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Character Interrelationship of Yield and Yield Components in F_2 Generation of Tomato (*Solanum lycopersicum* L.)

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A B S T R A C T

A study of correlation and path analysis was undertaken in two F_2 populations of Tomato in two promising hybrids Arka Samrat and Arka Rakshak for fruit yield and its component traits. This study helps in identifying the characters which mainly contributing to yield per plant. Yield per plant had highly significant and positive phenotypic correlation with average fruit weight (0.7732 and 0.8532), number of fruits per plant (0.4378 and 0.2011), plant height and Ascorbic acid content (0.1982 and 0.1906) respectively in both the populations, Suggesting the possibility of simultaneous selection for these traits for improving yield in the respective segregating populations. Path analysis for fruit yield per plant in the study revealed that average fruit weight (0.8961 and 0.0274), number of fruits per plant (0.6206 and 0.5354) and plant canopy (0.1376) had direct and positive effects with yield per plant indicating the possibility of increasing fruit yield by selecting these characters in both the segregating populations to have higher potential of yield.

Introduction

Tomato is one of the most important and popular vegetable crop which is widely grown and consumed throughout the world. There has been a tremendous increase in area and production in recent past and crop is estimated to occupy an area of 1.20 million hectares with an annual production of 19.40 million tonnes with an average yield of 16.10 tonne per hectare because of its immense use for both fresh fruit market and processed food industry (Anon., 2014). It is a rich source of vitamins and minerals and consumed as fresh or processed forms.

Genetic variability is essentially the first step of plant breeding for crop improvement which is immediately available from germplasm which is considered as the reservoir of variability for different characters including yield which is polygenically controlled and are much influenced by the environmental factors, an understanding of inheritance and study of association between yield and its components is necessary for planning an effective selection program in identifying high yielding genotypes. The estimation of correlation coefficients indicates only the extent and nature of association between yield and its components, but does not show the direct and indirect effects of different yield attributes on *yield per se*.Yield per plant is dependent on several characters which are mutually associated; these will in turn impair the true association existing between a

component and yield per plant. The present investigation was carried out to know the direct and indirect effects of yield and its attributing characters in tomato.

Materials and Methods

The experimental material for the present study consisted of two F_2 populations of tomato *i.e.,* Arka Samrat and Arka Rakshak. Salient features of hybrids which is used for study is presented in Table 1. The populations were evaluated in unreplicated trails design at the field of Vegetable Science of Kittur Rani Channamma College of Horticulture, Arabhavi, Belagavi District (Karnataka) during rabi 2015. Three to four weeks old seedlings of F_2 population comprising 250 plants in each hybrid and 20 plants of F_1 hybrids were used for transplanting in the main field. A spacing of 0.5 m was planted with marigold seedling between two F_2 populations. Ridges and furrows were prepared at 60 x 45 cm spacing. Fertilizer dose at the rate of 115 kg N, 100 kg P_20_5 and 60 kg K_20 per hectare was applied. All required agronomic practices were followed as per the package of practices to raise a good crop.

The phenotypic correlation studies were carried out to know the nature of relationship existing between yield per plant and its components characters plant height (cm), Plant spread from north to south (cm), Plant spread from east to west (cm), Plant canopy (cm^2) number of primary branches per plant, days to first flowering, days to 50 per cent flowering, days to first fruit set, days to first fruit maturity, polar diameter of fruit (mm), equatorial diameter of fruit (mm), number of fruits per plant, average fruit weight (g), fruit yield per plant (kg), pericarp thickness (mm), number of locules per fruit, lycopene content (mg/ 100g), ascorbic acid (mg/ 100g), total soluble solid (^{0}brix) and pH of fruit juice. Path analysis was also carried out to determine the relationship among the yield components (Dewey and Lu, 1959).

Results and Discussion

Yield is a complex polygenic character influenced by contributions from different component traits, which are under separate genetic control, thus, it is essential to have a clear picture of the contributions of each of the component characters towards the ultimate yield. The correlation between yield and its components is indispensable when it is required to amalgamate high yield potential with other desirable traits in a single genotype.

