International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(5): 3095-3098

Received: 21-07-2018
Accepted: 24-08-2018

Genetic variability, heritability and genetic gain for yield and quality traits in tomato (*Solanum lycopersicum* L.)

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Abstract
The study was carried out to investigate the yield and horticultural quality traits in tomato, in order to generate information regarding the extent of genetic variability, heritability and genetic gain within the tomato genotypes. The experiment was laid out during 2015-2016 in Randomized Complete Block Design (RCBD) at an experimental farm of the Department of Vegetable Science, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Solan (HP). Totally twenty five genotypes of tomato with three replications were considered for genetic variability study. Analysis of coefficient of variation revealed that, the magnitude of phenotypic coefficient of variation was slightly higher than the genotypic coefficient of variation for all the studied traits. Further, High heritability along with high estimates of genetic gain was observed for number of fruits per cluster, number of seeds per fruit, average fruit weight, fruit yield per plant and fruit yield per hectare. Thus, indicating direct selection for these traits as a criteria for improvement in tomato.

Keywords: genetic variability, heritability, genetic gain, tomato, *Solanum lycopersicum*

Introduction
Tomato (*Solanum lycopersicum* L.) is a Solanaceous vegetable originated in Peruvianum and Mexican region is one of the most important vegetable crop grown throughout the world after potato and sweet potato. Tomato is collectively considered as 'Protective food'. It has a good source of vitamins and minerals as compared to cereals, the pulp and juice are digestible and a mild promoter of gastric secretion and blood purifier. Lycopene is the major carotenoid present in tomato. Tomato is grown for its edible fruit which can be consumed either fresh or cooked and also in the form of various processed products like juice, ketch up, sauce and puree. Tomato is most remunerative cash crop of the low and mid hills of Himachal Pradesh, where it is grown for off season vegetable produce and it is a leading supplier of fresh market tomatoes to the Northern markets of country during rainy and autumn season fetching off season prices to our growers. But the production and productivity of this crop in India is far below compare to the global scenario. Hence, there is need to develop superior varieties/hybrids for different agro-ecological conditions with specific end use. Considering the potentiality and requirement of this crop, there is 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 program. Thus investigation was undertaken to ascertain the magnitude and the extent of genetic variability in tomato genotypes.

Material and Method
The experimental materials for the present investigation comprised to twenty five germplasm of tomato (Table 1) was carried out during kharif 2016 at Research Block, Department of Vegetable Science, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni Solan, Himachal Pradesh. The experiment was conducted in the Complete Randomized Block Design (RBD) with three replications at spacing of 90 x 30 cm which also include the check variety Solan Lalima. The present study deals with the following characters number of primary branches, plant height (cm), number of fruits per cluster, number of fruits per plant, number of fruit

cluster per plant, average fruit weight (g), fruit yield per plant (kg), fruit yield per hectare (q), fruit shape index, pericarp thickness (mm), number of locules per fruit, number of seeds per fruit, thousand seed weight(g) total soluble solids (°B), harvest duration (days) and buckeye rot incidence in five randomly selected plants from each genotype in each replication. The analysis of variance was calculated as per Gomez and Gomez (1983) [7]. Phenotypic and genotypic coefficient of variation was estimated according to Burton and De Vane (1953) [6]. Heritability and genetic advance were calculated as per formula given by Allard (1960) [2] and Jhonson *et al*. (1955) [8] respectively.

Results and Discussion

Range

A wide range of variation was observed among twenty five genotypes of tomato, evaluated for fourteen characters (Table 2). The *per se* performance of the genotypes revealed a wide range of variation for traits such as number of primary branches(1.50 to 4.19), plant height (50.26 to 118.38 cm), number of fruits per cluster (2.27 to 5.14), number of fruits per plant (16.13 to 55.83), number of fruit cluster per plant (9.47 to 20.80), fruit shape index (0.71 to 1.14), pericarp thickness (2.18 to 5.90mm), number of locules per fruit (2.45 to 5.87), number of seeds per fruit (46.67 to 140.00), thousand seed weight (2.12 to 4.06g), total soluble solids (2.13 to 5.15 °B), harvest duration (24.00 to 47.33days), average fruit weight (18.90 to 76.20 g), fruit yield per plant (0.32 to 1.84 kg) and fruit yield per hectare (130.37 to 545.48 q).

