Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5776

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (1):** 1587-1595 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Estimation of Genetic Variability and Character Association of Fruit Yield and Quality Traits in Tomato

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Received: 16.09.2017 | Revised: 24.10.2017 | Accepted: 01.11.2017

ABSTRACT

The present study was taken up at the Central Research Farm, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal during 2012-2013 for 16 characters of 30 tomato genotype. Maximum fruit yield was found in BCT115dg, BCT111rin, BCT 53hyv and AC aft. Among these genotype BCT111rin one of the most promising one showed maximum plant height, equator and polar diameter, TSS and fruit yield. The estimates of phenotypic and genotypic variances were found to be very high for acidity content, ascorbic acid, plant height and fruits plant^{-1}. Genetic advance in percentage along with heritability were highest for fruits plant^{-1} followed by acidity content and lycopene content indicating high selection response. Equatorial diameter, locule number, ascorbic acid and acidity content showed positive correlation with yield as well as they have direct effect. Hence these traits can be used as selection indices in tomato to bring about the improvement in fruit yield.

Key words: *Tomato (Solanum lycopersicum L.), Variability, Correlation, Path analysis*

INTRODUCTION

The tomato (*Solanum lycopersicum*) is the most important vegetable crop cultivated in popular vegetables in India as well as in the world because of its wider adaptability, high yielding potential and suitability for variety of uses in fresh as well as processed food industries[1,2]. Tomatoes are an excellent source of minerals and vitamins[3,4,5]. The fruit contains significant amounts of lycopene, beta-carotene, magnesium, iron, phosphorus, potassium, riboflavin, niacin, sodium and thiamine. It has antioxidant properties and potential beneficial health effects[6]. Tomato breeding programs have traditionally focused on developing hybrids with improved agronomic performance particularly traits related to yield and fruit quality. The approaches to make significant improvement in tomato production require information regarding nature and magnitude of genetic variation in quantitative traits[7,8,9] and their interrelationships in the available germplasm, which are important pre-requisites for a systematic breeding program.

Cite this article: Das, B., Murmur, D.K., Ghimiray, T.S., Karforma, J. and Kundu, S., Yonzone, R., Estimation of Genetic Variability and Character Association of Fruit Yield and Quality Traits in Tomato, *Int. J. Pure App. Biosci.* **6(1):** 1587-1595 (2018). doi: http://dx.doi.org/10.18782/2320-7051.5776

Selection for yield based on multiple traits is always better than selection based on yield alone[10,11]. Genetic variability for agronomic traits is the key component of breeding programmes for broadening the gene pool of any crop. The fruit yield is a complex character dependant on many component characters and it responds poorly to the direct selection. Plant breeders so, commonly select for yield components which indirectly increase yield. Heritability (h^2) of a trait is important in determining its response to selection. Moreover, knowledge of heritability is essential for selection based improvement as it indicates the extent of transmissibility of a character into future generations[12]. The progress in breeding for yield and its contributing characters of any crop is polygenically controlled, environmentally influenced and determined by the magnitude and nature of their genetic variability[13,14]. Hence, a successful breeding programme will depend on the genetic diversity of a crop for achieving the goals of improving the crop and producing high yielding varieties[15]. Genetic improvement of plants for quantitative traits requires reliable estimates of heritability in order to plan an efficient breeding program. For that reason, expanding knowledge about the nature and magnitude of correlations between traits of interest is of utmost importance. Selection for a particular trait may either increase or reduce the expression of another trait, depending on the genetic correlation between them. Yield component directly or indirectly increases fruit yield if the components are highly heritable and genetically independent or positively correlated with fruit yield. It is very difficult to judge whether observed variability is highly heritable or not. Knowledge of correlation between yield and its contributing characters are basic and for most endeavor to find out guidelines for plant selection. Correlation in grouping with path analysis would give a better insight into cause and effect relationship between different pairs of characters[16]. A significant association suggests that such characters could be improved simultaneously. However, such an improvement depends on phenotypic correlation, additive variance and heritability.Partitioning of total correlation into direct and indirect effect by path analysis helps in making the selection more effective[17]. Considering the importance of tomato on these aspects the present investigation was taken up to evaluate thirty tomato germplasm to identify genotypes with high yield and quality which would be utilized for further improvement of tomato through appropriate breeding programs

