RESEARCH ARTICLE

GENETIC STUDIES OF GENOTYPES FOR FRUIT YIELD AND ITS COMPONENT CHARACTERS IN TOMATO (*SOLANUM LYCOPERSICUM* L.)

Archana Dikshit[1]*, J. Singh[2] and D. Sharma[3]

[1] Department of Horticulture, College of Agriculture, IGKV, Raipur-492 012
[2] Department of Vegetable Science, College of Agriculture, IGKV, Raipur-492 012
[3] Department of Vegetable Science, College of Agriculture, IGKV, Raipur-492 012
Email: archieshine@gmail.com

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Abstract: The present investigation was conducted with twenty four hybrids along with their 10 parents (6 lines and 4 testers) were subjected to study the genetic variability indicated that genetic material in the present investigation possessed variability which provides sufficient basis for selection by breeder. The accessions revealed wide variability for characters evaluated. High estimates of PCV and GCV were obtained for number of secondary branches per plant, number of clusters per plant, number of fruits per cluster, number of fruits per plant, average fruit weight, pericarp thickness and total fruit yield per plot indicated a good deal of variability in those characters signifying the effectiveness of selection of desirable types for improvement. Phenotypic variances were higher than their respective genotypic variances thus revealing the role of environmental factors. High heritability assisted with high genetic advance as per cent of mean was observed for number of secondary branches per plant, number of fruits per plant, number of clusters per plant, average fruit weight (kg), pericarp thickness (mm), total fruit yield per plot (kg). Hence, simple selection based on phenotypic performance of these traits would be more effective.

Keywords: Genetic variability, Heritability, Genetic advance, F1 generation, Tomato

INTRODUCTION

Tomato (*Solanum lycopersicum* L.), 2n=24, is one of the most popular and widely grown vegetables in the world because of its wider adaptability, high yielding potential and suitability for variety of uses. Ripe tomato fruit is consumed fresh as salad and utilized in the preparation of range of processed products such as powder, puree, ketchup, sauce, soup, canned fruit. Unripe green fruits are used for preparation of pickles and chutney. Tomatoes are important source of lycopene (antioxidant) vitamin A, vitamin C and minerals. Exploring natural diversity as a source of desirable alleles for crop improvement (Fernie *et al*.,2006). The role of genetic variability in a crop is of paramount importance in selecting the best genotypes for making rapid improvement in yield and related characters as well as to select most potential parents for making the hybridization programme successful. The success of breeding programme depends on the availability of genetic variability present in the available germplasm (Prasad et al. 2012). Tomato is a distinctive vegetable crop, which is very responsive to genetic improvement due to its high degree of homogeneousness (Pradeepkumar, *et al.,* 2001).

The study of biological parameters is often considered to be useful step in the study of genotypic variability. Genetic parameters such as Genotypic, Phenotypic coefficient of variation (PCV and GCV) are useful in detecting the amount of variability present in the available genotypes. Genotypic and phenotypic coefficients of variability help to access the divergence of the characters (Uniyal *et al*., 2013). Partitioning of observed variability into heritable and non-heritable components is essential to get a true indication of the genetic variation of the trait Heritability and genetic advance help in determining the influence of environment in expression of the characters and the extent to which improvement is possible after selection. Heritable variation can be effectively studied in conjunction with genetic advance. High heritability alone is not enough to make efficient selection in segregation, unless the information is accompanied for substantial amount of genetic advance. Selection would be more meaningful for characters which exhibit high variability and heritability along with moderate to high genetic gain. Realizing the importance of the crop, there is urgent need to isolate such breeding lines having desirable horticultural trails, better quality coupled with high yield potential by analysing the genetic components of variability for desirable traits.

