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RESEARCH PAPER

Genetic variability, heritability and correlation studies in tomato genotypes (*Lycopersicon esculentum* Mill.)

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Abstract : Genetic variability, heritability, genetic advance and correlation for different yield contributing characters were studied in 19 genotypes of tomato. Significant differences were observed among the genotypes for all the traits. The phenotypic co-efficient of variation (PCV) was higher than genotypic co-efficient of variation (GCV) for all the traits.Traits like plant height 120 DAT, number of branches 120 DAT, number of fruits per plant, average fruit weight, number of cluster per plant, fruit set (%), radial diameter and polar diameter (mm), ascorbic acid (vita'C'), TSS (Brix), showed positive correlation with fruit yield per ha, plant height after 120 DAT, days to 50 per cent flowering, leaf curl incidence and intensity showed negative correlation at both phenotypic and genotypic level. Genetic advance at 5 per cent was found high for plant height after 120 DAT, number of fruits per plant, ascorbic acid and fruit yield per plant(g). Where as genetic advance as per cent of mean at 5 per cent was noticed high for all the traits except days to flower initiation and days to first harvest. Number of fruits per plant exhibited the highest positive direct effect followed by days to flower per cent, ascorbic acid content, plant height 120 DAT and fruit diameter at genotypic level. In view at the direct and indirect contributions of component traits towards fruit yield per plant, selection on the basis of horticultural traits *viz.*, average fruit weight and number of fruits per plant would be a paying preposition in the genotypes included in the study.

Key Words : Tomato, GCV, PCV, Heritability, Correlation, Path analysis

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INTRODUCTION

Tomato widely known as pepper is a member of family Solanaceae and is very important crop for vegetable. There is a good scope for increasing its export by pushing up production. In India especially, it is considered as a mint master for adding foreign exchange to the states have given it a good locus in the area of horticultural crops and hence, the breeder work for overall improvement of this crop for profitable returns. A wide range of variability in tomato is available which provide a great scope for improving fruit yield through a systematic and planned selection programme. The present investigation was conducted for selected 19 genotypes to determine the extent of genetic variability, genetic co-efficient, heritability, genetic advance and correlation of different characters in tomato.

MATERIALS AND METHODS

The field experiment was carried at the Vegetable Research Farm, Department of Horticulture, SHIATS, Allahabad. Seedlings of 19 genotypes of tomato were transplanted in a Randomized Block Design with three replications during 2011-12. Seedlings were transplanted in to the main field at 60cm row to row and 50cm between plant to plant spacing. All the recommended agro climatic package of practices were followed. Observation on five randomly selected plants of each plants of each genotype were recorded for 16 quantitative characters *viz.*, plant height, number of branches per plant, number of leaves, flower per plant, cluster

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per plant, days to 50 per cent flowering, fruit set per cent, number of fruits per plant, average fruit weight, capsaicin content, ascorbic acid content, TSS, fruit diameter, leaf curl incidence and intensity, and fruit yield per plant (g).The phenotypic and genotypic co-efficient of variability were calculated according to the method suggested by Burton (1953). For estimation of heritability (Broad sence), genetic advance and correlation were calculated according to the suggested by Johnson *et al.* (1955.

RESULTS AND DISCUSSION

Analysis of variance revealed significant differences among the genotypes for all the traits indicating the presence of sufficient genetic variability in the genotypes and considerable scope for their improvement. Sufficient genetic variability for many of the horticultural traits studied in tomato. The extent of variability with respect to 16 characters in different genotypes measured in terms of range, genotypic co-efficient of variation (GCV), phenotypic co-efficient of variation (PCV), along with the amount of heritability (h), expected genetic advance and genetic advance as per cent of mean (GAM) are given in (Table 1). The considerable amount of variation was observed for all the characters. The phenotypic co-efficient of variability (PCV) was higher than the genotypic co-efficient of variability in all the characters (Table 1). The estimates of PCV and GCV were high for fruit yield per plant, yield per ha. Fruits weight, radial diameter, polar diameter and average fruit weight moderate for days to 50 per cent flowering and low for ascorbic acid content. Also reported high phenotypic and genotypic co-efficient of variations, for fruit yield per plant, number of fruits per plant and fruit weight, respectively. The heritability of the highest magnitude was noticed for leaf curl intensity (98) and moderate for plant height 120 DAT (31). Thus, it indicated that larger proportion of phenotypic variance has been attributed to genotypic variance and reliable selection could be made for almost all the traits on the basis of phenotypic expression. High heritability estimates for average fruit weight (Das and Choudhary, 1999), number of fruits per plant (Sreelathakumary and Rajamony, 2002), plant height (Ibrahim *et al*., 2001; Bhardwaj *et al*., 2007) observed by earlier workers were in consonance with the present study. The heritability and high estimation of genetic advance case per cent of mean were observed in cas of leaf curl intensity (98) and (107.83), radial diameter (82) and (43.63), fruits weight (80) and (39.36). High heritability and high genetic advance have been obtained by many workers for average fruits weight, (Kataria *et al.*, 1997). For number of fruits per plant, high heritability along with moderate to low genetic advance was observed for average fruit weight, number of branches, fruit set percentage and fruits per plant. The result are in consonance with the finding for fruit weight (Rani and Anitha, 2011 and Tasisa *et al.*2011).