MATERIAL AND METHODS

The field experiments were carried out at Central Research Farm, Gayeshpur, Bidhan Chandra KrishiViswavidyalaya, Nadia, West Bengal, lying at $22^0 57'$ N latitude and $88^0 20'$ E longitude with an average altitude of 9.75 m above the mean sea level. It comes under Gangetic new alluvial plain of sandy loam soil with neutral to slight acidity. The experimental site is situated under sub-tropical humid region with an average temperature range of 25–37 ^{0}C during summer to 12–25 ^{0}C during winter months. Average annual rainfall is about 1500 mm. Field experiments were carried out over the period of two season and thirty tomato genotypes were evaluated in Randomized Complete Block Design with three replications. All the germplasm was undertaken the research project financed by Govt. of West Bengal. Standard crop management practices and plant protection measures were taken time to time. Ten randomly selected plants from each replication were taken to record the following quantitative observations. Quantitative character were recorded such as plant height, equatorial diameter (mm), polar diameter (mm), pericarp thickness (mm), locule number, primary branch, fruit number plant^{-1}, fruit weight (gm), total soluble solid, lycopene content (mg/100 gm), B-carotene (mg/100 gm),ascorbic acid (mg/100 gm), total chlorophyll (mg/100 gm), total sugar (%), acidity (%) and fruit yield plant^{-1}. Genotypic and phenotypic variation and coefficients of variation, broad sense heritability, genetic advance and genotypic correlation coefficients were estimated using the formula suggested by Singh and Chaudhury (1979)[18] and Johnson *et al.* (1955)[19]. Genotypic and phenotypic correlation coefficients for all the possible comparisons were computed as per the Formulae suggested by Miller *et al.* (1958)[20]. The partitioning of genotypic correlation coefficient of traits into direct and indirect effects was carried out using the procedure suggested by Dewey and Lu (1959)[21]. All the statistical analysis was carried out using Genres computer software.All the statistical analysis was carried out using Genres computer software. The Genes© software (Windows version 2004.2.1), was used to estimate the genotypic (r_G), phenotypic (r_F), and environmental (r_A) correlation coefficients for each pair of traits.

RESULTS AND DISCUSSION

Analysis of Genetic Parameters for different morphological and Yield Characters

A wide range of variation was noticed in all the characters among the genotypes which indicated that diverse genotypes were included in the present investigation which may provide sufficient scope for further selection for improvement on these traits (Table 1). This variability could be harnessed to gain improvement in yield and its attributing traits following appropriate breeding methods[22,9,23]. AC hp was found to be tallest growth which also shown good *per-se* performance with respect to equatorial and polar diameter, lycopene and beta carotene content. Berika had highest locule number (9.85) (Table 2). Maximum fruit plant^{-1} was found in Peru Introgress (131.2) followed by CLNR (117.28). Highest fruit yield was observed in BCT115dg (5.38 kg plant^{-1}) followed by BCT111rin (5.05 kg plant^{-1}), BCT 53hyv and AC aft. Among these genotype BCT111rin one of the most promising one showed maximum plant height, equator and polar diameter, TSS and fruit yield.

Genotypic and phenotypic variance, GCV, PCV, heritability and genetic advance are given in Table 3. The phenotypic variance was partitioned into genotypic and environmental variances for a clear understanding of the pattern of variations. All the characters studied indicated the large proportion of phenotypic variance is attributed to genotypic differences among the genotypes studied which reflect the least effect of environmental factors on expression of these traits. The estimates of phenotypic and genotypic variances were found to be very high for acidity, ascorbic acid, plant height and fruits plant^{-1} (Table 3). So, selection for improvement of tomato could be done on the basis of characters showing high genetic variability. The phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for most of the characters studied indicating the presence of environmental influence to some degrees in the phenotypic expression of characters[24].The highest PCV and GCV estimates obtained were highest was fruits plant^{-1} followed by acidity content, lycopene content, yield plant^{-1}, polar diameter and pericarp thickness and least PCV and GCV was obtained for fruit weight (Table 3). The magnitude of PCV was either substantially or marginally higher than GCV for most of the character. The characters having high GCV indicate high potential for effective selection. Estimates of genotypic coefficients of variation alone are not sufficient to assess the heritable variation. For more reliable conclusion, estimates of high heritability and high genetic gain should be considered together[19]. Heritability estimates in broad sense (h2b) were much higher for all the characters were recorded. All these characters were accompanied by high heritability (above 90%) and it could be suggested that the characters were governed predominantly by additive gene actions, which could provide scope to improve crops with respect to these characters through selection. Genetic advance in percentage were highest for fruits plant^{-1} followed by acidity contentand lycopene content indicating high selection response. High heritability associated with high genetic advance the character was simply inherited in nature and controlled by few major genes or possessed additive gene effects. Since high heritability do not always indicate high genetic gain, heritability with genetic advance considered together should be used in predicting the ultimate effect for selecting superior varieties[25].

