International Journal of Plant & Soil Science

Volume 37, Issue 7, Page 259-268, 2025; Article no.IJPSS.139603
ISSN: 2320-7035

Studies on Genetic Variability for Yield and Its Attributes in Tomato (*Solanum lycopersicon* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijpss/2025/v37i75571

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://pr.sdiarticle5.com/review-history/139603

Original Research Article

Received: 03/05/2025
Accepted: 05/07/2025
Published: 09/07/2025

ABSTRACT

The present investigation was carried out at the Horticulture Research Farm, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur (U.P.), to evaluate 20 genotypes of tomato (*Solanum lycopersicum* L.) for the nature and magnitude of associations among different characters

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Cite as: *Kumar, Dilip, Vinay Joseph Silas, Jitendra Kumar, Syed Mohd Quatadah, Ravikesh Kumar Pal, Anoop Singh Sengar, Saurabh Kumar, and Shubham Sharma. 2025. "Studies on Genetic Variability for Yield and Its Attributes in Tomato (Solanum Lycopersicon L.)". International Journal of Plant & Soil Science 37 (7):259-68. https://doi.org/10.9734/ijpss/2025/v37i75571.*

with fruit yield per plant (kg). The experiment was conducted using a Randomized Block Design (RBD) with three replications. The analysis of variance revealed that the mean sum of squares due to genotypes was highly significant for all the traits studied, indicating the presence of substantial genetic variability. All the genotypes exhibited considerable variation across the characters under observation. Among the genotypes, 'Kashi Aman' recorded the highest fruit yield per plot (53.17 kg) and per plant (6.12 kg), while the lowest fruit yield per plot (10.16 kg) and per plant (1.41 kg) was observed in 'Kashi Vishesh'. In genetic studies, the phenotypic and genotypic coefficients of variation (PCV and GCV) were highest for plant height (28.82% and 28.94%, respectively), indicating ample scope for improvement through selection. Genotypic and phenotypic correlation coefficients revealed that fruit yield per plant showed significant and positive associations with plant height (0.309* and 0.302*), days to 50% flowering (0.381* and 0.366*), number of flowers per cluster (0.342* and 0.336*), and fruit yield per plot (0.991** and 0.961**). Path coefficient analysis indicated that the maximum positive direct effect on fruit yield per plant was exerted by plant height (0.2743 & 0.0464), number of flowers per cluster (0.0533), number of fruits per plant (0.0382 & 0.0388), fruit weight (0.2021 g), acidity (0.2907 & 0.1146 mg/100g), ascorbic acid (0.3098 mg/100g), total soluble solids (0.2999 & 0.095 °Brix), lycopene content (0.0248 mg/100g), peroxidase activity (0.0019 & 0.0124), and fruit yield per plot (0.9878 & 0.9304) at genotypic and phenotypic levels, respectively. These findings suggest that plant height, number of flowers per cluster, and fruit yield per plot are key traits that may be used as selection criteria to improve tomato yield.

Keywords: Genetic variability; correlation; path and tomato.

1. INTRODUCTION

Tomatoes (*Solanum lycopersicum* L.) are classified as green fruit vegetables and belong to the family Solanaceae, which includes approximately 100 genera and over 2,500 species, encompassing several economically important crops such as potato, eggplant, chilli, and tobacco (Olmstead et al., 2008). The species *Solanum lycopersicum* possesses a diploid chromosome number of 2n = 2x = 24, with a genome size of approximately 950 Mbp, housing some of the most significant genes within the Solanaceae family (Arumuganathan & Earle 1991). Tomatoes thrive across a wide range of agro-climatic conditions and are warm-season crops requiring a relatively long growing period to achieve high yields. They hold a vital place in global human diets due to their nutritional and culinary versatility. The botanical classification of tomatoes has undergone significant debate and revision. Initially classified as *Lycopersicon esculentum* Miller by Phillip Miller in 1768 under the genus Lycopersicon, tomatoes have since been reclassified under the genus Solanum as *Solanum lycopersicum* L., following the work of Linnaeus in 1753 and further supported by Peralta and Spooner (2001). The term “lycopersicum” translates to “wolf peach” (from Greek lyco = wolf and persicum = peach), reflecting its historical perception. Tomato fruits are highly nutritious, containing 3–4% total sugars, 4–7% total soluble solids, 15–30 mg/100g of ascorbic acid, and 20–50 mg/100g of lycopene. Additionally, tomatoes supply various essential minerals and vitamins including sodium (45.8 mg), potassium (114 mg), copper (0.19 mg), sulfur (24 mg), chlorine (38 mg), calcium (20 mg), magnesium (15 mg), phosphorus (36 mg), iron (1.8 mg), and vitamins such as vitamin A, thiamine (0.07 mg), riboflavin (0.1 mg), nicotinic acid (0.4 mg), and vitamin C (31 mg) per 100 g of edible fruit (Saima et al., 2019). Evaluating genetic variability and trait associations is crucial in crop improvement programs, as it helps breeders design effective strategies for selection and hybrid development. Biometrical tools such as the genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability, and genetic advance are widely used to assess the genetic potential of traits. While high heritability indicates that trait expression is largely governed by genetic factors, it must be interpreted alongside genetic advance to determine the effectiveness of selection. Traits exhibiting both high heritability and high genetic advance are ideal for improvement through selection. The correlation coefficient is a statistical tool that determines the strength and direction of association between two or more variables and is critical in identifying traits that can contribute to higher yields. However, correlation alone does not reveal the cause-effect relationship. Therefore, path coefficient analysis is employed to partition the correlation coefficients into direct and indirect effects, providing deeper insight into the contribution of individual traits toward a dependent variable such as yield (Nagariya et al., 2015). Given these considerations, the present study was undertaken to assess the extent of variability, heritability, genetic advance, and the inter-relationships among various traits in tomato genotypes, with a specific aim to identify key yield-contributing traits. This will facilitate the development of high-yielding and nutritionally superior tomato hybrids (Akhter et al., 2021).

