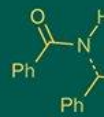


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Assessment of genetic variability, heritability and correlation studies in tomato (*Lycopersicon esculentum* Mill.)

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Abstract

The experiment entitled, "Assessment of Genetic Variability, Heritability, and Correlation Studie in Tomato (*Lycopersicon esculentum* Mill.)", was conducted at Horticulture Research Field, Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences (SHUATS), Prayagraj, during September 2025 to January 2026. The experiment was laid out in a Randomized Block Design (RBD) with 20 Genotypes including check with 3 replications. The result show significant results based on the mean performance of genotypes of twenty quantitative characters, Kashi Aman showed superior performance including number of clusters per plant (11.40), average fruit weight (70.47 g), fruit yield per plant (3.21 kg/plant), fruit yield per plot (28.85 kg/plot), fruit yield (118.62 t/ha). The Moderate magnitude of genotypic coefficient of variance GCV was recorded for Number of branches, Days to first flowering, Days taken for first fruit harvest, Number of days to marketable maturity, Number of clusters per plant, Fruit yield per plant (kg), Fruit yield per plot (kg), Fruit yield (t/ha), Test weight. The most elevated magnitude of the phenotypic coefficient of variance PCV was recorded for Number of branches. High heritability was recorded for plant height, number of branches, days to first flowering, days to 50% flowering, days to first fruiting, days taken for first fruit harvest, number of days to marketable maturity, number of clusters per plant, average number of fruits per plant, average fruit weight, fruit yield per plant, fruit yield per plot, Fruit yield, pericarp thickness, vitamin C content, total Soluble Solids, and test weight. High genetic advance as % of mean was recorded for Number of branches, Days to first fruiting, Days taken for first fruit harvest, Number of days to marketable maturity, Number of clusters per plant, Fruit yield per plant, Fruit yield per plot, Fruit yield. Genotypic Correlation coefficient and phenotypic correlation coefficient analysis revealed that Fruit yield per hectare exhibited highly significant and positive correlation with Number of clusters per plant, Average number of fruits per plant, Average fruit weight (g), Fruit yield per plant (kg), and Fruit yield per plot (kg).

Keywords: Tomato, GCV, PCV, heritability, correlation coefficient

Introduction

Tomato (*Lycopersicon esculentum* Mill.), belonging to the family Solanaceae ($2n = 24$), is one of the most important vegetable crops cultivated worldwide and is popularly known as the "poor man's orange" in India (Rick, 1976; Barton, 1950) ^[1, 2]. It is a rich source of vitamins (A, C), minerals, lycopene and antioxidants and occupies a prominent place among vegetables after potato and sweet potato. India ranks second in tomato production after China (FAOSTAT, 2020) ^[3]. In Uttar Pradesh, the area under tomato was approximately 0.20 lakh hectares with a production of 5.29 million tonnes during 2019-20 (NHB, 2020-21).

For a breeder, the presence of adequate genetic variability is the basic requirement for effective selection. Phenotypic variation is composed of genetic and environmental components, and only the heritable fraction can be exploited consistently through selection. Consequently, estimates of genotypic and phenotypic coefficients of variation, heritability and genetic advance are useful for understanding the probable response to selection (Johnson *et al.*, 1955; Falconer, 1989) ^[8, 5]. The usefulness of variability estimates in plant breeding has also been emphasized by Hutchinson (1940) ^[6].

Genetic variability is the basic requirement for any successful breeding programme. Estimation of genotypic and phenotypic coefficients of variation, heritability and genetic advance helps in understanding the nature of gene action and devising appropriate selection strategies (Burton, 1952; Johnson *et al.*, 1955; Lush, 1949) [7, 8, 14]. Correlation and path coefficient analyses further elucidate the inter-relationships among yield and its component traits (Al-Jibouri *et al.*, 1958; Dewey and Lu, 1959) [9, 10].