In the present experiment, the study of correlation among different characters revealed that, in general the genotypic correlation co-efficient was larger than the phenotypic correlation (Table 2). This indicate little role of environment in

Table 1: Range, mean, coefficient of variations, heritability and genetic advance of mean for 16 traits in tomato

Characters	Range		Mean	GCV	PCV	h^2(bs)	GA	GA as per cent on mean
	Max.	Min.						
Plant height 120 DAT(cm.)	134.8133	91.5100	104.8793	11.68	12.56	87	23.48	22.39
Leaves at 120 DAT	88.960	71.720	76.660	4.73	8.45	31	4.17	5.44
Branches at 120 DAT	13.076	7.686	11.023	13.46	18.24	54	2.26	20.47
Days to 50% flowering	75.966	46.536	64.927	11.49	13.50	72	13.08	20.14
Clusters/ plant	20.366	8.636	14.714	16.96	23.64	51	3.69	25.06
Flowers/ plant	110.500	63.766	85.022	13.08	17.57	55	17.06	20.07
Fruits set (%)	62.633	20.833	42.477	24.16	27.92	75	18.30	43.08
Fruits/ plant	45.033	21.966	33.591	18.92	23.11	67	10.72	31.90
Leaf curl incidence (%)	54.776	11.286	28.581	46.01	49.99	85	24.94	87.25
Leaf curl intensity (%)	54.476	6.873	26.162	52.81	53.43	98	28.13	107.83
Radial diameter (mm)	75.046	26.176	51.226	23.35	25.75	82	22.35	43.63
Polar diameter (mm)	60.916	26.483	39.341	22.76	25.68	79	16.34	41.54
TSS (Brix)	6.466	3.133	4.512	19.52	26.91	53	1.32	29.17
Vitamin 'C' (Mg.)/100g	41.510	26.090	32.957	9.73	14.53	45	4.42	13.19
Fruits weight (g)	61.353	30.246	43.931	21.39	23.94	80	17.29	39.36
Yield/plant(g)	2298.933	782.666	1450.492	20.71	25.67	65	499.23	34.42
Yield/ ha.(Tones)	76.700	26.100	49.542	21.10	26.23	65	17.32	34.96

GCV = Genotypic coefficient of variation, PCV = Phenotypic co-efficient of variation , h^2 = Heritability, GA = Genetic advance,
GA= Genetic advance as per cent of mean

Table 2: Estimates of phenotypic (P) and genotypic (G) correlation coefficient for different horticultural traits in tomato