The phenotypic correlation coefficients were worked out and presented in Table 2 and 3. Fruit yield per plant had significant and positive correlation with average fruit weight (0.7732), number of fruits per plant (0.4378), plant height (0.1982), plant spread from east west (0.1981), plant canopy (0.1863), plant spread from north to south (0.1539) and lycopene content (0.1300) in the population Arka Samrat. Similar findings were also made by Samadia *et al.,* (2006) and Kumar and Dudi (2011) for average fruit weight, number of fruits per plant and Rashwan and Shaieny (2016) for lycopene content in fruits. Whereas, in the population Arka Rakshak fruit yield per plant had significant and positive association with average fruit weight (0.8532), number of fruits per plant (0.2011) and ascorbic acid content (0.1906). These findings are in agreement with those of Kumar and Thakur (2007) and Parasanna *et al.,* (2005) for average fruit weight and number of fruits per plant and Rashwan and Shaieny (2016) for ascorbic acid content.

Plant height exhibited significant and positive correlation with plant canopy (0.7101), plant spread from north south (0.6993), plant

spread from east west (0.6394), number of primary branches per plant (0.6041), number of fruits per plant (0.2061) and lycopene content (0.1302) in the population Arka Samrat. Similar results were reported earlier in tomato by Ghosh *et al.,* (2010) for number of primary branches per plant and Patil *et al.,* (2013) for number of fruits per plant. Whereas, the population Arka Rakshak exhibited significant and positive correlation with number of primary branches per plant (0.7870), plant canopy (0.7701), plant spread from east to west (0.7492), plant spread from north to south (0.7338) and polar diameter of fruit (0.1745) for the character plant height. The study of Raut *et al.,* (2005) supports for number of primary branches per plant and Manivannan *et al.,* (2005) for plant canopy and spread components.

Plant spread from north to south and east to west direction had significant and positive association with plant canopy (0.9444 and 0.9418), number of primary branches per plant (0.4848 and 0.4017) and number of fruits per plant (0.1958 and 0.2048) in the population Arka Samrat. The population Arka Rakshak exhibited significant and positive association of plant spread from north to south and east to west direction with plant canopy (0.9641 and 0.9612), number of primary branches per plant (0.6178 and 0.6030), polar diameter of fruit (0.1294 and 0.1773) and equatorial diameter of fruit (0.1292 and 0.1356).

Plant canopy had significant and positive correlation with number of primary branches per plant (0.4705), number of fruits per plant (0.2124) and yield per plant (0.1863) in the population Arka Samrat, whereas population Arka Rakshak had significant and positive association of plant canopy with number of primary branches per plant (0.6342), polar diameter of fruit (0.1588) and equatorial diameter of fruit (0.1375).

Table.1 Salient features of hybrids used in study

Sl. No.	Hybrids	Source	Salient features
1	Arka Samrat	I.I.H.R, Bengaluru	It is oblate to high round fruited hybrid and bears more number of fruits per plant. The fruit weighs around 90-110g with large, deep red and firm fruits suitable for fresh market. Hybrid has triple disease resistance to tomato leaf curl virus, bacterial wilt and early blight. Yields 80-85 t/ha in 140 days.
2	Arka Rakshak	I.I.H.R, Bengaluru	High yielding F_1 hybrid with triple disease resistance to tomato leaf curl virus, bacterial wilt and early blight. Fruits are square round, large weighs around 90-100g, Deep red and firm fruits, suitable for fresh market and processing. Yield 19 kg/plant and 75-80 t/ha in 140 days.

Table.2 Estimates of correlation coefficients in population of Arka Samrat of tomato

