

STUDIES ON GENETIC VARIABILITY IN TOMATO (SOLANUM LYCOPERSICUM L.) UNDER PROTECTED CONDITIONS

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Abstract: In the present investigation, fifty genotypes including three check varieties of tomato was grown in Randomized Block Design (RBD) with three replications during Rabi/Kharif season 2021-2022 at Guru Kashi University Farm, Talwandi Sabo. Five randomly chosen plants from each plot were observed for yield and quality characteristics, and the means of these observations were calculated for statistical analysis. The phenotypic coefficient of variation and genotypic coefficient of variation were high for characters like the number of fruits per plant, the number of locules and average fruit weight. Heritability was high for characters like plant height, total soluble solids, polar diameter and equatorial diameter. High genetic gain was recorded for the number of fruits per plant, number of locules and average fruit weight. The path analysis estimates indicated that plant height has highest positive direct effect on total yield per plant followed by the number of primary branches.

Index terms: Phenotypic Coefficient, Genetic Variability, Genotypes, Heritability.

INTRODUCTION

Tomato (*Solanumlycopersicum* L.) is one of the most important vegetable. It is cultivated in most of the countries of the world in open fields, net houses, greenhouses and protected areas, with a global production of 186.82 Million MT (Anonymous, 2020). Tomatoes are taken into consideration as "poor man's apple" and "protective food" because they are rich sources of vitamins and minerals. The total sugar content in ripe fruit is 2.5% and amount of ascorbic acid ranges from 16-65mg/100g of fruit weight and the total amino acid content is 100-350mg/100g (Panchbhaiya*et al.* 2018). Tomato fruit contains 93-94% water and vitamins like thiamine, riboflavin, niacin, vitamin C, vitamin A and Carotene (National Horticulture Board). Lycopene is the major carotenoid that gives tomato its red colour. It is an antioxidant and is related to a reduced risk of certain cancers, heart diseases and age-related diseases (Heber and Lu, 2002).

Pooja HM *et al.* (2022) concluded high genotypic coefficients of variation (GCV) and phenotypic coefficients of variation (PCV) for average fruit weight, fruit volume, number of fruits per plant, number of locules per fruit, yield per plant, yield per plot, yield per hectare, ascorbic acid, pericarp thickness and titratable acidity. High heritability coupled with high genetic advance over the mean was observed for fruit length, fruit diameter,

© 2023 JJNRD | Volume 8, Issue 6 June 2023 | ISSN: 2456-4184 | IJNRD.ORG average fruit weight, fruit volume, number of locules per fruit, number of fruits per cluster, number of fruits per plant, yield per plot, yield per hectare, TSS, ascorbic acid content of fruit, lycopene content, titratable acidity, pericarp thickness and firmness. Kumari and Dogra (2021) recorded a highly positive and significant correlation of fruit yield/plant with days to marketable maturity, plant height, fruits/cluster, average fruit weight, pericarp thickness and harvest duration but it showed a negative and significant correlation with total soluble solids.

Demand for tomatoes is usually high due to their multi-purpose uses and nutritive value. Protected cultivation of tomatoes provides advantages in quality, productivity and favourable market prices to growers. Considering the potentiality and requirements of the tomato crop under protected conditions, there is a need for improvement and to identify varieties. The present investigation was undertaken with the objective of determining the genetic variability for fruit yield and its contributing characters in tomatoes.

RESEARCH METHODLOGY

The present investigation involving fifty genotypes including three check varieties of tomato was carried out in Randomized Block Design (RBD) with three replications during Rabi/Kharif season 2021-2022 at Guru Kashi University Farm, Talwandi Sabo. The genotypes were S-3, S-4, S-5, S-6, S-7, S-9, S-10, S-11, S-12, S-13, S-14, S-15, S-17, S-18, S-19, S-20, S-21, S-22, S-24, S-25, S-26, S-30, S-31, S-32, S-36, S-37, S-38, S-39, S-44, S-46, S-47, S-49, S-54, S-55, S-58, Marmade Pool, 27-30thers, 4-6P₅, Selection 21 Cherry Round P_{L1}, 59 P/2 Cherry Round Large, WI-321, Israel Selection, Selection 39, Oval 69 Selection, WI-181 Round Deep Red, B1 near Brinjal, Deep Red Marmade P9, Punjab Ratta Check, Punjab Upma and Punjab Sartaj .Seeds of all genotypes were sown in elevated nursery beds. Transplanting was done at a spacing of 1.25m×30cm on raised beds. The experiment was conducted in sawtooth-type, naturally ventilated protected conditions. The observations were recorded for characters like plant height (cm), number of primary branches (no.), days to first flowering (no.), days to first fruit set (no.), days to first fruit harvest (no.), days to last fruit harvest (no.), fruit pH, Fruit TSS (⁰Brix), polar diameter of fruit (cm), equatorial diameter (cm), pericarp thickness (mm), number of locules (no.), number of fruits per cluster (no.), average fruit weight (g), number of fruits per plant (no.) and total yield per plant (kg). Observations were recorded on five randomly selected plants from each plot and their means were worked out for statistical analysis. The statistical analysis was carried out for each observed character under study using MS-Excel and MVM Statistical software. The mean values of the data were subjected to analysis of variance as described by Gomez and Gomez (1983) for Randomized Complete Block Design. The total variability in different populations was divided into phenotypic, environmental and genotypic effects.

