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Genetic studies in tomato (*Solanum lycopersicum* [Mill.] Wettsd.) for yield and its attributing traits

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Abstract

The present investigation was carried out to estimate the genetic variability, heritability in broad sense, correlation and path coefficient and genetic divergence (D^2) analysis among 50 genotypes of tomato (*Solanum lycopersicum* [Mill.] Wettsd.) for twelve yield contributing traits during 2021 in Randomized Block Design with three replications. High magnitude of phenotypic as well as genotypic coefficient of variation were observed in case of number fruit per plant followed by unmarketable fruits yield per plant, average fruit weight, marketable fruit yield per plant and total fruit yield per plant. High heritability was recorded for all the traits. High heritability along with high genetic advance was estimated for average fruit weight followed by number of fruits per plant, marketable fruit yield per plant, unmarketable yield per plant and total fruit yield per plant. The polar diameter of fruit was highly significant and positive association with equitorial diameter of fruit. Positive direct effect was exerted by number of fruit per plant followed average fruit weight, polar diameter of fruit on fruit yield per plant. Maximum intra cluster distance was recorded within cluster III and inter cluster distance was recorded between cluster I to V III. Cluster III had maximum number of genotypes and highest per cent contribution towards clustering of genotypes were observe in average fruit weight.

Key words : Correlation, Genetic variability, Genetic divergence (D^2), Heritability, Path coefficient and Tomato.

Tomato (*Solanum lycopersicum* [Mill.] Wettsd.) is a major vegetable crop under the family solanaceae and genus *Solanum* which is herbaceous annual to

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perennial in nature and sexually propagated (by seed) crop plant with hermaphrodite flowers. Generally it is a day neutral and self-pollinated crop but a certain percentage of cross-pollination also occurs. It is a warm season vegetable crop reasonably resistant to heat, drought and can grow under wide range of soil and climatic conditions. It is widely cultivated vegetable throughout the world and ranks second importance after potato in many countries including India. In India, total area was 0.845 million hectares with production 21.181 million tonnes and there productivity 25.066 tonnes per hectare.

There are four to eight flowers in each compound inflorescence. Anthesis occurs from 7:00-8:00AM and dehiscence from 9:00-11:00AM. All different species of tomato are native to western South America[28]. Growth habit ranged from strongly determinate (bushy type) to indeterminate types.

Tomato is considered as "Poor man's Orange" and universally treated as 'Protective Food'. Tomato fruits are eaten raw or cooked. Tomato in large quantities is used for the preparation of several processed items like soup, juice, ketchup, puree, paste, powder and ripen fruits are used as raw vegetable in salad. Tomato is a good appetizer and its soup is said to be a good remedy for patients suffering from constipation.

Breeding efforts have contributed substantially for improving yield potential, wide adaptation through resistance or tolerance to abiotic and biotic stresses, plant type and fruit characteristics.

Study of genetic parameters provide an opportunity to study the variability, heritability, character association and diversity among 47 different genotypes with 3 checks for 12 characters of tomato under Ayodhya conditions.

The experimental material for the present investigation was comprised of 50 diverse genotypes including promising varieties, elite lines and land races with three checks (DVRT 2, NDT-7 and Arka Vikas) were replicated thrice in Randomized Complete Block Design. The whole investigation was conducted under the scientific management practices. During study, observations were recorded on five randomly selected plants from each treatment for characters like days to 50% flowering, plant height (cm), number of primary branches per plant, polar diameter of fruit (cm), equatorial diameter of fruit (cm), TSS (^{0}Brix), number of fruits per cluster, average fruit weight (g), number of fruits per plant, Marketable fruit yield per plant (g), unmarketable fruit yield per plant (g) and total fruit yield per plant (g).

The recorded data from experiment for eleven characters in tomato was subjected to the following statistical analysis such as heritability in broad sense, GCV and PCV [6], heritability in broad sense[3], genetic advance in per cent of mean[9], correlation coefficients[31], path coefficient analysis[5] and genetic divergence (D^2) analysis[13].

