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Genetic Variability Studies for Yield and Quality Traits in tomato (*Solanum lycopersicum* L.)

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ABSTRACT

In the present investigation, high genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) have observed for average fruit weight (42.26, 42.40%), titrable acidity (34.41, 36.11%), number of fruits per plant (24.71, 25.40%), ascorbic acid (20.31, 34.35%), TSS:Acid ratio (33.74, 36.31%) indicating high amount of variation for above mentioned traits in tomato revealed existence of broad genetic base, which would be amenable for further selection. High heritability (>60%) coupled with high estimates of genetic advance over mean (GAM) have been observed for average fruit weight (99.30, 86.76%), number of locules per fruit (93.40, 89.88%) and pericarp thickness (68.60, 20.70%), number of fruits per plant (94.60, 49.50%), number of clusters per plant (91.90, 37.71%), yield per plant (99.20, 39.37%), yield per hectare (99.20, 39.36%), titrable acidity (90.80, 67.56%) and TSS:Acid ratio (86.00, 64.58%), This indicates predominance of additive component for these traits and hence direct selection would be more effective in improving these traits.

Key words: *genotypic coefficient of variation, phenotypic coefficient of variation, Heritability, genetic advance over mean.*

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most important Solanaceous vegetable crops grown widely all over the world. It is a very versatile vegetable for culinary purposes. Ripe, tomato fruit is consumed fresh as salads and consumed after cooking and utilized in the preparation of range of processed products such as puree, paste, powder, ketchup, sauce, soup and canned whole fruits. Unripe green fruits are used for preparation of pickles and chutney. Tomatoes are important sources of lycopene (an antioxidant), ascorbic acid and β-carotene and valued for their colour and flavour. Existence of genetic variability among the genotypes for the said character to be improved is the most basic requirement for successful selection.

MATERIAL AND METHODS

Field experiment was conducted at vegetable block, College of Horticulture, UHS Campus, GKVK, Bengaluru during the year 2013-14.

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The experimental site is located at an altitude of 930 meters above mean sea level (MSL) and 13^0 N latitude and 77.37^0 E longitude in the Eastern Dry Zone of Karnataka (Zone-5). The soil of the experimental area was red sandy loam (Alfisol) with an uniform fertility having soil pH range 6 to 7.3.The material for the present study comprised a total of 22 genotypes which were procured from Indian Institute of Vegetable Research (IIVR), Varanasi, Uttara Pradesh, Indian Institute of Horticultural Research (IIHR), Hessarghatta, Bengaluru and University of Agricultural Sciences, GKVK, Bengaluru.

The seeds were sown in protrays containing 98 holes. Coir pith was used as growing media. The sown trays were stacked and covered with polythene for three days in order to get early as well as uniform germination. Trays were irrigated daily once or twice depending up on the temperature. After fifteen days of sowing the trays were drenched with 19:19:19 (NPK) at the concentration of 1g/lit in order to get good rooting as well as growth. The prophylactic sprays were taken against pest and diseases.

The field was brought to fine tilth by disc ploughing followed by harrowing and cross cultivation. Farm yard manure at the rate of 25 tonnes per hectare was also incorporated at the time of land preparation. Ridges and furrows were prepared at 60 cm spacing. The half dose of the nitrogen and full dose of phosphorus and potash at the rate of 150:150:150 kg (NPK) per hectare was applied at the time of planting. Twenty five days old seedlings were transplanted in the main field with a spacing of 45 cm between plants, on one side, half way up the ridges. Light irrigation was given at the time of planting. Subsequent irrigations were provided whenever it was required. Just prior to earthing up *i.e*. 30 days after transplanting, half of nitrogen was given as top dress. Regular weeding was carried out and staking was provided forty five days after transplanting[1].

Five plants were selected and labeled at random from each replication in each treatment for recording the following observations and the average from these plants was worked out for the purpose of statistical computation (analysis). The details of observations recorded in each experiment and techniques adopted for the recording the observations were as follows.