Fruit yield is a complex trait and its improvement requires understanding the relationships among yield and its component traits. Correlation analysis identifies the direction and magnitude of association, whereas path coefficient analysis partitions correlations into direct and indirect effects, thereby helping to identify characters that can be used as selection criteria (Searle, 1961; Kumar *et al.*, 2013) [11, 12]. Genetic divergence analysis is useful for identifying contrasting parents and planning crosses, particularly when a breeding programme aims to combine high yield with earliness and desirable quality traits. (Frankel, 1998) [13]

This study evaluates genetic variability, heritability, and genetic advance in tomatoes (*Lycopersicon esculentum* Mill.) to establish reliable selection criteria for yield and yield attributing traits. By utilizing correlation coefficient and path coefficient analysis to identify positive and negative relationships effecting yield and measuring genetic divergence among genotypes, to exploit the available variability present in the genetic material in the form of some specific group or classes, the divergences studies based upon some desirable parameter is very essential. Therefore, this experiment was conducted to observe growth, yield and quality attributes of cowpea on different levels of genetic variability, to identify the best genotypes with high yield, early maturing suited conditions of Prayagraj, Uttar Pradesh.

Materials and Methods

The experiment entitled "Genetic Variability, Heritability, and Correlation Studies in Tomato (*Lycopersicon esculentum* Mill.)" Under Prayagraj agro-climatic conditions, was done on genetic variability, heritability, correlation in tomato during September 2025- January 2026 at the Horticulture Research Field, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences. The analysis was laid out in randomized block design with three replications. The planting was done with a spacing of 60 cm, row to row and 45 cm, plant to plant respectively, each plot with 9 plants. Experimental materials comprised of 20 genotypes viz., TMTH 2246, TO 1057, TMTH 218, TMTH 291, Abhilash, TMTH 216, US 2853, Kashi Amul, Kashi Amrit, Kashi Chayan, Kashi Aman, Kashi Anmol, Kashi Aadarsh, Kashi Anupam, Kashi Lalima, Kashi Abhiman, Kashi Sharad, Kashi Hemant, Kashi Vishesh and Kashi Adbhut (Check) were used.

Results and Discussion

Analysis of variance

The analysis of variance (Table 1) revealed highly significant differences among the 20 genotypes for all 20 quantitative characters studied. This indicated the presence of substantial genetic variability in the experimental material, offering ample scope for selection and genetic

improvement of tomato. Similar findings of significant genotypic differences for yield and yield-attributing traits in tomato have been reported by earlier workers (Ahirwar and Prashad, 2013; Dar and Sharma, 2011; Kerketta and Bahadur, 2019; Kumar *et al.*, 2013) [15, 16, 17, 12].

Table 1: Analysis of variance for 20 quantitative characters in tomato

Characters	Mean sum of Squares		
	Replication (df=2)	Genotypes (df=19)	Error (df=38)
Plant height (cm)	4.17	143.10**	11.43
Number of branches (cm)	0.15	14.30**	0.16
Days to first flowering	0.44	56.54**	2.30
Days to first fruiting	14.84	55.50**	2.13
Days to 50% flowering	6.92	56.35**	3.90
Days to 50% fruits setting	8.88	36.65**	7.59
Number of days to marketable maturity	0.03	333.32**	13.95
Number of clusters per plant	0.02	3.94**	0.13
Average number of fruits per plant	0.06	26.60**	2.15
Days taken for first fruit harvest	14.59	359.84**	12.23
Fruit size- Polar (cm)	2.53	13.22**	3.82
Fruit size- Equatorial (cm)	8.28	15.12**	5.59
Average fruit weight (g)	0.27	69.26**	6.95
Fruit yield per plant (kg)	0.001	0.329**	0.014
Fruit yield per plot (kg)	0.14	27.26**	1.04
Fruit yield (t/ha)	2.51	479.65**	14.48
Test weight (g)	0.001	0.337**	0.20
Total soluble solids (^o Brix)	0.010	0.123**	0.021
Vitamin C content (mg/100g)	0.09	15.67**	1.62
Pericarp thickness	0.001	0.370**	0.020
*, ** Significant at 5% and 1% respectively.			

