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Study on Genetic Variability, Heritability, Genetic Advance and Correlation among different characters in tomato (*Solanum lycopersicum* L.)

Harpal Singh, Dr. Daljeet Singh

Department of Vegetable Science, University College of Agriculture, Guru Kashi University,Talwandi Sabo (Bathinda),Punjab, India

Email: harpal_dhaliwal@hotmail.com

Abstract*—The present investigation entitled "Studies on genetic variability in tomato (Solanum lycopersicum L.)" was carried out at the UCOA, vegetable research farm, Guru Kashi University, Talwandi Sabo, Bathinda during rabi 2015-16 to evaluate tomato genotypes. The experiment was laid out in CRD with three replications. Total 20 genotypes including check cultivar were evaluated for horticultural Traits contributing yield and quality (suitable for processing) .There is a wide variability in different genotypes in tomato. Traits i.e. Number of primary branches per plant, Days to first fruit harvest, Plant height (cm),number of fruits per cluster, number fruits per plant, average fruit weight (gm), equatorial diameter of fruit (cm), polar diameter of fruit (cm), number of locules per fruit, pericarp thickness (mm), fruit pH, Fruit TSS (^{0}brix), days to last fruit harvest and average yield per plant (kg) were studied during the investigation Analysis of variance showed significant differences among genotypes for all the characters under study during the investigation. High Phenotypic and Genotypic coefficient of variation were detected for characters like number of fruits per plant, number of locules per fruit, pericarp thickness and average yield per plant. High heritability coupled with genetic gain were recorded for number of fruits per plant, average fruit weight, number of locules per fruit and average yield per plant. Therefore these characters also show some scope for improvement through selection. A highly significant and positive phenotypic and genotypic correlation were found in number of fruits per cluster, plant height, number of fruits per plant and average fruit weight.*

***Keywords*—Tomato, Genotypes. Acc number, Traits, Heritability, Locules.**

I. INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is the member of family solanaceae. Tomato is one of the most popular vegetable grown all over the world both for fresh markets and processing industry. It is grown practically in open fields, green houses and net houses. Among the vegetable production it ranks third after potato and sweet potato, however it ranks first in first in processed vegetable. China followed by India, USA, Spain and Egypt are leading tomato producing countries. In India during the year 2015-16 according to 3rd advanced estimates the area under tomato cultivation is 760.0 thousand hectare with the production and productivity of 18399.0 thousand million tonnes and 24.2 million tonnes per hectare respectively . Whereas during the year 2014-15 the area under tomato cultivation was 767 thousand hectare and the production 16985.0 million tonnnes with the productivity of 21.4 million tonnes per hectare. In Punjab the area under tomato cultivation was 7.6 thousand hectare with the production and productivity of 181.1 million tonnes and 24.5 million tonnes per hectare respectively (Ministry of agriculture and farmers welfare, Govt of India). This is low as comparative to the average productivity globally.

Tomato being a self pollinated crop, it has a tremendous potential for heterosis breeding and it is used in different breeding programmes. Variability in tomato is expected to be immense as the fruits vary greatly in shape and size (Bhardwaj and Sharma, 2005). To improve the productivity of tomato, the primary consideration should be to bring out genetic improvement of the crop and development of superior varieties by selection among and within the population through the use of available genetic variability. As yield is the main objective of a breeder, it is important to know the relationship between various characters those contribute to the yield. The degree of relationship or

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association of these characters with the yield can be known by correlation studies. Genetic parameters such as Genotypic and Phenotypic coefficient of variation (GCV and PCV) are useful in detection of variability present in genotypes available. Heritability and genetic advance help in determining the influence of environment in determining the influence of environment in expression of the characters and the extent to which improvement is possible after selection (H.F. Robinson *et. al*., 1949). Therefore the investigation was carried out in tomato with the objective to estimate phenotypic coefficient of variation, genotypic coefficient of variation, heritability, genetic advance, correlation coefficient.

II. MATERIAL AND METHOD

The investigation was carried out during the rabi season of 2015-16 at the vegetable research farm of Guru Kashi University, Talwandi Sabo (Bathinda). The experimental material consisted of 20 genotypes along with check cultivar i.e. Punjab Chhuhara. The experiment was laid out in completely randomizes design (CRD) with three replications in each treatment. Plants were transplanted on 3rd Dec, 2015 at the plant to plant spacing of 30 cm in plot having size of 3.0 $m^{2,}$ accommodating 10 plants per plot. During the experiment data was recorded for 14 different characters. The Genotypic and phenotypic coefficients of variation were calculated as per the method suggested by Burton and De Vane (1953). Heritability (in broad sense) and genetic gain was calculated as per suggested by Allard (1960). Whereas correlation coefficient values were calculated as per given by Fishers and Yates (1963).