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1	**1.0000**	0.6993**	0.6394**	0.7101**	0.6041**	-0.1497*	-0.1872**	-0.0462	0.0428	0.0442	0.0468	-0.0437	0.2061**	0.0712	0.1302*	0.0828	0.0898	0.0276	0.1982**
2		**1.0000**	0.7788**	0.9444**	0.4848**	-0.1034	-0.1264*	-0.0854	-0.0833	-0.0453	-0.0164	-0.0199	0.1958**	0.0328	0.0718	0.0265	-0.0132	0.0210	0.1539*
3			**1.0000**	0.9418**	0.4017**	-0.1327*	-0.1666**	-0.0760	-0.0166	0.0203	0.0154	-0.0027	0.2048**	0.0769	-0.0225	0.0238	-0.0038	-0.0364	0.1981**
4				**1.0000**	0.4705**	-0.1250*	-0.1551*	-0.0856	-0.0534	-0.0136	-0.0007	-0.0121	0.2124**	0.0579	0.0267	0.0267	-0.0091	-0.0078	0.1863**
5					**1.0000**	-0.1043	-0.2379**	0.0113	-0.0729	0.0011	-0.1107	-0.0740	0.2151**	0.0025	0.0754	0.0151	-0.0187	-0.0168	0.1239
6						**1.0000**	0.4333**	-0.0335	0.0861	0.0381	0.1053	0.0946	-0.0451	-0.0199	-0.0623	-0.0205	-0.0534	0.0584	-0.0645
7							**1.0000**	-0.0750	0.1141	0.0492	0.0805	0.1580*	-0.1653	-0.0951	-0.0827	-0.0967	-0.0189	-0.0129	-0.1814**
8								**1.0000**	-0.0666	-0.1658**	0.0779	-0.0455	-0.0248	0.0408	-0.0777	-0.0208	-0.0294	-0.0850	0.0328
9									**1.0000**	0.5453**	0.0356	0.2189**	-0.0333	0.0877	0.1085	0.0846	0.0139	0.0181	0.0533
10										**1.0000**	0.0694	0.2100**	0.0138	0.1072	-0.0038	0.0301	0.0352	0.0695	0.1006
11											**1.0000**	-0.0010	-0.0795	-0.0714	-0.0578	-0.0227	0.0579	-0.0315	-0.0953
12												**1.0000**	0.0194	-0.0388	-0.0615	-0.0239	0.0318	0.0155	-0.0323
13													**1.0000**	-0.1996**	0.0267	-0.0034	0.0149	0.0591	0.4378**
14														**1.0000**	0.0818	0.0691	-0.1213	0.0169	0.7732**
15															**1.0000**	0.6527**	-0.0270	-0.0800	0.1300*
16																**1.0000**	-0.0127	-0.0781	0.0876
17																	**1.0000**	0.0003	-0.0873
18																		**1.0000**	0.0420
19																			**1.0000**

*** Significant at P = 0.05, **Significant at P = 0.01, critical r value = 0.1241 (5%) and 0.1626 (1%)**

1. **Plant height**
2. **Plant spread from North to South**
3. **Plant spread from East to West**
4. **Plant canopy**
5. **Number of primary branches**
6. **Days to first flowering**
7. **Days to 50% flowering**
8. **Days to first fruit maturity**