2. MATERIALS AND METHODS

The present investigation, entitled "Studies on Genetic Variability for Yield and Its Attributes in Tomato (Solanum lycopersicum L.)", was conducted at the Horticulture Research Farm, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur (U.P.), during the 2024–2025 growing season. The experiment comprised 20 tomato genotypes sourced from the Indian Institute of Vegetable Research (IIVR), Varanasi.

The experiment was laid out in a Randomized Block Design (RBD) with three replications to assess the relative performance of genotypes and to estimate genetic parameters for various growth, biochemical, and yield-related traits. Observations were recorded on 17 characters.

The collected data were statistically analyzed to compute the analysis of variance (ANOVA) for each trait to test the significance of differences among genotypes, as per the standard procedure outlined by Panse and Sukhatme (1967). Estimates of Genotypic Coefficient of Variation (GCV) and Phenotypic Coefficient of Variation (PCV) were calculated following the methods proposed by Johnson et al. (1955) and Hanson et al. (1956). Broad-sense heritability (h^2) was estimated as per the method of Robinson et al. (1949), and Genetic Advance (GA) as a percentage of mean was computed using the formula suggested by Johnson et al. (1955). Genotypic and phenotypic correlation coefficients were calculated following the method of Johnson et al. (1955), while path coefficient analysis for direct and indirect effects of various traits on fruit yield per plant was conducted using the method described by Dewey and Lu (1959).

3. RESULTS AND DISCUSSION

The analysis of variance (ANOVA) revealed highly significant differences among the 20 tomato genotypes for all the 17 characters studied, indicating the presence of substantial genetic variability within the experimental material (Table 1). The observed variation suggests ample scope for the improvement of these traits through selection. These findings are consistent with earlier reports by Chabbi et al. (2018), Namita et al. (2021), and Pooja et al. (2022), who also observed significant genetic variability for various morphological and yield-related traits in tomato genotypes.

Table 1. Analysis of variance for 17 different growth, yield and quality of tomato

Sl.No.	Source	Mean Sum of Squares (MSS)		
		Replication	Treatment	Error
	Degrees of freedom	2	19	38
1	Plant height (cm)	4.8110	3557.575**	9.331
2	Days to first flowering	0.290	16.4**	0.729
3	Days to 50% flowering	0.1350	7.151**	0.074
4	Number of flowers per cluster	0.0880	33.967**	0.044
5	Number of fruits per plant	0.0160	351.613**	0.495
6	Fruit set per cluster	0.0540	5.967**	0.077
7	Fruit weight (g)	1.1490	2223.017**	1.621
8	Proline (Mg/100gm)	00	0.042**	0
9	ß Carotene Mg /100gm	00	0.005**	0
10	Acidity Mg /100gm	00	0.004**	0
11	Ascorbic Acid (100g/mg)	0.352**	20.879**	0.062
12	Carotenoids (mg/100gm)	0.030	7.156**	0.027
13	Total Soluble Solids (0Brix)	0.0290	1.804**	0.023
14	Lycopene (mg/100gm)	0.0110	0.219**	0.012
15	Peroxidase	00	0.046**	0.002
16	Fruit yield per plot (Kg)	1.440	423.719**	3.67
17	Fruit yield per plant (kg)	0.0030	5.624**	0.065