III. RESULTS AND DISCUSSION

3.1 Genetic variability

The analysis of variance indicated significantly higher amount of variability among the genotypes for all the characters studied during the investigation. This showed that there is a great scope foe selection of breeding material to initiate any breeding programmme for crop improvement. But to know the absolute extent of variability the phenotypic coefficient of variance and genotypic coefficient of variance was calculated.

The Phenotypic coefficient of variance was found higher magnitude than genotypic coefficient of variance for all the character under the study, though the difference was very less under the majority of the cases. Phenotypic coefficient of variance was high for character like number of fruits per plant (40.92%), Number of locules per fruit (38.05%), Average fruit yield per plant (37.52%, Pericarp thickness (32.81%) and while moderate for No of fruits per cluster (28.59%), Average fruit weight (28.56%), No of primary branches per plant (23.09%), Polar diameter of fruit (19.07%), Plant height (18.58) and Fruit TSS (18.07). Low values of phenotypic coefficient of variation were observed in Equatorial fruit diameter (12.36%), Fruit pH (5.15), Days to first fruit harvest (3.62%), Days to last fruit harvest (3.34%). Whereas Genotypic coefficient of variance was high Genotypic coefficient of variation (Table 4.3) was high for characters like No of fruits per plant (35.88%), Average yield per plant (35.88%) and No of locules per Fruit (34.17%), while moderate for Average fruit weight (28.20%), Plant height (18.11%), Pericarp thickness (16.87%), Polar diameter of fruit (16.76%), No of fruits per cluster (15.62%) and Fruit TSS (15.37%). Low values of phenotypic coefficient of variation were observed in No of primary branches per plant (13.73%), Equatorial diameter of fruit (9.10%), Fruit pH (3.42%), Days to first fruit harvest (3.36%) and days to last fruit harvest (2.91%).

3.2 Heritability

The estimates of heritability varied from 26.43 to 97.52 % for different characters under study (Table 4.3). It was high for characters like Average fruit weight (97.52%), Plant height (95.06%), Number of fruits per plant (94.64%), Average yield per plant(91.46%), Days to first fruit harvest (85.80%) and No of locules per fruit (80.65%), while moderate for Polar diameter of fruit (77.26%), Days to last fruit harvest (75.80%), fruit TSS (72.28%) and Equatorial diameter of fruit (54.69%). Low values of Heritability were observed in Fruit pH (44.13%), Number of fruits per cluster (36.40%), No of primary branches per plant (35.37%) and Pericarp thickness (26.43%).

3.3 Genetic advance and genetic gain

The genetic gain (genetic advance expressed as percentage of population mean) was low to high in nature and ranged from 4.62 to 79.20 % (Table 4.3).High genetic gain was recorded for Number of fruits per plant (79.20%), Average yield per plant, Number of locules per fruit (63.21%) and average fruit weight (57.38%), while moderate for Plant height (36.38%), Polar diameter of fruit (30.36%) and Fruit TSS (26.91%). Low values of genetic gain were observed in number of fruits per cluster (19.41%), Pericarp thickness (17.86%), Number of primary branches per plant (16.82%), Equatorial diameter of fruit (13.86%), Days to first fruit harvest (6.40%), Days to last fruit harvest (5.21%) and Fruit pH (4.68%). Kumar *et al* (2013) also reported High phenotypic coefficient of variability (PCV), genotypic coefficient of variability (GCV) and heritability estimates

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coupled with high genetic gain were recorded for number of fruits per plant, yield per plant and fruit weight.

These results were found in accordance with Bangaru *et al.* (1983) Reported high GCV and PCV for number of fruits per plant. Mittal *et al.* (1996) who observed high heritability along with high genetic advance in number of fruits per plant. Aysh *et al.*(2012) observed Highest GCV and PCV for number of fruits per plant. High heritability for Fruit weight, number of locules per fruit and fruit yield was reported by Golani *et al.* (2007).

