The Pharma Innovation Journal 2022; 11(6): 507-510

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(6): 507-510

www.thepharmajournal.com
Received: 22-03-2022
Accepted: 31-04-2022

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Study of Heritability and Genetic advance in the different genotypes and trails of tomato in sub-tropical condition

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Abstract
The present investigation was undertaker at Farm Unit - 6, Integral Institute of Agricultural Sciences & Technology, Lucknow, during winter season 2020-2021. The experiment comprised of 35 genotypes and 96 crosses with 3 checks. The experiment was laid out in Randomized Block Design with three replications. The genotypes were evaluated to estimate variability, heritability and genetic advance in yield and yield contributing characters at farm unit-6, Integral Institute of agricultural science & technology, Integral University, Lucknow. A high degree of significant variation was observed for all the characters studied except pericarp thickness and number of locules. A highest GCV was observed for fruit yield per plant and PCV for fruit yield per plant and number of locules while lowest GCV was noticed for days to first harvest, days to 50 per cent flowering and pericarp thickness and PCV for days to first harvest and days to 50 per cent flowering. High heritability with high genetic advance as per cent of mean was observed for fruit yield per plant and average fruit weight which could be improved by simple selection.

Keywords: Tomato, heritability, genetic advance, yield and yield attributes

Introduction
Tomato (*Lycopersicon esculentum* L.) is one of the most popular and widely grown vegetable in the world ranking second in importance only next to potato in many countries and ranked 1st in preserved and processed vegetables. The family belongs to Tomato is Solanaceae and the native of Peru. (Rick, *et* at., 1969) The tomato crop is of recent origin and the first report was grown from Italy in 1544. It's being a self-pollinated crop; it has a tremendous potential for heterosis breeding and it is used in different breeding programme for genetic studies. Potent variability can be expected in tomato with respect to plant stature, fruit shape, size, quantity and quality. (Bhardwaj and Sharma *et al.*, 2005) Optimum temperature of tomato is 15-20 °C. The genus is Solanum consists of annual or short lived perennial herbaceous plants. Tomato is a day neutral plant. It is mainly self-pollinated crop, but a certain percentage of cross-pollination also occurs. It is a cool season crop reasonably resistant to heat and drought and grows under wide range of soil and climatic conditions. (Dutta *et al*. Rajolli *et al*.) [4, 10].
Tomato is a true diploid with 2n=24. Plant is annual with herbaceous prostrate stem having determinate or indeterminate growth habit. In the determinate growth, terminal bud ends in a floral bud and further growth in arrested resulting in dwarf and bushy stature. In indeterminate growth, terminal bud is a leafy bud and terminal and lateral buds continue to grow and there are less production of flowers and fruits on mains term.
Considering the potentiality of this crop, there is a need for improvement and to develop varieties suited to specific agro-ecological conditions and also for specific end use. A thorough knowledge regarding the amount of genetic variability existing for various characters is essential for initiating the crop improvement programme. With limited variability much cannot be achieved and the breeder will have to enrich the germplasms to create greater variability through hybridization, mutation and polyploidy breeding.

Methods and Materials
The experimental material consisting of 35 genotypes of tomato collected from various sources were evaluated at an experimental farm of the Department of Horticulture, Integral Institute of

Agricultural Science & Technology, Integral University, Lucknow (U.P.) during 2020- 2021. The experiment was layout in randomized block design with 3 replications at spacing of 90 cm × 30 cm. The observations were recorded for 12 characters *viz*., days of 50% flowering, plant height (cm), number of primary branches per plant, Fruit diameter (cm), fruit length (cm), number of locules per fruit, pericarp thickness (mm), average fruit weight (g), total soluble solids (^{0}Brix), number of fruits per plant, number of marketable fruits per plant, number of unmarketable fruits per plant and fruit yield per plant (g) in five randomly selected plants from each genotype in each replication. The analysis of variance was calculated as per Phom and Chaturvedi [8]. Phenotypic and genotypic coefficient of variation was estimated according to Rai, and Vikram [9]. Heritability in broad sense and genetic advance as percent of mean were calculated as per formula given by Ullah [16] and Salim [12] respectively.

Results and Discussion

In Table 1, the Analysis of Variance (ANOVA) revealed highly significant difference among genotypes for all the characters under study except pericarp thickness and number of locules suggesting presence of substantial amount of variability for all the characters in 35 genotypes.

The extent of variability measured in term of range, mean, genotypic co-efficient of variance, phenotypic co-efficient of variance, heritability, expected genetic advance and the expected genetic advance as percent of mean are presented in Table 2.