RESULTS AND DISCUSSION.

Genetic variability, heritability and genetic advance

The phenotypic coefficient of variation (Table 4.1) was high for characters like number of fruits per plant (57.66%), number of locules (50.48%) and average fruit weight (32.39%). Moderate values were recorded in pericarp thickness (26.50%), polar diameter (24.62%), equatorial diameter (24.37%), TSS (20.39%), number of primary branches (19.99%), total yield per plant (19.01%) and number of fruits per cluster (15.18%). Low values of the phenotypic coefficient of variation were observed in plant height (10.61%), pH (7.35%), days to first flowering (5.35%), days to first fruit set (4.29%), days to first fruit harvest (3.54%) and days to last fruit harvest (1.44%).

Genotypic coefficient of variation (Table 4.1.) was high for characters like number of fruits per plant (57.38%), number of locules (46.70%) and average fruit weight (31.71%). Moderate values were recorded in pericarp thickness (24.52%), polar diameter (24.16%), equatorial diameter (23.84%), TSS (19.29%), total yield per plant (16.88%) and number of primary branches (16.58%). Low values of the phenotypic coefficient of variation were observed in number of fruits per cluster (10.40%), plant height (10.39%), pH (5.77%), days to first fruit harvest (2.54%), days to first flowering (1.86%), days to first fruit set (0.79%) and days to last fruit harvest (0.15%).

© 2023 JJNRD | Volume 8, Issue 6 June 2023 | ISSN: 2456-4184 | JJNRD.ORG Heritability was high for characters like plant height (95.95%), total soluble solid (89.53%), polar diameter (96.28%), equatorial diameter (95.65%), pericarp thickness (85.65%), number of locules (85.57%), average fruit weight (95.86%) and number of fruits per plant (99.03%). High heritability (broad senses) estimates were observed for all the tested characters indicating that these characters are controlled by additive gene action which is very useful in selection. High genetic gain was recorded for the number of fruits per plant (117.63%), number of locules (88.99%) and the average fruit weight (63.96%).

Path analysis

The path analysis estimates in Table 4.2 indicated that plant height (105.2669) has the highest positive direct effect on total yield per plant followed by number of primary branches (94.8043), number of fruits per plant (22.3882), TSS (8.9062), average fruit weight (8.6324), equatorial diameter (6.7775), number of fruits per cluster (4.7711), number of locules (2.3328), pericarp thickness (1.0072), polar diameter (0.9827), pH (0.8117), days to first flowering (0.7924), days to last fruit harvest (0.7547), days to first fruit harvest (0.5385) and days to first fruit set (0.1753).

CONCLUSION

The objectives of the present investigation were to work out the parameters of genetic variability, coefficients of variation and associations among different characters. In addition to associations among different characters path coefficient analysis was carried out considering yield and yield components. The path analysis estimates indicated that plant height has the highest positive direct effect on total yield per plant followed by the number of primary branches.