Table.1: Range, Mean and Genetic parameters for different characters under study in tomato

S.No	Characters	Range		Mean	PCV (%)	GCV (%)	Heritability (%)	Genetic advance	Genetic gain (%)
		Max	Min						
1.	Number of primary branches	3.0	6.0	4.62	23.09	13.73	35.37	0.78	16.82
2	Days of 1st fruit harvest	126.33	149.66	140.07	3.62	3.36	85.80	8.97	6.40
3	Plant height	51.00	95.33	74.44	18.58	18.11	95.06	27.08	36.38
4	Number of fruits per cluster	2.33	4.33	3.14	25.89	15.62	36.40	0.61	19.41
5	Number of fruits per plant	14.00	67.00	32.31	40.62	35.88	94.64	25.59	79.20
6	Average fruit weight (g)	28.0	68.38	42.88	28.56	28.20	97.52	24.61	57.38
7	Total yield per plant (kg)	0.58	2.14	1.31	37.52	35.88	91.46	0.94	70.69
8	Equatorial diameter of fruit (cm)	3.76	5.46	4.55	12.36	9.10	54.69	0.63	13.86
9	Polar diameter of fruit (cm)	3.50	6.23	5.00	19.07	16.76	77.26	1.52	30.36
10	No. of locules per fruit	2.00	5.66	3.04	38.05	34.17	80.65	1.93	63.21
11	Pericarp thickness (mm)	4.00	9.33	5.72	32.81	16.87	26.43	1.02	17.86
12	Fruit pH	3.56	4.16	3.87	5.15	3.42	44.13	0.18	4.68
13	Fruit TSS (Brix)	2.80	5.36	3.86	18.07	15.37	72.28	1.04	26.91
14	Days to last fruit Harvest	153.33	175.67	166.73	3.34	2.91	75.80	8.69	5.21

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3.4 Studies of correlation.

The correlation studies carried out during the investigation show that the in general the genotypic correlations were high than that of phenotypic correlation. In the investigation it was analysed that on the basis of phenotypic correlations among 14 characters (Table 2) showed that fruit yield per plant had positive and significant association with number of fruits per plant (0.7397), plant height (0.4215), number of fruits per cluster (0.4410), average fruit weight (0.3101) and polar diameter (0.2637). However, it showed significant negative correlation with number of day to first harvest (-0.2795) and pericarp thickness (-0.2688).

Number of fruits per cluster had significant positive correlation with number of fruits per plant (0.4477).Number of primary branches had significant positive correlation with fruit TSS (0.3207)and day to first harvest (0.2534), it showed significant negative correlation with fruit pH (-0.3033).Days to first fruit harvest had significant positive correlation with days to last fruit harvest (0.8538) and no. of locules per fruit (0.2621) and negative correlation with no. of fruits per plant (-0.4599).Plant height had significant positive correlation with equitorial diameter of fruit (0.3441), average fruit weight (0.3092), no. of locules per fruit (0.2893) and negative correlation with fruit pH (-0.2613).Number of fruit per plant had significant negative correlation with average fruit weight (-0.3599) and days to last fruit harvest (-0.2705).Average fruit weight had significant positive correlation with polar diameter (0.5991) and equatorial diameter (0.5778). Equitorial diameter had significant positive correlation with no. of locules per fruit (0.4568), polar diameter (0.2978), and fruit TSS (0.2952) and fruit pH (0.2652). Polar diameter had significant negative correlation with no. of locules per fruit (-0.5133).No. flocules per fruit had significant positive correlation with fruit TSS (0.3473).

Whereas the study of genotypic correlations among 14 characters under investigation show that fruit yield per plant had positive and significant association with number of fruits per cluster (0.6489), plant height (0.4390), average fruit weight (0.3148) and polar diameter (0.2736). However, it showed significant negative correlation with number of day to first harvest (-0.2956) and pericarp thickness (-0.5330).

Number of fruits per cluster had significant positive correlation with number of fruits per plant (0.7002), pericarp thickness (0.5379), fruit pH (0.3348), plant height (0.3271) and no. of locules per fruit (0.2571).Number of primary branches had significant positive correlation with fruit TSS (0.5322), day to first harvest (0.4785), plant height (0.3777), average fruit weight (0.3353) and days to last fruit harvest (0.3114), it showed significant negative correlation with fruit pH (-0.5793) and no. of fruits per plant (-0.3304).Days to first fruit harvest had significant positive correlation with days to last fruit harvest (0.9072), fruit TSS (0.3068), equatorial diameter (0.2745) and no. of locules per fruit (0.2626) and negative correlation with polar diameter (-0.2743).Plant height had significant positive correlation with equitorial diameter of fruit (0.4306), no. of locules per fruit (0.3394) and average fruit weight (0.3335) and negative correlation with fruit pH (-0.4334).Number of fruit per plant had significant negative correlation with average fruit weight (-0.3648) , equatorial diameter (-0.3283) and days to last fruit harvest (-0.3124).Average fruit weight had significant positive correlation with polar diameter (0.6501) and equatorial diameter (0.7342). Equitorial diameter had significant positive correlation with no. of locules per fruit (0.6150), fruit pH (0.4399) and fruit TSS (0.4022). Polar diameter had significant positive correlation with fruit pH (0.2705) and negative correlation with no. of locules per fruit (-0.6025), pericarp thickness (-0.5960) and days to last fruit harvest (-0.3092).Number of locules per fruit had significant positive correlation with fruit TSS (0.5333) and pericarp thickness (0.4258).Pericarp thickness had significant positive correlation with fruit TSS (0.3710). The estimates of genotypic and phenotypic correlation coefficients imparted that the genotypic correlation were higher magnitude than the corresponding phenotypic ones for most of the character combinations , thereby establishing predominant role of heritable factor.