The estimation of genotypic and phenotypic coefficient of variation for twelve characters of tomato germplasm has been presented in (Table-1). The estimate of phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the characters. Highest phenotypic coefficient of variation was observed in number of fruit per plant, unmarketable fruit yield per plant, average fruit weight, marketable fruit yield per plant and total fruit yield per plant. While low magnitude of coefficient of variability was exhibited by total soluble solid and days to 50 per cent flowering. While, high estimate of genotypic coefficient of variation were observed in case of number of fruit per plant, unmarketable fruit yield per plant, average fruit weight, marketable fruit yield per plant, total fruit yield per plant. Moderate variations were recorded for number of fruit per cluster, plant height, equatorial diameter of fruit primary branches of fruit and polar diameter of fruit. While low magnitude of coefficient of variability was exhibited by total soluble solid and days to 50 per cent flowering. The high estimates of PCV and GCV for these characters were reported by Dar and Sharma[4] and Rani and Anitha[25], and Rai *et al.*,[23], while, moderate and low variability were also reported by Sahanur *et al.,*[30] and Madhurina and Paul[12].

Table-1. Estimates of range, grand mean, phenotypic (PCV), genotypic (GCV), heritability in broad sense, genetic advance (Ga) and genetic advance (in per cent of mean) for twelve characters in tomato germplasm

S. No.	Genetic parameters Characters	Range		Grand mean	PCV (%)	GCV (%)	Herita-bility in broad sense (%)	Genetic adva-nce (ga)	Genetic advance in per cent of mean
		Lowest	Highest						
1.	Days to 50 per cent flowering	22.33	37.00	32.07	9.72	8.70	80.18	5.15	16.06
2.	Plant height (cm)	39.66	97.16	64.98	18.45	18.32	98.56	24.35	37.48
3.	Primary branches per plant	4.66	9.53	7.26	16.64	16.23	95.16	2.36	32.63
4.	Polar diameter of fruit (cm)	3.66	7.30	5.16	15.94	15.84	98.79	1.67	32.45
5.	Equitorial diameter of fruit (cm)	3.99	8.28	5.46	17.66	17.50	98.02	1.95	35.73
6.	Total soluble solids (^{0}Brix)	5.55	7.40	6.26	8.40	6.19	54.40	0.58	9.41
7.	Number of fruits per cluster	1.43	5.50	3.60	21.55	21.13	96.08	1.53	42.66
8.	Average fruit weight (g)	29.45	142.28	70.36	38.77	38.67	99.46	55.90	79.45
9.	Number of fruits per plant	4.66	40.71	14.38	53.68	53.15	98.03	15.59	108.41
10.	Marketable fruit yield per plant (g)	388.44	1531.66	807.51	36.89	35.73	93.83	575.78	71.03
11.	Unmarketable fruit yield per plant(g)	31.53	260.00	84.80	48.58	46.93	93.32	79.19	93.39
12.	Total fruit yield per plant (g)	428.88	1705.00	892.32	36.26	35.33	94.91	632.73	70.90

Table-2. Estimates of phenotypic correlation coefficients among eleven characters in tomato germplasm