** Significant at 5 percent level of significance*

The estimates of GCV and PCV from present investigation are presented in Table 2 The genotypic and phenotypic coefficient variance value was categorized as low (0-10%), moderate(10-20%) and high (20% and above) given by Sivasubramanian and Madhavamenon (1973). Wide range of genotypic coefficient of variation (GCV) was observed for the characters ranging fruit weight (g) (57.42) to lycopene (mg/100gm) (4.78) and PCV fruit weight (g) (57.49) to days to 50% flowering (4.97). High magnitude of GCV and PCV were recorded for plant height (cm) (28.82 & 28.94), number of flowers per cluster (31.29 & 31.35), number of fruits per plant (25.13& 25.18), fruit weight (g) (57.42& 57.49), proline (mg/100gm) (34.41& 35.01), carotenoids (mg/100gm) (23.57& 23.70), Peroxidase (21.61& 23.32), fruit yield per plot (kg) (43.57& 44.14) and fruit yield per plant (kg) (44.20& 44.97. While as moderate estimates were observed for fruit set per cluster (19.30 & 19.67), ß carotene mg /100gm (14.37 & 16.03), acidity mg /100gm (17.58 & 19.35), ascorbic acid (100g/mg) (11.06 & 11.11) and total soluble solids (0brix) (17.75 & 18.09). Whereas low estimates were observed for days to first flowering (9.29 & 9.92), days to 50% flowering (4.89& 4.97) and lycopene (mg/100gm) (4.78& 5.17). Comparable results were reported by Mehta and Asati (2008), Anitha et al., (2013), Arun et al., (2016), Shankar (2016), Kumar et al., (2017) and Somraj et al., (2017). The estimates of heritability from present investigation are presented in Table 2. In the present study the heritability estimates in broad sense were classified into 3 groups such as high (>75%), moderate (60% - 75%), low (<60%). The heritability estimates were found to be high (more than 75%). The high heritability in broad sense was observed for the characters viz. plant height (cm) (99.22), days to first flowering (87.76), days to 50% flowering (96.97), number of flowers per cluster (99.62), number of fruits per plant (99.58), fruit set per cluster (96.24), fruit weight (g) (99.78), proline (mg/100gm) (96.62), ß carotene mg /100gm (80.34), acidity mg /100gm(82.52), ascorbic acid (100g/mg) (99.12), carotenoids (mg/100gm) (98.87), total soluble solids (0brix) (96.29), lycopene (mg/100gm) (85.67), peroxidase (85.84), fruit yield per plot (kg) (97.45) and fruit yield per plant (kg) (96.61). Similar results were also quoted by Nwosu et al., (2014), Meena et al., (2015), Dutta et al., (2018) and Sharmin et al., (2019). In the present investigation, the genetic advance estimates were found to be high for plant height (cm) (70.57), number of fruits per plant (22.24), fruit weight (g) (55.99) and fruit yield per plot (kg) (24.06). While as moderate estimates were observed days to first flowering, days to 50% flowering, number of flowers per cluster, fruit set per cluster, proline (mg/100gm), ß carotene mg /100gm, acidity mg /100gm, ascorbic acid (100g/mg), carotenoids (mg/100gm), total soluble solids (0brix), lycopene (mg/100gm), peroxidase and fruit yield per plant (kg). In the present investigation, the genetic adv as % of mean 5% estimates were found to be high for plant height (cm) (59.14), number of flowers per cluster (64.32), number of fruits per plant (51.65), fruit set per cluster (39.01), fruit weight (g) (118.16), proline (mg/100gm) (69.68), ß carotene mg /100gm (26.54), acidity mg /100gm (32.89), ascorbic acid (100g/mg) (22.68), carotenoids (mg/100gm) (48.28), total soluble solids (0brix) (35.88), peroxidase (41.24), fruit yield per plot (kg) (88.60) and fruit yield per plant (kg) (89.50). While as moderate estimates were observed days to first flowering (17.93). Whereas low estimates were observed for days to 50% flowering and lycopene (mg/100gm). Similar results were also reported by Patel et al., (2013) and Bhandari et al., (2017) and Dutta et al., (2018).

Correlation coefficient is a statistical measure which is used to find out the degree (strength) and direction of relationship between two or more variables. A positive value of correlation shows that the changes of two variables are in the same directions. In the present investigation correlation coefficient analysis measure the mutual relationship between various plant characters and to determine the component character on which selection can be used for genetic improvement in yield while selecting the suitable plant type, correlation studies would provide reliable information in nature of extent and the direction of the selection especially when the breeder needs to combine high yield potential with desirable traits. In this study the genotypic and phenotypic correlation coefficient of different characters with fruit yield per plant (kg) and their relationship among themselves are presented in Table 3 and are discussed here under following points. Genotypic and phenotypic correlation coefficient analysis revealed that fruit yield per plant (kg) showed positive significant association with plant height (cm) (0.309* and 0.302*), days to 50% flowering (0.381* and 0.366*), number of flowers per cluster (0.342* and 0.336*) and fruit yield per plot (kg) (0.991** and 0.961**) While non-significant and positive association was observed with ascorbic acid (100g/mg) (0.1676

& 0.1673), total soluble solids (0brix) (0.1302 & 0.1252), peroxidase (0.2225 & 0.2085) and number of fruits per plant (0.2117 0.2079). Similar finding were observed by Nagariya et al., (2015) Sudesh and Anita (2016) and Singh et al., (2018). As the number of independent variables influencing a particular dependent variable increases the amount of interdependence of variable also increase such that indirect association becomes more complex and important. Under such situation, correlation alone is not sufficient to explain the true association for effective manipulation of characters. It also does not indicate the cause and effect of relationship as independent, one may not be able to know which of the independent characters has the most direct effect on fruit yield per plant. The genotypic and phenotypic path coefficient among the different growth, yield and quality with fruit yield per plant (kg) traits in tomato were worked out to assess the association among themselves. Perusal of Table 4 revealed that highest positive direct effect on fruit yield per plant (kg) was exhibited by plant height (cm) (0.2743 & 0.0464), number of flowers per cluster (0.0533), number of fruits per plant (0.0382 & 0.0388), fruit weight (g) (0.2021), acidity mg /100gm (0.2907 & 0.1146), ascorbic acid (100g/mg) (0.3098), total soluble solids (0brix) (0.2999 & 0.095), lycopene (mg/100gm) (0.0248), peroxidase (0.0019 & 0.0124) and fruit yield per plot (kg) (0.9878 & 0.9304) at genotypic and phenotypic levels. The character days to first flowering days to 50% flowering, number of flowers per cluster, fruit set per cluster, fruit weight (g), proline (mg/100gm), b carotene mg /100gm, ascorbic acid (100g/mg), carotenoids (mg/100gm) and lycopene (mg/100gm) showed direct negative effect at genotypic and phenotypic levels. Similar results were also reported in tomato by Asati et al., (2008), Tiwari et al., (2013), Meitei et al., (2014) and Rakesh et al., (2014), Raut, et al., (2021).