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Characters	Heritability	Genetic	%	Coefficient	of Variability	Coefficient of		
	(%)	Advance	Genetic	Phenotypic	Genotypic	Variation		
			Gain					
Plant height(cm)	95.95	34.1	20.97	10.61	10.39	2.14		
No. of primary branches	68.83	3.21	28.34	19.99	16.58	11.16		
Days to first flowering	12.07	0.42	1.33	5.35	1.86	5.01		
Days to first fruit set	3.4	0.16	0.3	4.29	0.79	4.21		
Days to first fruit harvest	51.54	4.32	3.76	3.54	2.54	2.46		
Days to last fruit harvest	1.16	0.06	0.03	1.44	0.15	1.43		
Ph	61.74	0.43	9.35	7.35	5.77	4.54		
TSS(°Brix)	89.53	1.88	37.6	20.39	19.29	6.6		
Polar diameter(cm)	96.28	2.03	48.83	24.62	24.16	4.75		
Equatorial diameter(cm)	95.65	2.09	48.03	24.37	23.84	5.08		
Pericarp thickness(mm)	85.65	2.71	46.75	26.5	24.52	10.04		
No. of locules	85.57	3.43	88.99	50.48	46.7	19.18		
No. of fruits per cluster	46.95	0.86	14.68	15.18	10.4	11.06		
Average fruit weight(g)	95.86	24.46	63.96	32.39	31.71	6.59		
No. of fruits per plant	99.03	73.55	117.63	57.66	57.38	5.68		
Total yield per plant(kg)	78.06	0.63	30.89	19.01	16.88	8.74		

Table 4.1: Genetic variability, heritability and genetic advance

Characters		Plant height (cm)	No. of primary branche s	Days to first flowerin g	Days to first fruit set	Days to first fruit harvest	Days to last fruit harvest	рН	TSS (°Brix)	Polar diamete r (cm)	Equatoria l diameter (cm)	Pericarp thickness (mm)	No. of locule s	No. of fruits per cluster	Average fruit weight (g)	No. of fruits per plant	Total yield per plant (kg)
Plant height (cm)	G	- 10.260 0	9.6606	0.2912	0.2733	0.0064	1.2246	0.0460	-1.7890	-0.4886	1.1759	0.5689	- 0.3491	-1.8728	-1.5998	3.2976	105.2669
	Р	-0.2699	0.1669	0.0092	- 0.0020	-0.0003	-0.0076	0.0049	-0.1793	-0.0743	-0.0518	0.0552	0.0065	0.0047	-0.2545	0.7848	0.0728
No. of primary branches	G	- 10.179 7	9.7367	0.1756	0.2662	-0.1309	1.5395	0.0230	-1.9470	-0.5707	1.1891	0.6043	- 0.4309	-1.8494	-1.6053	3.2541	94.8043
	Р	-0.2310	0.1951	0.0095	- 0.0010	0.0002	-0.0072	0.0041	-0.1659	-0.0724	-0.0445	0.0489	0.0051	0.0037	-0.2166	0.6973	0.0380
Days to first flowering	G	3.3558	-1.9207	-0.8902	- 0.9153	0.0410	-1.7688	- 0.2805	1.0591	-0.0851	-0.1561	-0.1512	0.5231	1.1259	1.1123	-1.1066	0.7924
	Р	0.0458	-0.0341	-0.0543	0.0008	0.0001	-0.0042	0.0079	0.0429	-0.0059	0.0010	-0.0035	- 0.0038	-0.0014	0.0663	-0.1141	0.0029
Days to first fruit set	G	-6.6978	6.1906	1.9460	0.4187	-0.0644	0.8868	- 0.6654	-1.9609	-0.3914	1.4620	0.2857	-0.376	-1.2811	-1.9046	2.1358	0.1753
	Р	-0.0291	0.0109	0.0023	- 0.0184	0.0001	0.0067	- 0.0066	-0.0224	-0.0111	-0.0104	0.0089	0.0024	0.0011	-0.0557	0.0808	0.0003
Days to first fruit harvest	G	0.0890	1.7371	0.0497	0.0367	-0.7339	-0.9046	- 0.0662	-0.6426	-0.3040	0.1466	0.3795	0.1439	-0.0872	-0.5533	0.8479	0.5385

Table 4.2: Path analysis: Direct and indirect effects at genotypic and phenotypic levels in tomato