Characters	Plant height (cm)	Primary branches per plant	Polar diameter of fruit (cm)	Equitorial diameter of fruit (cm)	Total soluble solids (TSS)	Number of fruit per cluster	Average fruit weight (g)	Number of fruit per plant	Unmarketable fruit yield perplant (g)	Total fruit yieldper plant (g)
Days to 50% flowering	0.11	0.24**	0.40**	0.33**	0.03	-0.27**	0.27**	-0.31**	-0.02**	-0.03*
Plant height (cm)	1.00	0.32**	-0.05	-0.02	-0.04	0.18	-0.12	0.01	0.05	-0.02*
Primary branches per plant			0.17	0.21**	-0.12	0.09	0.09	-0.21**	-0.10	-0.09
Polar diameter of fruit (cm)				0.86**	-0.11	-0.19*	0.76**	-0.51**	0.05	0.12
Equitorial diameter of fruit (cm)					-0.05	-0.21**	0.77**	-0.43**	0.20*	0.18*
Total soluble solids (TSS)						-0.21**	-0.08	-0.09	-0.04	-0.09
Number of fruit per cluster							0.26	0.25**	0.02	0.06
Average fruit weight (g)								-0.58**	0.17*	0.17**
Number of fruit per plant									0.30**	0.59**
Unmarketable fruit yield per plant (g)										0.66**

*,** Significant at 5% and 1% probability level respectively

Table-3. Estimates of genotypic correlation coefficients among eleven characters in tomato germplasm

Characters	Plant height (cm)	Primary branches per plant	Polar diameter of fruit (cm)	Equitorial diameter of fruit (cm)	Total soluble solids (TSS)	Number of fruit per cluster	Average fruit weight (g)	Number of fruit per plant	Unmarketable fruit yield perplant (g)	Total fruit yieldper plant (g)
Days to 50% flowering	0.14	0.27	0.45	0.39	0.02	-0.31	0.31	-0.35	-0.00	-0.04
Plant height (cm)		0.34	-0.05	-0.02	-0.07	0.18	-0.12	0.02	0.05	-0.02
Primary branches per plant			0.18	0.21	-0.18	0.11	0.09	-0.22	-0.11	-0.09
Polar diameter of fruit(cm)				0.87	-0.15	-0.20	0.76	-0.52	0.05	0.12
Equitorial diameter of fruit (cm)					-0.08	-0.21	0.78	-0.44	0.21	0.18
Total soluble solids (TSS)						-0.29	-0.11	-0.00	-0.07	-0.09
Number of fruit per cluster							-0.27	0.25	0.02	0.05
Average fruit weight (g)								-0.58	0.18	0.17
Number of fruit per plant									0.32	0.58
Unmarketable fruit yield per plant (g)										0.70

Table-4. Direct and indirect effects of eleven characters on fruit yield per plant (g) at phenotypic level in tomato germplasm

Characters	Days to 50% flowering	Plant height (cm)	Primary branches/ plant	Polar diameter of fruit (cm)	Equitorial Diameter of fruit (cm)	Total soluble solids (TSS)	Number of fruit per cluster	Average fruit weight (g)	Number of fruits per plant	Unmarketable fruit yield/ plant (g)	Correlation with fruit yield per plant
Days to 50% flowering	0.0229	0.0011	0.0189	0.1871	-0.0835	0.0005	-0.0024	0.1582	-0.2849	-0.0065	0.0360
Plant height (cm)	0.0026	0.0091	0.0255	-0.0175	-0.0069	-0.0007	-0.0016	0.0709	0.0182	0.0183	-0.0282
Primary branches per plant	0.0055	0.0030	0.0783	0.0602	-0.0538	-0.0019	0.0009	0.0532	-0.1964	-0.0349	-0.0936
Polar diameter of fruit(cm)	0.0093	0.0005	0.0140	0.3360	-0.2132	-0.0017	0.0017	0.4324	-0.4733	0.0172	0.1230
Equitorial Diameter of fruit(cm)	0.0078	0.0003	0.0171	0.2911	-0.2461	-0.0008	0.0018	0.4421	-0.3988	0.0666	0.1812
Total soluble solids (TSS)	0.0007	0.0004	-0.0096	-0.0375	0.0127	0.0154	0.0019	-0.0478	-0.0179	-0.0143	-0.0959
Number of fruit per cluster	-0.0063	0.0017	0.0077	-0.0659	0.0527	-0.0034	-0.0086	-0.1507	0.2325	0.0092	0.0657
Average fruit weight (g)	0.0064	0.0011	0.0073	0.2561	-0.1918	-0.0013	0.0023	0.5672	-0.5335	0.0579	0.1717
Number of fruits per plant	-0.0071	0.0002	-0.0167	-0.1731	0.1068	-0.0003	-0.0022	-0.3295	0.9184	0.0990	0.5951
Unmarketable fruit yield/ plant (g)	-0.0005	0.0005	-0.0084	0.0179	-0.0507	-0.0007	-0.0002	0.1014	0.2808	0.3238	0.6628