9. **Polar diameter**
10. **Equatorial diameter**
11. **Number of locule per fruit**
12. **Pericarp thickness**
13. **Number of fruits per plant**
14. **Average fruit weight**
15. **Lycopene content**
16. **Ascorbic acid**
17. **TSS**
18. **pH**
19. **Yield per plant**

Table.3 Estimates of correlation coefficients in population of Arka Rakshak of tomato

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1	**1.0000**	0.7338**	0.7492**	0.7701**	0.7870**	-0.1242*	-0.1466*	-0.0662	0.1745**	0.0858	-0.0443	0.0485	0.0065	0.0692	0.0681	0.0067	0.0087	0.0495	0.0731
2		**1.0000**	0.8534**	0.9641**	0.6178**	-0.1282*	-0.1328*	0.0777	0.1294*	0.1292*	-0.0340	0.0184	0.0135	0.0543	-0.0086	0.0686	0.0121	0.0120	0.0575
3			**1.0000**	0.9612**	0.6030**	-0.0934	-0.1119	0.0147	0.1773**	0.1356*	-0.0902	0.0340	0.0714	0.0126	0.0491	0.0251	0.0040	0.0372	0.0453
4				**1.0000**	0.6342**	-0.1154	-0.1273*	0.0486	0.1588*	0.1375*	-0.0640	0.0271	0.0436	0.0351	0.0205	0.0491	0.0084	0.0253	0.0535
5					**1.0000**	-0.0313	-0.0479	-0.0709	0.1175	0.0485	-0.0619	0.0492	-0.0019	0.0009	0.0353	-0.0974	0.0914	0.0472	-0.0072
6						**1.0000**	0.7198**	-0.0113	-0.1270*	-0.0990	0.0151	-0.0760	-0.0321	-0.1333*	-0.0870	-0.1001	0.0589	-0.0428	-0.1564*
7							**1.0000**	-0.0628	-0.0968	-0.0853	0.0402	-0.0474	-0.0759	-0.0624	-0.1361*	-0.0672	0.0686	-0.0719	-0.1088
8								**1.0000**	0.0459	0.0027	-0.0311	-0.0161	0.0679	0.0168	-0.0800	0.0350	0.0073	-0.0712	0.0521
9									**1.0000**	0.6373**	-0.0675	0.2502**	0.0147	0.0531	0.1107	0.0616	0.1178	0.0103	0.0692
10										**1.0000**	0.1312*	0.2769**	0.0491	0.0183	0.0351	-0.0164	0.0800	0.0203	0.0382
11											**1.0000**	0.0587	0.0740	-0.0397	0.0824	0.0119	-0.0045	-0.0323	0.0071
12												**1.0000**	0.0199	-0.0085	-0.0970	-0.0800	0.0027	-0.0340	-0.0084
13													**1.0000**	-0.3259**	-0.0328	-0.0373	0.0813	0.0464	0.2011**
14														**1.0000**	0.0609	0.2016**	-0.0027	-0.0503	0.8532**
15															**1.0000**	0.1012	0.0009	0.0546	0.0488
16																**1.0000**	-0.0261	-0.0720	0.1906**
17																	**1.0000**	0.0445	0.0401
18																		**1.0000**	-0.0082
19																			**1.0000**