RESULTS AND DISCUSSION

Analysis of variance in respect of 22 characters are presented in Table 1. Mean sum of square due to treatments found to be significant for all the characters except for plant height at 30 days after transplanting (DAT) and number of branches at 30 DAT. Mean sum of square due to replicates are not significant for all the characters studied.

Mean, range, phenotypic variance (PV), genotypic variance (GV), environmental variance (EV), phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), environmental coefficient of variation (ECV), heritability (h^2), genetic advance (GA) and genetic advance as per cent mean(GAM) for various 22 characters are presented in Table 2.

Low estimates of GCV (2.80%), PCV (3.73%) and genetic advance as per cent mean (GAM) (4.33%) and moderate estimate of heritability (56.40%) were observed for days taken to 50% flowering (Table 2). Lower estimates of genetic parameters like GCV (4.01 & 5.17%), PCV (9.52 & 6.76 %) and GAM (3.48 & 8.15%) and moderate heritability (56.00 & 59.00%) was observed at 30 and 45 DAT respectively and low estimates of GCV (7.10%) and moderate estimate of PCV (10.20%), heritability (48.50%) and GAM (8.15%) were observed at 60 DAT (Table 2).

Low estimates of GCV (5.56%), heritability (16.40%) and GAM (4.64%) and moderate estimation of PCV (13.73%) were observed at number of branches at 30 DAT (Table 2). With respect to genotypic parameters, lower estimates of GCV (7.03%) and PCV (9.48%) and moderate estimates of heritability (55.00 %) and GAM (10.74%) were observed for number of branches at 45 DAT (Table 2). Lower estimates of GCV

(7.12%), heritability (62.90%) and GAM (11.63%) and moderate estimation of PCV (8.97%) were observed for number of branches at 60 DAT (Table 2).

Genetic parameters estimated that, very high values of GCV (42.26%), PCV (42.40%), heritability (99.30%) and GAM (86.76%) were observed for average fruit eight (Table 2). Variability parameters estimated that, higher values of GCV (45.16%), PCV (46.73%), heritability (93.40%) and GAM (89.88%) were observed for number of locules per fruit (Table 2). Moderate estimate of GCV (12.14%) & PCV (14.66%) and higher estimates of heritability (68.60%) and GAM (20.70%) were observed for pericarp thickness (Table 2).

Genetic parameters exhibited lower values of GCV (9.23%) PCV (9.45%) and higher values of heritability (95.60%) and moderate values for GAM (18.60%) were observed for number of flowers per cluster (Table 2). For number of fruits per cluster, genetic parameters exhibited lower values of GCV (9.51%) and moderate value of PCV (10.41%) GAM (17.88%) and higher values for heritability (83.40%) were observed (Table 2).

Genetic parameters indicated that, the moderate values of GCV (19.09%), PCV (19.92%) and high heritability (91.90%) and GAM (37.71%) were observed for number of clusters per plant (Table 2). For number of fruits per plant, the higher values of GCV (24.71%), PCV (25.40%), heritability (94.60%) and GAM (49.50%) were observed (Table 2).

Variability parameters estimated that, the moderate values of GCV (19.19, 19.19, 12.63%), PCV (19.28, 19.27, 13.78%) and high value of heritability (99.20, 99.20, 84.10%) and GAM (39.37, 39.36, 23.86%) were observed for yield per plant, yield per hectare and total soluble solid respectively (Table 2).

Genetic parameters indicated that, moderate estimate of GCV (13.17%) PCV (18.14%), heritability (52.70%) and GAM (19.69%) were observed for fruit firmness (Table 2). Variability parameters estimated that, the higher values of GCV (34.41, 33.74, 20.31%), PCV (36.11, 36.31, 34.35%) and GAM (67.56, 64.58, 24.75%) and heritability (90.80, 86, 35%) were observed for titratable acidity, TSS: acid ratio and ascorbic acid respectively (Table 2). Lower estimates of GCV (7.73%), PCV (9.56%) and moderate value of GAM (12.87%) and high heritability (65.40%) were observed for the PH trait (Table 2).