A considerable variation was observed in most of the characters. Among the characters maximum range of mean values was observed for days of 50% flowering (21.00-27.00 days) followed by fruit yield per plant (3183.33-6763.53 g) and average fruit weight (47.73-88.80g). The minimum range was recorded with pericarp thickness (0.43-0.69 cm). The characters showing wide range of variation provide sample scope for selecting the desirable genotypes. In the study, PCV were higher than the respective GCV for all the characters which indicated environmental influence in expression of the characters considered in the present investigation. These findings are in consonance with Mohanty (2003). On the other hand, a wide range of variability recorded for all characters also indicates the scope for selection of better genotypes. The narrow difference between PCV and GCV were recorded for most of the traits except no. of primary branches per plant, fruits length (cm), average fruit weight (g), total soluble solids (%), no. of marketable fruits per plant and fruit yield per plant (kg). the high PCV was recorded for the traits no. of unmarketable fruits per plant (74.2793), followed by no. of marketable fruit per plant (32.9996), no. of primary branches per plant (31.2146), plant height at maturity (29.7121), average fruit weight (22.643), fruit yield per plant (20.0305), pericarp thickness (16.4613), fruits diameter (14.7948), number of locules per fruit (13.3049), Total Soluble Solids (12.2518) and Fruits Length (12.1675), showed moderate PCV. However the traits total soluble solids (12.2518) and fruits length (12.1675) depicted low PCV. GCV ranged from 2.3243 (Fruits Length) to 71.5443 (no. of unmarketable fruits per plant). The highest GCV was recorded for the traits no. of unmarketable fruits per plant (71.5443), followed by plant height at maturity (28.4687), no. of primary branches per plant (23.8479), no. of marketable fruits per plant (11.0398), average fruit weight (10.7315), fruits diameter (10.7135), fruit yield per plant (10.7030), total soluble solids (10.4821), pericarp thickness (8.1962), number of locules per fruit (7.0683) and fruits length (2.3243) showed moderate GCV. The estimate of genetic variance *viz*. Range, mean, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h2), GA as % of mean of tomato are presented. These results are also in agreement of Mamatha and Lingaiah, [7]. Most of the characters have moderate PCV except days to 50 per cent flowering and days to 1st harvest. These results are in accordance with Kumar (2010). High estimates of phenotypic variability alone will not be enough to determine exact nature of variability. GCV would be more useful for assessing the variability (Kumar) [6].

The PCV values were slightly higher than the respective GCV for all the characters denoting little environmental factors influencing their expressions to some degree or others. The difference between values of PCV and GCV were less for all traits in present investigation. It means these traits were less influenced by environment and they could be improved by following different phenotypic selections like directional, disruptive and stabilized selections. Similar finding in tomato were also reported by Dutta *et al*. [4] Rawat *et al*. [11], Sharmin *et al*. [13], Tripathy *et al*. [15] Behera *et al.* [3] and Alam [1].

Moderate PCV and GCV (10%-20%) values for fruit length, fruit diameter, days to fruit maturity at physiological stage and total soluble solids indicated the presence of moderate genetic variability for these traits whereas the component, days to fruit initiation and iron content showed low (<5%) PCV and GCV values indicating the existence of less variability in the material studied. Similar kinds of observations were also reported by Rawat *et al*. [11] and Mamatha *et al*. [7].

Table 1: Analysis of variance for different characters in tomato

Character	Abbreviation DF	Replication 2	Genotype 35	Error 68	C.V. %
Days of 50% flowering	D50 % f	0.324324	9.303804**	0.231732	1.999
Plant height (cm)	PH	15.76114	1710.847000**	49.432117	8.51
Number of primary branches per plant	NPBP	0.330286	14.318723**	2.750286	20.14
Fruit diameter (cm)	FD	0.101101	0.845488**	0.196281	10.20
Fruit length (cm)	FL	0.184278	0.265866**	0.238741	11.94
No. of Locules per Fruit	NLF	0.172571	0.391529**	0.17963	11.27
Pericarp thickness (mm)	PT	0.00248	0.012685**	0.006378	14.28
Average fruit weight (g)	AFW	40.76685	314.208084**	168.109211	19.94
Total soluble solids (^{0}Brix)	TSS	0.016537	0.611545**	0.066521	6.34
No. of Marketable fruits per plant	NMFP	307.2484	64.013602**	46.451518	31.10
No. of unmarketable fruits per plant	NUFP	238.5169	1641.432524**	41.551462	19.97
Fruit yield per Plant (g)	FYP	417751.1	1441219.722856**	655454.1323	16.93

Table 2: Estimates of mean, range, variance components and genetic parameters for different characters