R Square = 0.8454 Residual effect = 0.3932

Table-5. Direct and indirect effects of eleven characters on fruit yield per plant (g) at genotypic level in tomato germplasm

Characters	Days to 50% flowering	Plant height (cm)	Primary branches/ plant	Polar diameter of fruit (cm)	Equitorial Diameter of fruit (cm)	Total soluble solids (TSS)	Number of fruit per cluster	Average fruit weight (g)	Number of fruits per plant	Unmarketable fruit yield/ plant (g)	Correlation with fruit yield per plant
Days to 50% flowering	0.0091	0.0023	0.0270	0.1220	-0.1289	0.0011	0.0014	0.1733	0.3166	0.0019	0.0457
Plant height (cm)	0.0017	0.0163	0.0337	-0.0224	0.0096	0.0039	-0.0008	0.0700	0.0189	0.0227	0.0268
Primary branches per plant	0.0025	0.0056	0.0986	0.0763	-0.0717	0.0095	-0.0005	0.0536	-0.1977	-0.0437	-0.0977
Polar diameter of fruit(cm)	0.0042	0.0042	0.0180	0.4184	-0.2885	0.0078	0.0009	0.4267	-0.4670	0.0205	0.1262
Equitorial Diameter of fruit(cm)	0.0036	0.0005	0.0215	0.3672	-0.3287	0.0044	0.0009	0.4377	-0.3941	0.0843	0.1883
Total soluble solids (TSS)	0.0002	0.0012	-0.0181	-0.0634	0.0283	0.0516	0.0012	-0.0637	-0.0085	-0.0282	-0.0993
Number of fruit per cluster	0.0029	0.0030	0.0109	-0.0838	0.0708	0.0150	-0.0043	-0.1513	0.2264	0.0104	0.0582
Average fruit weight (g)	0.0028	0.0021	0.0095	0.3221	-0.2596	0.0059	-0.0012	0.5543	-0.5228	0.0702	0.1739
Number of fruits per plant	0.0032	0.0003	-0.0219	-0.2195	0.1455	0.0005	-0.0011	-0.3255	0.8903	0.1235	0.5873
Unmarketable fruit yield/ plant (g)	0.0000	0.0010	-0.0112	0.0222	-0.0719	0.0038	-0.0001	0.1011	0.2856	0.3850	0.7059

R Square = 0.8670 Residual effect =SQRT (0.3648)

Table-6. Clustering pattern of fifty genotypes of tomato germplasm on the basis of Mahalanobis' D^2 statistics

Cluster number	No. of genotypes	Genotypes
I	4	NDT-2, NDT-7-1, NDT-13H-6-5-3, NDT-13-1
II	4	NDT-11-5-1-1, NDT-11-8-2, NDT-11-17-1, NDT-11-21-1
III	9	NDT-6, NDT-11-6-1, NDT-11-6-2, NDT-11-13-1-1, NDT-11-13-1-2, NDT-12R-1-2, NDT-13VI-5, NDT-13VI-6, NDT-15VI-1
IV	7	NDT-3-1, NDT-11-22-1, NDT-12H-1-2, NDT-13H-6-5-2, NDT-13VI-2, NDT-13VI-3, Arka Vikas (C)
V	6	NDT-3, NDT-8, NDT-1-1, NDT-13V-4, DVRT-2 (C), NDT-T (C)
VI	7	NDT-1, NDT-2-2, NDT-2-3, NDT-5, NDT-5-1, NDT-5-2, NDT-5-3
VII	7	NDT-11-3-2, NDT-2-1, NDT-11-4-1, NDT-11-18-1, NDT-11S5x3-2-1, NDT-11S5x7-2, NDT-12R-7-1
VIII	6	NDT-13VI-4, NDT-11-8-1-1, NDT-11-9-1-1, NDT-11S5x3-2-2, NDT-11S5x3-5-3-1, NDT-13V-2