MATERIAL AND METHOD

The present investigation was undertaken during *Rabi*, 2014 at AICRP on Vegetable Crops, IGKV, Raipur (C.G.). The experimental material consisted of 24 F1 hybrids, 10 parents (6 lines and 4 testers) and a commercial check (Arka Vikas). The crop was grown in randomized block design with three replications at spacing of 60 x 45 cm. All recommended agronomic package of practices were followed to grow a healthy crop. Observations of quantitative characters were recorded from 5

*Corresponding Author

sampled plants in each replication for each genotype. The analysis of variance for testing the variance among treatments was carried out as per the method suggested by Panse and Sukhatme (1967). The data obtained from selected plants were subjected to analysis of genetic variability, heritability and genetic advance (Gomez and Gomez, 1983).

RESULT AND DISCUSSION

Table 1. Analysis of variance for Line X Tester analysis for fruit yield and its component characters in tomato

S. No.	Character	Replications	Treatment	Error
	df	02	33	66
1.	Plant height (cm)	6.20	525.41	4.98
2.	Number of Primary branches per plant	3.13	10.71	0.350
3.	Number of Secondary branches per plant	1.82	66.54	0.52
4.	Days to first flowering	8.11	137.84	2.78
5.	Days to 50% flowering	2.12	148.17	1.85
6.	Number of flowers per cluster	0.05	2.74	0.11
7.	Number of clusters per plant	0.51	12.95	0.69
8.	Number of Fruits per cluster	0.05	3.58	0.37
9.	Number of Fruits per plant	7.17	1,532.18	3.68
10.	Fruit Length (cm)	0.02	3.42	0.07
11.	Fruit Girth (cm)	0.04	2.46	0.03
12.	Days to first harvest	2.70	178.15	6.45
13.	Days to last harvest	18.43	106.75	3.28
14.	Average Fruit Weight (kg)	0.01	0.54	0.01
15.	Pericarp Thickness	0.003	0.06	0.09
16.	Number of locules per fruit	0.02	3.477	0.06
17.	Total fruit yield per plot (kg)	0.82	398.06	1.69

* Significant at P = 0.05 level

The ANOVA and mean performance of different genotypes are presented in the Table 1 and 2 respectively. Highly significant differences among the genotypes for all the characters indicating sufficient variability existed in the present material selected for the study and indicating the scope for selection of suitable initial breeding material for crop improvement. This indicates the presence of much more variability among the genotypes used in present study. Parthasarathy *et al.,* (1976), Nandpuri *et al.,* (1977), Reddy and Reddy (1992) also reported significant difference among tomato genotypes for different characters. A high degree of variability for fruit weight has also been reported by Dhaduk et al., (2004), Borgohain and Swargiary (2008) and Hedau *et al.,* (2008) in tomato. Mean values of all the characters showed wide variations for the plant height (54.19 -89.46 cm), number of primary branches per plant (12.67-4.53), number of secondary branches per plant (6.32-11.28), days to first flowering (22.99-29.06), days to 50 % flowering (33.96-40.47), number of flowers per cluster (4.66-6.20), number of clusters per plant(4.16-7.36), number of fruits per cluster (3.06-4.90), number of fruits per plant (22.43-32.52), Fruit length (4.00-5.95 cm), fruit girth (4.51-5.85 cm), days to first harvest (78.00-90.72), days to last harvest (103.36-117.61), average fruit weight (0.75-1.65 kg), pericarp thickness (0.38-0.57 mm), number of locules per fruit (2.73-4.44) and fruit yield per plant (24.84-38.63 kg).