	Р	0.0080	0.0055	-0.0004	- 0.0003	0.0087	0.0024	- 0.0142	-0.0493	-0.0350	-0.0048	-0.0248	- 0.0009	0.0002	-0.0715	0.1317	0.0001
Days to last fruit harvest	G	- 14.462 4	17.2548	1.8125	0.4274	0.7641	0.8687	0.1975	-3.4855	0.3232	0.3213	0.0591	- 1.5338	-3.2943	-3.5451	3.1590	0.7547
	Р	-0.0330	0.0226	-0.0037	0.0020	-0.0003	-0.0619	- 0.0175	-0.0435	0.0089	0.0002	-0.0038	0.0015	0.0009	-0.0655	0.0730	0.0038
рН	G	0.5240	-0.2485	-0.2771	0.3092	-0.0539	-0.1904	- 0.9010	0.6455	0.2425	-0.3391	-0.0472	0.2359	0.0853	-0.0273	-0.0682	0.8117
	Р	0.0093	-0.0056	0.0030	- 0.0009	0.0009	-0.0077	- 0.1414	0.0342	0.0310	0.0131	-0.0036	- 0.0035	-0.0001	-0.0011	-0.0140	0.0200
TSS (°Brix)	G	-6.1506	6.3522	0.3159	0.2751	-0.1580	1.0146	0.1949	-2.9843	-0.5771	1.5929	0.5774	- 0.6563	-1.1638	-1.6241	2.9663	8.9062
	Р	-0.1520	0.1017	0.0073	- 0.0013	0.0013	-0.0085	0.0152	-0.3183	-0.0843	-0.0677	0.0534	0.0115	0.0031	-0.2501	0.6728	0.1013
Polar diameter	G	5.0567	-5.6055	0.0764	- 0.1653	0.2251	0.2832	- 0.2204	1.7374	0.9913	-1.5040	-0.7075	0.236	0.6800	1.1263	-2.2308	0.9827
(cm)	Р	0.1281	-0.0902	0.0020	0.0013	-0.0019	-0.0035	- 0.0279	0.1714	0.1566	0.0701	-0.0703	- 0.0042	-0.0016	0.1789	-0.5229	0.0245
Equatorial diameter (cm)	G	4.6343	-4.4473	-0.0534	- 0.2351	0.0413	-0.1072	- 0.1174	1.8259	0.5727	-2.6034	-0.3930	0.8097	0.9879	1.4577	-2.3086	6.7775
	Р	0.1170	-0.0726	-0.0005	0.0016	-0.0003	-0.0001	- 0.0155	0.1801	0.0918	0.1196	-0.0396	- 0.0146	-0.0023	0.2317	-0.5416	0.0143
Pericarp thickness (mm)	G	5.8162	-5.8627	-0.1341	- 0.1192	0.2775	-0.0512	- 0.0424	1.7170	0.6988	-1.0194	-1.0036	0.0688	0.9639	1.4696	-3.0346	1.0072

	Р	0.1388	-0.0890	-0.0018	0.0015	-0.0020	-0.0022	- 0.0048	0.1584	0.1026	0.0441	-0.1073	- 0.0004	-0.0022	0.2169	-0.6725	0.0115
No. of locules (no.)	G	2.3448	-2.7471	-0.3049	- 0.1031	-0.0692	-0.8724	- 0.1392	1.2823	0.1532	-1.3801	-0.0452	1.5274	0.5281	1.1683	-1.2941	2.3328
	Р	0.0562	-0.0323	-0.0065	0.0014	0.0002	0.0029	- 0.0158	0.1177	0.0210	0.0561	-0.0012	- 0.0311	-0.0015	0.1780	-0.2822	0.0010
No. of fruits per cluster	G	-8.7970	8.2439	0.4588	0.2456	-0.0293	1.3102	0.0352	-1.5901	-0.3086	1.1774	0.4429	- 0.3693	-2.1843	-1.4987	3.0875	4.7711
(no.)	Р	-0.1535	0.0858	0.0091	- 0.0025	0.0002	-0.0069	0.0013	-0.1176	-0.0302	-0.0337	0.0286	0.0056	0.0083	-0.1710	0.5045	0.0001
Average fruit	G	5.5867	-5.3199	-0.3370	- 0.2714	0.1382	-1.0482	0.0084	1.6496	0.3800	-1.2917	-0.5020	0.6074	1.1142	2.9381	-3.8759	8.6324
weight (g)	Р	0.1407	-0.0865	-0.0074	0.0021	-0.0013	0.0083	0.0003	0.1631	0.0574	0.0567	-0.0477	- 0.0113	-0.0029	0.4882	-0.9105	0.2383
No. of fruits per plant (no.)	G	-7.1505	6.6962	0.2082	0.1890	-0.1315	0.5800	0.0130	-1.8709	-0.4674	1.2702	0.6437	- 0.4178	-1.4253	-2.4068	4.7316	22.3882
	Р	-0.1860	0.1194	0.0054	0.0013	0.0010	-0.0040	0.0017	-0.1881	-0.0719	0.0569	0.0634	00077	0.0037	-0.3903	1.1387	1.2966