit)**
22. **Total carotenoides (mg/100 g of fruit)**
23. **Lycopene content (mg/100 g of fruit)**

Table 2: Direct (diagonal) and indirect effects (off diagonal) and genotypic correlation of different characters with yield in tomato

Characters	1	2	3	4	5	6	7	8	9	11	12	13	14	15	16	17	18	19	20	21	22	23	G.C.Y.
1	-0.07	0.01	0.06	-0.03	0.06	0.00	-0.01	-0.10	0.00	0.00	-0.01	-0.01	0.00	-0.07	0.03	0.07	0.00	0.00	-0.01	0.02	-0.01	0.03	-0.04
2	-0.01	0.16	0.00	-0.03	0.11	0.12	-0.04	-0.20	0.00	0.01	-0.02	-0.04	0.00	0.13	-0.26	-0.01	-0.05	0.00	-0.01	-0.03	-0.01	0.03	-0.14
3	-0.02	0.00	0.22	-0.04	0.07	-0.01	-0.01	0.05	0.00	0.01	-0.01	-0.02	0.00	-0.27	0.15	0.00	-0.05	0.00	-0.01	-0.02	-0.02	0.05	0.07
4	-0.01	-0.03	0.05	-0.14	0.09	-0.29	0.03	0.32	0.00	-0.01	0.00	0.04	-0.01	-0.25	0.21	0.02	0.10	0.00	-0.02	0.00	0.00	0.00	0.09
5	-0.01	0.05	0.04	-0.03	0.38	-0.04	-0.04	-0.10	0.00	0.01	-0.02	-0.07	-0.01	-0.21	-0.09	0.01	-0.13	0.00	-0.02	0.00	-0.04	0.13	-0.19
6	0.00	0.02	0.00	0.04	-0.01	1.06	-0.01	-0.37	0.00	0.00	-0.01	0.00	0.01	0.11	-0.34	-0.04	0.04	0.00	0.00	0.01	0.00	0.00	0.51
7	0.00	0.06	0.02	0.04	0.13	0.10	-0.12	-0.11	0.00	0.02	0.01	-0.05	-0.01	-0.17	0.09	-0.01	-0.04	0.00	-0.01	0.00	-0.01	0.02	-0.05
8	0.01	-0.04	0.01	-0.06	-0.05	-0.47	0.02	0.82	-0.01	-0.01	0.02	0.05	0.00	-0.14	0.27	0.01	0.05	0.00	0.00	-0.02	0.02	-0.06	0.43
9	0.00	-0.01	0.03	-0.02	0.01	-0.01	-0.01	0.24	-0.02	0.00	0.00	0.01	-0.01	-0.04	0.06	-0.04	0.06	0.00	-0.01	0.01	0.01	-0.02	0.24
11	-0.01	-0.04	-0.02	-0.02	-0.08	0.05	0.05	0.12	0.00	-0.05	0.01	0.07	0.00	0.22	-0.21	0.02	0.09	0.00	0.02	-0.01	0.04	-0.12	0.13
12	0.01	-0.03	-0.02	-0.01	-0.11	-0.10	-0.02	0.19	0.00	-0.01	0.07	0.05	-0.01	-0.11	0.22	-0.02	0.07	0.00	0.01	0.01	0.04	-0.13	0.10
13	0.00	-0.04	-0.02	-0.03	-0.13	0.02	0.03	0.23	0.00	-0.02	0.02	0.20	0.00	0.20	-0.20	-0.03	0.11	0.00	0.01	-0.04	0.04	-0.12	0.24
14	-0.01	-0.02	0.02	-0.04	0.09	-0.25	-0.02	0.04	-0.01	0.00	0.01	-0.02	-0.04	-0.12	0.04	-0.02	0.00	0.00	-0.01	0.07	-0.02	0.05	-0.22
15	0.01	0.02	-0.06	0.04	-0.08	0.11	0.02	-0.11	0.00	-0.01	-0.01	0.04	0.00	1.01	-0.94	-0.04	0.00	0.00	0.00	-0.02	0.00	0.01	-0.02
16	0.00	0.04	-0.03	0.03	0.03	0.34	0.01	-0.21	0.00	-0.01	-0.01	0.04	0.00	0.90	-1.06	-0.03	-0.01	0.00	0.00	-0.01	-0.01	0.03	0.04
17	-0.02	0.00	0.00	-0.01	0.01	-0.18	0.01	0.04	0.00	0.00	-0.01	-0.03	0.00	-0.17	0.16	0.21	-0.02	0.00	0.01	0.00	0.01	-0.02	-0.03
18	0.00	-0.03	-0.04	-0.05	-0.17	0.15	0.01	0.13	0.00	-0.01	0.02	0.08	0.00	0.00	0.03	-0.02	0.30	0.00	0.04	0.00	0.06	-0.18	0.29
19	0.01	0.02	0.00	0.00	0.01	0.05	-0.02	0.05	0.00	0.00	-0.01	-0.02	0.00	0.00	0.03	-0.01	0.05	0.01	0.00	-0.03	0.02	-0.06	0.12
20	0.01	-0.03	-0.05	0.04	-0.10	0.02	0.02	-0.01	0.00	-0.01	0.01	0.02	0.00	0.04	-0.05	0.00	0.01	0.00	0.06	0.00	0.03	-0.08	-0.03
21	0.01	0.02	0.02	0.00	0.00	-0.06	0.00	0.08	0.00	0.00	0.00	0.04	0.02	0.09	-0.07	0.00	0.00	0.00	0.00	-0.18	0.04	-0.11	-0.12
22	0.01	-0.01	-0.03	0.00	-0.16	0.00	0.01	0.16	0.00	-0.02	0.03	0.07	0.01	-0.02	0.10	0.01	0.17	0.00	0.02	-0.07	0.10	-0.31	0.07
23	0.01	-0.01	-0.03	0.00	-0.16	0.00	0.01	0.16	0.00	-0.02	0.03	0.07	0.01	-0.02	0.10	0.01	0.17	0.00	0.02	-0.07	0.10	-0.31	0.07

Residual effect = 0.1118 Diagonal values are direct effects

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G.C.Y.= Genotypic correlation with fruit yield