Genetic Parameters

Estimates of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense), genetic advance (GA) and genetic advance as percent of mean (GAM) are presented in Table 2.

Moderate Genotypic coefficient of variation (GCV) was recorded for Number of branches and number of clusters per plant (19.74%), Fruit yield t/ha (12.96%), Fruit yield per plot (12.69%), Fruit yield per plant (12.53%), Days taken for first fruit harvest (11.85%), Days to first flowering (11.69%), Number of days to marketable maturity (10.84%), Test weight (10.39%). Low GCV was recorded for pericarp thickness (9.81%), plant height (7.43%), Average number of fruits per plant (7.18%), Days to 50% flowering (7.16%), Average fruit weight (7.15%), Vitamin C content (7.08%), Days to first fruiting (7.00%), Total Soluble Solids (5.21%), Days to 50% fruits setting (3.70%), Fruit size- Polar (3.55%), and Fruit size- Equatorial (2.92%) with least value. Whereas Moderate Phenotypic coefficient of variation (PCV) was recorded for Fruit yield t/ha (13.55%), Fruit yield per plot (13.43%), Fruit yield per plant (13.35%), Number of clusters per plant (12.92%), Days taken for first fruit harvest (12.46%), Days to first flowering (12.42%), Number of days to marketable maturity (11.53%), Test weights (11.13%), and Pericarp thickness (10.62%). Low PCV was recorded for Plant height (8.34%), Average fruit weight (8.26%), Vitamin C content (8.21%), Average number of fruits per plant (8.07%), Days to 50% flowering (7.92%), Days to first fruiting (7.41%), Total Soluble Solids (6.54%), Fruit size- Polar (5.29%), Days to 50% fruits

setting (4.94%), and Fruit size- Equatorial (4.85%) with least value.

High heritability was recorded for Number of branches (96.80%), Fruit yield (91.46%), number of clusters per plant (90.88%), days taken for first fruit harvest (90.45%), fruit yield per plot (89.33%), days to first fruiting (89.32%), days to first flowering (88.73%), number of days to marketable maturity (88.41%), fruit yield per plant (88.07%), test weights (87.11%), pericarp thickness (85.22%), days to 50% flowering (81.76%), plant height (79.33%), average number of fruits per plant (79.12%), average fruit weight (74.93%), vitamin C content (74.32%), and total Soluble Solids (62.58%). Moderate heritability (broad sense) was observed for days to 50% fruits setting (56.08%), fruit size- Polar (45.08%), and fruit size- Equatorial (36.22%) with lowest value.

High genetic advance was observed for Fruit yield (24.53), and Days taken for first fruit harvest (21.09). Moderate Genetic advance was observed in Number of days to marketable maturity (19.99), and Plant height (12.16). While low Genetic advance was observed for all other characters i.e. Days to first flowering (8.25), Days to first fruiting (8.21), Average fruit weight (8.13), Days to 50% flowering (7.79), Fruit yield per plot (5.76), Average number of fruits per plant (5.23), Days to 50% fruits setting (4.80), Number of branches (4.40), Vitamin C content

(3.84), Fruit size- Polar (2.45), Number of clusters per plant and Fruit size- Equatorial with (2.21), Test weights and Fruit yield per plant with (0.63), Pericarp thickness (0.65), and Total Soluble Solids (0.30).

High genetic advance as % of mean was recorded for Number of branches (40.01%), Fruit yield (25.53%), Fruit yield per plot (24.71%), Fruit yield per plant (24.22%), Number of clusters per plant (24.18%), Days taken for first fruit harvest (23.22%), Days to first fruiting (22.69%), and Number of days to marketable maturity (20.99%). Moderate Genetic advance as % of mean was recorded for Test weights (19.97%), Pericarp thickness (18.65%), Days taken for first fruit harvest and Plant height with (13.63), Days to 50% flowering (13.34), Average number of fruits per plant (13.16), Average fruit weight (12.75), and Vitamin C content (12.57). Low Genetic advance as % of mean was recorded for rest of the characters viz., Total Soluble Solids (8.48%), Days to 50% fruits setting (5.71%), Fruit size- Polar (4.91%), and Fruit size- Equatorial (3.62%) with lowest value.