So.No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	P	1.0000	0.2379*	-0.470*	0.0261	0.0653	0.4569	0.2172	0.4517*	-0.423*	-0.3998**	0.3689**	0.2450	0.3422**	0.3567**	-0.1593	0.2964*
	G	1.0000	0.5096**	-0.7869**	-0.0354*	0.0977	0.5883**	0.2747*	0.5324**	-0.5085**	-0.4255**	0.4625**	0.2657*	0.5564**	0.4719**	-0.2084	0.3078*
2.	P		1.0000	0.3564*	-0.3112	0.1455	0.2141	0.2774*	0.1140	-0.1361	-0.1120	0.1070	0.0834	0.2500	0.0423	0.1333	0.2404
	G		1.0000	-0.9502**	-0.5344*	0.6310*	0.3175*	0.6377**	0.3205*	-0.2753*	-0.2176	0.0436	0.0345	0.6994**	0.8406**	0.2098	0.5435**
3.	P			1.0000	0.1233	0.0169	-0.4049	0.0242	-0.0186	0.4136*	0.4087**	-0.2810*	-0.0880	-0.0865	-0.2488	0.0512	0.0638
	G			1.0000	0.1457	-0.0009	-0.6711*	-0.0723	-0.1933	0.6009**	0.5827**	-0.3753*	-0.2461**	-0.3044*	-0.4108**	0.1735	0.0170
4.	P				1.0000	0.2685	0.3284	-0.4804*	-0.2582	-0.2002	-0.0936	0.2596	0.0801	0.1029	0.0311	0.3775**	0.0569
	G				1.0000	-0.4096	0.4105*	-0.5113**	-0.3480**	-0.2363	-0.1108	0.3972**	0.0968	0.1750	-0.3376*	0.4831**	0.0670
5.	P					1.0000	0.1062	0.4282	0.4115*	0.0746	0.0727	-0.0206	0.0047	0.1292	-0.0485	-0.1391	0.3010*
	G					1.0000	0.0482	0.7043**	0.5530**	0.1802	0.1071	-0.0381	0.0152	0.2616	0.0783	-0.1942	0.3884**
6.	P						1.0000	-0.2274	0.0531	0.3086*	-0.2898*	0.5530**	0.2066	0.2374	0.1142	0.1863	0.2164
	G						1.0000	-0.1471	0.0132	0.4635**	-0.3452*	0.7787**	0.2740*	0.3069*	0.2392*	0.2831*	0.2631*
7.	P							1.0000	0.7388*	0.0809	0.0418	0.3030*	0.2623*	0.4233**	0.0945	0.1826	0.5208**
	G							1.0000	0.9008**	-0.1116	-0.0497	-0.3622*	-0.3550**	0.5865**	0.3435*	-0.2039	0.6854**
8.	P								1.0000	-0.1143	-0.0228	0.0208	-0.1497	0.3527**	0.0520	-0.4047**	0.5693**
	G								1.0000	-0.1094	-0.0378	-0.0608	-0.2081	0.4104**	0.0742	-0.4683**	0.4677**
9.	P									1.0000	0.8543**	-0.1265	0.0796	-0.4507**	-0.2407	-0.2105	-0.2731
	G									1.0000	0.9418**	-0.1523	0.1125	-0.5198**	-0.3250*	-0.2487*	-0.3291*
10.	P										1.0000	-0.0871	0.0756	-0.2438	-0.1832	-0.2177	-0.2086
	G										1.0000	-0.1113	0.0715	-0.3359*	-0.2609*	-0.2430*	-0.2697*
11.	P											1.0000	0.6129**	0.0890	0.0730	0.0637	0.0732
	G											1.0000	0.7651**	0.0308	0.1618	0.0981	0.0328
12.	P												1.0000	-0.0436	0.1118	-0.0390	-0.1416
	G												1.0000	-0.0758	0.4203**	-0.0592	-0.2159
13.	P													1.0000	0.2717*	0.1929	0.5144**
	G													1.0000	0.6591**	0.3256*	0.7316**
14.	P														1.0000	0.0007	0.1299
	G														1.0000	-0.0067	0.1926
15.	P															1.0000	0.4858**
	G															1.0000	0.5382**

* and ** indicate significant at 5% and 1% level, respectively. 1= Plant height 120 DAT(Cm.), 2= leaves at 120 DAT, 3= branches at 120 DAT, 4= Days to 50 % flowering, 5= clusters/ plant, 6= Flowers/ plant, 7= Fruits set (%), 8= Fruits/ plant, 9= Leaf curl incidence (%), 10= Leaf curl Intensity (%), 11= Radial diameter (mm), 12= Polar diameter (mm, 13= TSS (Brix), 14= Vitamin 'C' (Mg.)/100g, 15= Fruits weight (g), 16= Yield/ plant(g)

Table 3: Estimates of direct and indirect effect of different horticultural traits on fruit yield per plant at phenotypic (P) and genotypic (G) levels in tomato