Table-7. Average on intra-and inter-clusters D^2 values for eight clusters in tomato germplasm

Cluster number	I	II	III	IV	V	VI	VII	VIII
I	**395.733**	832.577	1575.353	1620.027	1519.769	3134.044	3054.339	5626.236
II		**237.101**	630.951	461.913	740.716	1315.611	1234.894	3815.211
III			**534.065**	675.295	697.62	1248.221	783.044	3302.723
IV				**242.413**	970.551	792.249	760.753	2996.178
V					**430.593**	1875.543	1088.301	4286.714
VI						**525.372**	727.880	1784.806
VII							**251.451**	2333.565
VIII								**232.734**

Note: Bold figures indicate intracluster distance

Table-8. Intra-cluster group means for twelve characters in tomato germplasm

Character Cluster	Days to 50% flowering	Plant height (cm)	Primary bran-ches per plant	Polar diameter of fruit (cm)	Equi-torial diameter of fruit (cm)	Total soluble solids (TSS)	Number of fruit per cluster	Average fruit weight (g)	Number of fruits per plant	Market-able fruit yield per plant (g)	Unmarket-able fruit yield per plant (g)	Total fruit yield per plant (g)
I	32.80	55.92	6.77	6.38	6.96	6.28	3.2	124.86	6.97	798.58	81.74	880.33
II	33.33	55.39	7.36	5.57	5.89	6.21	3.83	92.87	11.20	938.25	83.66	1021.91
III	33.25	72.19	7.53	4.94	5.68	6.25	2.71	84.89	11.52	802.75	112.18	914.94
IV	33.42	54.49	7.36	5.54	5.51	6.29	2.92	64.08	10.85	635.61	60.52	696.14
V	33.71	79.90	8.24	6.03	6.40	6.04	3.92	83.84	12.92	985.05	102.65	1087.71
VI	29.88	58.98	6.21	4.36	4.60	6.29	4.04	48.17	18.76	805.41	86.71	892.12
VII	31.95	77.46	7.97	4.67	4.74	6.36	3.64	51.12	13.68	614.77	73.83	688.64
VIII	27.83	67.83	7.28	4.01	4.47	6.41	4.10	33.73	40.60	1276.45	95.26	1371.72

Table-9. Per cent contribution of twelve characters towards total genetic divergence in tomato germplasm

S. No.	Characters	Per cent contribution
1.	Days to 50% flowering	0.24
2.	Plant height (cm)	18.61
3.	Primary branches per plant	4.33
4.	Polar diameter of fruit (cm)	10.45
5.	Equitorial diameter of fruit (cm)	1.71
6.	Total soluble solids (TSS)	0
7.	Number of fruit per cluster	5.06
8.	Average fruit weight (g)	43.92
9.	Number of fruits per plant	3.10
10.	Marketable fruit yield per plant (g)	8.57
11.	Unmarketable fruit yield per plant (g)	3.92
12.	Total fruit yield per plant (g)	0.08

