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Research Article

ESTIMATES OF GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE FOR YIELD AND YIELD COMPONENT TRAITS IN THERMO TOLERANT TOMATO (*Solanum lycopersicum* L.) GENOTYPES

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Abstract- Twenty one diverse thermo tolerant tomato genotypes were evaluated to estimate variability, heritability and genetic advance over mean for fruit yield and component characters. Analysis of variance revealed highly significant mean sum of square due to treatment for all the traits suggested thereby the substantial amount of genetic variability was existed in the material under study. Phenotypic coefficient of variation (PCV) was higher than the corresponding genotypic coefficient of variation (GCV) in all the morphological traits under study and the GCV was very close to PCV for most of the characters indicating a highly significant effect of genotype on phenotypic expression indicating ample scope for selection of genotypes from available germplasm for these traits. High heritability in combination with high genetic advance as per cent over mean was recorded in yield per plant, fruit pericarp thickness and fruit equatorial diameter explaining that these characters are governed by additive gene action which is crucial in selection.

Keywords- *Solanum lycopersicum*, thermo tolerance, variability, heritability, genetic advance

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Introduction

Tomato (*Solanum lycopersicon* L.) is considered as one of the most popular and widely grown vegetable crops throughout the world. Tomato is also known for medicinal properties besides for its taste and nutritional quality. It ranks second in importance next to potato and ranks first among preserved and processed vegetables in many countries. The effectiveness of selection in any crop improvement programme is primarily dependent on the variation present in the population. Information on genetic diversity among available genotypes is necessary for development of a promising variety [1]. Heritability and genetic advance are important selection parameters. Heritability is the heritable portion of phenotypic variation. It is a good index of characters transmission from parents to their off spring. The estimates of heritability help in the selection of elite genotypes from diverse genetic population. Genetic advance measures the amount of progress that could be expected with selection in a character. However, the character showing high heritability needs not exhibit high genetic advance [6]. High heritability coupled with high genetic advance indicates that the improvement could be made for a character by simple selection. Estimation of genetic variability and heritability of various yield attributing traits *viz.,* per cent fruit set, yield per plant, and fruit weight in tomato under temperature stress will be helpful in formulating selection strategies for these traits in future tomato breeding programme. Hence the present study focuses on assessment of available genetic variability, heritability and genetic advance for yield and yield component traits in selected thermo tolerant tomato genotypes under high temperature conditions.

Materials and Methods

The present experiment was carried out at the Research Farm of Division of Vegetable Science, Indian Agricultural Research Institute, New Delhi (latitude 28°40' North, longitude 77°12' East and at an altitude of 228.6 m above mean sea level) during the summer season (March–June) of the year 2014. The climate of Delhi is semi-arid with hot summers and cool winters. The experimental material consisted of 21 contrasting thermo tolerant and diverse genotypes of tomato [Table-1] and the experiment was laid out in randomized block design with 3 replications. All the recommended cultural practices were followed to raise a healthy crop. Five plants from each replicated plots were selected at random at the time of recording the data on various characters *viz.,* leaf length (cm), leaf width (cm), days to 50 per cent flowering, In vitro pollen germination, average fruit weight (g), fruit polar diameter (cm), fruit equatorial diameter (cm), pericarp thickness of fruit (cm), fruit set per cent and yield per plant (g). The mean data was recorded and statistical analysis was performed to estimate genetic variability, phenotypic and genotypic coefficient of variation [3], [5] and genetic advance [6].

Statistical analysis: The mean values were utilized for statistical analysis. The correlation and path analysis was performed by using the software SPSS version 17.0 and GENRES.

Results and Discussion

Analysis of variance showed highly significant difference between the genotypes for all the traits suggested, thereby the substantial amount of genetic variability were existed in the materials under study. The combined mean performance of 21 thermo tolerant tomato genotypes for various morphological traits is presented in [Table-2]. Leaf length varied from 1.8 cm (Spr-2) to 7.2 cm (Chikko), while the leaf