Character Association

Pearson correlation analysis among yield and its contributing characters are shown in Table 4. For clear understanding correlation coefficients are separated into genotypic and phenotypic level. Selection of a character for its improvement may simultaneously lead to selection of the associated characters. Complete knowledge on interrelationship of plant character like fruit yield with other characters is of paramount importance to the breeder for making improvement in complex quantitative character like yield for which direct selection is not much effective. Hence, association analysis was undertaken to determine the direction of selection and number of characters to be considered in improving fruit yield. The present investigation indicated that, the genotypic correlation coefficients were higher than the phenotypic correlation coefficients demonstrating that, the observed relationships among the various characters were due to genetic causes. Therefore, in plant breeding it is essential to understand the inter-relationship among different characters so that improvement of the targeted character does not carry with it the non-targeted characters rather desirable characters could be simultaneously included which may lead to ultimate success on breeding programme. Higher genotypic correlations than phenotypic ones might be due to modifying or masking effect of environment in the expression of these characters under study[26]. Higher genotypic correlation than phenotypic correlation indicated an inherent association between various characters[19]. In this study fruit yield was positively correlated with equatorial diameter, locule number, ascorbic acid and acidity content indicating the importance of these traits as selection criterion in yield enhancement programmes.Plant height was found to have positive and significant correlation with equatorial diameter, total chlorophyll content and total sugar content both at genotypic and phenotypic levels and showed non-significant positive correlation in high magnitude both at genotypic and phenotypic levels with fruit yield plant^{-1}. Equatorial diameter showed significant positive correlation with lycopene content, ascorbic acid and fruit yield plant^{-1} at genotypic and phenotypic levels. Polar Diameter showed significant positive correlation with pericarp thickness, primary branch and ascorbic acid at genotypic and phenotypic levels. Pericarp thickness showed significant positive correlation with locule number, fruit weight and ascorbic acid at genotypic and phenotypic levels.

Direct and indirect influences of some important yield contributing character

As simple correlation does not provide the true contribution of the characters towards the yield, these genotypic correlations were partitioned into direct and indirect effects through path coefficient analysis. While correlation values illustrate the inter-relationship between different characters, path coefficient splits the amount of inter relationship to measure contribution due to their direct and indirect effects. Therefore, in order to obtain a clear picture of the inter-relationship between different characters the direct and indirect effects of different characters on yield plant^{-1} are presented in Table 5. The path coefficient analysis provides an effective mean of untangling direct and indirect cases of relationship and permits a critical examination of the specific forces acting to produce a given correlation.

Direct effects of independent characters viz. fruits plant^{-1}, followed by pericarp thickness, acidity content, ascorbic acid, total Sugar (%), locule number, equatorial diameter, primary branch, lycopene and total chlorophyll showed positive effect on yield. Plant height, polar diameter, b-carotene and TSS incurred negative direct effect towards tuber yield plant^{-1}. Fruits plant^{-1} imparted the maximum positive direct effect (0.663) on fruit yield plant^{-1}

followed by pericarp thickness (0.406), acidity content (0.294), ascorbic acid (0.2870), total sugar (0.282), locule number (0.270), equatorial diameter (0.208), primary branch (0.177), lycopene (0.150) and total chlorophyll (0.105). The characters showing high direct effect on yield plant^{-1} indicated that direct selection for these traits might be effective and there is a possibility of improving yield plant^{-1} through selection based on these characters[23].