Estimation of heritability and genetic advance for different characters are presented in Table-2. The heritability in broad sense ranged from 54.40 (Total soluble solid) to 99.46 per cent for average fruit weight. However, the heritability was higher for all the characters. The genetic advance in per cent of mean was also high for unmarketable fruit yield per plant (93.39%), average fruit weight (79.45%), marketable fruit yield per plant (71.03) and total fruit yield per plant (70.90). It is to be noted that these traits also showed high estimates of broad sense heritability. High heritability coupled with high genetic advance were estimated for average fruit weight followed by number of fruits per plant, marketable fruit yield per plant, unmarketable yield per plant and total fruit yield per plant. High heritability along with high genetic advance have also been reported for most of the yield and yield attributing traits by Kumari *et al.,*[11], Saeed *et al.,*[29], Prema *et al*.,[22], Tasisa *et al.,*[36], Sahanur *et al.,*[30], Patel *et al.,*[20] and Singh *et al.,* 2017. The high estimates of heritability, genetic advance and genetic advance per cent of mean for these characters were also reported earlier by Singh *et al*.,[35], Kumari *et al*.,[10], Maurya *et al.,*[16], Tasisa *et al.,*[36], Reddy *et al.,*[27], Hasan *et al*.,[7] and Singh *et al*.,[35].

In general the magnitude of genotypic correlation coefficient was higher than the corresponding values of the phenotypic correlation coefficient except few exceptions (Tables-2 and 3). This indicated a strong genetic association between there traits and the phenotypic expression was suppressed due to environmental influence. The present study also suggested that both genotypic and phenotypic correlations were similar in direction[11], also reported higher estimates of genotypic than the corresponding phenotypic correlation between yield and yield component. The most important trait, polar diameter of fruit had exhibited highly significant and positive phenotypic correlation coefficient with equitorial diameter of fruit (0.86). Equitorial diameter of fruit (0.77), and polar diameter of fruit (0.76) had highly significant and positive correlation with average fruit weight. Unmarketable fruit yield per plant (0.66) and number of fruit per plant (0.59) had highly significant and positive correlation with total fruit yield per plant which are also proposed earlier by Makesh *et al*.,[15], Maurya *et al*.,[16] Madhurina and Paul[12], and Hasan *et al.,*[7]. While average fruit weight (-0.58), polar diameter of fruit (-0.51), equitorial diameter of fruit (-0.43), and days to 50% flowering (-0.31) were highly significant and negative correlation with number of fruit per plant respectively. Days to 50% flowering (-0.27) was highly significant and negative correlation with number of fruit per cluster. Some researchers also reported by Madhurina and Paul[12], Maurya *et al*.,[16], Ara *et al*.,[2] and Singh[33].

The direct and indirect effect of different characters on fruit yield per plant at phenotypic and genotypic level has presented in Table 4 and 5. The higher magnitude of positive direct effect on fruit yield per plant was exerted by number of fruit per plant (0.9184) followed by average fruit weight (0.5672), polar diameter of fruit (0.3360), unmarketable fruit yield per plant (0.3238), while primary branches per plant (0.0783), days to 50% flowering (0.0229), total soluble solids (0.0154) and plant height (0.0091) showed substantially low positive direct effect. The negative direct effect on fruit yield per plant was showed by equitorial diameter of fruit (-0.2461) and number of fruit per cluster (-0.0086). Substantial positive indirect effect was exerted by equitorial diameter of fruit (0.4421), polar diameter of fruit (0.4324) via average fruit weight, unmarketable fruit yield per plant (0.2808), number of cluster per plant (0.2325) via number of fruit per plant, average fruit weight (0.2561) via polar diameter of fruit, days to 50% flowering (0.1582), via average fruit weight, exerted on fruit yield per plant. While average fruit weight (-0.5355), polar diameter of fruit (-0.4733), equitorial diameter of fruit (-0.3988) via number of fruit per plant, number of fruit per plan (-0.3295) via average fruit weight, days to 50 per cent flowering (-0.2849) and primary branches per plant (-0.1964) via number of fruits per plant showed negative indirect effect on fruit yield per plant. Similar results were also described by Makesh *et al.,*[15], Narolia *et al.,*[19] and Rajolli *et al.,*[24].

