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STUDY ON GENETIC VARIABILITY AND CHARACTER INTER-RELATIONSHIP OF QUALITY AND YIELD COMPONENTS IN TOMATO (*Solanum lycopersicum* L.)

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ABSTRACT : The present investigation was conducted to elucidate the genetic characters *viz.* variability, heritability and correlation between yield and yield components of different tomato (*Solanum lycopersicum* L.) genotypes. Thirty genotypes including released varieties, land races and germplasms were used in this investigation for assessment of quality, yield and yield components. The experiment was conducted during summer, 2012-13 at field of Department Vegetable Science, KRC College of Horticulture, Arabhavi, Karnataka. The study revealed that high heritability coupled with high genetic advance over per cent mean were noticed for number of clusters per plant, number of branches per plant, number of locules per fruit, average fruit weight, equatorial and polar diameter of fruit, lycopene content and fruit firmness, which might be assigned to additive gene effect, selection for such characters gives more importance in crop improvement of tomato. The phenotypic coefficient of variation (PCV) were higher with smaller magnitude than genotypic coefficient of variation (GCV), indicating the apparent variation is not only due to genotypic but also due to influence of environmental factors. The character association analysis indicated that fruit yield were significantly and positively correlated with fruit yield per plant (0.81), number of fruits per plant (0.65) and average fruit weight (0.45), whereas, number of fruits per cluster (-0.15), TSS (-0.04), polar diameter (-0.34) and equatorial diameter (-0.30) were negatively correlated with total yield.

Keywords : *Tomato, genetic advance, variability, correlation, lycopene, heritability.*

Tomato (*Solanum lycopersicum* L.) belongs to the family Solanaceae and is one of the most remunerable and widely grown vegetables in the world. Among the vegetables, tomato ranks next to potato in world acreage and ranks first among the processing crops. Tomato is grown for its edible fruits, which can be consumed either fresh or in processed form and is a very good source of vitamins A, B, C and minerals. Tomato cultivation has become more popular since mid nineteenth century because of its varied climatic adaptability and high nutritive value. Tomato is considered as protective food as it possesses several special nutritive value traits particularly antioxidants compound which are being used in several commercial therapeutical formulation (Simon, 18). Lycopene is the major antioxidantal pigment, which is responsible for red colour in tomato. Lycopene and their production plays important role in human health in order to reduce the risk of chronic diseases (Mascio *et al.,* 11). Tomato is being exported in the form of whole fruits, paste and in canned form to West Asian countries, U.K. Canada and USA. Area and production of tomato in India was about 0.865 mha and 16.82 mt, respectively (Anon. 3). 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 reported by (Vavilov, 20). Since, most of the economic characters including yield are 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. However, the inheritance of quantitative characters is often influenced by variation in other characters, which may be due to pleiotropy genetic linkage (Hanson *et al.,* 7). Hence, it is necessary to partition the observed overall phenotypic variation into heritable and non-heritable components using suitable design which enable us to know whether the superiority of selection is inherited by the progenies. Information regarding the genetic parameters such as variation coefficient, heritability, expected genetic advance, degree of association between the various characters, direct and indirect effects of characters contributing to total fruit yield are of paramount significance in formulating appropriate breeding strategy and exploiting the inherent variability of the experimental materials. The present investigation was carried out to gather the information on some collected land races which would be utilized for further improvement of tomato yield and quality through an appropriate and sound breeding plan.