Table 1: Analysis of variance for fruit yield and its contributing traits in tomato

Sl. No.	Character	Replication (2)	Genotype (29)	Error (58)
1	**Plant height (cm)**	22.74	2391.75**	0.0971
2	**Equatorial Diameter**	7.71	7.067**	0.0330
3	**Polar Diameter (mm)**	12.48	662.14**	0.0395
4	**Pericarp Thickness (mm)**	21.38	662.22**	0.0626
5	**Locule Number**	3.52	8.57**	0.0392
6	**Primary Branch**	0.607	4.05**	0.0055
7	**Fruits Plant^{-1}**	20.29	2313.28**	0.0207
8	**Fruit Weight (gm)**	1.836	1.94**	0.0215
9	**TSS**	0.737	3.17**	0.0071
10	**Lycopene (mg/100)**	0.039	0.0744	0.0002
11	**B-Carotene (mg/100g)**	5.29	144.67**	0.0315
12	**Ascorbic Acid (mg/100)**	15.70	5036.14**	0.151
13	**Total Chlorophyll (mg/100g)**	0.705	1.549**	0.0018
14	**Total Sugar (%)**	0.408	0.073	0.0033
15	**Acidity (%)**	19.84	5571.95**	0.962
16	**Fruit yield plant^{-1}**	0.308	3.17**	0.0028

Table 2: Mean of Sixteen characters of Thirty genotypes in *Solanum lycopersicum* L.

Genotypes	Plant height	Equatorial Diameter	Polar Diameter	Pericarp Thickness	Locule Number	Primary Branch	Fruits Plant^{-1}	Fruit Weight	TSS	Lycopene (mg/100)	B-Carotene (mg/100g)	Ascorbic Acid (mg/100)	Total Chlorophyll (mg/100g)	Total Sugar	Acidity	Fruit yield
Patharkutchi	154.56	11.26	43.15	54.75	6.15	4.33	56.24	5.35	5.24	0.42	25.94	237.24	4.89	0.85	65.75	3.63
Berika	98.92	7.34	52.65	60.85	9.85	2.00	31.25	5.25	5.41	0.45	26.85	182.63	2.92	0.27	76.24	2.35
AlisaCraig	127.39	11.64	54.15	48.95	6.45	2.22	64.28	4.58	4.44	0.53	11.81	277.37	3.03	0.41	59.39	3.82
AC aft	80.02	7.97	57.58	47.55	5.25	5.50	35.00	6.85	4.92	0.59	24.62	225.61	3.74	0.71	122.37	4.28
AC hp	171.37	12.24	57.35	58.58	4.28	2.10	44.36	5.25	5.55	0.68	45.38	250.07	4.45	0.57	43.49	1.89
AC ogc	131.65	7.87	36.25	45.85	6.65	2.35	42.75	5.45	5.98	0.78	29.33	257.26	3.74	0.78	71.62	3.04
AC ful	141.63	11.87	44.75	41.38	4.25	2.00	86.35	4.95	3.77	0.53	39.45	142.91	3.64	0.54	34.42	2.97
Antho Local	92.37	9.24	44.25	37.55	4.15	4.15	44.27	4.75	2.09	0.16	21.52	223.81	3.11	0.36	40.55	1.79
Purulia 1	96.67	8.81	44.82	33.75	5.45	5.50	38.39	4.65	4.74	0.37	25.34	259.24	4.01	0.37	64.37	2.47
Purulia 2	95.24	7.67	43.85	28.75	5.40	3.50	29.47	4.01	4.56	0.37	26.62	259.42	3.98	0.38	87.57	2.58
Parul Local	89.11	7.41	64.25	48.85	6.85	5.33	26.38	4.85	2.79	0.17	31.23	207.37	3.77	0.63	96.43	2.54
Peru Introgress	96.41	8.74	7.87	6.55	3.55	2.00	131.29	5.85	4.92	0.33	20.57	237.45	3.16	0.37	10.39	1.36
Oregon Star	102.94	8.89	25.25	44.15	6.58	3.50	42.61	5.01	5.14	0.39	31.24	233.95	3.33	0.34	47.34	2.01
Pusa Ruby	86.71	8.31	61.25	59.55	5.35	4.67	31.64	4.71	2.65	0.22	35.61	198.36	2.01	0.45	58.27	1.84
Pusa Early Dwarf	60.75	9.31	64.15	54.25	6.25	5.33	32.24	4.68	3.66	0.31	28.23	175.75	1.95	0.35	61.24	1.97
CLNB	76.65	8.65	27.35	28.35	5.40	3.15	96.47	4.05	4.68	0.39	24.95	222.34	2.19	0.49	38.72	3.73
CLNR	84.35	9.42	23.35	27.25	4.85	2.00	117.28	4.05	4.05	0.33	17.92	194.78	2.96	0.58	32.17	3.77
BCT 53hyv	105.27	9.25	42.55	67.35	9.45	4.50	84.25	5.45	4.27	0.51	29.54	221.34	3.85	0.31	58.35	4.91
BCT59	101.24	8.21	69.25	71.64	9.25	4.35	21.69	4.25	2.78	0.24	24.57	211.36	3.04	0.59	194.71	4.22
BCT67	92.47	8.41	52.85	58.95	4.15	3.32	36.44	3.45	3.81	0.49	25.33	222.15	3.81	0.41	77.94	2.84
BCT82	107.81	8.17	55.65	58.15	6.45	4.45	26.24	5.65	3.04	0.24	32.85	221.36	3.01	0.23	113.85	2.98
BCT111rin	165.85	13.25	67.25	68.45	8.15	3.33	34.25	3.55	3.05	0.48	34.09	296.17	2.39	0.71	147.56	5.05
BCT115dg	68.17	11.25	59.85	58.27	6.25	4.85	47.42	5.55	5.82	0.71	36.76	325.25	3.17	0.36	112.87	5.35
BCT119hp	112.25	9.15	54.85	48.15	5.48	4.25	45.87	5.35	3.80	0.59	21.33	241.14	3.85	0.69	82.64	3.79
H-24	127.84	8.52	45.25	50.65	5.85	2.15	56.61	5.29	3.82	0.29	27.61	227.33	4.12	0.51	64.87	3.67
Nenadoro	88.24	8.41	41.25	45.48	9.65	2.43	41.26	4.58	4.72	0.39	26.28	205.02	4.42	0.42	71.29	2.94
EC620176 ps-2	115.71	8.21	78.25	78.85	7.75	3.45	11.28	5.25	2.82	0.41	22.09	170.86	3.92	0.45	196.71	2.21
2-Feb	76.64	7.95	48.85	54.35	5.15	3.63	37.45	5.45	5.14	0.41	25.14	177.33	4.05	0.42	82.64	3.09
TPOP	88.67	8.81	49.05	48.65	5.55	3.33	34.75	5.15	4.11	0.65	38.85	295.88	3.01	0.42	69.05	2.39
BCPS	145.29	8.27	44.68	47.42	5.58	3.33	48.10	7.05	3.61	0.43	23.24	175.78	3.54	0.61	52.71	2.53
Mean	106.07	9.15	48.73	49.44	6.18	3.57	49.20	5.01	4.18	0.43	27.81	225.88	3.44	0.49	77.85	3.07
SED	0.254	0.148	0.162	0.204	0.162	0.060	0.117	0.120	0.069	0.011	0.145	0.318	0.035	0.047	0.801	0.043
CD(5%)	0.509	0.297	0.325	0.409	0.324	0.121	0.235	0.239	0.138	0.022	0.290	0.636	0.069	0.094	1.603	0.087