Phenotypic and genotypic coefficient of variability

The data presented in Table 3 revealed that phenotypic variance for all the traits had higher values corresponding to their genotypic counterpart although the differences were not much high in all the cases. High phenotypic and genotypic coefficient of variability were recorded for number of fruits per plant (39.82 % and 30.76%), number of locules (36.02% and 19.63%), number of seeds per fruit (32.21% and 30.94%), average fruit yield (36.41% and 34.40%), fruit yield per plant (33.12% and 31.13%) and fruit yield per hectare (33.18% and 31.18%) Moderate coefficient of variability observed for plant height (25.40% and 21.85%), number of primary branches (27.70% and 25.85%), number of fruits per cluster (28.33% and 27.75%), number of fruit clusters per plant (24.83% and 14.95%), pericarp thickness (22.30% and 18.33%) and total soluble solids (22.38% and 19.92%). Low coefficient of variability observed for fruit shape index (17.05% and 12.08%), thousand seed weight (18.65% and 18.24%) and harvest duration (17.95% and 16.765). These were in accordance with the findings of Mahesha *et al.* (2006) [11], Shashikanth *et al.* (2010) [15], Kaushik *et al.* (2011) [9], Tasisa *et al.* (2011) [19], Buckseth *et al*. (2012) [5] and Kumar *et al.* (2013) [10].

Table 1: Twenty-five genotypes were taken in the proposed study. The list of different genotypes are as given

Sr. No	Genotypes	Sources
1	EC-164660	IIVR, Varanasi
2	EC-521079	IIVR, Varanasi
3	EC-531803	IIVR, Varanasi
4	EC-5863	IIVR, Varanasi
5	EC-620383	IIVR, Varanasi
6	EC-620396	IIVR, Varanasi
7	EC-620424	IIVR, Varanasi
8	EC-620434	IIVR, Varanasi
9	UHSB- 8	University of Horticulture Science, Bagalkot
10	UHSB-11	University of Horticulture Science, Bagalkot
11	UHSB-12	University of Horticulture Science, Bagalkot
12	UHSB-14	University of Horticulture Science, Bagalkot
13	UHSB-15	University of Horticulture Science, Bagalkot
14	UHSB-17	University of Horticulture Science, Bagalkot
15	UHSB-21	University of Horticulture Science, Bagalkot
16	UHSB-22	University of Horticulture Science, Bagalkot
17	UHSB-23	University of Horticulture Science, Bagalkot
18	UHSB-27	University of Horticulture Science, Bagalkot
19	UHSB-28	University of Horticulture Science, Bagalkot
20	UHSB-29	University of Horticulture Science, Bagalkot
21	UHSB-30	University of Horticulture Science, Bagalkot
22	UHSB-32	University of Horticulture Science, Bagalkot
23	UHSB-33	University of Horticulture Science, Bagalkot
24	UHSB-34	University of Horticulture Science, Bagalkot
25	Solan Lalima	UHF, Nauni

Heritability and genetic gain

A broad sense heritability estimate provides information on relative magnitude of genetic and environmental variation in germplasm pool. The heritability estimate varied from 29.70 per cent in number of locules to 96.00 per cent in number of fruits per cluster (Table 3).

Heritability estimates were recorded high for characters viz., primary branches (87.07%), plant height (74.03%), number of fruits per cluster (96.00%), number of seeds per fruit (92.27%), thousand seed weight (95.57%), and total soluble solids (79.17%), harvest duration (87.17%), average fruit yield (89.31%), fruit yield per plant (88.36%) and fruit yield per hectare (88.28%). Moderate heritability estimate were recorded in number of fruits per plant (59.67%) fruit shape index (50.21%) and pericarp thickness (67.54%). Low heritability estimates were recorded in number of fruit clusters per plant (36.23%) and number of locules (29.70%).

The genetic gain (genetic advance expressed as per cent of population mean) recorded high estimates in number of fruits per cluster (56.01%), number of seeds per fruit (61.22%), average fruit weight (66.98%), fruit yield per plant (60.27%) and fruit yield per hectare (60.34%). However genetic gain was moderate for primary branches (49.69%), plant height (38.73%), and number of fruits per plant (48.95%), thousand seed weight (36.72%), pericarp thickness (31.02), total soluble solids (36.50%) and harvest duration (32.24%). Low genetic gain was observed for number of fruit clusters per plant (18.53%), fruit shape index (17.63%) and number of locules (22.04%).