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MATERIALS AND METHODS

The experimental material for the present study consisted of 30 genotypes collected from different diverse sources (Table 1). The genotypes were evaluated in randomized block design with two replications at the field of Vegetable Science of Kittur Rani Channamma College of Horticulture, Arabhavi, Belagavi District (Karnataka) during summer 2012-13. Thirty days old seedlings were transplanted at a spacing of 60 × 45 cm line to line and plant to plant, respectively, by accommodating 20 plants in each row of genotype. Five plants were sampled at random in each genotype and observations were recorded on growth, fruit yield and quality parameters, *viz.,* plant height (cm), number of fruits per plant, fruit yield per plant (g), average fruit weight (g), fruit firmness (mm), total soluble solid (°brix), number of locules per fruit and lycopene content (mg/100g). The polar and equatorial diameters (mm) of fruits were measured by Vernier Calipers. The total soluble solids (°brix) of the selected samples was determined with hand refractometer and the estimation of lycopene was carried as described by Garge *et al.* (5). Analysis of variance, genotypic variances, phenotypic variances, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability in broad sense (h^2 bs), genetic advance (GA) and genetic advance as percentage over mean (GAM) were analyzed following the formula illustrated by Singh and Chaudhary (19).

Table 1: Tomato genotypes used for present experiment.

Sl. No.	Germplasm	Source
1	EC570021	(NBPGR), New Delhi
2	EC570028	(NBPGR), New Delhi
3	EC608263	(NBPGR), New Delhi
4	EC608288	(NBPGR), New Delhi
5	EC608290	(NBPGR), New Delhi
6	EC608320	(NBPGR), New Delhi
7	EC608348	(NBPGR), New Delhi
8	EC638519	(NBPGR), New Delhi
9	EC654696	(NBPGR), New Delhi
10	EC675832	(NBPGR), New Delhi
11	EC677044	(NBPGR), New Delhi
12	EC677102	(NBPGR), New Delhi
13	EC686527	(NBPGR), New Delhi
14	EC686545	(NBPGR), New Delhi
15	EC686550	(NBPGR), New Delhi
16	EC686553	(NBPGR), New Delhi
17	EC686554	(NBPGR), New Delhi
18	EC-10304	(NBPGR), New Delhi
19	Mukti	Kerala Agricultural University, Thrissur
20	Swarna Lalima	IIVR, Varanasi
21	Swarna Naveen	IIVR, Varanasi
22	Pusa Rohini	IIVR, Varanasi
23	Kashi Hemanth	IIVR, Varanasi
24	Kashi Sharad	IIVR, Varanasi
25	Kashi Anupam	IIVR, Varanasi
26	NTDR-1	IIVR, Varanasi
27	Hissar Arun	IIVR, Varanasi
28	Pusa Gaurav	IIVR, Varanasi
29	Pusa-120	IIVR, Varanasi
30	Selection-12	KRC College of Horticulture, Arabhavi

RESULTS AND DISCUSSION

The analysis of variance indicated that there was highly significant difference among the genotypes for all the characters. The significant difference indicated existence of good amount of variability with respect to various traits (Table 2). The mean values for different characters (Table 3) revealed that maximum plant height at 60 DAT (104 cm), whereas produced by EC686553 followed by EC686554 (102.13 cm). The minimum plant height was observed in the genotype EC654696 (53.25 cm). The maximum plant height at 90 DAT (124.10 cm) was produced by EC686554 followed by EC686553 (121.20 cm) and the minimum plant height was observed in the genotype EC608288 (67.20 cm).The maximum number of clusters per plant was observed in the genotype EC638519 (9.94) and minimum was observed in the genotype EC608290 (3.5). The maximum number of branches per plant was observed in the genotype EC686554 (13.02) followed by EC686553 (10.70) and the minimum was observed in EC608290 (3.84). Prominant variability in tomato genotypes had also been reported by Manna and Paul (9) and Mohanty (12).

Table 2: Analysis of variance (mean sum of squares) for various characters in tomato.