Table 3: Variability and Genetic parameters for different yield parameters of tomato

Sl. No.	Characters	GV	PV	GCV	PCV	ECV	HERT	GA (%)OF MEAN
1	**Plant height (cm)**	797.21	797.31	26.62	26.62	0.29	0.99	54.83
2	**Equatorial Diameter**	2.34	2.37	16.74	16.85	1.98	0.99	34.23
3	**Polar Diameter (mm)**	220.70	220.74	30.49	30.49	0.41	0.98	62.80
4	**Pericarp Thickness (mm)**	220.72	220.78	30.05	30.05	0.51	0.97	61.89
5	**Locule Number**	2.84	2.88	27.29	27.48	3.20	0.99	55.84
6	**Primary Branch**	1.35	1.35	32.58	32.65	2.07	0.97	66.99
7	**Fruits Plant^{-1}**	771.08	771.11	56.44	56.45	0.29	0.99	116.27
8	**Fruit Weight (gm)**	0.642	0.66	15.99	16.25	2.92	0.97	32.39
9	**TSS**	1.05	1.063	24.58	24.67	2.02	0.99	50.47
10	**Lycopene (mg/100)**	0.025	0.025	36.66	36.80	3.20	0.99	75.24
11	**B-Carotene (mg/100g)**	48.21	48.24	24.97	24.98	0.64	0.98	51.42
12	**Ascorbic Acid (mg/100)**	1678.66	1678.81	18.14	18.14	0.17	0.96	37.36
13	**Total Chlorophyll (mg/100g)**	0.51	0.518	20.91	20.94	1.23	0.97	42.99
14	**Total Sugar (%)**	0.023	0.027	31.52	33.70	1.90	0.88	60.75
15	**Acidity (%)**	1856.99	1857.96	55.35	55.37	1.26	0.96	114.00
16	**Yield Plant^{-1}**	1.058	1.06	33.55	33.59	1.74	0.99	69.01