Table 2. Mean performance of F_1 tomato genotypes

	Hybrids	Characters																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	**ITOM-11-1 x Pusa Ruby**	75.27	6.83	8.08	24.11	34.10	6.90	4.63	5.83	26.23	5.28	4.81	88.67	126.23	1.63	0.58	3.07	29.37
2.	**ITOM-11-1 x Kashi Anupam**	57.63	5.30	7.11	29.97	33.96	7.60	4.97	6.10	23.90	6.90	7.00	90.81	121.53	1.60	0.56	4.27	48.43
3.	**ITOM-11-1 x Pant T-3**	79.63	8.97	8.45	24.68	39.03	6.93	8.70	6.07	31.73	5.58	5.67	86.07	122.43	1.82	0.52	4.17	35.53
4.	**ITOM-11-1 x Cherry Tomato-1**	69.90	9.47	9.78	23.20	37.30	7.83	9.73	6.53	36.67	6.06	5.36	92.94	113.87	1.13	0.38	5.33	24.85
5.	**ITOM-11-3 x Pusa Ruby**	67.37	4.53	17.33	32.50	50.60	6.13	6.60	4.73	37.47	7.63	5.13	87.67	114.07	1.66	0.61	3.03	34.27
6.	**ITOM-11-3 x Kashi Anupam**	58.47	7.57	9.08	24.47	36.03	5.53	5.27	4.07	22.80	7.13	7.25	90.95	114.87	2.39	0.53	5.47	60.67

	Hybrids	Characters																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
7.	**ITOM-11-3 x Pant T-3**	64.57	7.83	8.29	33.90	48.60	7.10	5.90	6.20	23.63	7.85	6.25	81.91	110.37	1.95	0.58	4.33	30.02
8.	**ITOM-11-3 x Cherry Tomato-1**	72.53	7.03	13.38	28.83	39.60	6.02	8.00	4.90	40.30	7.06	5.23	78.00	112.10	1.15	0.48	5.73	28.90
9.	**ITOM-11-6 x Pusa Ruby**	58.60	9.82	10.86	32.90	44.73	6.10	5.53	5.60	29.30	5.64	5.64	95.98	121.50	1.41	0.70	3.17	28.67
10.	**ITOM-11-6 x Kashi Anupam**	59.37	6.35	9.07	36.60	41.07	5.30	5.80	4.43	25.10	6.52	6.08	84.44	115.53	1.64	0.80	4.43	53.80
11.	**ITOM-11-6 x Pant T-3**	65.83	7.20	8.84	35.00	44.50	6.36	9.73	5.33	36.93	4.81	6.21	82.53	117.43	1.82	0.51	3.77	30.59
12.	**ITOM-11-6 x Cherry Tomato-1**	61.10	6.23	12.59	29.67	44.97	7.11	7.57	6.13	38.33	6.38	4.52	90.56	116.60	0.77	0.38	5.30	25.11
13.	**ITOM-11-11 x Pusa Ruby**	70.70	6.33	15.77	33.30	50.70	5.03	8.17	3.83	32.70	5.43	5.71	101.17	126.80	1.68	0.91	4.53	34.83
14.	**ITOM-11-11 x Kashi Anupam**	63.30	7.57	7.60	24.63	37.17	4.87	4.17	4.10	24.97	6.41	7.48	87.30	117.50	2.31	0.85	5.57	64.44
15.	**ITOM-11-11 x Pant T-3**	76.48	7.67	9.24	36.80	51.90	6.07	8.97	3.87	37.00	4.66	6.49	104.20	122.30	1.48	0.47	4.41	44.60
16.	**ITOM-11-11 x Cherry Tomato-1**	87.00	5.97	19.05	24.66	36.87	5.70	11.50	3.53	35.00	5.44	5.54	101.23	124.10	0.76	0.49	4.57	31.36
17.	**ITOM-11-12 x Pusa Ruby**	58.23	7.48	13.35	27.57	38.80	5.50	7.77	3.07	33.13	5.32	5.77	108.02	124.50	2.10	0.52	2.73	36.53
18.	**ITOM-11-12 x Kashi Anupam**	54.19	5.53	7.59	27.47	34.70	4.67	7.33	3.50	22.43	6.04	7.22	89.91	111.50	1.81	0.48	5.37	59.40
19.	**ITOM-11-12 x Pant T-3**	62.01	8.50	8.85	22.99	34.37	5.75	7.27	3.57	35.17	5.23	6.06	83.23	117.17	2.07	0.51	3.57	37.00
20.	**ITOM-11-12 x Cherry Tomato-1**	65.82	11.00	17.71	27.07	35.57	5.87	8.83	4.77	52.97	5.09	5.81	78.43	103.37	1.28	0.44	5.52	31.51
21.	**ITOM-11-14 x Pusa Ruby**	62.87	6.16	15.66	36.57	46.07	7.33	5.47	6.27	27.97	7.38	4.68	91.40	119.87	1.90	0.63	4.39	40.50
22.	**ITOM-11-14 x Kashi Anupam**	89.47	6.35	6.33	26.20	38.07	5.27	5.07	3.97	23.43	6.31	5.26	88.80	114.27	2.20	0.73	5.10	34.87
23.	**ITOM-11-14 x Pant T-3**	70.53	8.08	7.71	27.00	38.67	7.73	8.27	6.73	35.30	4.68	5.61	95.47	119.57	1.72	0.57	4.11	43.72
24.	**ITOM-11-14 x Cherry Tomato-1**	59.47	7.13	19.21	26.79	34.07	6.13	11.43	4.53	48.23	4.01	5.64	80.93	115.33	1.38	0.48	4.80	38.33
	CD at 5 %	4.5	1.16	1.32	3.21	2.72	0.60	1.39	1.10	3.74	0.43	0.26	4.74	2.79	0.22	0.05	0.42	2.21
	CV%	3.91	9.35	6.81	6.46	3.91	5.71	11.06	13.08	6.72	4.28	2.66	3.07	1.38	8.09	5.84	5.50	3.33

