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Study on Genetic Variability, Heritability, Genetic Advance in Tomato (*Solanum lycopersicum* L.)

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A B S T R A C T

An experiment was conducted to evaluation of genetic variability present in the twenty genotypes and observations were recorded on various yield and yield contributing characters. Analysis of variance showed the significant variability for all the studied characters. High values of GCV and PCV were observed for characters viz., number of fruits per plant (55.74, 56.21), number of locules per fruit (36.44, 37.15), average fruit weight (35.45, 35.97) fruit yield per plant (31.09,32.35) marketable fruit yield per plot (31.10, 32.36) and which indicates the presence of high genetic variation. High heritability coupled with high genetic advance observed for the traits viz., plant height, number of flowers per cluster, number of fruit set per cluster, average fruit weight, number of fruits per plant, fruit yield per plant, fruit yield per plot, fruit shape index, TSS^{0}Brix, Ascorbic acid, Beta carotene, Pericarp thickness, Number of locules per fruit. Which indicates presence of additive gene action and demands for population improvement by selection

Introduction

Tomato belongs to the family solanaceae and is native of Peru Equador region Rick. Tomato is a typical day neutral plant and is mainly self-pollinated, but a certain percentage of cross-pollination also occurs. It is a warm season crop reasonably resistant to heat and drought and grows under wide range of soil and climatic conditions. The ancestor of cultivated tomato is cherry tomato (*Lycopersicon esculantum var. cereasiforme).* There are several species of tomato but the fruits are edible only of two species namely (*Lycopersicon esculantum* and *L. pimpinellifolium*). Tomato is a major source of vitamins and minerals. The nutrition value of tomato per 100 g fruit weight is, Energy-18 Kcal (1%), Carbohydrates-3.9g (3%), Protein-0.9g (1.6%), Total Fat, 0.2g (0.7%), Folates-15µg (4%), Niacin-0.594mg (4%), Vitamin A-833 IU (28%), VitaminC-13mg (21.5%), Vitamin E-0.54mg (4%), Calcium10 mg (1%), Iron 0.3mg (4%), Magnesium-11mg (3%), ß Carotene 449µg, Carotene-α-101µg, Lycopene-2573µg (20-50 mg). (USDA National Nutrient data base, 2012-13)[38]. Inheritance of quantitative characters is often influenced by variation in other character which may be due to pleotropic or genetic

linkage. There, must be a thorough knowledge of the existence genetic variability, mode of inheritance of economic characters, heritability, kind of gene action and the relative magnitude of additive, dominance and total genotypic and phenotypic variance of the population is essential to formulate an effective crop improvement programme. There is a scope of yield and quality improvement and there by develop export potential of tomato. Hence the present investigation carried out for genetic variability for quantitative and qualitative traits in genotypes of tomato. The knowledge of genotypic and phenotypic coefficient of variation is being useful in designing selection criteria from variable population. In general, it was noted that the value of phenotypic coefficient of variation is higher than the genotypic Coefficient of Variation For all the traits.

Materials and Methods

The present investigation the experiment was carried out at the horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Science Technology, Allahabad. The experimental material comprised of twenty genotypes, collected from source (Table 1). The genotypes were grown in a randomized block design with three replicates during winter season 2016-2017. keep distance of line to line distance 60cm. and plant to plant distance 45cm. Observations were recorded on five randomly selected plants per treatment for sixteen quantitative and qualitative characters *viz.,* Plant height (cm), Days to first flowering, Days to 50 % flowering, Flowers/cluster, Fruit set/cluster, Fruit weight (kg), Fruits/ Plant, Fruits/Plant, Fruit yield/ Plant (g), Fruit yield/ Plot (kg), Fruit shape index, TSS ^{0}Brix, Ascorbic acid (Vit C) mg/100g, Lycopene (mg/100g), ß Carotene (mg), Pericarp Thickness (mm), Number of Locules/ Fruit. The analysis of variance was done as suggested by Panse and Sukhatme The phenotypic and phenotypic coefficients of variation were worked out according to the Robinson *et al.,* Heritability in broad sense and expected genetic advance on the basis of percent of mean were worked out according to the method advocated by (Burton and Devane) and Johnson *et al.,* (1955) respectively. The analysis of genetic divergence was worked out by Mahalanobis D^2 statistics as per Mahalanobis method and genotypes are grouped into different cluster following Tocher's method as described by Rao.