width was maximum in PSH-3 (4.8 cm) followed by Chikko (4.3 cm). Earliest 50 % flowering was recorded in Pusa Sadabahar (49 days), closely followed by Balkan (50 days) and TH-348-T2 (51 days). Spr-1 and Spr-2 were found to be very late in flowering (68 and 66 days respectively). At high temperature pollen germination per cent ranged from 32 % (Pusa Rohini and SPM 4 each) to 55 % (Pusa Sadabahar). High pollen germination per cent (more than 45 %) was recorded in several genotypes, *viz.,* TH-348-T2, Balkan, TH-348-4-R, TH -348-4-2, TH-348-4-5-1, Spr-1 and Pusa Sheetal. It is concluded that under heat stress, pollen germination and fruit set per cent may be considered as important parameter for distinguishing heat tolerant and heat sensitive genotypes. Similarly high pollen germination (62.9 %) was recorded in Pusa Sadabahar, whereas the susceptible genotype, Pusa Rohini recorded low pollen germination and exerted stigma in 100 % flowers at 27/37°C day/night temperature [12]. Average fruit weight was maximum in Pusa Sadabahar (49.7 g) and minimum in Spr-2 (3.5 g). It was noticed that under heat stress fruit weight reduced significantly in most of the genotypes. Similar trends were recorded in case of fruit polar diameter, fruit equatorial diameter and fruit pericarp thickness. Fruit set per cent was recorded maximum in Pusa Sadabahar (66.6 %). Low fruit set per cent was recorded in all the heat sensitive genotypes, *viz.,* Pusa Ruby (28 %), Pusa Rohini (26 %) and Pusa 120 (32.6 %). [1] reported that heat tolerant line and cultivar performed better than heat sensitive cultivar in terms of fruit set %. Yield per plant was found maximum in tolerant genotype Pusa Sadabahar (685 g) followed by LP-2 (610 g), Balkan (605 g) and TH-348-4-R (594 g). The heat sensitive genotypes, *viz.,* Pusa Ruby, Pusa Rohini, Pusa 120 and Pusa Gaurav recorded significantly low yield (290 g, 280 g, 285 g and 342 g respectively).

Table-1 *List of genotypes and standard released varieties included in the study*

Sl. No.	Varieties/genotypes		Sl. No.	Varieties/genotypes	
1.	Pusa Sadabahar	HT	12.	TH-348-4-R	HT
2.	Pusa Ruby	HS	13.	TH-348-4-2	HT
3.	Pusa 120	HS	14.	TH-348-4-5-1	HT
4.	Pusa Rohini	HS	15.	Spr-1*	HT
5.	Pusa Gaurav	HS	16.	Spr-2*	HT
6.	Pusa Sheetal	HT	17.	Spm**	HT
7.	Chikko	HT	18.	SPM 1**	HT
8.	LP-2	HT	19.	SPM 2**	HT
9.	PSH-3	HT	20.	SPM 3**	HT
10.	TH-348-T2	HT	21.	SPM 4**	HT
11.	Balkan	HT			

(Where, HT- heat tolerant, HS- heat sensitive) (Where,* *S. peruvianum*, ** *S. pimpinellifolium*)

Phenotypic coefficient of variation (PCV) was higher than the corresponding genotypic coefficient of variation (GCV) in all the morphological traits under study [Table-3]. The highest PCV and GCV were recorded in yield per plant (39.15 and 38.79), followed by fruit pericarp thickness (35.05 and 34.97) and leaf length (34.63 and 32.41). A critical perusal of data showed that days to 50 % flowering and fruit equatorial diameter had very less difference in PCV and GCV (8.50 and 8.02; 28.95 and 28.05 respectively) indicating that variation in these traits were mainly due to genotype. Similar results of these traits were also reported by [9], [7], [10], [4] and [8] in tomato. Heritability in broad sense was found high in most of the traits. Yield per plant recorded maximum heritability (98.84%) followed by fruit pericarp thickness (98.51 %) and fruit equatorial diameter (93.82 %) while fruit set per cent recorded low per cent (37.35 %). The results are in conformity with [11], [4] and [8], indicating that these characters are under additive gene effects and more reliable for effective selection. Similarly genetic advance as per cent over mean was recorded maximum for yield per plant (79.30 %) followed by fruit pericarp thickness (71.85 %), leaf length (62.49 %), fruit polar diameter (55.96 %) and fruit equatorial diameter (54.03 %). High heritability along with high genetic advance as per cent over mean was recorded in yield per plant (98.84 and 79.30 respectively), fruit pericarp thickness (98.51% and 71.85 %) and fruit equatorial diameter (93.82 and 55.96 respectively). This showed that selection for these traits may be highly effective as these traits are less influenced by environment. Similarly, a joint consideration of heritability, GCV and genetic advance revealed high value for yield per plant, fruit pericarp thickness and leaf length.

Table-2 *Mean performance of 21 thermo tolerant tomato genotypes for morphological traits under heat stress.*

