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Genetic variability studies of tomato (*Solanum lycopersicum* L.) under protected conditions of Kerala

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ABSTRACT : Forty tomato genotypes were evaluated in Randomized Block Design with three replications at College of Agriculture, Vellayani, Kerala, during October 2014 to April 2015. Wide range of variability was observed among the characters studied for effective selection of superior genotypes suited which have a great interest for polyhouse tomato breeding. The present appraisal uncovered that PCV and GCV were higher for plant height, truss per plant, fruit weight, fruits per truss, fruits per plant and yield per plant which suggested greater variability among the accessions and sensitiveness of the attributes for making further improvement by selection. High heritability was observed for plant height, pollen viability, truss per plant, fruit weight, fruit girth, fruits per truss, fruits per plant, lycopene and yield per plant.

KEY WORDS : Tomato, Variability, Heritability, Genetic advance

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Protected cultivation is a unique and specialized form of agriculture in which the microclimate surrounding the plant is controlled partially or fully, as per the requirement of the plant species grown during their growth period. Tomato (*Solanum lycopersicum* L.), one of the premier crop of India generating sizeable employment is widely grown under protected conditions. Growth, development and productivity of crops largely depend on the interaction between the genetic make-up of the species with environment under which they are grown. To achieve genetic improvement, tomato breeders need to work with population having wider genetic base. Investigations were conducted at Department of Olericulture, College of Agriculture, Vellayani to identify superior tomato genotypes with respect to yield, quality as well as resistance to pests and disease and to develop superior F_1 hybrids for protected conditions.

RESEARCH METHODS

The experimental materials consisted of 40 tomato genotypes collected from national and international sources (Table A). The tomato genotypes were laid out in Randomized Block Design (RBD) with three replications at College of Agriculture, Vellayani, Kerala during October 2014 to April 2015. The experiment was conducted in saw toothed type naturally ventilated polyhouse of gutter height of 5m, gutter slope of 2 per cent and size 1000 m^2 (50 m x 20 m) located in Instructional farm, Vellayani. Transplanting was done at a spacing of 75 x 60 cm in raised beds. Data were recorded on various characters. Analysis of variance was done based on RBD as suggested by Panse and Sukhatme (1967) for each of the characters separately.

RESEARCH FINDINGS AND DISCUSSION

The present study revealed highly significant

Table A : Details of 40 tomato genotypes used for the study

Sr. No.	Accession number	EC No./Accession name	Source
1.	LE 1	EC-775045	AVRDC, Taiwan
2.	LE 2	EC-775046	AVRDC, Taiwan
3.	LE 3	EC-775047	AVRDC, Taiwan
4.	LE 4	EC-775048	AVRDC, Taiwan
5.	LE 5	EC-775049	AVRDC, Taiwan
6.	LE 6	EC-775050	AVRDC, Taiwan
7.	LE 7	EC-775051	AVRDC, Taiwan
8.	LE 8	EC-775052	AVRDC, Taiwan
9.	LE 10	EC-596779	NBPGR, New Delhi
10.	LE 11	EC 570015	NBPGR, New Delhi
11.	LE 12	EC 570017	NBPGR, New Delhi
12.	LE 13	EC 570021	NBPGR, New Delhi
13.	LE 14	EC 570028	NBPGR, New Delhi
14.	LE 15	EC 605785	NBPGR, New Delhi
15.	LE 16	EC 608244	NBPGR, New Delhi
16.	LE 17	EC 608288	NBPGR, New Delhi
17.	LE 18	EC 608359	NBPGR, New Delhi
18.	LE 19	EC 608363	NBPGR, New Delhi
19.	LE 20	EC 608365	NBPGR, New Delhi
20.	LE 21	EC 608389	NBPGR, New Delhi
21.	LE 22	EC 608393	NBPGR, New Delhi
22.	LE 23	EC 608418	NBPGR, New Delhi
23.	LE 24	EC 608438	NBPGR, New Delhi
24.	LE 25	EC 608441	NBPGR, New Delhi
25.	LE 26	EC 685176	NBPGR, New Delhi
26.	LE 27	EC 677080	NBPGR, New Delhi
27.	LE 28	EC 677111	NBPGR, New Delhi
28.	LE 29	EC 686704	NBPGR, New Delhi
29.	LE 30	Arka Vikas	ICAR-IIHR, Bengaluru
30.	LE 31	Arka Saurabh	ICAR-IIHR, Bengaluru
31.	LE 32	Arka Meghna	ICAR-IIHR, Bengaluru
32.	LE 33	Arka Alok	ICAR-IIHR, Bengaluru
33.	LE 36	Pant Bahar	GBPUAT, Pantnagar
34.	LE 37	LE 1-2 (Manuprabha)	ARS, Mannuthy
35.	LE 38	Manulakshmi	KAU, Thrissur
36.	LE 39	Akshaya	KAU, Thrissur
37.	LE 49	Marutham	TNAU, Coimbatore
38.	LE 53	Anagha	KAU, Thrissur
39.	LE 54	T34	Trivandrum
40.	LE 56	Local	Kollam