Results and Discussion

The mean sum of squares in ANOVA revealed high variability among 20 genotypes. The variation due to genotypes was significant for all the characters under study both at 5 and 1 per cent probability levels (Table 2). The high variability observed might be attributed to their genetic makeup of germplasm lines and the different geographical regions from which they have originated. This result of present investigation is in accordance with Singh and Cheema, Mahesha *et al.,* (2006) and Basavaraj *et al.,* (2010) also recorded highly significant difference among the tomato genotypes with respect to all the characters under studied. Mean performance for various genotypes has also showed good range of variability for various characters, studied in present investigation (Table 2). The range recorded for plant height (78.00-171.00) number of days taken to first flowering (31.33-40.6). number of days taken to 50% flowering (30.66-43.33) average fruit weight (6.88-87.46g), Number of fruits per plant (164.93-27.86), Fruit yield per plant (kg) (1.13-3.98kg), Marketable fruit yield per plot (10.24-35.89), Soluble Solid TSS^{0}Brix (3.12-

7.78), Ascorbic acid (mg/100g) (11.61-18.65mg), lycopene content (5.20-6.46mg) per 100 g of pulp. Beta carotene content (0.21-0.37mg) per 100 g of pulp, fruit shape index (0.38-1.53), Pericarp Thickness (1.77-5.27mm), Number of locules per fruit (2.27-6.27), The characters under investigation were analyzed for genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense) and genetic advance as percent of mean (Table 2). In the present study, magnitude of phenotypic variances has high values than genotypic variances for the all characters, which is an indicator of additive effect of the environment on expression of traits. Low range of GCV and PCV reveals that these traits have low sensitivity to environmental effect and it is reducible. High values of GCV and PCV were observed for characters *viz*., number of fruits per plant, number of locules per fruit, average fruit weight, fruit yield per plant, marketable fruit yield per plot, fruit shape index, plant height, number of fruit set per cluster, TSS^0Brix. Moderate GCV and PCV were observed for traits *viz.,* pericarp thickness, of flowers per cluster, Beta carotene, Ascorbic acid. Low GCV and PCV were observed for traits *viz.,* days to first flowering, Lycopene content, days to 50% flowering.

Table.1 List of different genotypes was used in present investigation (Source of collection from IIVR Varanasi)

S.No.	Genotype Symbol	Name of Genotypes	Determinate/Indeterminate / Semi Determinate	Source of Released
1	G_1	ArkaVikas	Determinate	IIHR,Bangalore
2	G_2	Punjab Chhuhara	Determinate	PAU, Ludhiana
3	G_3	Azad T-5	Determinate	CSAUA&T, Kanpur
4	G_4	Azad T-6	Determinate	CSAUA&T, Kanpur
5	G_5	EC-501574	Determinate	IARI New Delhi
6	G_6	Kashi Vishesh	Determinate	IIVR, Varanasi
7	G_7	S 22	Determinate	IARI New Delhi
8	G_8	Pant T-5	Semi Determinate	GBPUA&T, Pantnagar,
9	G_9	Pant T-7	Semi Determinate	GBPUA&T, Pantnagar,
10	G_{10}	Hissar Lalit	Semi Determinate	HAU, Hissar
11	G_{11}	Kashi Aman	Semi Determinate	IIVR, Varanasi
12	G_{12}	Kashi Hemant	Semi Determinate	IIVR, Varanasi
13	G_{13}	Kashi Sharad	Indeterminate	IIVR, Varanasi
14	G_{14}	H-88-78-1	Indeterminate	IIVR, Varanasi
15	G_{15}	H-88-78-5	Indeterminate	IIVR, Varanasi
16	G_{16}	Ageta-32	Indeterminate	IARI New Delhi
17	G_{17}	Pusa Cherry	Indeterminate	IARI New Delhi
18	G_{18}	Angoorlata	Indeterminate	IIVR, Varanasi
19	G_{19}	Pusa Ruby	Indeterminate	IARI,New Delhi
20	G_{20}	Arka Abha	Indeterminate	IIHR, Bangolore

Table.2 Analysis of variance for yield and its components in Tomato

S. No.	Character	Mean sum of squares		
		Replications	Genotypes	Error
1	Plant Height (cm)	22.73	2994.3 **	23.14
2	Days to First Flowering	0.88	17.76**	0.92
3	Days to 50 % Flowering	0.61	11.01**	1.529
4	Number of Flowers/cluster	0.13	9.47**	0.42
5	Number Fruit set/cluster	0.10	6.15**	0.19
6	Average Fruit Weight (g)	11.77	1188.08**	12.28
7	Number of Fruits/ Plant	25.75	2511.23**	14.09
8	Fruit Yield/ Plant (kg)	0.065	1.88**	0.05
9	Marketable Fruit Yield/ Plot (kg)	5.38	152.87**	4.09
10	Fruit shape Index	0.029	0.259**	0.023
11	TSS (°Brix))	0.050	2.861**	0.04
12	Ascorbic Acid(Vit C)mg/100g	0.33	12.00**	0.70
13	Lycopene Content (mg/100g)	0.005	0.30**	0.01
14	ß Carotene (mg)	0.00	0.005**	0.001
15	Pericarp Thickness (mm	0.02	1.66**	0.009
16	Number of Locules/ Fruit	0.04	5.52**	0.07