The results those were carried out for correlation studies during the invest tigation were found to be in accordance with Singh and Cheema (2006) they observed that genotypic correlations were of higher magnitude than the corresponding phenotypic correlation values for most of the character combinations in tomato which were similar to results of correlation among different characters in the investigation carried out. The results also corroborated with the results carried out by Pradheep *et al* (2007) for correlation for fruits per plant, fruit weight and fruit yield. The results were also found to be in accordance with those of Shushay et *al* (2014) fruit yield and number of fruits per plant. The results for correlation studies were also in accordance the results carried out by Golani *et al*. (2007) for number of primary branches and number of locules per fruit.

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Table: 2 Phenotypic and Genotypic correlation of different characters of tomato

Characters		No fruits per cluster	No primary branches	Days to first harvest	Plant height	No of fruits per plant	Average fruit weight (g)	Equatorial diameter (cm)	Polar diameter (cm)	No of locules per fruit	Pericarp thickness (mm)	Fruit pH	Fruit TSS (Brix)	Days to Last fruit harvest	Average yield per plant (kg)
No fruits per cluster	P		-0.1501	-0.0921	.01728	0.4477**	-0.386	0.1086	0.0184	0.1239	0.1334	-0.0174	-0.0537	-0.0579	0.4410**
	G		-0.4429**	-0.1235	0.3271*	0.7002**	-0.0995	0.1833	-0.0110	0.2571*	0.5379**	0.3348**	-0.0276	-0.0420	0.6489**
No primary branches	P			0.2534*	0.2145	-0.2025	0.1810	-0.0276	-0.0481	0.0986	0.1158	-0.3033*	0.3207*	0.1711	-0.0277
	G			0.4785**	0.3777**	-0.3304**	0.3353**	0.1008	-0.1113	0.1843	0.1589	-0.5793**	0.5322**	0.3114*	-0.0525
Days to first harvest	P				0.0817	-0.4599**	0.1556	0.1421	-0.2116	0.2621*	0.0762	0.0375	0.2255	0.8538**	-0.2795*
	G				0.0920	-0.2120	0.1789	0.2745*	-0.2743*	0.2626*	0.1938	0.0204	0.3068*	0.9072**	-0.2956*
Plant height	P					0.1166	0.3092*	0.3441**	-0.0371	0.2893*	-0.0495	-0.2613*	0.0547	0.0462	0.4215**
	G					0.1083	0.3335**	0.4306**	-0.0734	0.3394**	-0.0758	-0.4334**	0.0640	0.0707	0.4390**
No of fruits per plant	P						-0.3599**	0.2383	-0.1331	0.0872	-0.1201	-0.1183	-0.0786	-0.2705*	0.7397**
	G						-0.3648**	-0.3283**	-0.1438	0.0794	-0.2300	-0.1315	-0.0728	-0.3124**	0.2487
Average fruit weight (gm)	P							0.5778**	0.5991**	0.0557	-0.1678	-0.0179	0.1117	0.0752	0.3101*
	G							0.7342**	0.6501**	0.0744	-0.4599**	-0.0551	0.1059	0.0794	0.3148*
Equatorial diameter (cm)	P								0.2978*	0.4568**	0.1183	0.2652*	0.2952*	0.0990	0.1809
	G								0.1424	0.6150**	-0.0317	0.4399**	0.4022**	0.1071	0.1840
Polar	P									-	-0.2148	0.1655	-0.0834	-0.2009	0.2637*

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diameter (cm)										0.5153**					
	G									-0.6025**	-0.5960**	0.2705*	-0.2075	-0.3092*	0.2736*
No of locules per fruit	P										0.0485	0.0140	0.3473**	0.1975	0.1327
	G										0.4258**	0.0890	0.5333**	0.1712	0.1497
Pericarp thickness (mm)	P											0.1301	0.2187	0.0386	-0.2688*
	G											-0.3612	0.3710**	0.1228	-0.5330**
Fruit pH	P												0.0107	0.0265	-0.1605
	G												0.0806	-0.0737	-0.1985
Fruit TSS (Brix)	P													0.1306	0.0029
	G													0.2214	0.0141
Days to Last fruit harvest	P														-0.1098
	G														-0.1235

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