Here; GV= Genotypic variance, PV= phenotypic variance, EV= environmental variance

GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of variation

ECV = Environmental coefficient of variation, h^2 = Heritability (Broad sense)

GA = Genetic Advance

Table 4: Genotypic and Phenotypic Correlation coefficient among different yield parameters of Tomato

Character	G & P co-relation	Equatorial Diameter	Polar Diameter (mm)	Pericarp Thickness (mm)	Locule Number	Primary Branch	Fruits Plant^{-1}	Fruit Weight (gm)	TSS	Lycopene (mg/100)	B-Carotene (mg/100g)	Ascorbic Acid (mg/100)	Total Chlorophyll (mg/100g)	Total Sugar (%)	Acidity (%)	Yield Plant^{-1}
Plant height (cm)	G	0.567**	0.086	0.232	0.020	-0.405*	0.005	0.100	0.025	0.286	0.218	0.098	0.362*	0.508**	0.016	0.073
	P	0.562**	0.086	0.232	0.020	-0.404*	0.005	0.098	0.025	0.285	0.218	0.098	0.361*	0.475**	0.016	0.073
Equatorial Diameter	G		0.104	0.131	-0.131	-0.188	0.240	-0.198	0.098	0.362*	0.295	0.371*	-0.021	0.250	-0.101	0.362*
	P		0.103	0.130	-0.130	-0.188	0.239	-0.192	0.096	0.364*	0.293	0.368*	-0.021	0.241	-0.100	0.347
Polar Diameter (mm)	G			0.818**	0.346	0.442*	- 0.775**	-0.062	- 0.429*	0.012	0.232	-0.021	-0.064	0.096	0.750**	0.191
	P			0.818**	0.343*	0.441*	- 0.775**	-0.062	- 0.428*	0.012	0.232	-0.021	-0.064	0.091	0.749**	0.191
Pericarp Thickness (mm)	G				0.574**	0.252	- 0.651**	-0.006	-0.253	0.130	0.286	-0.066	0.029	0.064	0.686**	0.314
	P				0.570**	0.252	- 0.651**	-0.005	-0.252	0.129	0.285	-0.066	0.029	0.060	0.686**	0.314
Locule Number	G					0.062	-0.349	-0.081	-0.023	-0.033	-0.026	-0.040	-0.019	-0.084	0.513**	0.363*
	P					0.063	-0.347*	-0.078	-0.023	-0.031	-0.025	-0.040	-0.020	-0.083	0.508**	0.349
Primary Branch	G						-0.454*	0.126	-0.276	-0.239	0.065	0.092	-0.098	-0.003	0.356	0.154
	P						-0.453*	0.129	-0.277	-0.238	0.065	0.092	-0.098	-0.006	0.365*	0.153
Fruits Plant^{-1}	G							0.008	0.243	0.035	-0.239	-0.043	-0.092	0.011	- 0.652**	0.101
	P							0.008	0.243	0.035 -	0.239	-0.043	-0.092	0.010	- 0.652**	0.101
Fruit Weight (gm)	G								0.258	0.249	0.032 -	0.135	0.272	0.114	-0.063	-0.067
	P								0.243	0.244	0.032	-0.132	0.268	0.102	-0.062	-0.066
TSS	G									0.652**	0.100	0.318	0.347	0.052	-0.314	0.120
	P									0.647**	0.100	0.317	0.345	0.053	-0.313	0.120
Lycopene (mg/100)	G										0.287	0.442	0.246	0.283	-0.017	0.331
	P										0.286	0.440*	0.244	0.271	-0.016	0.329
B-Carotene (mg/100g)	G											0.157	-0.005	-0.009	-0.001	-0.059
	P											0.157	-0.005	-0.007	-0.001	-0.058
Ascorbic Acid (mg/100)	G												-0.005	0.065	0.073	0.367*
	P												-0.005	0.061	0.073	0.367*
Total Chlorophyll (mg/100g)	G													0.292	0.018	0.021
	P													0.271	0.018	0.021
Total Sugar (%)	G														0.159	0.319
	P														0.150	0.301
Acidity (%)	G															0.373*
	P															0.374*