High genetic advance as percent of mean coupled with high heritability was observed for number of branches (40.01%), fruit yield (25.53%), fruit yield per plot (24.71%), fruit yield per plant (24.22%), number of clusters (24.18%), days to first fruit harvest (23.22%), days to first flowering (22.69%) and days to marketable maturity (20.99%).

Table 2: Estimates of GCV, PCV, heritability, genetic advance and genetic advance as percent of mean for 20 characters

Character	GCV (%)	PCV (%)	h ² (%)	GA	GAM (%)
Plant height	7.43	8.34	79.33	12.16	13.63
No. of branches	19.74	20.06	96.80	4.40	40.01
Days to first flowering	11.69	12.42	88.73	8.25	22.69
Days to first fruiting	7.00	7.41	89.32	8.21	13.63
Days to 50% flowering	7.16	7.92	81.76	7.79	13.34
Days to 50% fruit setting	3.70	4.94	56.08	4.80	5.71
Marketable maturity	10.84	11.53	88.41	19.99	20.99
Clusters per plant	19.74	20.06	96.80	4.40	40.01
Fruits per plant	12.31	12.92	90.88	2.21	24.18
Days to first harvest	11.85	12.46	90.45	21.09	23.22
Fruit size - Polar	3.55	5.29	45.08	2.45	4.91
Fruit size - Equatorial	2.92	4.85	36.22	2.21	3.62
Average fruit weight	7.15	8.26	74.93	8.13	12.75
Fruit yield/plant	12.53	13.35	88.07	0.63	24.22
Fruit yield/plot	12.69	13.43	89.33	5.76	24.71
Fruit yield (t/ha)	12.96	13.55	91.46	24.53	25.53
Test weight	10.39	11.13	87.11	0.63	19.97
TSS (°Brix)	5.21	6.58	62.58	0.30	8.48
Vitamin C	7.08	8.21	74.32	3.84	12.57
Pericarp thickness	9.81	10.62	85.22	0.65	18.65

GCV = Genotypic coefficient of variation; PCV = Phenotypic coefficient of variation; h² = Heritability (broad sense); GA = Genetic advance; GAM = Genetic advance as percent of mean

Correlation coefficient analysis

Genotypic Correlation coefficient (Table 3) analysis revealed that Fruit yield per hectare exhibited highly significant and positive correlation with Plant height, Number of branches, Number of clusters per plant, Average number of fruits per plant, Fruit size- Polar (cm), Fruit size- Equatorial (cm), Average fruit weight (g), Fruit yield per plant (kg), Fruit yield per plot (kg), Test weights, Vitamin C content (mg/100g), and Pericarp thickness. Fruit yield per hectare showed significant negative correlation with Days to first flowering, Days to first fruiting, Days to 50% flowering, Days to 50% fruits setting, Number of days to marketable maturity, Days taken for first fruit harvest, and TSS (°Brix).

Phenotypic Correlation coefficient (Table 4) analysis revealed that Fruit yield per hectare exhibited highly significant and positive correlation with Plant height, Number of branches, Number of clusters per plant, Average number of fruits per plant, Fruit size- Polar (cm), Fruit size- Equatorial (cm), Average fruit weight (g), Fruit yield per plant (kg), Fruit yield per plot (kg), Test weights, Vitamin C content (mg/100g), and Pericarp thickness. Fruit yield per hectare showed significant negative correlation with Days to first flowering, Days to first fruiting, Days to 50% flowering, Days to 50% fruits setting, Number of days to marketable maturity, Days taken for first fruit harvest, and TSS (°Brix).

Table 3: Estimates of genotypic correlation coefficients among 20 different quantitative characters in tomato genotypes.