High heritability along with high estimates of genetic gain was observed for number of fruits per cluster (96.00% and 56.01%), number of seeds per fruit (92.27% and 61.22%), average fruit weight (89.31% and 66.98%), fruit yield per plant (88.36% and 60.27%) and fruit yield per hectare (88.28% and 60.34%). Which were in accordance with the findings of Mahesh *et al.* (2006) [11], Singh *et al.* (2006) [18], Ahmed *et al*. (2006) [1], Asati *et al*.(2008) [4], Ara *et al*. (2009) [3], Suarma *et al.* (2009), Singh (2009) [17], Rahaman *et al.* (2012) [13], Kumar *et al*. (2013) [10], Reddy *et al.* (2013) [14], Premalakshmi *et al.* (2014) [12.

High heritability along with high estimates of genetic gain was recorded in the character average fruit weight, number of fruits per cluster, number of seeds per fruit, average fruit weight, fruit yield per plant and fruit yield per hectare. This character indicates the presence of additive gene effect and selection based on the phenotypic performance could be very effective in improvement of this character and which can also be retained in the subsequent generation.

Table 2: Analysis of variance for various horticultural traits in tomato

Characters	Abbreviation	Replication	Treatment	Error
DF		2	24	63
Primary branches	PB	0.06	3.40*	9.57
Plant height (cm)	PH	156.02	2559.41*	7232.94
Number of fruits per clusters	NFPC	0.59	5.04*	14.13
Number of fruits per plant	NFPP	261.92	265.80*	773.64
Number of fruits cluster per plant	NFCPP	19.59	82.40*	236.58
Fruit shape index	FSI	0.04	0.33*	0.93
Pericarp thickness (mm)	PT	0.07	6.45*	18.24
Number of Locules	LC	3.04	6.40*	18.98
Number of seed per fruit (g)	NSPF	41.32	3081.59*	8650.46
Thousand seed weight (gm)	TSW	0.1	4.11*	11.5
Total soluble solids (B^o),	TSS	0.56	5.71*	16.06
Harvest duration	HD	2.28	549.89*	1540.75
Average fruit weight(g)	AFW	54.5	819.51*	2311.36
Fruit yield per plant(kg)	YPP	0.05	0.58*	1.64
Fruit yield per hectare (q)	YPH	464.04	50956.77*	143573

*at 5% level of significance

Table 3: Estimates of population mean range, phenotypic and genotypic coefficients of variability, heritability, genetic advance and genetic gain

Characters	Population mean	Range		Coefficient of variability		Heritability Broad sense (%)	Genetic advance	Genetic gain (%)
		Minimum	Maximum	Phenotypic	Genotypic			
PB	2.92	1.50	4.19	27.70	25.85	87.07	1.45	49.69
PH	80.58	50.26	118.38	25.40	21.85	74.03	31.21	38.73
NFPC	3.53	2.27	5.14	28.33	27.75	96.00	1.98	56.01
NFPP	25.25	16.13	55.83	39.82	30.76	59.67	12.36	48.95
NFCPP	14.58	9.47	20.80	24.83	14.95	36.23	2.70	18.53
FSI	0.93	0.71	1.14	17.05	12.08	50.21	0.16	17.63
PT	4.07	2.18	5.90	22.30	18.33	67.54	1.26	31.02
LC	4.00	2.45	5.87	36.02	19.63	29.70	0.88	22.04
NSPF	84.79	46.67	140.00	32.21	30.94	92.27	51.91	61.22
TSW	3.26	2.12	4.06	18.65	18.24	95.57	1.20	36.72
TSS	3.82	2.13	5.15	22.38	19.92	79.17	1.40	36.50
HD	37.80	24.00	47.33	17.95	16.76	87.17	12.16	32.24
AFW	44.47	18.90	76.20	36.41	34.40	89.31	29.20	66.98
YPP	1.18	0.32	1.84	33.12	31.13	88.36	0.72	60.27
YPH	350.72	130.37	545.48	33.18	31.18	88.28	212.32	60.34

Conclusion

A wide range of variation was observed among twenty five genotypes of tomato, evaluated for fourteen characters. From above study we concluded that traits like number of fruits per plant, number of fruits cluster per plant, average fruit weight, number of seeds per fruit and followed by thousand seed weight, plant height, pericarp thickness are important traits for which selection based on the phenotypic performance could be very effective in improvement of this character and which can also be retained in the subsequent generation.

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