Table 5: Path Coefficient among Different yield Parameters of Tomato

Character	Plant height (cm)	Equatorial Diameter	Polar Diameter (mm)	Pericarp Thickness (mm)	Locule Number	Primary Branch	Fruits Plant^{-1}	Fruit Weight (gm)	TSS	Lycopene (mg/100)	B-Carotene (mg/100g)	Ascorbic Acid (mg/100)	Total Chlorophyll (mg/100g)	Total Sugar (%)	Acidity (%)
Plant height (cm)	**-0.309**	0.118	-0.002	0.094	0.005	-0.072	0.004	-0.003	-0.001	0.043	-0.019	0.028	0.038	0.143	0.005
Equatorial Diameter	-0.175	**0.208**	-0.003	0.053	-0.035	-0.033	0.159	0.005	0.004	-0.054	-0.026	0.106	-0.002	0.070	-0.030
Polar Diameter (mm)	-0.026	0.022	**-0.029**	0.332	0.093	0.078	-0.514	0.002	0.017	0.002	-0.020	-0.006	-0.007	0.027	0.220
Pericarp Thickness (mm)	-0.072	0.027	-0.024	**0.406**	0.155	0.045	-0.432	0.000	0.010	0.019	-0.025	-0.019	0.003	0.018	0.201
Locule Number	-0.006	-0.027	-0.010	0.233	**0.270**	0.011	-0.231	0.002	0.001	-0.005	0.002	-0.011	-0.002	-0.024	0.151
Primary Branch	0.125	-0.039	-0.013	0.102	0.017	**0.177**	-0.301	-0.003	0.011	-0.036	-0.006	0.026	-0.010	-0.001	0.104
Fruits Plant^{-1}	-0.002	0.050	0.022	-0.265	-0.094	-0.080	**0.663**	0.000	-0.010	0.005	0.021	-0.012	-0.010	0.003	-0.192
Fruit Weight (gm)	-0.031	-0.041	0.002	-0.002	-0.022	0.022	0.005	**-0.028**	-0.010	0.037	-0.003	-0.039	0.029	0.032	-0.019
TSS	-0.008	0.020	0.012	-0.103	-0.006	-0.049	0.161	-0.007	**-0.040**	0.098	-0.009	0.091	0.037	0.015	-0.092
Lycopene (mg/100)	-0.088	0.075	0.000	0.053	-0.009	-0.042	0.023	-0.007	-0.026	**0.150**	-0.025	0.127	0.026	0.080	-0.005
B-Carotene (mg/100g)	-0.067	0.061	-0.007	0.116	-0.007	0.011	-0.159	-0.001	-0.004	0.043	**-0.088**	0.045	-0.001	-0.002	0.000
Ascorbic Acid (mg/100)	-0.030	0.077	0.001	-0.027	-0.011	0.016	-0.029	0.004	-0.013	0.066	-0.014	**0.287**	-0.001	0.018	0.021
Total Chlorophyll (mg/100g)	-0.112	-0.004	0.002	0.012	-0.005	-0.017	-0.061	-0.008	-0.014	0.037	0.000	-0.002	**0.105**	0.082	0.005
Total Sugar (%)	-0.157	0.052	-0.003	0.026	-0.023	0.000	0.007	-0.003	-0.002	0.042	0.001	0.019	0.031	**0.282**	0.047
Acidity (%)	-0.005	-0.021	-0.022	0.279	0.138	0.063	-0.432	0.002	0.012	-0.002	0.000	0.021	0.002	0.045	**0.294**

RESIDUAL EFFECT= 0.482873

CONCLUSION

Maximum fruit yield was found in BCT115dg, BCT111rin, BCT 53hyv and AC aft. Among these genotype BCT111rin one of the most promising one showed maximum plant height, equator and polar diameter, TSS and fruit yield.The estimates of phenotypic and genotypic variances were found to be very high for acidity, ascorbic acid, plant height and fruits plant^{-1}. Genetic advance in percentage were highest for fruits plant^{-1} followed by acidity content and lycopene content indicating high selection response.It could also be concluded that the traits like; equatorial diameter, locule number, ascorbic acid and acidity content showed positive correlation with yield as well as they have direct effect on yield. Hence these traits can be used as selection indices in tomato to bring about the improvement in fruit yield. Correlation and path coefficient studies suggested that the selection should be primarily based on the component characters which exhibited significant positive correlation with yield and also had either direct or indirect effect on yield.

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