differences among the 40 genotypes of tomato for the characters studied *viz.*, plant height (m), days to first flowering, fruitset (%), pollen viability (%), fruits per plant, truss per plant, fruits per truss, fruit length (cm), fruit girth (cm), fruit weight (g), yield /plant (g), TSS, beta carotene, lycopene and ascorbic acid (Table 1). Indeterminate genotypes with long vines are preferred for tomato under polyhouse conditions. The present study revealed that among the 40 genotypes evaluated, plant height ranged from 1.13 m to 2.85 m with a mean performance of 1.91 m. Indeterminate genotypes with long vines are preferred for tomato under polyhouse conditions. Considerable variability for plant height under protected structures was reported by Cheema *et al*. (2013). Commencement of flowering with minimum number of days is a desirable character since it denotes earliness under protected conditions. The study revealed a range of 24.50 days to 32.00 for days to flowering. Tomato plants grown under polyhouse was observed to be earlier in flowering as reported by Kengar (2011).

In this study, pollen viability fluctuated from 38.76 per cent to 67.27 per cent. These results are in agreement with Adams *et al.* (2001) who reported the influence of high temperature on low pollen viability. Fruitset per cent is an important parameter for greenhouse tomato production, which determines the suitability of a variety to a particular temperature and environment. Fruit set percentage varied from 33.33 per cent to 73.25 per cent with a mean value of 54.62 per cent. Cheema *et al.* (2013) reported variations in fruitset percentage due to variation in pollen release under heat stress environment. In this study a range of 6.60 to 27.60 and a pooled mean of 15.84 was observed for truss per plant. Among the genotypes, fruits per truss exhibited a range of 2.00 to 7.20. The number of fruits per plant is a genetic character and is also governed by the microclimatic condition surrounding the tomato plant under the protected conditions. The on-topic results revealed a wide range of variation for fruits per plant (17.30 - 65.53) with a mean value of 65.06. Polyhoused tomato had higher retention of fruits per plant for longer time without loss of firmness compared to open field tomato. The result is in harmony with the outcome of experiments conducted by Singh *et al*. (2014) under different protected conditions.

Fruit size is an important index for polyhouse tomato. Fruit length and fruit girth determines the fruit size. In the present study fruit length showed a range from 3.52 cm to 7.20 cm. Fruit weight exhibited a wide range from 31.95 g to 104.23 with a mean fruit weight of 62.70 g. The variability in fruit size is correlated with the genetic makeup of genotypes as well as the cell size and intercellular flesh space. This is in parallel with the results of Nangare *et al.* (2015) under protected condition. Yield is a polygenic trait which is highly influenced by various parameters like fruitset, truss per plant, fruits per truss,

Table 1 : Estimates of genetic parameters for various characters in tomato genotypes

Characters	Mean	Range	Genotypic variance	Phenotypic variance	GCV	PCV	Heritability	Genetic advance as % of mean
Plant height (m)	1.91	1.13-2.85	0.22	0.24	24.58	25.37	93.86	49.06
Days to flowering	27.43	24.50-32.00	1.30	2.14	4.16	5.33	60.93	6.69
Pollen viability (%)	48.07	38.76-67.27	50.99	53.06	14.85	15.15	96.09	30.00
Fruitset (%)	54.62	33.33-73.25	99.33	111.75	18.25	19.36	88.88	35.44
Truss plant^{-1}	15.84	6.60-27.60	32.53	33.18	35.90	36.26	98.04	73.22
Fruits truss^{-1}	3.36	2.00-7.20	1.22	1.26	32.90	33.45	96.72	66.64
Fruits plant^{-1}	65.06	17.30-65.53	102.91	107.65	30.34	31.03	95.59	61.10
Fruit length (cm)	5.55	3.52-7.20	0.52	0.59	13.01	13.82	88.61	25.22
Fruit girth (cm)	5.09	4.10-6.18	0.30	0.32	10.69	11.15	91.88	21.11
Fruit weight (g)	62.70	31.95-104.23	449.77	458.87	33.25	33.59	98.02	67.82
Yield plant^{-1} (g)	197.14	589.23-2479.21	27.95	28.61	40.63	41.09	97.72	82.73
TSS (ºBrix)	5.28	4.95-5.85	0.02	0.07	2.85	4.91	33.66	3.40
Beta carotene (mg/100g)	161.60	130.96-181.07	142.15	157.78	7.35	7.74	72.12	13.13
Lycopene (mg/100g)	9.85	4.77-13.86	5.48	5.66	23.76	24.14	96.86	48.17
Ascorbic acid (mg/100g)	24.56	20.61-30.90	6.01	7.76	9.98	11.34	77.51	18.10