The genetic divergence was estimated by Mahalanobis' D^2 statistics as described by Rao[26]. The clustering pattern of the fifty genotypes were grouped into eight different non-overlapping cluster (Table-6). Cluster III had highest number of genotypes (9) followed by cluster IV (7), cluster VI (7), cluster VII (7), cluster V (6), cluster VIII (6), Cluster I (4) and Cluster II (4) genotypes.

The minimum intra cluster distance (Table-7) was found for cluster VIII (232.734) and maximum was found for cluster III (534.065) followed by cluster VI (525.372) and cluster V (430.593) and cluster I (395.733). The maximum inter-cluster distance was found between cluster I to cluster VIII (5626.236) followed by cluster V to cluster VIII (4286.714), cluster II to cluster VIII (3815.211), cluster III to cluster VIII (3302.723) and cluster I to cluster VI (3134.04).

The minimum inter-cluster D^2 value were found in case of cluster II to cluster IV (461.913) followed by cluster II to cluster III (630.951) and cluster III to IV (675.295). The higher inter-cluster distance indicated greater genetic divergence between the genotypes of those clusters, while lower inter-cluster values between the clusters suggested that the genotypes of the clusters were not much genetically diverse from each other.

A perusal of Table-8 shows that cluster means for different traits indicated considerable differences between the clusters. The entire cluster from cluster I to cluster VIII had average mean performance for most of the characters, exhibiting extreme cluster means for none of the characters under study. Cluster I showed maximum mean values for the average fruit weight (124.86), equitorial diameter of fruit (6.96), and polar diameter of fruit (6.38) cluster III showed maximum mean values for the unmarketable fruit yield per plant (112.18) and minimum mean values number of fruit per cluster (2.71), Cluster IV showed minimum mean values for the unmarketable fruit yield per plant (60.52), cluster V showed maximum mean values plant height (79.90), days to 50% flowering (33.71), primary branches per plant (8.24) while cluster V showed minimum mean values total soluble solid (6.04). Cluster VI showed minimum mean values of primary branches per plant (6.21), cluster VII showed minimum mean values of marketable fruit yield per plant (614.77) and cluster VIII showed maximum mean values of the total fruit yield (1371.72) and total soluble solid (6.41).

Highest per cent contribution towards clustering of genotypes were observe (Table-9) for average fruit weight (43.92%) followed by plant height (18.61%), polar diameter of fruit (10.45%), marketable fruit yield per plant (8.57%), and the contribution for other eight characters *viz.*, number of fruit per cluster (5.06%), primary branches per plant (4.33%), unmarketable fruit yield per plant (3.92%), number of fruits per plant (3.10%), equitorial diameter of fruit (1.71%), days to 50 per cent flowering (0.24%), fruit yield per plant (0.08%) and total soluble solid (0.00) very low for the diversification genotype in Table-9. Similar result were also described by Mahesha *et al.,*[14], Mehta *et al.,*[17], Jogi *et al.*,[8], Mehta and Asati[18], Prashanth *et al.*,[21] and Singh *et al.*,[32].

Thus, in the light of above findings it may be concluded that high magnitude of phenotypic as well as genotypic coefficient of variation, high heritability along with high genetic advance were observed in some characters, which are indicating possibility of obtaining higher selection response in respect of these traits. The polar diameter of fruit has highly significant and positive association with equitorial diameter of fruit and selection for this trait would be effective for yield improvement. The occurrence of negative as well as positive direct and indirect effects by yield components on fruit yield *via* one or other characters, simultaneously presents a complex situation where a compromise is required to attain a proper balance of different yield components for determining the ideotype for high fruit yield in tomato.

The genotypes in cluster I and II are mostly identical and have less diversity. The high genetic distance of the genotypes on the basis of quantitative traits revealed the diversity in the germplasm of tomato (*Solanum lycopersicum* [Mill.] Wettsd.), which can be used for the improvement of crop. Therefore, these genotypes should be considered to improve the fruit yield per plant in tomato crop.

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