Sr. No.		1	2	3	4	5	6	6	7	8	9	10	11	12	13	14	15
1.	P	0.0235	0.0056	-0.0111	0.0006	0.0015	0.0107	0.0051	0.0106	-0.0099	-0.0094	0.0087	0.0058	0.0080	0.0084	-0.0037	0.2964
	G	0.045	0.024	-0.037	-0.0017	0.0046	0.0278	0.0130	0.0251	-0.024	-0.020	0.0218	0.0126	0.0263	0.0223	-0.0098	0.3078
2.	P	0.0092	0.0388	-0.0138	-0.0121	0.0056	0.0083	0.0108	0.0044	-0.0053	-0.0043	0.0042	0.0032	0.0097	0.0016	0.0052	0.2404
	G	-0.0237	-0.0465	0.0442	0.0249	-0.0293	-0.0148	-0.0297	-0.0149	0.0128	0.0101	-0.0020	-0.0016	-0.0325	-0.0391	-0.0098	0.5435
3.	P	-0.0471	-0.0357	0.1000	0.0123	0.0017	-0.0405	0.0024	-0.0019	0.0414	0.0409	-0.0281	-0.0088	-0.0087	-0.0249	0.0051	0.0628
	G	-0.1557	-0.1881	0.1979	0.0288	-0.0002	-0.1328	-0.0143	-0.0383	0.1189	0.1153	-0.0743	-0.0487	-0.0603	-0.0813	0.0353	0.0170
4.	P	-0.0017	0.0209	-0.0083	-0.0670	0.0180	-0.0220	0.0322	0.0173	0.0134	0.0063	-0.0174	-0.0054	-0.0069	-0.0021	-0.0253	0.0569
	G	0.0079	0.1192	-0.0325	-0.2231	0.0914	-0.0916	0.1141	0.0776	0.0527	0.0247	-0.0886	-0.0216	-0.0390	0.0753	-0.1078	-0.0670
5.	P	0.0038	0.0084	0.0010	-0.0156	0.0580	0.0062	0.0748	0.0239	0.0043	0.0042	-0.0012	0.0003	0.0075	-0.0028	-0.0081	-0.3010
	G	0.0062	0.0399	-0.0001	-0.0259	0.0633	0.0031	0.0446	0.0350	0.0114	0.0068	-0.0024	0.0010	0.0166	0.0050	-0.0123	0.3884
6.	P	0.0014	0.0007	-0.0013	0.0010	0.0003	0.0031	-0.0007	0.0002	-0.0010	-0.0009	0.0017	0.0006	0.0007	0.0004	0.0006	0.2164
	G	0.0427	0.0230	-0.0487	0.0298	0.0035	0.0725	-0.0107	0.0010	-0.033	-0.025	0.0565	0.0199	0.0223	0.0173	0.0205	0.2631
7.	P	-0.0256	-0.0327	-0.0029	0.0567	-0.0505	0.0268	-0.1180	-0.0872	0.0095	0.0049	0.0357	0.0309	-0.0499	-0.0111	0.0215	0.5208
	G	-0.0381	-0.0884	0.0100	0.0709	-0.0977	0.0204	-0.1387	-0.1249	0.0155	0.0069	0.0502	0.0492	-0.0813	-0.0479	0.0283	0.6854
8.	P	0.4233	0.1069	-0.0174	-0.2420	0.3857	0.0498	0.6924	0.9372	-0.1071	-0.0214	0.0195	-0.1403	0.3306	0.0487	-0.3793	0.5693
	G	0.4443	0.2675	-0.1513	-0.2904	0.4615	0.0110	0.7517	0.8345	-0.091	-0.031	-0.0508	-0.1736	0.3425	0.0620	-0.3908	0.4677
9.	P	-0.0246	-0.0079	0.0241	-0.0117	0.0044	-0.0180	-0.0047	-0.0067	0.0584	0.0499	-0.0074	0.0046	-0.0263	-0.0141	-0.0123	-0.2731
	G	-0.0842	-0.0456	0.0995	-0.0391	0.0299	-0.0768	-0.0185	-0.0181	0.1656	0.1560	-0.0252	0.0186	-0.0861	-0.0538	-0.0412	-0.3291
10.	P	0.0258	0.0072	-0.0263	0.0060	-0.0047	0.0187	0.0027	0.0015	-0.0551	-0.0644	0.0056	-0.0049	0.0157	0.0118	0.0140	-0.2086
	G	0.0807	0.0413	-0.1105	0.0210	-0.0203	0.0655	0.0094	0.0072	-0.178	-0.189	0.0211	-0.0136	0.0637	0.0495	0.0461	-0.2697
11.	P	-0.0070	-0.0020	0.0053	-0.0049	0.0004	-0.0105	0.0058	-0.0004	0.0024	0.0017	-0.0190	-0.0116	-0.0017	-0.0014	-0.0012	0.0732
	G	0.0389	0.0037	-0.0315	0.0334	-0.0032	0.0654	-0.0304	-0.0051	-0.012	-0.009	0.0840	0.0643	0.0026	0.0136	0.0082	0.0328
12.	P	0.0019	0.0006	-0.0007	0.0006	0.0000	0.0016	-0.0020	-0.0012	0.0006	0.0006	0.0047	0.0077	-0.0003	0.0009	-0.0003	0.1416
	G	-0.0222	-0.0029	0.0205	-0.0081	-0.0013	-0.0228	0.0296	0.0173	-0.009	-0.006	-0.0638	-0.0834	0.0063	-0.0350	0.0049	0.2159
13.	P	0.0143	0.0105	-0.0036	0.0043	0.0054	0.0100	0.0177	0.0148	-0.0189	-0.0102	0.0037	-0.0018	0.0419	0.0114	0.0081	0.5144
	G	0.1173	0.1474	-0.0542	0.0369	0.0551	0.0647	0.1236	0.0865	-0.109	-0.070	0.0065	-0.0160	0.2108	0.1389	0.0686	0.7316
14.	P	0.0366	0.0043	-0.0255	0.0032	-0.0050	0.0117	0.0097	0.0053	-0.0247	-0.0188	0.0075	0.0115	0.0278	0.1025	0.0001	0.1299
	G	0.0339	0.0604	-0.0295	-0.0243	0.0056	0.0172	0.0248	0.0053	-0.023	-0.018	0.0116	0.0302	0.0474	0.0719	-0.0005	0.1926
15.	P	-0.1373	0.1148	0.0441	0.3253	-0.1199	0.1605	-0.1573	-0.3486	-0.1813	-0.1875	0.0549	-0.0336	0.1662	0.0006	0.8614	0.4858
	G	-0.1872	0.1884	0.1603	0.4340	-0.1745	0.2543	-0.1832	-0.4206	-0.223	-0.218	0.0882	-0.0532	0.2925	-0.0060	0.8983	0.5382