DISCUSSION

In the present investigation, high genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) have observed for average fruit weight, number of fruits per cluster and titrable acidity[4,7] number of fruits per plant[4,11,12] ascorbic acid[4,6,5] TSS:Acid ratio indicating high amount of variation for above mentioned traits in tomato revealed existence of broad genetic base, which would be amenable for further selection.

Moderate GCV and PCV have been observed for pericarp thickness, yield per plant, yield per hectare and number of clusters per plant. This suggested that presence of moderate amount of variability for above mentioned traits.

Low GCV and PCV have been observed for days to 50% flowering, plant height at 30 and 45 DAT, plant height at 60 DAT for GCV[4,14,13] number of branches at 30, 45 and 60 DAT[3,12] pericarp thickness, number of fruits per cluster, TSS[4] firmness and pH[9]. Low GCV and PCV was observed for all these characters indicated the narrow genetic base and hence, variability has to be generated either through introduction or hybridising divergent genotypes to recover transgressive segregants.

High heritability (>60%) coupled with high estimates of genetic advance over mean (GAM) have been observed for average fruit weight[4,3,11] number of locules per fruit and pericarp thickness[4,10] number of fruits per plant and number of clusters per plant[4,2] yield per plant and yield per hectare[4,7,6] titrable acidity and TSS:Acid ratio[4,6]. Similar results were also

reported by earlier workers mentioned in the parenthesis. This indicates predominance of additive component for these traits and hence direct selection would be more effective in improving these traits.

High heritability and moderate GAM is observed for number of branches at 60 DAT, number of flowers per cluster, number of fruits per cluster and pH indicated that prevalence of non additive components and there can be little response to selection and these traits can be exploited through heterosis breeding. Similar results were also obtained by Jaiprakashnarayan[4] and Narendrakumar and Arya[8].

Moderate heritability with low GAM was obtained for days to 50% flowering and plant height at 45 DAT[4,14]. Low heritability and low GAM is obtained for plant height and number of branches at 30 DAT[4],[13]. Similar results were also reported by earlier workers mentioned in the parenthesis. These findings elucidate prevalence of higher influence of environment on these traits and hence, selection would be ineffective.

Expected GAM depends on the magnitude of heritability and phenotypic variance. If both are high, it would be high. If heritability and phenotypic variance is low, the expected GAM would be moderate or low. The high expected GAM is observed for average fruit weight, number of locules per fruit, number of fruits per plant, titrable acidity and TSS:Acid ratio, because of high PCV as well as high heritability and it indicated that the possibility of achieving higher degree of genetic improvement for these traits through selection using the germplasm stock involved in this study.

Table 1: Analysis of variance for various parameters in 22 tomato genotypes during summer 2012

Sl. No.	**Characters** (Degrees of freedom)	**Replicates** (2)	**Treatments** (23)	**Error** (23)
1	Days taken to 50% flowering	0.672	1.710**	10.96
2	Plant height at 30 DAT (cm)	0.735	9.781	157.25
3	Plant height at 45 DAT (cm)	15.837	11.775**	3.083
4	Plant height at 60 DAT (cm)	33.040	41.849**	14.490
5	Number of branches at 30	0.267	0.137	0.099
6	Number of branches at 45	0.216	0.299**	0.086
7	Number of branches at 60	0.171	0.753**	0.171
8	Average fruit weight (g)	20.850	158.760**	5.310
9	Number of locules per fruit	0.706	7.494**	0.257
10	Pericarp thickness (mm)	0.038	0.700 **	0.130
11	Number of flowers per cluster	0.042	0.450**	0.010
12	Number of fruits per cluster	0.071	0.430**	0.039
13	Number of fruits per plant	2.570	150.210**	4.170
14	Yield per plant (kg)	0.012	0.355**	0.010
15	Yield per hectare (t)	6.438	175.308**	0.728
16	Number of cluster per plant	0.021	7.423**	0.316
17	Total soluble solid (^{o}Brix)	0.161	0.832**	0.072
18	Fruit firmness (kg/cm^2)	0.020	0.254**	0.078
19	Ascorbic acid (mg/100g)	0.144	70.216**	33.820
20	Titratable acidity (%)	0.095*	0.022**	0.010
21	TSS : Acid ratio	78.82*	82.301**	6.029
22	pH	0.113	0.254**	0.053