Sl. No.	Character	Replicat-ion	Treat-ments	Error
	Degrees of freedom	1	29	29
1.	Plant height at 55 DAT(cm)	0.10	371.61**	11.9
2.	Plant height at 90 DAT(cm)	3.31	635.26**	8.8
3.	Number of clusters per plant	0.41	15.60**	0.21
4.	Number branches per plant	0.16	7.22**	0.30
5.	Number of fruits per cluster	0.52	1.46*	3.51
6.	Number of fruits per plant	34.93	376.6**	5.16
7.	Yield per plant (kg)	0.45	0.73**	0.02
8.	Average fruit weight (g)	870.51	6740.61**	240.4
9.	Yield (t/ha)	265.13	402.97**	9.72
10.	TSS (brix)	0.31	0.71*	0.13
11.	Fruit firmness (mm)	0.23	1.90*	0.30
12.	Polar diameter(cm)	92.25	69.33**	3.37
13.	Equatorial diameter(cm)	18.35	86.52**	21.61
14.	Number of locules per fruit	0.20	0.52*	0.18
15.	Lycopene (mg/100g)	2.2	1.8*	1.44

*and ** indicate significance of values at p=0.05 and p=0.01, respectively. NS : Non significant, DAT : Days after transplanting.

The genotype Kashi Anupam recorded the highest number of fruits per cluster (6.49) and lowest was observed in EC608288 (2.12).The maximum number of fruits per plant was observed in EC686554. The highest yield per plant as well as per hectare was observed in the genotype Kashi Anupam (2.53 kg) and (48.64 tonnes), respectively. However, lowest yield per hactare was observed in EC608288 (12.04 tonnes). The average fruit weight was maximum in the genotype EC-10304 (49.46 g) which was followed by NTDR-1 (44.73 g) and minimum in EC638519 (20.10 g). The TSS was more in the genotype Pusa-120 (5.25 °brix) and the genotype Mukti showed least TSS content (3.38 °brix). The genotype Pusa Rohini recorded maximum fruit firmness (5.81 mm) and the genotype EC686554 showed lowest fruit firmness (2.10 mm).

The maximum polar diameter was observed in the genotype EC677044 (5.61cm) and lowest was observed in the EC686554 (2.10 cm), whereas more equatorial diameter was noticed in the selection-12 (6.15 cm) and the genotype EC686554 showed the least equatorial diameter (2.96 cm).The genotype EC686550 (4.70) showed maximum number of locules per fruit and minimum was observed in EC686554 (2.25). The highest lycopene content was recorded with genotype EC677102 (5.69 mg/100g) and minimum was obsereved in EC570028 (2.33 mg/100g). The yield results of present investigation are in accordance to those of Sharma *et al.* (16) and Satish *et al.* (15) who have also reported variation in yield ranging from 12.40 to 44.33 t/ha.

Estimation of different genetic variability parameters (Table 4) showed that the Genotypic Coefficient of Variation (GCV) was highest for average fruit weight (89.28), followed by number of fruits per plant (85.14), TSS (70.92), number of branches per plant (52.75), plant height at 90 DAT (33.80), yield per plant (33.63), equatorial diameter (26.01), plant height at 55 DAT (24.79), polar diameter (20.98), lycopene content (20.14), number of fruits per cluster (14.73), number of clusters per plant (11.34), number of locules per fruit (6.75), whereas the lowest GCV was found for fruit firmness (4.30). The highest phenotypic coefficient of variation (PCV) was for average fruit weight (97.36), followed by number of fruits per plant (92.33), equatorial diameter (69.40), yield per plant (58.86), number of branches per plant (57.32), TSS (47.24), plant height at 90 DAT (35.91), plant height at 55 DAT (26.86), polar diameter (22.08), lycopene content (20.99), number of fruits per cluster (17.06), number of clusters per plant (11.63) and number of locules per fruit (10.13), whereas the lowest PCV was found for fruit firmness (4.79). Similarly the highest GCV and PCV values were reported for fruit weight by Mohanty (12) and Haydar *et al.* (8). Genotypic coefficient of variation, which is the true indicator of the extent of genetic variability in a population, was high for all the characters except fruit firmness and number of locules per fruit. Similar results were also obtained by Manna and Paul (9) and Pradeepkumar and Tiwari (14). Generally, higher PCV values than GCV were obtained for all tested traits.