Table 2. Estimation of component of variance and genetic parameters for 17 character growth, yield and quality of 20 genotypes in tomato

Sl.No.	Characters	GCV	PCV	h2 (Broad Sense)	Genetic Advancement 5%	Gen. Adv as % of Mean 5%
1	Plant height (cm)	28.82	28.94	99.22	70.57	59.14
2	Days to first flowering	9.29	9.92	87.76	4.41	17.93
3	Days to 50% flowering	4.89	4.97	96.97	3.12	9.93
4	Number of flowers per cluster	31.29	31.35	99.62	6.91	64.32
5	Number of fruits per plant	25.13	25.18	99.58	22.24	51.65
6	Fruit set per cluster	19.30	19.67	96.24	2.83	39.01
7	Fruit weight (g)	57.42	57.49	99.78	55.99	118.16
8	Proline (Mg/100gm)	34.41	35.01	96.62	0.24	69.68
9	ß Carotene Mg /100gm	14.37	16.03	80.34	0.07	26.54
10	Acidity Mg /100gm	17.58	19.35	82.52	0.07	32.89
11	Ascorbic Acid (100g/mg)	11.06	11.11	99.12	5.40	22.68
12	Carotenoids (mg/100gm)	23.57	23.70	98.87	3.16	48.28
13	Total Soluble Solids (0Brix)	17.75	18.09	96.29	1.56	35.88
14	Lycopene (mg/100gm)	4.78	5.17	85.67	0.50	9.11
15	Peroxidase	21.61	23.32	85.84	0.23	41.24
16	Fruit yield per plot (Kg)	43.57	44.14	97.45	24.06	88.60
17	Fruit yield per plant (kg)	44.20	44.97	96.61	2.76	89.50

Table 3. Estimates of genotypic and phenotypic correlation coefficient for 17 Growth, yield and quality with fruit yield per plant (kg)

		Plant height (cm)	Days to first flowering	Days to 50% flowering	Number of flowers per cluster	Number of fruits per plant	Fruit set per cluster	Fruit weight (g)	Proline (Mg/100gm)	B Carotene Mg /100gm	Acidity Mg /100gm	Ascorbic Acid (100g/mg)	Carotenoids (mg/100gm)	Total Soluble Solids (0Brix)	Lycopene (mg/100gm)	Peroxidase	Fruit yield per plot (Kg)	Fruit yield per plant (kg)
Plant height (cm)	G	1	-0.565**	0.0993	0.395*	-0.0303	-0.2033	-0.507**	-0.0176	0.0127	-0.368*	0.213	0.329*	0.1777	-0.2421	-0.0106	0.317*	0.309*
	P	1	-0.528**	0.0957	0.393*	-0.0308	-0.2008	-0.504**	-0.0156	0.0143	-0.330*	0.2098	0.326*	0.1761	-0.2261	-0.0144	0.313*	0.302*
Days to first flowering	G		1	-0.0674	-0.13	0.1891	-0.1673	0.648**	0.0293	0.0609	-0.0295	-0.0774	-0.0753	0.1262	0.0943	0.1104	-0.0472	-0.0434
	P		1	-0.0663	-0.1232	0.1746	-0.1318	0.605**	0.0298	0.0824	-0.0139	-0.0702	-0.073	0.134	0.0942	0.1258	-0.0434	-0.0547
Days to 50% flowering	G			1	0.034	0.2297	-0.2256	0.2353	-0.2115	0.0069	0.1138	0.0537	-0.2045	-0.0985	-0.0208	-0.0617	0.393*	0.381*
	P			1	0.0343	0.2246	-0.2187	0.2326	-0.2073	0.0194	0.0896	0.053	-0.2019	-0.0989	0.0034	-0.0511	0.374*	0.366*
Number of flowers per cluster	G				1	0.0674	0.370*	-0.294*	0.1264	-0.411*	0.0213	-0.270*	0.309*	0.2297	-0.1214	0.256*	0.297*	0.342*
	P				1	0.067	0.363*	-0.294*	0.1256	-0.356*	0.0207	-0.268*	0.306*	0.2266	-0.1038	0.2384	0.293*	0.336*
Number of fruits per plant	G					1	-0.350*	0.1743	-0.294*	-0.0758	0.0003	0.2219	0.2044	0.0853	-0.0022	0.0794	0.2103	0.2117
	P					1	-0.343*	0.1733	-0.288*	-0.0692	0.0018	0.2206	0.2016	0.0793	-0.0027	0.0804	0.2085	0.2079
Fruit set per cluster	G						1	-0.2255	0.370*	-0.1566	0.533**	-0.620**	-0.0329	-0.0713	-0.290*	0.0318	-0.294*	-0.2421
	P						1	-0.2242	0.359*	-0.1358	0.465**	-0.606**	-0.0316	-0.0593	-0.258*	0.0284	-0.283*	-0.2288
Fruit weight (g)	G							1	-0.0765	0.2006	0.0847	-0.0506	-0.273*	-0.512**	-0.089	-0.1181	-0.1487	-0.1829
	P							1	-0.0758	0.1784	0.0798	-0.0513	-0.271*	-0.503**	-0.0875	-0.1134	-0.1471	-0.1806
Proline (Mg/100gm)	G								1	-0.1058	0.0887	-0.296*	-0.462**	0.0543	-0.0102	-0.277*	-0.0897	-0.0076
	P								1	-0.0828	0.0844	-0.294*	-0.453**	0.0566	0.0046	-0.2473	-0.0888	-0.0106
B Carotene Mg /100gm	G									1	0.045	0.0935	0.0263	-0.0679	0.0978	-0.2422	-0.354*	-0.436**
	P									1	0.113	0.0789	0.0228	-0.047	0.0957	-0.1466	-0.327*	-0.350*
Acidity Mg /100gm	G										1	-0.1549	-0.0292	-0.353*	-0.279*	0.0656	-0.1259	-0.1143
	P										1	-0.1406	-0.0259	-0.321*	-0.278*	0.0524	-0.1162	-0.0808
Ascorbic Acid (100g/mg)	G											1	-0.1158	0.0131	0.1614	-0.1347	0.270*	0.1676
	P											1	-0.1104	0.009	0.1499	-0.1358	0.266*	0.1673
Carotenoids (mg/100gm)	G												1	0.385*	-0.325*	0.469**	-0.0213	-0.0542
	P												1	0.369*	-0.301*	0.414*	-0.0213	-0.0492
Total Soluble Solids (0Brix)	G													1	0.2122	0.0744	0.0957	0.1302
	P													1	0.1974	0.0664	0.0928	0.1252
Lycopene (mg/100gm)	G														1	0.1077	-0.0725	-0.0492
	P														1	0.1071	-0.0846	-0.0671
Peroxidase	G															1	0.2507	0.2225
	P															1	0.2229	0.2085
Fruit yield per plot (Kg)	G																1	0.991**
	P																1	0.961**