Chars	DF	D50F	DFFS	D50FS	MH	PH	NB	NCP	NFP	DFFH	FSP	FSE	AFW	TSS	VTC	PT	TW	FYP	FYPP	FYH
DF	1.000	0.928*	0.916*	0.945*	0.598*	0.533*	0.308*	0.662*	0.287*	0.579*	0.672*	0.567*	0.036	0.297*	-0.212	-0.179	0.525*	0.286*	0.350*	0.412*
D50F			1.005*	0.927*	0.694*	0.601*	0.261*	0.724*	0.309*	0.636*	0.758*	0.956*	-0.060	-0.221	-0.133	0.383*	0.641*	-0.244	0.437*	0.590*
DFFS				0.881*	0.686*	0.562*	0.278*	0.673*	0.327*	0.630*	0.736*	0.872*	-0.092	-0.252	-0.161	0.336*	0.667*	-0.172	0.451*	0.578*
D50FS					0.638*	0.566*	-0.240	0.703*	0.399*	0.545*	0.550*	0.664*	-0.055	0.504*	-0.201	0.323*	0.459*	-0.097	0.400*	0.371*
MH						0.593*	-0.096	0.677*	0.281*	0.913*	0.847*	0.669*	-0.086	0.302*	-0.012	-0.112	0.662*	0.444*	0.348*	0.532*
PH							0.474*	0.914*	0.449*	0.545*	0.601*	0.581*	0.535*	-0.101	0.218	0.693*	0.566*	0.443*	0.904*	0.947*
NB								0.409*	0.292*	-0.087	-0.125	0.139	0.340*	0.020	0.474*	0.353*	0.076	0.183	0.587*	0.460*
NCP									0.621*	0.639*	0.744*	0.639*	0.124	0.065	0.196	0.614*	0.713*	0.575*	0.725*	0.862*
NFP										-0.205	0.435*	0.054	-0.261*	0.668*	0.236	0.243	0.498*	0.300*	0.414*	0.473*
DFFH											0.763*	0.775*	-0.068	-0.228	-0.003	-0.061	0.657*	0.403*	0.321*	0.473*
FSP												0.761*	-0.129	0.367*	0.315*	0.079	0.958*	0.361*	0.398*	0.623*
FSE													0.442*	0.026	-0.083	0.797*	0.641*	0.392*	0.568*	0.670*
AFW														-0.146	-0.083	0.213	0.227	-0.244	0.647*	0.499*
TSS															0.178	0.302*	0.293*	-0.215	-0.172	-0.046
VTC																0.112	0.020	-0.040	0.151	0.209
PT																	0.250	0.349*	0.696*	0.610*
TW																		0.280*	0.587*	0.657*
FYP																			0.276*	0.317*
FYPP																				0.908*
FYH																				1.000

*, ** significant at 5% and 1% level, respectively.

Abbreviations used: PH: Plant height, NB: Number of branches, DF: Days to first flowering, DFFS: Days to first fruiting, D50F: Days to 50% flowering, D50FS: Days to 50% fruits setting, MH: Number of days to marketable maturity, NCP: Number of clusters per plant, NFP: Average number of fruits per plant, DFFH: Days taken for first fruit harvest, FSP: Fruit size- Polar (cm), FSE: Fruit size- Equatorial (cm), AFW: Average fruit weight (g), FYP: Fruit yield per plant (kg), FYPP: Fruit yield per plot (kg), FYH: Fruit yield (t/ha), TW: Test weights, TSS: Total Soluble Solids (^oBrix), VTC: Vitamin C content (mg/100g), PT: Pericarp thickness.

Table 4: Estimates of phenotypic correlation coefficients among 20 different quantitative characters in tomato genotypes.