1. Plant Height (cm)
2. No. of primary branches/ plant
3. No. of secondary branches/ plant
4. Days to first flowering
5. Days to 50% flowering
6. No. of flowers/cluster
7. No. of clusters/plant
8. No. of fruits/cluster
9. No. of fruits/plant
10. Fruit Length (cm)
11. Fruit Girth (cm)
12. Days to first harvest
13. Days to last harvest
14. Average fruit weight (kg)
15. Pericarp Thickness
16. No. of locules/fruit
17. Total fruit yield /plot (kg)

However, the absolute variability in different characters does not permit identification of the characters showing the highest degree of variability. Therefore, PCV and GCV values were estimated. The coefficient of variation whether it is genotypic or phenotypic, both are useful in studying the extent of variability in different characters as it measures the range of variability. The PCV values were slightly higher than the respective GCV for all the characters denoting little influence of environmental factors on their expression. The difference between values of PCV and GCV were less for all traits except for number of primary branches per plant and number of fruits per cluster in present investigation. It means that these traits were less influenced by environment and hence, they could be improved by following different phenotypic selections like directional, disruptive and stabilized selections. The PCV and GCV values were very high particularly for number of secondary branches per plant, total fruit yield per plot (kg), number of clusters per plant, average fruit weight (kg), pericarp thickness, number of fruits per cluster, number of fruits per plant due to very high variability available in these traits (Table 3). This moderate to low variability indicates the need for improvement of base population through intercrossing in F2 generation followed by recurrent selection to increase the gene flow and to fix favourable alleles. High values of GCV and heritability estimates appended with better genetic gains also exposed role of additive gene effects regulating the inheritance of such traits (Narayan *et al.*, 1996).

Heritability is an index of transmissibility of characters from a parent to off-spring. Perusal of

results on heritability and genetic advance as per cent of mean (GAM) revealed that heritability estimates were high for all the characters studied. This suggested the greater effectiveness of selection due to less influence of environment and improvement to be expected for these characters in future breeding programme. Johnson *et al*. (1955) suggested that high heritability coupled with high genetic advance as percentage of mean (GAM) were more useful than heritability alone in predicting the resultant effect during selection of best individual genotype. Genetic advance is the measure of genetic gain under selection and expression in percentage of mean. In the present experiment high heritability was recorded for plant height , number of secondary branches per plant, days to 50% flowering, number of fruits per plant, fruit length, fruit girth, days to last harvest, average fruit weight (kg), number of locules per fruit , pericarp thickness , total fruit yield per plot (kg) indicating predominance of additive gene action for these characters. Simple selection based on phenotypic performance of these characters would be more effective. Haydar et al., (2007), Chadha and Bhushan (2013) have also reported this estimate of heritability for different traits in tomato.