*** Significant at P = 0.05, **Significant at P = 0.01, critical r value = 0.1241 (5%) and 0.1626 (1%)**

1. **Plant height**
2. **Plant spread from North to South**
3. **Plant spread from East to West**
4. **Plant canopy**
5. **Number of primary branches**
6. **Days to first flowering**
7. **Days to 50% flowering**
8. **Days to first fruit maturity**
9. **Polar diameter**
11. **Equatorial diameter**
20. **Number of locule per fruit**
21. **Pericarp thickness**
22. **Number of fruits per plant**
23. **Average fruit weight**
24. **Lycopene content**
25. **Ascorbic acid**
26. **TSS**
27. **pH**
19. **Yield per plant**

Table.4 Path coefficient analysis in F_2 population of Arka Samrat in tomato

	X1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15	x16	x17	x18	x19
x1	**0.0077**	-0.0521	-0.0416	0.0977	-0.0117	0.0036	-0.0039	-0.0007	-0.0005	0.0002	0.0008	0.0003	0.1279	0.0638	0.0056	0.0002	0.001	-0.0001	0.1982**
x2	0.0054	**-0.0745**	-0.0506	0.1300	-0.0094	0.0025	-0.0026	-0.0013	0.0010	-0.0002	-0.0003	0.0001	0.1215	0.0294	0.0031	0.0001	-0.0001	-0.0001	0.1539*
x3	0.0049	-0.0580	**-0.0650**	0.1296	-0.0078	0.0032	-0.0034	-0.0012	0.0002	0.0001	0.0003	0.0000	0.1271	0.0689	-0.0010	0.0001	0.0000	0.0001	0.1981**
x4	0.0054	-0.0703	-0.0612	**0.1376**	-0.0091	0.0030	-0.0032	-0.0013	0.0007	-0.0001	0.0000	0.0001	0.1318	0.0519	0.0011	0.0001	-0.0001	0.0000	0.1863**
x5	0.0046	-0.0361	-0.0261	0.0647	**-0.0194**	0.0025	-0.0049	0.0002	0.0009	0.0000	-0.0019	0.0005	0.1335	0.0023	0.0032	0.0000	-0.0002	0.0001	0.1239
x6	-0.0011	0.0077	0.0086	-0.0172	0.0020	**-0.0238**	0.0089	-0.0005	-0.0011	0.0002	0.0018	-0.0007	-0.0280	-0.0179	-0.0027	0.0000	-0.0006	-0.0002	-0.0645
x7	-0.0014	0.0094	0.0108	-0.0213	0.0046	-0.0103	**0.0206**	-0.0011	-0.0014	0.0002	0.0014	-0.0011	-0.1026	-0.0852	-0.0035	-0.0002	-0.0002	0.0000	-0.1814**
x8	-0.0004	0.0064	0.0049	-0.0118	-0.0002	0.0008	-0.0015	**0.0152**	0.0008	-0.0008	0.0013	0.0003	-0.0154	0.0365	-0.0033	0.0000	-0.0003	0.0003	0.0328
x9	0.0003	0.0062	0.0011	-0.0073	0.0014	-0.0021	0.0024	-0.0010	**-0.0122**	0.0026	0.0006	-0.0015	-0.0207	0.0786	0.0046	0.0002	0.0002	-0.0001	0.0533
x10	0.0003	0.0034	-0.0013	-0.0019	0.0000	-0.0009	0.0010	-0.0025	-0.0067	**0.0048**	0.0012	-0.0015	0.0086	0.0961	-0.0002	0.0001	0.0004	-0.0002	0.1006
x11	0.0004	0.0012	-0.0010	-0.0001	0.0021	-0.0025	0.0017	0.0012	-0.0004	0.0003	**0.0169**	0.0000	-0.0493	-0.0640	-0.0025	-0.0001	0.0006	0.0001	-0.0953
x12	-0.0003	0.0015	0.0002	-0.0017	0.0014	-0.0023	0.0033	-0.0007	-0.0027	0.0010	0.0000	**-0.0069**	0.0120	-0.0347	-0.0026	-0.0001	0.0004	0.0000	-0.0323
x13	0.0016	-0.0146	-0.0133	0.0292	-0.0042	0.0011	-0.0034	-0.0004	0.0004	0.0001	-0.0013	-0.0001	**0.6206**	-0.1789	0.0011	0.0000	0.0002	-0.0002	0.4378**
x14	0.0005	-0.0024	-0.0050	0.0080	0.0000	0.0005	-0.0020	0.0006	-0.0011	0.0005	-0.0012	0.0003	-0.1239	**0.8961**	0.0035	0.0002	-0.0013	-0.0001	0.7732**
x15	0.0010	-0.0053	0.0015	0.0037	-0.0015	0.0015	-0.0017	-0.0012	-0.0013	0.0000	-0.0010	0.0004	0.0166	0.0733	**0.0426**	0.0015	-0.0003	0.0002	0.1300*
x16	0.0006	-0.0020	-0.0015	0.0037	-0.0003	0.0005	-0.002	-0.0003	-0.0010	0.0001	-0.0004	0.0002	-0.0021	0.0619	0.0278	**0.0023**	-0.0001	0.0002	0.0876
x17	0.0007	0.0010	0.0002	-0.0012	0.0004	0.0013	-0.0004	-0.0004	-0.0002	0.0002	0.0010	-0.0002	0.0093	-0.1087	-0.0012	0.0000	**0.0111**	0.0000	-0.0873
x18	0.0002	-0.0016	0.0024	-0.0011	0.0003	-0.0014	-0.0003	-0.0013	-0.0002	0.0003	-0.0005	-0.0001	0.0367	0.0152	-0.0034	-0.0002	0.0000	**-0.0031**	0.0420

Diagonal values indicate direct effects **Residual = 0.1185**

***Significant at p=0.05** ****Significant at p=0.01**

X1 Plant height
X2 Plant spread from north to south
X3 Plant spread from east to west
X4 Plant canopy
X5 Number of primary branches
X6 Days to first flowering
X07 Days to 50 per cent flowering
X08 Days to first fruit maturity
X09 Polar diameter
x10 Equatorial diameter
x11 Number of locules per fruit
x12 Pericarp thickness
x13 Number of fruits per plant
x14 Average fruit weight
x15 Lycopene content
x16 Ascorbic acid
x17 TSS
x18 pH
x19 Yield per plant