Chars	DF	D50F	DFFS	D50FS	MH	PH	NB	NCP	NFP	DFFH	FSP	FSE	AFW	TSS	VTC	PT	TW	FYP	FYPP	FYH
DF	1.000	0.755*	0.771*	0.702*	0.551*	0.395*	0.291*	0.575*	0.300*	0.505*	0.521*	0.269*	0.004	-0.142	-0.182	-0.135	0.470*	0.263*	0.302*	0.403*
D50F			0.960*	0.547*	0.597*	0.486*	-0.205	0.615*	-0.209	0.530*	0.486*	0.446*	-0.083	-0.146	-0.079	0.367*	0.570*	-0.237	0.424*	0.498*
DFFS				0.583*	0.593*	0.470*	-0.246	0.609*	-0.253	0.560*	0.452*	0.503*	-0.082	-0.205	-0.107	0.317*	0.579*	-0.183	0.423*	0.511*
D50FS					0.344*	0.388*	-0.176	0.485*	-0.197	0.395*	0.410*	-0.221	0.088	0.284*	-0.044	0.260*	0.326*	-0.105	-0.211	0.322*
MH						0.528*	-0.086	0.604*	0.255*	0.889*	0.491*	0.503*	-0.109	0.271*	-0.077	-0.030	0.630*	0.361*	0.356*	0.459*
PH							0.411*	0.780*	0.328*	0.484*	0.323*	0.377*	0.365*	-0.026	0.118	0.509*	0.535*	0.355*	0.784*	0.804*
NB								0.374*	0.272*	-0.072	-0.092	0.116	0.296*	-0.027	0.419*	0.297*	0.060	0.174	0.521*	0.440*

NCP									0.512*	-0.544*	0.459*	0.342*	0.059	0.112	0.158	0.539*	0.607*	0.490*	0.674*	0.732*
NFP										-0.195	0.273*	0.053	-0.109	0.456*	0.227	0.208	0.394*	0.264*	0.312*	0.413*
DFFH											0.472*	0.422*	-0.099	-0.224	0.040	-0.072	0.545*	0.364*	0.272*	0.459*
FSP												0.230	-0.048	0.075	0.000	0.175	0.577*	0.223	0.198	0.410*
FSE													0.132	0.123	-0.048	0.323*	0.445*	0.207	0.343*	0.357*
AFW														-0.124	-0.079	0.206	0.127	-0.232	0.522*	0.418*
TSS															0.083	-0.207	0.190	-0.178	-0.065	-0.090
VTC																0.026	0.047	-0.046	0.094	0.189
PT																	0.169	0.330*	0.569*	0.524*
TW																		0.242	0.566*	0.588*
FYP																			0.223	0.307*
FYPP																				0.786*
FYH																				1.000

*, ** significant at 5% and 1% level, respectively.

Abbreviations used: PH: Plant height, NB: Number of branches, DFF: Days to first flowering, DFFS: Days to first fruiting, D50F: Days to 50% flowering, D50FS: Days to 50% fruits setting, MH: Number of days to marketable maturity, NCP: Number of clusters per plant, NFP: Average number of fruits per plant, DFFH: Days taken for first fruit harvest, FSP: Fruit size- Polar (cm), FSE: Fruit size- Equatorial (cm), AFW: Average fruit weight (g), FYP: Fruit yield per plant (kg), FYPP: Fruit yield per plot (kg), FYH: Fruit yield (t/ha), TW: Test weights, TSS: Total Soluble Solids (^oBrix), VTC: Vitamin C content (mg/100g), PT: Pericarp thickness.

Conclusion

From the present study it was concluded that out of 20 genotypes of Tomato, genotypes namely, Kashi Aman exhibited substantially higher yield and performed better for yield and its attributing traits.

Moderate estimate of GCV along with high heritability coupled with high genetic advance as percent of mean was recorded for days to first flowering, number of days to marketable maturity, number of branches, number of clusters per plant, days taken for first fruit harvest, test weights, fruit yield per plant (kg), fruit yield per plot (kg), Fruit yield (t/ha).

Genotypic correlation was higher than the phenotypic ones. Genotypic Correlation coefficient analysis revealed that Fruit yield per hectare exhibited highly significant and positive correlation with Plant height, Number of branches, Number of clusters per plant, Average number of fruits per plant, Fruit size- Polar (cm), Fruit size- Equatorial (cm), Average fruit weight (g), Fruit yield per plant (kg), Fruit yield per plot (kg), Test weights, Vitamin C content (mg/100 g), and Pericarp thickness.

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