*Significant at 5% level of probability, ** Significant at 1% level of probability

Table.3 Range, mean, variance, coefficient of variations, heritability, genetic advance and genetic advance as % of mean for 16 characters of tomato

S. No.	Characters	Mean	Range		Coefficient of variance		h^2 (b.s.) (%)	Genetic Advance (5%)	Genetic Advance as % of mean (5%)
			Min.	Max.	GCV (%)	PCV (%)			
1.	**Plant Height (cm)**	116.46	78.00	171.00	27.02	27.34	97.71	64.08	55.03
2.	**Days to First Flowering**	34.66	31.33	40.07	6.83	7.38	85.83	4.52	13.04
3.	**Days to 50 % Flowering**	40.08	35.65	43.33	4.44	5.40	67.40	3.01	7.50
4.	**Number of Flowers/cluster**	9.06	6.13	11.93	19.16	20.46	87.68	3.35	36.97
5.	**Number of Fruit set/cluster**	6.34	4.33	8.87	22.23	23.31	90.93	2.77	43.67
6.	**Average Fruit Weight (g)**	55.90	6.89	87.47	35.45	35.97	96.95	40.16	71.84
7.	**Number of Fruits/ Plant**	51.76	27.87	164.93	55.74	56.21	98.33	58.94	113.86
8.	**Fruit Yield/ Plant (g)**	2.52	1.14	3.99	31.09	32.35	92.33	1.55	61.54
9.	**Marketable Fruit Yield/ Plot (kg)**	22.64	10.24	35.89	31.10	32.36	92.23	13.94	61.57
10.	**Fruit shape Index**	0.92	0.38	1.53	30.46	34.71	77.02	0.51	55.08
11.	**TSS (°Brix))**	4.37	3.12	7.78	22.17	22.70	95.36	1.95	44.60
12.	**Ascorbic Acid(Vit C)mg/100g**	14.17	11.61	18.65	13.20	14.38	84.28	3.67	24.96
13.	**Lycopene Content (mg/100g)**	5.61	5.20	6.46	5.54	5.83	90.03	0.61	10.82
14.	**ß Carotene (mg)**	0.26	0.21	0.37	16.68	16.94	97.03	0.09	33.85
15.	**Pericarp Thickness (mm)**	5.35	1.77	5.27	19.36	19.32	98.30	1.52	39.54
16.	**Number of Locules/ Fruit**	6.42	2.27	6.27	36.44	37.15	96.21	2.72	73.64

Table.4 Summary of genotypic and phenotypic coefficient of variation with heritability and genetic as percent of mean for yield and its component in tomato

Sr. No.	Components	Status in present study	Characters	Supported by
1	GCV and PCV	High	Number of fruits per plant, number of locules per fruit average Fruit Weight, fruit yield per plot, fruit yield per plant, fruit shape index, plant height, number of fruit set per cluster, TSS^{0}Brix.	Supe *et al.*, (2006), Sharma *et al.*,.(2006),. Lal *et al.*, (1991), Bharti *et al.*, (2002), Brar et al., (2000), Mohanty (2002), Kaushik *et al.*, (2011), Islam *et al.*, (2012). Rahaman *et al.*, (2012), Vinod Kumar *et al.*, (2013), Dar and Sharma (2011), Rani and Anitha (2011), Golani *et al.*, (2007).
		Moderate	Pericarp thickness, Number of flowers per cluster, Beta carotene, Ascorbic acid.	Manna and Paul (2012)
		Low	Days to first flowering, Lycopene content, days to 50% flowering	Islam *et al.*,(2012)
2	Genetic Advance as a percent mean	High	Plant Height, Number of fruits per plant average fruit weight, Number of Flowers/cluster, number of fruit set/cluster, average fruit weight, number of fruits per plant, fruit yield/plant, marketable fruit yield, fruit shape index, TSS, Ascorbic acid, beta carotene, pericarp thickness, number of locules/fruit	Haydar *et al.*, (2007), Tasisa *et al.*, (2011), Ahmed *et al.*, (2006), Bharti *et al.*, (2002), Manna and Paul (2012)
		Moderate	Days to first flowering, lycopene content	-
		Low	Days to 50% flowering	-
3	Heritability	High	Plant Height, Days to First Flowering, Days to 50 % Flowering, Flowers/cluster, Fruit set/cluster, Fruit Weight, Fruits/ Plant, Fruits/Plant, Fruit Yield/ Plant (g), Fruit Yield/ Plot, Fruit shape Index, TSS ^{0}Brix, Ascorbic Acid (Vit C) mg/100g, Lycopene (mg/100g),ß Carotene (mg), Pericarp Thickness (mm), Number of Locules/ Fruit.	Phookan *et al.*, Ahmed *et al.*, (2006), Mahesha *et al.*,.Joshi and Singh,. Singh *et al.*, Bharti *et al.*, (2002), Dar and Sharma (2011), Kumar *et al.*, (2004).
		Moderate	-	
		Low	-	