SL .No.	Genotypes	Leaf length (cm)	Leaf width (cm)	Days to 50 % flowering	Pollen germination %	Avg. fruit weight (g)	Fruit polar diameter (cm)	Fruit equatorial diameter (cm)	Fruit pericarp thickness (mm)	Fruit set %	Yield/plant (g)
1	Pusa Sadabahar	3.1	2.0	49	48.6	49.7	4.2	3.1	5.8	66.6	685
2	Pusa Ruby	5.5	2.7	58	34.3	42.8	2.8	3.3	4.9	28	290
3	Pusa 120	5.9	4.1	60	35.0	45.5	2.6	3.3	6.3	32.6	280
4	Pusa Rohini	6.8	3.1	60	32.0	45.1	2.4	3.3	6.6	26	285
5	Pusa Gaurav	6.2	3.7	59	41.6	32.9	2.8	3.0	4.6	38.3	342
6	Pusa Sheetal	3.3	2.0	58	45.3	48.8	4.3	3.6	5.2	51.3	557
7	Chikko	7.2	4.3	52	39.6	43.3	4.2	3.4	6.9	44.6	514
8	LP-2	5.3	2.4	52	44.3	41.1	3.5	3.5	6.3	60	610
9	PSH-3	7.1	4.8	55	43.6	55.2	4.2	3.7	5.1	48.3	548
10	TH-348-T2	5.9	3.6	51	47.3	41.6	3.7	3.4	4.7	48	542
11	Balkan	4.5	2.7	50	47.0	35.5	3.3	3.4	4.1	62.3	605
12	TH-348-4-R	5.1	3.1	53	48.0	38.1	3.2	3.5	4.4	57.6	594
13	TH-348-4-2	6.3	3.5	58	46.6	36.6	2.9	3.1	4.7	55.6	582
14	TH-348-4-5-1	4.9	3.4	56	45.6	34.2	2.6	2.5	5.1	53.	568
15	Spr-1	3.3	2.1	68	45.3	4.00	0.9	0.9	2.6	48	152
16	Spr-2	1.8	2.1	66	39.6	3.5	0.9	0.9	2.3	45	160
17	Spm	2.2	1.9	62	40.6	5.0	3.0	1.8	1.9	45	170
18	SPM 1	4.1	3.4	55	41.3	7.0	2.5	2.5	2.8	51.6	183
19	SPM 2	2.9	2.9	56	39.6	6.5	2.6	2.5	2.8	46.6	180
20	SPM 3	3.4	2.8	52	40.6	6.3	2.5	2.3	2.7	51.3	188
21	SPM 4	3.4	2.4	52	31.6	6.5	2.4	2.4	2.7	44.3	190
	Mean	4.70	3.02	56.64	41.83	29.96	2.94	2.83	4.42	47.86	391.6
	SED	0.07	0.15	1.43	1.51	0.75	0.08	0.06	0.09	1.48	4.79
	CD at 5%	0.14	0.30	2.92	3.09	1.53	0.16	0.12	0.18	3.02	7.33
	CV	1.83	6.00	3.10	4.43	1.63	3.31	2.45	2.49	3.78	0.70

Table-3 *Mean, Range, PCV, GCV, heritability (h2), genetic advance (GA) and genetic advance as percent over mean of morphological traits of 21 thermo tolerant tomato genotypes under heat stress.*

Sl. No.	Characters	Mean	Range		PCV	GCV	Heritability (%)	GA	GA as % over mean
			Minimum	Maximum					
1	Leaf length(cm)	4.70	1.77	7.29	34.63	32.41	87.60	2.93	62.49
2	Leaf width(cm)	3.02	1.98	4.87	27.77	20.59	54.96	1.03	31.44
3	Days to 50 % flowering	56.64	49.00	68.33	8.50	8.02	89.16	9.42	15.61
4	Pollen germination %	41.83	31.67	48.67	12.07	11.59	92.32	12.64	22.95
5	Avg. fruit weight (g)	29.96	3.5	55.2	59.73	58.66	96.76	117.10	35.05
6	Fruit polar diameter (cm)	2.94	0.97	4.32	29.06	27.61	90.25	1.79	54.03
7	Fruit equitorial diameter(cm)	2.83	0.90	3.71	28.95	28.05	93.82	1.78	55.96
8	Fruit pericarp thickness(mm)	4.42	1.93	6.97	35.05	34.97	98.51	3.36	71.85
9	Fruit set %	47.86	26	66.67	6.97	4.26	37.35	4.43	5.36
10	Yield/plant (g)	391.67	152.00	685.00	39.15	38.79	98.84	308.01	79.30

Conclusion

Based upon the results recorded in this experiment it could be concluded that genotypes Pusa Sadabahar, Balkan, TH-348-T2 and LP-2 recorded early 50 per cent flowering (49, 50, 51 and 52 days respectively) under heat stress. Therefore, they could produce significantly higher yield as compared to heat sensitive genotypes under stress, which can be utilized for further crop improvement programmes.

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Author contributions

Manish Kumar -conception and design of the work, data collection, data analysis and interpretation, drafting the article, critical revision of the article, final approval of the version to be published and acted as corresponding author

R.K. Yadav -conception and design of the work, critical revision of the article, final approval of the version to be published

Rajeev K. Yadav -critical revision of the article

T.K. Behera and Akshay Talukdar -critical revision of the article, final approval of the version to be published

Abbreviations: The abbreviations used in this study are-

PCV- Phenotypic coefficient of variation; GCV- genotypic coefficient of variation; GA- genetic advance; HT- heat tolerant; HS- heat sensitive.

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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