Residual effect(P) = 0.1472, (G)=0.1267; Bold values indicate direct effects. 1= Plant height 120 DAT(Cm.), 2= leaves at 120 DAT, 3= branches at 120 DAT, 4= Days to 50 % Flowering. 5= clusters/ plant, 6= Flowers/ plant, 7= Fruits set (%), 8= Fruits/ plant, 9= Leaf curl incidence (%), 10= Leaf curl Intensity (%), 11= Radial diameter (mm), 12= Polar diameter (mm, 13= TSS (Brix), 14= Vitamin 'C' (Mg.)/100g, 15= Fruits weight (g), 16= Yield/ plant(g).

the expression of genetic relationship of characters in the phenotype. Number of fruits per plant was significantly and positively by correlated with no. of branches 120 DAT, number of fruits per plant, average fruit weight, ascorbic acid content, suggested that effective improvement in tomato through these component could be achieved by simple selection. These results are in consonance with the earlier researcher for number of fruits per plant, fruit weight (Mishra *et al*., 1998). The significant association of average fruit weight, number of fruits, fruit diameter suggests that increase in any one of these traits may results in increase in fruit yield per plant. Thease results are in conformity with those reported by Smith 2005, who advocated that the importance should be given to number of fruits per plant, average fruit weight, number of branches per plant and fruit diameter during selection process because these characters contribute directly towards yield.

At genotypic level, number of fruits per plant had the highest positive direct effect on yield per plant followed by fruits per plant (0.8345), flowers per plant (0.0725), cluster per plants (0.0633), number of branches at 120 DAT (0.1979), TSS (0.2108), plant height at 120 DAP (0.0472) and fruits weight (0.8983). While negative direct effect was observed for leaf curl intensity (-0.1897), fruits set percentage (-0.1387), days to 50 per cent flowering (-0.2231), leaves at 120 DAP (-0.0465), presented in Table 3. High direct and positive effect of fruits weight (Mohanty, 2002), number of fruits per plant (Johson *et al*. 1955) have been reported to earlier workers.

Conclusion :

In the direct and indirect contributions of component traits towards fruit yield, selection on the basis of horticultural traits *viz.*, number of fruits per plant, and average fruit weight would be paying preposition in the genotypes included in the study.

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