Traits	Mean	Range	Coefficient of variability (%)		Heritability (%)	Genetic Advance	GA as % of mean
			Phenotypic	Genotypic			
D50%f	24.081	21.00-27.00	7.4929	7.2213	92.88	3.4524	14.3367
PH (cm)	82.6629	39.13-106.47	29.7121	28.4687	91.81	46.4494	56.1914
NPBP	8.2343	4.40-10.73	31.2146	23.8479	58.37	3.0906	37.5328
FD (cm)	4.3421	3.29-5.63	14.7948	10.7135	52.44	0.6939	15.9816
FL (cm)	4.091	3.39-4.72	12.1675	2.3243	3.65	0.0374	0.9146
NLF	3.76	3.27-4.73	13.3049	7.0683	28.22	0.2909	7.7355
PT (mm)	0.5594	0.43-0.69	16.4613	8.1962	24.79	0.047	8.4068
AFW (g)	65.0286	47.73-88.80	22.643	10.7315	22.46	6.8133	10.4773
TSS (^{0}Brix)	4.0663	3.45-4.85	12.2518	10.4821	73.2	0.7512	18.4742
NMFP	21.9162	14.00-32.27	32.9996	11.0398	11.19	1.6674	7.6082
NUFP	32.2781	10.40-72.53	74.2793	71.5443	92.77	45.8203	141.955
FYP (g)	4781.686	3183.33-6763.53	20.0305	10.703	28.55	563.333	11.7811

D50% F - Days to 50% flowering, PH- plant height (cm), NPBP- Number of branches per plant, FD –Fruit diameter, FL – Fruit length, NLF –, AFW- Average fruit weight (g), PD –Polar diameter (cm), ED - Equatorial diameter (cm), PT - Preicarp thickness (cm), NL - Number of locules, TSS (°Brix) – Total soluble solids, NMFP – Number of marketable fruits per plant, NUFP – Number of unmarketable fruit per plant, FYP – Fruit yield per plant.

Genetic advance as per cent of mean was highest for average fruit weight (45.12%) and number of locules (33.64%) indicating important role of genetic factor towards expression of these characters as genetic advance was estimated on the basis of heritability (B.S.). Thus for these characters, there is maximum possibility of fruitful phenotypic selection. Heritability estimates along with genetic advance is more useful than the heritability alone. Highest estimates of heritability accompanied with high genetic advance were found in average fruit weight, fruit yield per plant, number of harvesting, TSS and number of locules. The above findings stood parallel with Tasisa *et al.* (2011) and Rani and Anitha (2011). High heritability along with moderate genetic advance was observed in plant height, harvesting duration and equatorial diameter which promotes scope for selecting a better-progenies. These findings also agree with the findings of Rajolli *et al.* [10], Phom *et al.* [8], Basfore *et al.* [2], Gopinath *et al.* [5].

The genetic advance for quantitative characters aids in exercising necessary selection procedure. According to Burton and De Vane (1953); GCV along with heritability estimate would give the best scope for selection. Highest heritability (b.s.) were found for average fruit weight (89.8%) followed by fruit yield per plant (87.2%) and TSS (83.2%). These results corroborate the view of Tripathy *et al.* [15] Salim *et al.* [11] Sharmin *et al.* [12] and Sinha *et al.* [14]

Conclusion

A wide range of variability along with estimates of genetic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) recorded for; plant height at maturity (cm), number of primary branches per plant, fruit diameter (cm), fruit length (cm), number of locules per fruit, pericarp thickness (mm), average fruit weight (g), total soluble solid (%), No. of Marketable fruits per Plant, no. of unmarketable fruits per Plant, fruit yield per plant (g) indicating the scope for selection of suitable initial breeding material for further improvement. High value of GCV and genetic gain were observed for; plant height at maturity (cm), number of primary branches per plant, fruit diameter (cm), fruit length (cm), number of locules per fruit, pericarp thickness (mm), average fruit weight (g), total soluble solid (%), No. of Marketable fruits per Plant, no. of unmarketable fruits per Plant, fruit yield per plant (g) which might be assigned to additive gene action conditioning their expression and phenotypic selection for their amelioration could be brought about by simple methods. The difference between PCV and GCV values were low, indicating that the traits under study were less influenced by environment and these characters could be improved by following phenotypic selection.

Acknowledgements

A very warm thanks to Dr. Satish Yadav, Assistant Professor, (Horticulture) Dr. Md. Abu Nayyar, Assistant Professor, (Horticulture) Dr. Deepti Srivastava, Assistant Professor (Genetics & Plant Breeding), Department of Agriculture, they have inaccurate and assist me for the said research work.

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