Significant at 5 percent level of significance

Table 4. Estimates of genotypic and phenotypic path coefficient for 17 Growth, yield and quality with fruit yield per plant (kg)

		Plant height (cm)	Days to first flowering	Days to 50% flowering	Number of flowers per cluster	Number of fruits per plant	Fruit set per cluster	Fruit weight (g)	Proline (Mg/100gm)	B Carotene Mg /100gm	Acidity Mg /100gm	Ascorbic Acid (100g/mg)	Carotenoids (mg/100gm)	Total Soluble Solids (0Brix)	Lycopene (mg/100gm)	Peroxidase	Fruit yield per plot (Kg)	Fruit yield per plant
Plant height (cm)	G	**0.2743**	-0.1549	0.0272	0.1085	-0.0083	-0.0558	-0.1392	-0.0048	0.0035	-0.1008	0.0584	0.0901	0.0487	-0.0664	-0.0029	0.0868	0.309*
	P	**0.0464**	-0.0245	0.0044	0.0182	-0.0014	-0.0093	-0.0234	-0.0007	0.0007	-0.0153	0.0097	0.0151	0.0082	-0.0105	-0.0007	0.0145	0.302*
Days to first flowering	G	0.0552	**-0.0977**	0.0066	0.0127	-0.0185	0.0163	-0.0633	-0.0029	-0.006	0.0029	0.0076	0.0074	-0.0123	-0.0092	-0.0108	0.0046	-0.0434
	P	0.0155	**-0.0293**	0.0019	0.0036	-0.0051	0.0039	-0.0177	-0.0009	-0.0024	0.0004	0.0021	0.0021	-0.0039	-0.0028	-0.0037	0.0013	-0.0547
Days to 50% flowering	G	-0.0224	0.0152	**-0.2259**	-0.0077	-0.0519	0.051	-0.0532	0.0478	-0.0016	-0.0257	-0.0121	0.0462	0.0223	0.0047	0.0139	-0.0887	0.381*
	P	-0.005	0.0035	**-0.0524**	-0.0018	-0.0118	0.0114	-0.0122	0.0109	-0.001	-0.0047	-0.0028	0.0106	0.0052	-0.0002	0.0027	-0.0196	0.366*
Number of flowers per cluster	G	-0.0104	0.0034	-0.0009	**-0.0263**	-0.0018	-0.0097	0.0077	-0.0033	0.0108	-0.0006	0.0071	-0.0081	-0.006	0.0032	-0.0067	-0.0078	0.342*
	P	0.0209	-0.0066	0.0018	**0.0533**	0.0036	0.0194	-0.0157	0.0067	-0.019	0.0011	-0.0143	0.0163	0.0121	-0.0055	0.0127	0.0156	0.336*
Number of fruits per plant	G	-0.0012	0.0072	0.0088	0.0026	**0.0382**	-0.0133	0.0067	-0.0112	-0.0029	0	0.0085	0.0078	0.0033	-0.0001	0.003	0.008	0.2117
	P	-0.0012	0.0068	0.0087	0.0026	**0.0388**	-0.0133	0.0067	-0.0112	-0.0027	0.0001	0.0086	0.0078	0.0031	-0.0001	0.0031	0.0081	0.2079
Fruit set per cluster	G	0.0375	0.0309	0.0416	-0.0683	0.0645	**-0.1844**	0.0416	-0.0682	0.0289	-0.0982	0.1144	0.0061	0.0131	0.0534	-0.0059	0.0543	-0.2421
	P	0.0283	0.0186	0.0308	-0.0512	0.0483	**-0.141**	0.0316	-0.0506	0.0191	-0.0656	0.0855	0.0045	0.0084	0.0364	-0.004	0.04	-0.2288
Fruit weight (g)	G	-0.1025	0.131	0.0476	-0.0595	0.0352	-0.0456	**0.2021**	-0.0155	0.0405	0.0171	-0.0102	-0.0552	-0.1034	-0.018	-0.0239	-0.03	-0.1829
	P	0.0126	-0.0152	-0.0058	0.0074	-0.0043	0.0056	**-0.0251**	0.0019	-0.0045	-0.002	0.0013	0.0068	0.0126	0.0022	0.0028	0.0037	-0.1806