Table.5 Path coefficient analysis in F2 population of Arka Rakshak in tomato

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15	x16	x17	x18	X19
x1	**0.0129**	0.0139	0.0069	-0.0267	-0.0110	-0.0003	0.0007	0.0001	0.0043	-0.0018	-0.0006	-0.0005	0.0035	0.0711	-0.0001	0.0000	0.0000	0.0009	0.0731
x2	0.0095	**0.0189**	0.0079	-0.0334	-0.0087	-0.0003	0.0006	-0.0001	0.0032	-0.0027	-0.0004	-0.0002	0.0072	0.0557	0.0000	0.0001	0.0000	0.0002	0.0575
x3	0.0097	0.0161	**0.0092**	-0.0333	-0.0084	-0.0002	0.0005	0.0000	0.0043	-0.0029	-0.0012	-0.0004	0.0382	0.0129	-0.0001	0.0000	0.0000	0.0007	0.0453
x4	0.0099	0.0182	0.0089	**-0.0346**	-0.0089	-0.0003	0.0006	-0.0001	0.0039	-0.0029	-0.0008	-0.0003	0.0233	0.0361	0.0000	0.0000	0.0000	0.0005	0.0535
x5	0.0102	0.0117	0.0056	-0.022	**-0.014**	-0.0001	0.0002	0.0001	0.0029	-0.0010	-0.0008	-0.0005	-0.0010	0.0009	-0.0001	-0.0001	-0.0001	0.0009	-0.0072
x6	-0.0016	-0.0024	-0.0009	0.0040	0.0004	**0.0024**	-0.0034	0.0000	-0.0031	0.0021	0.0002	0.0008	-0.0172	-0.1370	0.0002	-0.0001	-0.0001	-0.0008	-0.1564*
x7	-0.0019	-0.0025	-0.0010	0.0044	0.0007	0.0017	**-0.0047**	0.0001	-0.0024	0.0018	0.0005	0.0005	-0.0407	-0.0641	0.0003	-0.0001	-0.0001	-0.0014	-0.1088
x8	-0.0009	0.0015	0.0001	-0.0017	0.0010	0.0000	0.0003	**-0.0011**	0.0011	-0.0001	-0.0004	-0.0002	0.0364	0.0173	0.0002	0.0000	0.0000	-0.0014	0.0521
x9	0.0023	0.0024	0.0016	-0.0055	-0.0016	-0.0003	0.0005	-0.0001	**0.0244**	-0.0134	-0.0009	-0.0026	0.0079	0.0546	-0.0002	0.0001	-0.0001	0.0002	0.0692
x10	0.0011	0.0024	0.0013	-0.0048	-0.0007	-0.0002	0.0004	0.0000	0.0156	**-0.021**	0.0017	-0.0029	0.0263	0.0188	-0.0001	0.0000	-0.0001	0.0004	0.0382
x11	-0.0006	-0.0006	-0.0008	0.0022	0.0009	0.0000	-0.0002	0.0000	-0.0017	-0.0028	**0.0131**	-0.0006	0.0396	-0.0408	-0.0002	0.0000	0.0000	-0.0006	0.0071
x12	0.0006	0.0003	0.0003	-0.0009	-0.0007	-0.0002	0.0002	0.0000	0.0061	-0.0058	0.0008	**-0.0105**	0.0106	-0.0087	0.0002	-0.0001	0.0000	-0.0007	-0.0084
x13	0.0001	0.0003	0.0007	-0.0015	0.0000	-0.0001	0.0004	-0.0001	0.0004	-0.001	0.0010	-0.0002	**0.5354**	-0.3349	0.0001	0.0000	-0.0001	0.0009	0.2011**
x14	0.0009	0.0010	0.0001	-0.0012	0.0000	-0.0003	0.0003	0.0000	0.0013	-0.0004	-0.0005	0.0001	-0.1745	**1.0274**	-0.0001	0.0002	0.0000	-0.0010	0.8532**
x15	0.0009	-0.0002	0.0005	-0.0007	-0.0005	-0.0002	0.0006	0.0001	0.0027	-0.0007	0.0011	0.001	-0.0176	0.0626	**-0.002**	0.0001	0.0000	0.0010	0.0488
x16	0.0001	0.0013	0.0002	-0.0017	0.0014	-0.0002	0.0003	0.0000	0.0015	0.0003	0.0002	0.0008	-0.020	0.2071	-0.0002	**0.0008**	0.0000	-0.0014	0.1906**
x17	0.0001	0.0002	0.0000	-0.0003	-0.0013	0.0001	-0.0003	0.0000	0.0029	-0.0017	-0.0001	0.0000	0.0435	-0.0028	0.0000	0.0000	**-0.0012**	0.0009	0.0401
x18	0.0006	0.0002	0.0003	-0.0009	-0.0007	-0.0001	0.0003	0.0001	0.0003	-0.0004	-0.0004	0.0004	0.0248	-0.0517	-0.0001	-0.0001	-0.0001	**0.0191**	-0.0082