The highest heritability was recorded on number of clusters per plant (97 per cent) with an expected genetic advance over percentage of mean on 23.35, followed by equatorial diameter (96 per cent) with

Table 3: Mean performance of different genotypes of tomato (*Solanum lycopersicum* L.) for yield and quality traits.

Sl. No.	Germplasms	Plant ht. at 55 DAT (cm)	Plant ht. at 90 DAT (cm)	No .of clusters /plant	No of. branches/ plant	No. of fruits /cluster	No. of fruits /plant	Yield /plant (kg)	Single fruit wt. (g)	TSS (brix)	Fruit firmness (mm)	Polar diameter (cm)	Equatorial diameter (cm)	No. of locules/fruit	Lycopene (mg/ 100g)	Yield (t/ha)
1	EC570021	71.75	81.08	3.97	6.59	5.74	22.82	0.81	35.63	4.51	3.11	4.24	5.93	2.87	4.02	18.64
2	EC570028	83.12	98.99	6.12	5.75	3.85	23.56	0.85	36.26	4.52	4.22	4.56	4.22	2.67	2.33	19.56
3	EC608263	63.25	79.15	4.37	5.18	4.38	19.14	0.48	25.52	3.97	2.40	4.00	3.29	2.62	4.02	12.04
4	EC608288	56.00	67.20	7.25	6.21	2.11	12.25	0.60	39.98	3.48	4.46	3.91	4.36	3.00	3.43	16.21
5	EC608290	61.25	69.57	3.50	3.84	5.46	19.11	0.77	40.81	4.45	2.48	4.13	4.92	2.37	5.42	18.20
6	EC608320	81.37	99.65	6.08	6.85	4.37	26.56	1.07	40.29	3.51	2.91	4.34	4.62	2.50	4.64	24.36
7	EC608348	62.43	71.18	5.43	5.84	4.75	25.79	0.98	39.12	4.35	2.40	4.68	5.54	2.80	4.28	22.42
8	EC638519	81.50	90.18	9.94	7.54	5.11	50.79	1.02	20.10	4.37	2.27	4.16	4.67	2.12	3.49	23.36
9	EC654696	53.25	75.21	3.52	5.42	4.46	15.69	0.54	34.53	4.17	3.41	5.34	6.10	2.50	4.60	12.60
10	EC675832	75.01	86.18	11.25	8.38	3.62	40.72	1.87	46.51	3.93	2.38	4.97	6.72	3.62	4.41	42.63
11	EC677044	73.24	80.24	6.45	8.59	4.46	28.76	1.10	36.98	4.35	3.72	5.61	4.41	2.87	3.71	26.71
12	EC677102	64.55	71.08	5.63	6.88	3.41	19.19	0.58	30.26	4.81	2.73	3.94	2.64	2.62	5.69	13.35
13	EC686527	54.62	63.87	4.00	5.57	4.00	16.00	0.50	31.85	4.77	3.28	4.21	4.52	2.62	2.53	12.68
14	EC686545	66.48	78.24	5.23	4.85	4.90	25.62	0.78	30.69	5.13	4.53	4.68	5.10	3.25	3.88	19.02
15	EC686550	83.500	97.750	8.40	3.80	4.12	34.60	1.26	36.45	4.07	2.88	3.90	5.65	4.70	3.59	28.16
16	EC686553	104.00	121210	7.49	10.70	5.71	42.76	1.64	38.47	3.20	4.09	4.87	5.00	3.50	3.04	37.72
17	EC686554	102.12	124.10	15.55	13.02	5.07	78.83	1.26	21.58	5.12	2.10	2.96	3.10	2.25	4.41	39.40
18	Mukti	60.00	71.37	5.94	5.41	3.28	19.48	0.78	40.51	3.38	4.32	3.96	4.83	3.12	2.88	17.80
19	Swarna Lalima	85.25	94.25	6.24	6.93	3.50	21.84	0.81	37.41	3.57	3.07	3.89	4.93	2.87	5.51	18.80
20	Swarna Naveen	84.50	90.68	3.47	7.73	4.12	14.29	0.57	40.35	4.46	4.12	3.98	5.20	3.07	3.08	13.15
21	Pusa Rohini	74.27	83.22	10.50	7.00	4.95	51.97	1.80	34.81	4.43	5.81	5.46	4.00	2.62	3.97	40.08
22	Kashi Hemanth	92.80	107.60	12.74	8.23	4.18	53.25	2.26	42.54	5.24	2.67	4.42	6.02	3.07	5.28	44.56
23	Kashi Sharad	63.50	78.64	3.60	5.02	2.95	10.62	0.44	41.62	4.18	3.06	4.50	4.78	2.62	2.97	11.12
24	Kashi Anupam	91.00	102.98	10.75	9.61	6.48	69.66	2.53	36.37	3.33	3.27	5.14	6.24	3.27	4.43	48.64