Proline (Mg/100gm)	G	0.0029	-0.0048	0.0345	-0.0206	0.0479	-0.0602	0.0125	**-0.1629**	0.0172	-0.0144	0.0483	0.0752	-0.0088	0.0017	0.0452	0.0146	-0.0076
	P	0.0004	-0.0007	0.0049	-0.0029	0.0067	-0.0084	0.0018	**-0.0234**	0.0019	-0.002	0.0069	0.0106	-0.0013	-0.0001	0.0058	0.0021	-0.0106
B Carotene Mg /100gm	G	-0.0017	-0.0081	-0.0009	0.0549	0.0101	0.0209	-0.0268	0.0141	**-0.1336**	-0.006	-0.0125	-0.0035	0.0091	-0.0131	0.0324	0.0473	-0.436**
	P	-0.0004	-0.0021	-0.0005	0.0091	0.0018	0.0035	-0.0046	0.0021	**-0.0256**	-0.0029	-0.002	-0.0006	0.0012	-0.0025	0.0038	0.0084	-0.350*
Acidity Mg /100gm	G	0.1069	-0.0086	0.0331	0.0062	0.0001	0.1548	0.0246	0.0258	0.0131	**0.2907**	-0.045	-0.0085	-0.1026	-0.081	0.0191	-0.0366	-0.1143
	P	0.0379	-0.0016	0.0103	0.0024	0.0002	0.0533	0.0092	0.0097	0.013	**0.1146**	-0.0161	-0.003	-0.0368	-0.0319	0.006	-0.0133	-0.0808
Ascorbic Acid (100g/mg)	G	0.066	0.024	-0.0166	0.0836	-0.0687	0.1921	0.0157	0.0918	-0.029	0.048	**0.3098**	0.0359	-0.0041	-0.05	0.0417	-0.0836	0.1676
	P	0.0365	0.0122	-0.0092	0.0467	-0.0384	0.1056	0.0089	0.0511	-0.0137	0.0245	**-0.1741**	0.0192	-0.0016	-0.0261	0.0236	-0.0464	0.1673
Carotenoids (mg/100gm)	G	0.11	0.0252	0.0685	-0.1034	-0.0684	0.011	0.0914	0.1547	-0.0088	0.0098	0.0388	**-0.3348**	-0.1289	0.1086	-0.1572	0.0071	-0.0542
	P	0.0534	0.012	0.0331	-0.0502	-0.0331	0.0052	0.0444	0.0742	-0.0037	0.0042	0.0181	**-0.1641**	-0.0606	0.0494	-0.0679	0.0035	-0.0492
Total Soluble Solids (0Brix)	G	0.0533	0.0378	-0.0295	0.0689	0.0256	-0.0214	-0.1534	0.0163	-0.0204	-0.1059	0.0039	0.1154	**0.2999**	0.0636	0.0223	0.0287	0.1302
	P	0.0167	0.0127	-0.0094	0.0215	0.0075	-0.0056	-0.0478	0.0054	-0.0045	-0.0305	0.0009	0.0351	**0.095**	0.0187	0.0063	0.0088	0.1252
Lycopene (mg/100gm)	G	-0.006	0.0023	-0.0005	-0.003	-0.0001	-0.0072	-0.0022	-0.0003	0.0024	-0.0069	0.004	-0.008	0.0053	**0.0248**	0.0027	-0.0018	-0.0492
	P	0.0038	-0.0016	-0.0001	0.0018	0	0.0044	0.0015	-0.0001	-0.0016	0.0047	-0.0025	0.0051	-0.0033	**-0.0169**	-0.0018	0.0014	-0.0671
Peroxidase	G	0	0.0002	-0.0001	0.0005	0.0002	0.0001	-0.0002	-0.0005	-0.0005	0.0001	-0.0003	0.0009	0.0001	0.0002	**0.0019**	0.0005	0.2225
	P	-0.0002	0.0016	-0.0006	0.0029	0.001	0.0004	-0.0014	-0.0031	-0.0018	0.0006	-0.0017	0.0051	0.0008	0.0013	**0.0124**	0.0028	0.2085
Fruit yield per plot (Kg)	G	0.3126	-0.0466	0.388	0.2928	0.2077	-0.2907	-0.1469	-0.0886	-0.3497	-0.1244	0.2666	-0.021	0.0945	-0.0716	0.2476	**0.9878**	0.991**
	P	0.2914	-0.0404	0.3483	0.2724	0.194	-0.2637	-0.1368	-0.0826	-0.3041	-0.1082	0.2478	-0.0198	0.0864	-0.0787	0.2074	**0.9304**	0.961**