GCV measures the amount of variation present in a particular character but it doesn't provide an idea about the proportion of heritable variation present in the total variation therefore, heritability estimates were calculated in the present study. In the present study heritability estimates were high for all the studied character as categorized (Low <30%; Moderate 30-60%; high >60%) by Johnson *et al.,* (1955) (Table 3).

High heritability coupled with high genetic advance observed for the traits viz., plant height, number of flowers per cluster, number of fruit set per cluster, average fruit weight, number of fruits per plant, fruit yield per plant, fruit yield per plot, fruit shape index, TSS^0Brix, Ascorbic acid, Beta carotene, Pericarp thickness, Number of locules per fruit. High heritability coupled with moderate genetic advance was observed for characters viz., days to first flowering, lycopene content. indicates the presence of both additive and non-additive gene action for these traits. High heritability coupled with low genetic advance found for only one character days to 50% flowering, which clearly states the presence of non-additive gene action and selection is not rewarding for this trait. Recombination breeding and recurrent selection may be used for such type of traits for population improvement.

References

Ahmed, N., Khan, M. I. and Gupta, A. J. Variability and heritability in tomato (*Lycopersicon esculentum* Mill.).*Envt. Eco*, 2: 386-388 (2006).

Arun, J. and Kohli, U. K. Genetic divergence for qualitative and quantitative in tomato, *Indian J. Agric. Sci.*, 73(2): 110-113 (2003).

Basavaraj,S. N., Hosamani, R. M. and Patil, B. C. Genetic variability and genetic divergence in tomato (*Solanum lycopersicon* [Mill] Wattsd.). *Karnataka J. Agric. Sci*., 23(3): 536-537 (2010).

Bharti, A., Jain, B. P.,Verma, A. K. and Bharti,O. A. Genetic variability, heritability and genetic advance in tomato (*Lycopersicon esculentum* Mill.).*J. Res., Birsa Agri. Uni*., 14(2): 249-252 (2002).

Brar, G. S., Singh, S., Cheema, D. S. and Dhaliwal, M. S. Studies on variability, heritability and genetic advance for yield and component characters in tomato (*Lycopersicon esculentum* Mill*).J. Res.Punjab Agric. Uni*.,37(3/4): 190-193 (2000).

Burton and Devane Estimating heritability in tall Fesscue from replicated clonal marterial. *Agron. J.*, 45: 474-481(1953).

Burton, G. W. Quantitative inheritance in grass. *Proc. 6th Int. Grassland Cong.*,1: 227-283 (1955).

Dar, R. A. and Sharma, J. P. Genetic variability studies of yield and quality traits in tomato (*Lycopersicon esculentum* Mill). *International J. Plant Breeding and Genetic*, 5(2): 168-174 (2011).

Golani, I. J., Mehta, D. R., Purohit, V. L., Pandya, H. M. and Kanzariya, M. V. Genetic variability, correlation and path coefficient studies in tomato. *Indian J. Agric. Res.*,41(2): 146 – 149 (2007).

Haydar, A, Mandal, M.A, Ahmed, M.B, Hannan, M.M, Karim, R, Razvy, M.A, Roy, U.K and Salahin, M. Studies on Genetic Variability and Interrelationship among the different traits in tomato *(Solanum lycopersicum L.). Middle-East Journal of Scientific Research.* 2 (3-4): 139-142 (2007).

Islam, M.S, Mohanta, H.C, Rafii, M.Y and Malek, M.A. Genetic variability and trait relationship in cherry tomato (*Solanum lycopersicum* L.). *Bangladesh J. Bot*. 41(2):163-16 (2012).

Johnson, H. W., Robinson, H. F. and Comstock, R. E. Genotypic and phenotypic correlations in soybean and their implication in selection. *Agron. J.*,47: 477- 483 (1955).