Diagonal values indicate direct effects **Residual = 0.1185**

***Significant at p=0.05** ****Significant at p=0.01**

X1 Plant height
X2 Plant spread from north to south
X3 Plant spread from east to west
X4 Plant canopy
X5 Number of primary branches
X6 Days to first flowering
X07 Days to 50 per cent flowering
X08 Days to first fruit maturity
X09 Polar diameter
x10 Equatorial diameter
x11 Number of locules per fruit
x12 Pericarp thickness
x13 Number of fruits per plant
x14 Average fruit weight
x15 Lycopene content
x16 Ascorbic acid
x17 TSS
x18 pH
x19 Yield per plant

In the population of Arka Samrat, number of primary branches per plant had significant and positive correlation with number of fruits per plant (0.2151). Days to first flowering had significant and positive correlation with days to 50 per cent flowering (0.4333) in Arka Samrat and 0.7198 in Arka Rakshak. These results are in agreement with the findings made by Sharma *et al.,* (2015). Polar diameter of fruit had significant and positive correlation with equatorial diameter of fruit (0.5453 and 0.6373) and pericarp thickness (0.2189 and 0.2502). Equatorial diameter of fruit exhibited significant and positive correlation with pericarp thickness (0.2100 and 0.2769) in both the populations whereas, number of locules per fruit (0.1312) in the population of Arka Rakshak. These findings are in consonance by the findings of Mukul *et al.,* (2014). Lycopene content had significant and positive correlation with ascorbic acid content (0.6527) in the population of Arka Samrat. Average fruit weight had significant and positive correlation with ascorbic acid content (0.2016) in the population of Arka Rakshak. Similar results were obtained by Rashwan and Shaieny (2016).

Assessment of direct and indirect effects of characters on yield per plant through path analysis (Table 5 and 6) indicated, maximum positive direct effect of average fruit weight (0.8961) followed by number of fruits per plant (0.6206) and plant canopy (0.1376). The findings of Manna and Paul (2012), Kumari and Sharma (2013) and Mahapatra *et al.,* (2013) are in agreement with the above results. Negligible positive direct effects on fruit yield per plant was observed through plant height (0.0077), lycopene content (0.0426), days to 50 per cent flowering (0.0206), number of locules per fruit (0.0169), equatorial diameter of fruit (0.0048) and ascorbic acid (0.0023) content which is supported by the findings of Sharma and Sadhawi (2013) and Sharma *et al.,* (2015) and days to first fruit maturity (0.0152) was supported by Ara *et al.,* (2009). TSS (0.0111) had low positive direct effects on fruit yield per plant. Similar reports were made by Makesh *et al.,* (2006).This indicates the true positive association of these characters with fruit yield per plant. Therefore, direct selection for average fruit weight, number of fruits per plant and plant canopy would reward for improvement of yield as these characters exhibited high direct effects on yield per plant in the population of Arka Samrat. In the population of Arka Rakshak maximum positive direct effect on fruit yield per plant was observed through average fruit weight (1.0274) followed by number of fruits per plant (0.5354). These findings were supported by Manna and Paul (2012) and Kumari and Sharma (2013). Ascorbic acid (0.0008) had positive direct effect on yield per plant. The results are in conformity with Meena and Bahadur (2014). The characters *viz.,* Polar diameter (0.0244), pH of fruit juice (0.0191), plant spread from north to south (0.0189), number of locules per fruit (0.0131) and plant height (0.0129) had positive direct effect. Similar findings were made by Patil *et al.,* (2013). Plant spread from east to west (0.0092) and days to first flowering (0.0024) also exhibited positive direct effects. The results are in consonance of Kumari and Sharma (2013). Therefore direct selection for average fruit weight and number of fruits per plant would reward for improvement of yield as these two characters had high direct effects on yield per plant.

Correlation studies in F_2 generations of the population Arka Samrat for yield revealed high significant positive correlation with plant height, plant spread from east to west, plant canopy, average fruit weight, number of fruits per plant and plant spread from north to south, whereas lycopene content showed positive and significant association with yield per plant. Whereas, the population Arka Rakshak

had positive and significant association of average fruit weight, number of fruits per plant and ascorbic acid content with yield per plant thus, suggesting the possibility of simultaneous selection for these traits for improving yield in the respective segregating populations. The present study suggested that while selection, emphasis should be given on average fruit weight, number of fruits per plant and plant canopy for improvement of yield in both the segregating populations of tomato.

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