4. CONCLUSION

The analysis of variance revealed that the mean sum of squares due to genotypes was highly significant for all the characters, indicating the presence of substantial genetic variability among the genotypes studied. Therefore, it can be concluded from the present study that there is sufficient genetic variability in the tomato genotypes for various traits. All the cultivars exhibited ample variation for the characters under investigation. The highest fruit yield per plot (53.17 kg) was recorded in the genotype Kashi Aman, while the lowest (10.16 kg) was observed in Kashi Vishesh. Similarly, the highest fruit yield per plant (6.12 kg) was also recorded in Kashi Aman, whereas the lowest (1.41 kg) was observed in Kashi Vishesh. In genetic studies, the phenotypic and genotypic coefficients of variation were highest for plant height (28.82% and 28.94%, respectively), suggesting a strong potential for improvement of this trait through selection. Genotypic and phenotypic correlation coefficient analyses revealed that fruit yield per plant (kg) showed a positive and significant association with: Plant height (0.309* genotypic and 0.302* phenotypic), Days to 50% flowering (0.381* genotypic and 0.366* phenotypic), Number of flowers per cluster (0.342* genotypic and 0.336* phenotypic), Fruit yield per plot (kg) (0.991** genotypic and 0.961** phenotypic), Path coefficient analysis further revealed that the highest positive direct effect on fruit yield per plant (kg) was exhibited by: Plant height (cm) (0.2743 genotypic and 0.0464 phenotypic), Number of flowers per cluster (0.0533), Number of fruits per plant (0.0382 genotypic and 0.0388 phenotypic), Fruit weight (g) (0.2021), Acidity (mg/100g) (0.2907 genotypic and 0.1146 phenotypic), Ascorbic acid (mg/100g) (0.3098), Total soluble solids (°Brix) (0.2999 genotypic and 0.095 phenotypic), Lycopene (mg/100g) (0.0248), Peroxidase (0.0019 genotypic and 0.0124 phenotypic), Fruit yield per plot (kg) (0.9878 genotypic and 0.9304 phenotypic), These results indicate that selection based on these traits could be effective for improving fruit yield in tomato.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Akhter, A., Nabi, A., Afroza, B., Dar, Z. A., Malik, A. A., Ali, G., Akhter, S., Indrabi, S. A., Sultan, A., & Javeed, I. (2021). Study of genetic variability and heritability in cherry tomato (*Solanum lycopersicum* L. var. *cerasiforme*) genotypes. *Journal of Experimental Agriculture International*, *43*(7), 76–81.

Anitha, P. (2013). *Studies on genetic diversity, screening and identification of parents and hybrids for drought tolerance in tomato (Solanum lycopersicum L.)* [Doctoral dissertation, Dr. Y. S. R. Horticultural University].

Arumuganathan, K., & Earle, E. D. (1991). Nuclear DNA content of some important plant species. *Plant Molecular Biology Reporter*, *9*(3), 208–218.

Arun Kumar, P., Ravinder Reddy, K., Reddy, R. V. S. K., Pandravada, S. R., & Saidaiah, P. (2016). Genetic divergence studies in tomato genotypes. *The Bioscan: An International Quarterly Journal of Life Sciences*, *11*(4), 3071–3074.

Asati, B. S., Rai, N., & Singh, A. K. (2008). Genetic parameters study for yield and quality traits in tomato. *Asian Journal of Horticulture*, *3*(2), 222–225.

Bhandari, H. R., Srivastava, K., & Reddy, G. E. (2017). Genetic variability, heritability and genetic advance for yield traits in tomato (*Solanum lycopersicum* L.). *International Journal of Current Microbiology and Applied Sciences*, *6*(7), 4131–4138.

Chabbi, V., Gupta, R. K., Kumar, S., & Kumar, M. (2018). Genetic variability studies in tomato (*Solanum lycopersicum* L.) under ecofriendly management. *Vegetable Science*, *45*(2), 191–196.

Dewey, D. R., & Lu, K. (1959). A correlation and path-coefficient analysis of components of crested wheatgrass seed production. *Agronomy Journal*, *51*(9), 515–518.

Dutta, P., Hazari, S., Karak, C., & Talukdar, S. (2018). Study on genetic variability of different tomato (*Solanum lycopersicum* L.) cultivars grown under open field condition. *International Journal of Chemical Studies*, *6*(5), 1706–1709.

Hanson, C. H., Robinson, H. F., & Comstock, R. E. (1956). Biometrical studies on yield in segregating population of Korean lespedeza. *Agronomy Journal*, *48*, 268–272.

Johnson, W. W., Robinson, H. F., & Comstock, R. E. (1955). Genotypic and phenotypic correlations in soybeans and their implications in selection. *Agronomy Journal*, *47*, 477–482.