fruit size, fruit weight and number of fruits. The results of present study alluded that yield per plant recorded a high value as 2479.21 g whereas minimum yield per plant recorded was 589.23 g. Many workers have reported ample variability of yield under protection (Singh *et al.*, 2014 and Nangare *et al.*, 2015). The present study of tomato under polyhouse conditions revealed variation among genotypes for biochemical qualities like TSS, beta carotene, ascorbic acid and lycopene. Total soluble solids of tomato fruits was recorded using a hand refractometer (0-32 ^{o}Brix). TSS of the genotypes exhibited a range of 4.95 - 5.85 ^{o}Brix. Kengar (2011) and Singh *et al.* (2014) found significant variation for TSS under protected environment. Beta carotene of the fruits ranged from 130.96 mg/100g to 181.07 mg/100g. Colour is a major quality attribute in tomato and uniformity of colour is a prime prerequisite of export standards. The highest value of lycopene was recorded as 13.86 mg/100g. The lycopene contents in the fruits of the evaluated genotypes are in agreement with the values presented by Frusciante *et al.* (2000). In this study, fruits had a range of 20.61 mg/100g to 30.90 mg/100g as far as ascorbic acid is considered. Significant variation of biochemical characters under protected cultivation is in line with the results of Nangare *et al*. (2015). The magnitude of variability present in a population is of utmost importance as it provides the basis for effective selection (Table 1). The PCV and GCV are the major components used to measure the variability present in a population. The present study reavealed that GCV and PCV were higher (>20) for plant height (24.58 and 25.37), truss per plant (35.90 and 36.26), fruit weight (33.25 and 33.59), fruits per truss (32.90 and 33.45), fruits per plant (30.34 and 31.03) and yield per plant (40.63 and 41.09). Among the quality parameters lycopene had a GCV of 23.76 and PCV of 24.14. Moderate PCV and GCV were observed for the characters like fruitset, fruit length and fruit girth. Low PCV and GCV (<10%) were observed for days to flowering, TSS and beta carotene. Many workers like Reddy *et al.* (2013) and Kumar *et al*. (2014) have reported similar results for various traits. Difference between phenotypic and genotypic co-efficient of variations were less. This indicates the low impact of environment on the expression of characters and hence, they could be improved by following different phenotypic selections. On the other hand, a wide range of variability recorded for all characters also indicates the scope for selection of better genotypes. In the present study, high heritability was observed for truss per plant (98.04), fruit weight (98.02), yield per plant (97.72), fruits per truss (96.72), pollen viability (96.09), fruits per plant (95.59), plant height (93.86), fruit girth (91.88), fruitset (88.88) and fruit length (88.61). Among the biochemical traits high heritability was observed for lycopene (96.86), ascorbic acid (77.51) and beta carotene (72.12). Moderate heritability was observed for TSS (33.66). The results are in accordance with Reddy *et al.* (2013) for various characters. High genetic advance was observed for yield per plant (82.73), truss per plant (73.22), fruit weight (67.82), fruits per truss (66.64), fruits per plant (61.10), plant height (49.06), lycopene (48.17) and fruitset (35.44). Moderate genetic advance was observed for ascorbic acid (18.10) and beta carotene (13.13). High heritability coupled with high genetic advance was observed for the characters like yield per plant, fruits per plant, truss per plant, fruits per truss, fruit set, fruit weight, fruit length, fruit girth, plant height and lycopene. Environment has least influence for the characters with high heritability and there could be greater correspondence between phenotypes and breeding value while selecting individuals.

The present investigation helped to quantify the variability among tomato genotypes for yield and yield related characters under protected conditions. The study under protected conditions revealed that simultaneous selection based on multiple characters having high estimates of heritability coupled with genetic advance may be of appreciable use in the crop. The evaluation of the 40 genotypes revealed that tomato genotypes can perform better under protected conditions of Kerala and the promising genotypes identified in the study can be progressed for further trials.

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