Joshi, A. and Singh, J. P. Studies on genetic variability in tomato. *Progr. Hort.*, 35(2): 179-182. (2003).

Karasava, M, Rodrigues, R, Sudre, C.P, Silva, M.P, da Riva, E.M and Junior, A.T. Cluster analysis for the evaluation of divergence among tomato accessions. *Horticultura Brasileira* 23(4) : 1000-1005 (2005).

Kaushik, S.K, Tomar, D.S and Dixit, A.K. Genetics of fruit yield and it's contributing characters in tomato (*Solanum lycopersicom L.*). *J. of Agri. Biotech and Sustainable Developement*. 3(10): 209 -213 (2011).

Kumar, S., Singh, T., Singh, B. and Singh, J. P. Studies on heritability and genetic advance in tomato (*Lycopersicon esculentum* Mill.). *Progr. Agric.*,4(1): 76-77 (2004).

Lal, G, Singh, D.K and Tiwari, R.P. Performance of some tomato cultivars during summer in Tarai region. Vegetable Science. 18 : 99-101(1991).

Lush Inter-se correlation and regression of characters *Pro.of Amer. Soci. of Ani. Production*,33: 293-301 (1949)

Mahalanobis, P. C. On the generalized distance in statistics. *Proc. Nat. Inst. Sci. India*, 2: 49-55 (1936).

Mahesha, D. K., Apte, U. B. and Jadhav, B. B. Genetic variability and genetic divergence in tomato (*Lycopersicon esculentum* Mill.).*Res. Crops*, 7(3): 771-773 (2006).

Manna, M. and Paul, A. Studies on genetic variability and character association of fruit quality parameters in tomato. *Hort. Flora Res. Spec*., 1(2): 110-116 (2012).

Mohanty, B. K. Studies on variability, heritability, interrelationship and path analysis in tomato. *Annals Agric. Res.*, 2(1): 65-69 (2002).

Panse, V. G. and Sukhatme, P. V. *Statistical Methods for Agricultural Workers* (2ndEdn.), Indian Council of Agricultural Research, New Delhi, 381p (1985).

Phookan, D. B., Talukdar, P., Shadeque, A. and Chakravarty, B. K. Genetic variability and heritability in tomato (*Lycopersicon esculentum*) genotypes during summer season under plastic-house condition.*Indian J. Agric. Sci.*,68(6): 304-306 (1998).

Rahaman, S., Lakshman, S. S. and Maitra, N. J. Genetic variability and heritability in tomato (*Lycopersicon esculentum* Mill.). *International J. Plant Sci.* (Muzaffarnagar),7(1):58-62 (2012).

Rani, K. R. and Anitha, V. Studies on variability, heritability and genetic advance in tomato (*Lycopersicon esculentum* Mill.). *International J. Bio-resource and Stress Manag.*,2(4): 382-385 (2011).

Rao, C. R. *Advanced Statistical Methods in Biometrical Research*. John Wiley and Sons, Inc., New York. (1952).

Rick, C.M.. Origin of cultivated tomato, current status of the problem. *Abstract XI International Botanical Congress*. p: 180 *(*1969.)

Robinson, H.F. Comstock, R.E. and Harvey, V.H. Estimates of heritability and degree of dominance in corm. *Agron. J.*,41:353-359 (1949).

Singh, B., Singh, S. P., Kumar, D. and Verma, H. P. S. Studies on variability, heritability and genetic advance in tomato (*Lycopersicon esculentum* Mill.).*Progr. Agric.*,1(2): 76-78 (2001).

Singh, H. and Cheema, D. S. Studies on genetic variability and heritability for quality traits of tomato (*Lycopersicon esculentum* Mill.) under heat stress

conditions. *J. App. Hort.*, 7(1): 55-57 (2005).

Supe, V.S and Kale, P.B. Varibility, herrtability and genetic advance in tomato (*Lycopersicon esculentum* Mill.). Scientific Horticulture 2 : 91-94. *The Journal of Horticulture*. 30(2) : 29-31 (1991).

Tasisa, J., Belew, D., Bantte, K. and Gebreselassie, W. Variability, heritability and genetic advance in tomato (*Lycopersicon esculentum* Mill.) genotypes in West Shoa, Ethiopia. *American-Eurasian J. Agric. Envt. Sci*., 11(1): 87-94 (2011).

USDA National Nutrient data base Nutritative value in Tomato.(2012-13).

Vinod Kumar, R, Nandan, K, Srivastava, S.K, Sharma, Ravindra Kumar and Anuj Kumar. Genetic parameters and correlation study for yield and quality traits in tomato (*Solanum Lycopersicum* L.). *Plant Archives.* 13 (1): 463-467 (2013).

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