Kumar, M., Yadav, R. K., Yadav, R. K., Behera, T. K., & Talukdar, A. (2017). Estimates of genetic variability, heritability and genetic advance for yield and yield component traits in thermo tolerant tomato (*Solanum lycopersicum* L.) genotypes. *International Journal of Agriculture Sciences*, *9*(2), 3640–3642.

Meena, O. P., Bahadur, V., Jagtap, A. B., Saini, P., & Meena, Y. K. (2015). Genetic variability studies of fruit yield and its traits among indeterminate tomato genotypes under open field condition. *African Journal of Agricultural Research*, *10*(32), 3170–3177.

Mehta, N., & Asati, B. S. (2008). Genetic relationship of growth and development traits with fruit yield in tomato (*Lycopersicon esculentum* Mill.). *Karnataka Journal of Agricultural Sciences*, *21*(1), 92–96.

Meitei, K. M., Broda, G. C., Singh, S. J., & Sinha, A. K. (2014). Morphology-based genetic variability analysis and identification of important characters for tomato (*Solanum lycopersicum* L.). *American-Eurasian Journal of Agricultural and Environmental Sciences*, *14*(10), 1105–1111.

Nagariya, N. K., Bhardwaj, R., Sharma, N., Mukherjee, S., & Umesh. (2015). Correlation and path analysis in tomato (*Solanum lycopersicum* L.). *International Journal of Farm Sciences, 5*(4), 111–117.

Raut, N., Patil, H. B., Basavaraj, N., Jagadeesha, R. C., Fakrudin, B., Cholin, S., et al. (2021). Assessment of genetic variability in tomato (*Solanum lycopersicum* L.) for yield and yield attributing traits. *The Pharma Journal, 10*(4), 399–403.

Nwosu, D. J., Onakoya, O. A., Okere, A. U., Babatunde, A. O., & Popoola, A. F. (2014). Genetic variability and correlations in rainfed tomato (*Solanum* spp.) accessions in Ibadan, Nigeria. *Greener Journal of Agricultural Sciences, 4*(5), 211–219.

Olmstead, R. G. (2008). A molecular phylogeny of the Solanaceae. *Taxon, 57*(4), 1159–1181.

Panse, V. G., & Sukhatme, P. V. (1967). *Statistical methods for agricultural workers* (2nd ed.). ICAR Publication.

Patel, S. A., Kshirsagar, D. B., Attar, A. V., & Bhalekar, M. N. (2013). Study on genetic variability, heritability and genetic advance in tomato. *International Journal of Plant Sciences, 8*(1), 45–47.

Pooja, H. M., Gasti, V. D., Kumar, A. B., Yashavantakumar, H. K., Prashantha, A., & Srikantaprasad, D. (2022). Genetic variability, heritability and genetic advance in determinate type of tomato (*Solanum lycopersicum* L.). *The Pharma Innovation, 11*(4), 222–225.

Rakesh, K., Ram, C. N., Yadav, G. C., Chandra, D., Vimal, S. C., & Bhartiya, H. D. (2014). Studies on correlation and path coefficient analysis in tomato (*Solanum lycopersicum*). *Plant Archives, 14*, 443–447.

Saima, S., Malik, A., Zargar, M. Y., Showkat, M., Shakeel, A. M., Zahoor, A. B., Zaffar, M. D., Shayan, & Ayman. (2019). Impact of microbial inoculants on growth and yield of tomato (*Solanum lycopersicon* L.) under temperate conditions. *Journal of Pharmacognosy and Phytochemistry, 8*(1), 1261–1264.

Shankar, A. (2016). *Studies on heterosis, combining ability and stability for yield and its components in tomato (Solanum lycopersicum L.)* [Doctoral dissertation, Dr. Y. S. R. Horticultural University].

Sharmin, S., Hannan, A., Tahjib, M., Arif, U., & Sagor, G. H. M. (2019). Genetic association and path coefficient analysis among yield and nutritional traits of tomato (*Lycopersicon esculentum* L.). *Journal of the Bangladesh Agricultural University, 17*(2), 187–193.

Singh, A. K., Solankey, S. S., Akhtar, S., Kumari, P., & Chaurasiya, J. (2018). Correlation and path coefficient analysis in tomato (*Solanum lycopersicum* L.). *International Journal of Current Microbiology and Applied Sciences, 7*, 4278–4285.

Somraj, B., Reddy, R. V. S. K., Reddy, R., Saidaiah, P., & Reddy, T. M. (2017). Genetic variability, heritability and genetic advance for yield and quality attributes in heat tolerant exotic lines of tomato (*Solanum lycopersicum* L.). *Journal of*

Pharmacognosy and Phytochemistry, 6(4), 1956–1960.

Sudesh, K., & Anita, S. (2016). Assessment of genetic variability, character association and path analysis in tomato (*Solanum lycopersicum* L.) under Tarai condition of Uttarakhand. *International Journal of Agricultural Sciences, 34*(8), 1706–1709.

Tiwari, J. K., Tiwari, A. K., & Mehta, N. (2013). Selection strategies for fruit yield in tomato (*Solanum lycopersicum* L.). *Vegetable Science, 40*(1), 23–27.

Peer-review history:
The peer review history for this paper can be accessed here:
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