*Significant @ P = 0.05, **Significant @ P = 0.01

Table 2: Variability studies in 24 tomato genotypes for various characters during summer 2012

Sl. No.	Characters	Mean	Range	Genotypic variance (σ^2g)	Phenotypic variance (σ^2p)	Genotypic coefficient of variation (GCV %)	Phenotypic coefficient of variation (PCV %)	Heritability (h^2bs) (%)	Genetic advance (GA)	Genetic advance over mean (GAM)
1	Days taken to 50% flowering	28.05	`26.50-30.25	0.62	1.09	2.80	3.73	56.40	1.22	4.33
2	Plant height at 30 DAT (cm)	30.27	26.31-34.35	1.47	8.31	4.01	9.52	17.70	1.05	3.48
3	Plant height at 45 DAT (cm)	40.30	35.37-44.53	4.35	7.43	5.17	6.76	58.50	3.28	8.15
4	Plant height at 60 DAT (cm)	52.05	36.50-57.86	13.68	28.17	7.10	10.20	48.50	5.31	10.20
5	Number of branches at 30 DAT	2.51	1.78-3.12	0.02	0.12	5.56	13.73	16.40	0.12	4.64
6	Number of branches at 45 DAT	4.64	4.10-5.32	0.11	0.19	7.03	9.48	55.00	0.50	10.74
7	Number of branches at 60 DAT	7.58	6.00-8.92	0.29	0.46	7.12	8.97	62.90	0.88	11.63
8	Average fruit weight (g)	66.46	33.25-165.37	788.72	794.04	42.26	42.40	99.30	57.66	86.76
9	Number of locules per fruit	4.21	2.30-10.10	3.62	3.88	45.16	46.74	93.40	3.79	89.88
10	Pericarp thickness (mm)	4.40	3.42-5.82	0.29	0.42	12.14	14.66	68.60	0.91	20.70
11	Number of flowers per cluster	5.08	4.06-6.06	0.22	0.23	9.23	9.45	95.60	0.95	18.60
12	Number of fruits per cluster	4.65	4.00-5.49	0.20	0.24	9.51	10.41	83.40	0.83	17.88
13	Number of fruits per plant	34.58	23.10-52.32	73.02	77.19	24.71	25.40	94.60	17.12	49.50
14	Yield per plant (g)	2.19	1.45-3.06	0.18	0.18	19.19	19.28	99.20	0.86	39.37
15	Yield per hectare (t)	48.70	32.07-68.06	87.29	88.02	19.19	19.27	99.20	19.17	39.36
16	Number of cluster per plant	9.88	6.22-13.63	3.56	3.87	19.09	19.92	91.90	3.72	37.71
17	Total soluble solid (^oBrix)	4.88	3.95-6.65	0.38	0.45	12.63	13.78	84.10	1.17	23.86
18	Fruit firmness (kg/cm^2)	2.25	1.63-2.97	0.09	0.17	13.17	18.14	52.70	0.44	19.69
19	Ascorbic acid (mg/100g)	20.10	10.21-33.16	18.20	52.02	20.31	34.35	35.00	5.20	24.75
20	Titratable acidity	0.29	0.17-0.57	0.01	0.01	34.41	36.11	90.80	0.20	67.56
21	TSS : Acid ratio	18.30	7.98-33.03	38.14	44.17	33.74	36.31	86.30	11.82	64.58
22	pH	4.10	3.17-4.50	0.10	0.15	7.73	9.56	65.40	0.53	12.87

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