25	NTDR-1	60.94	74.70	4.00	7.95	5.74	22.96	1.02	44.73	3.94	5.36	5.28	5.93	3.70	4.05	23.36
26	HissarAru n	61.00	70.60	8.12	6.45	4.51	36.62	1.30	36.32	4.44	4.27	4.70	4.97	2.95	4.33	30.63
27	Pusa Gaurav	63.50	72.72	6.82	6.62	3.76	25.64	0.94	36.91	3.60	2.41	4.93	4.51	3.31	5.25	20.42
28	Pusa-120	72.48	82.05	6.87	7.12	4.09	28.09	1.12	40.10	5.25	4.06	4.05	5.07	3.20	3.04	26.70
29	Selection-12	70.63	87.56	7.85	8.65	64.65	52.20	2.10	40.40	4.94	4.54	4.50	6.15	2.62	3.68	42.63
30	EC-10304	64.75	72.57	9.69	4.45	3.48	33.72	1.66	40.76	3.47	3.89	4.23	6.04	3.57	4.05	36.99
CD (P = 0.01)		10.65	11.95	1.37	1.37	0.98	6.04	3.89	6.23	0.88	0.96	0.44	2.96	0.67	0.58	5.03
CD (P =0.05)		7.90	8.86	1.01	1.01	0.73	8.03	5.15	8.28	0.65	0.71	0.56	3.92	0.49	0.43	6.68

Table 4: Estimation of range, mean, genotypic and phenotypic coefficient of variation (GCV and PCV), heritability and genetic advance for different traits of tomato genotypes.

Sl. No.	Characters	Range	Grand mean	Coefficient of variation		Herita bility % (H)	Genetic advance (%)	
				GCV	PCV		GA	GA (%) of mean
1.	Plant height at 55 DAT(cm)	53.25 – 104	143.873	24.79	26.86	92.00	36.76	51.10
2.	Plant height at 90 DAT(cm)	67 – 125	178.15	33.80	35.91	94.00	62.02	69.62
3.	Number of clusters per plant	3.5 - 9.95	135.68	11.34	11.63	97.00	15.86	23.35
4.	Number branches per plant	3.7 - 13.02	13.08	52.75	57.32	92.00	7.10	10.85
5.	Number of fruits per cluster	2.95 -5.74	88.02	14.73	92.06	86.00	38.89	88.38
6.	Number of fruits per plant	10.62 - 69.66	66.37	85.14	97.36	84.00	57.63	73.68
7.	Yield per plant (kg)	0.44 - 2.53	205.83	33.63	58.86	57.00	72.44	69.26
8.	Average fruit weight (g)	21.58 - 49.46	725.90	89.28	97.33	84.00	51.70	142.46
9.	Yield (t/ha)	11.12 - 48.64	406.32	16.95	23.25	53.06	18.47	21.38
10.	TSS (^{o}brix)	3.2 - 5.1	8.46	70.92	47.24	15.00	6.18	45.99
11.	Fruit firmness (mm)	2.1 - 5.30	6.95	4.30	4.79	40.00	18.54	8.88
12.	Polar diameter(cm)	2.10 - 5.61	79.76	20.98	22.08	95.00	15.68	43.20
13.	Equatorial diameter (cm)	2.96 - 6.24	81.01	26.01	69.40	96.00	21.70	53.58
14.	Number of locules per fruit	2.1 - 4.7	5.93	6.75	10.13	66.00	40.78	137.79
15.	Lycopene (mg/100g)	2.33 - 5.42	8.00	20.14	20.99	90.00	1.23	39.93