Table 3. **Genetic parameters of variation for fruit yield and its components in tomato**

S. No.	Parameters / Characters	Mean ↓	Range		Coefficient of variation (%)		h^2(b) (%)	Genetic Advance	Genetic advance as per cent of mean
			Minimum	Maximum	GCV	PCV			
1.	Plant Height (cm)	67.09	54.19	89.46	13.62	14.17	92.38	18.09	26.96
2.	No. of Primary Branches Per Plant	11	12.67	4.53	19.95	22.04	81.98	2.71	37.22
3.	No. of Secondary Branches Per Plant	11.28	6.32	19.21	36.18	36.81	96.56	8.26	73.24
4.	Days to First Flowering	29.06	22.99	36.8	15.10	16.47	83.99	8.28	28.50
5.	Days to 50% Flowering	40.47	33.96	51.9	14.18	14.71	92.90	11.39	28.15
6.	No. of Flower Per Cluster	6.20	4.66	7.83	14.55	15.63	86.64	1.73	27.90
7.	No. of Cluster Per Plant	7.36	4.16	11.5	27.40	29.55	85.99	3.85	52.30
8.	No. of Fruits Per Cluster	4.90	3.06	6.73	21.71	25.35	73.37	1.87	38.32
9.	No. of Fruits Per Plant	32.52	22.43	52.96	24.32	25.24	92.91	15.71	48.31
10.	Fruit Length (cm)	5.95	4.00	7.84	17.01	17.54	94.02	2.02	33.98
11.	Fruit Girth (cm)	5.85	4.51	7.47	13.54	13.80	96.28	1.60	27.37
12.	Days to First Harvest	90.72	78.00	108.01	8.53	9.04	89.02	15.04	16.58
13.	Days to Last Harvest	117.61	103.36	126.8	4.66	4.86	91.90	10.83	9.20
14.	Average Fruit Weight (kg)	1.65	0.75	2.39	25.71	26.96	90.99	0.83	50.53
15.	Pericarp Thickness	0.57	0.38	0.91	23.97	24.67	94.38	0.27	47.97
16.	No. of Locules Per Fruit	4.44	2.73	5.73	19.63	20.39	92.70	1.73	38.93
17.	Total Fruit Yield Per Plot (kg)	38.63	24.84	64.43	29.16	29.35	98.70	23.06	59.69

The high value of genetic advance in percent of mean was recorded for plant height, number of primary branches per plant, number of secondary branches per plant, days to first flowering, days to 50% flowering, number of flowers/cluster, number of clusters/plant, number of fruits per cluster, number of fruits per plant, fruit length, fruit girth, average fruit weight (kg), number of locules per fruit , pericarp thickness , total fruit yield per plot (kg). Nair and Thamburaj (1995) and Bora *et al*., (1993) has also reported these estimates of genetic advance for different traits in tomato.

Heritability alone does not provide full evidence regarding the amount of genetic progress which could be possible through selection. In the present investigations, high heritability with high genetic advances in percent of mean was recorded for number of secondary branches per plant, number of fruits per plant, number of clusters per plant, average fruit weight (kg), pericarp thickness (mm), total fruit yield per plot (kg).These findings are in accordance with the results of Singh and Narayan, 2004 in tomato. These traits could be exploited through manifestation of dominance and epistatic components through heterosis.

CONCLUSION

The high amount of genetic variability in the material indicated there is a good scope for a breeder to adopt suitable breeding methodology to utilize both additive and non-additive gene effects simultaneously, since varietal and hybrid development will go a long way in the breeding programmes especially in case of tomato.

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