GAM of 53.58 per cent, polar diameter (95 per cent) with GAM of 43.20 per cent, plant height at 90 DAT (94 per cent) with GAM of 69.62 per cent, plant height at 55 DAT (92 per cent) with GAM of 51.10 per cent, number of branches per plant (92 per cent) with GAM of 10.85 per cent, lycopene (90 per cent) with GAM of 39.93 per cent, number of fruits per cluster (86 per cent) with GAM of 88.38 per cent, number of fruits per plant (84 per cent) with GAM of 73.68 per cent, average fruit weight (84 per cent) with GAM of 142.46 per cent, number of locules per fruit (66 per cent) with expected genetic advance over percentage of mean of 137.79, yield per plant (57 per cent) with an expected genetic advance over percentage of mean of 69.26 and fruit firmness (40 per cent) with genetic advance as per cent mean of 8.88, while the lowest heritability was that of TSS (15 per cent) with an expected genetic advance over percentage of mean of 45.99. These results agreed with those of Manna and Paul (9) and Pradeep kumar and Tiwari (14).

All the tested characters of high heritability estimates illustrated that they will be affected by environmental condition. High genotypic variance was observed for most of the characters indicating more contribution of genetic component for the total variation. Therefore, these characters (Table 3) could be considered and exploited for selection purpose. Whereas, the characters like average fruit weight,

Table 5: Correlation among different characters studied in tomato.

Character	Yld/ ha	Yld/ plnt	PH. 55	PH. 90	Cluster	Branches	Ft/cl	Ft/pl	Av. Frt. wt	TSS	Frt. Firm	Pol dia	Eq. Dia	Loc/ ft	Lyco
Yld/ha	1.00														
Yld/plnt	0.81	1.00													
PH 55	0.28	0.88	1.00												
PH 90	0.15	0.76	0.89	1.00											
Cluster	0.03	0.89	0.49	0.33	1.00										
Branches	0.09	0.53	0.39	0.37	0.38	1.00									
Ft/cl	-0.13	-0.57	0.09	0.07	0.39	0.32	1.00								
Ft/pl	0.65	0.44	0.29	0.31	0.02	0.49	0.08	1.00							
Av. Frt.wt	0.45	0.51	-0.16	-0.29	-0.21	-0.29	-0.17	-0.04	1.00						
TSS	-0.04	-0.84	0.05	0.047	-0.19	0.28	0.07	0.06	-0.27	1.00					
Ft. Firm	0.17	-0.60	-0.12	-0.24	0.10	-0.05	0.09	0.11	0.40	-0.03	1.00				
haPol dia	-0.34	-0.46	-0.40	-0.32	-0.17	-0.06	0.26	-0.18	0.02	0.06	0.30	1.00			
Eq. Dia	-0.30	-0.60	-0.52	-0.41	-0.24	-0.12	0.25	-0.20	0.04	0.17	0.26	0.84	1.00		
Loc/ft	0.21	0.38	0.11	-0.01	0.09	-0.31	-0.12	0.04	0.41	-0.31	0.20	-0.08	-0.11	1.00	
Lyco	0.05	0.11	0.01	-0.00	-0.03	0.16	0.08	0.04	-0.02	-0.01	-0.42	-0.02	-0.04	-0.09	1.00

R-0.415 @ 5% 0.524@1%

* Yld/ha : Yield /ha, Yl/plnt **:**Yield/plant(g)**,** PH 55: Plant height at 55 days after transplanting (DAT) (cm), PH 90: Plant height at 90 DAT (cm), Cluster : No. of clusters /plant, No. branches: No. branches/plant, Ft/cl: No. of fruits/clusters: Ft/pl: No. of fruits/plant, Av. Ft.wt : Average fruit weight (g), Yld/plnt: Yield/plant(kg), Tss : TSS(brix), Ft. Firm: Fruit firmness (mm), Pol dia: Polar diameter (cm), Eq. Dia: Equatorial diameter (cm), Loc/ft : No. of loculs/fruit, Lyco: Lycopene (mg/100g).

number of fruits per plant, equatorial diameter, yield per plant, number of branches per plant, TSS, plant height, polar diameter, lycopene content, number of fruits per cluster, number of clusters per plant and number of locules per fruit showed high phenotypic variance indicating the strong influence of environmental factors for their expression. These results are in accordance of the results obtained by Vineet (22) and Agong *et al*. (1).

Higher GCV and PVC were recorded for characters like average fruit weight, number of fruits per plant, number of fruits per cluster, equatorial diameter, yield per plant, number of branches per plant and TSS indicating higher magnitude of variability for these characters. The results are in conformity with the findings of Anandgouda (2) and Manna and Paul (9).

Heritability was observed for the characters like number of clusters per plant, equatorial diameter, polar diameter, plant height, number branches per plant, lycopene, number of fruits per plant, average fruit weight, number of locules per fruit and yield per plant indicating that these traits are controlled by additive gene action which is very useful in selection. Similar results were noticed by Parvinder *et al.* (13). The estimates of heritability alone failed to indicate the response to selection as noticed by Shashikanth *et al.* (17). Therefore, heritability estimates appear to be more meaningful when accompanied by estimates of GA and GAM.

Basically yield is the main character with which all other characters are positively or negatively correlated (Table 4). Fruit yield per hactare had positive and significant correlation with fruit yield per plant, number fruits per plant, average fruit weight, plant height at 55 and 90 DAT, number of clusters per plant, number of branches per plant, fruit firmness and number of locules per fruit with confirmation of reports of Manna and Pal (9). Significant negative correlation was observed between the fruits per cluster, TSS, equatorial diameter, polar diameter and lycopene content. Similar results were reported by Agong *et al.* (1), Dhankar *et al.* (4) and Haydar (8). These findings illustrated markedly that number of fruits per plant were the important components in selection for higher yield of tomato. It could be noticed that most of the direct effects were less than one at the phenotypic level but more than one at the genotypic level indicating that

inflation due to multicolinearity was minimal phenotypically whereas maximum genetically was reported by Gravois and Helms (6) Manna and Paul (10) and Verma and Sarnaik (21).

CONCLUSION

High estimates of heritability and genetic advance as per cent over mean was noticed for number of clusters per plant, number of branches per plant, number of fruits per cluster, number of locules per fruit, average fruit weight, equatorial diameter, polar diameter, lycopene content and fruit firmness, which might be assigned to additive gene effects governing their inheritance and phenotypic selection for their improvement could be achieved by simple breeding methods. These traits are controlled by additive gene action which is very useful in selection. The estimates of heritability alone fail to indicate the response to selection. Therefore, heritability estimates appear to be more meaningful when accompanied by estimates of GA and GAM. According to correlation, it was observed that fruit yield per plant, number of fruits per plant, average fruit weight, plant height at 55 and 90 DAT, number of clusters per plant, number of branches per plant, fruit firmness and number of locules per fruit showed positive and significant correlation with total fruit yield indicating that direct selection for these traits might be effective and there is a possibility of improving yield per hactare through selection based on these characters.

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