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Studies on genetic variability in tomato (*Solanum lycopersicum* L.) for growth, yield and quality traits

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Abstract
The present investigation entitled "Studies on genetic variability in tomato (*Solanum lycopersicum* L.) for growth, yield and quality traits" was carried out at the Experimental Farm, Department of Vegetable Science, Dr YSR Horticulture University, Venkataramannagudem, (AP) during *Rabi* season of 2020-21, to evaluate fourty five diverse genotypes of tomato in RCBD model replicated twice. Amongst the various parameters of variability, high phenotypic and genotypic coefficients of variability were recorded average fruit weight followed by lycopene conten, seed:pulp ratio, fruit firmness, shelf life, number of primary branches per plant, number of locules per fruit and pericarp thickness and high heritability coupled with high genetic gain was observed for average fruit weigh. While, high heritability along with moderate genetic gain was observed for plant height at 90 DAT, days to 50 percent flowering, average fruit weight, days to first harvest and days to last fruit harvest, indicating a wide range of variation and offered better scope for improvement through selection.

Keywords: Tomato, *Solanum lycopersicum*, yield and quality traits

Introduction
Tomato (*Solanum lycopersicum* L. 2n=24) is a widely grown vegetable in the world in varying climatic conditions and it is second most important vegetable after potato and it ranks third in India. Tomato belongs to the family Solanaceae and is native of Andean region that includes parts of Colombia, Ecuador, Peru, Bolivia and Chile. Tomato is a versatile fruit which contains most powerful anti-oxidant, lycopene which have effective anti-cancer properties and flushes out free radicals, protect against inflammation, heart diseases and prevent DNA damage in human body.

It is a very good source of income to small and marginal farmers and has a great nutritional value. Tomato is a rich source of minerals, vitamins and organic acids. It is a reservoir of diverse antioxidant like ascorbic acid, vitamin C, carotenoides, flavonoides and phenolic acids. Tomato is a good appetizer and its soup is good remedy for patient suffering from the constipation. It is mostly considered as 'Protective food' based on its nutritive value and antioxidant properties due to the presence of lycopene and flavonoids.

Assessment of variability present in tomato is essential pre requisite for formulating an effective selection programme, to identify dual purpose genotype. The existing variability in available genotypes can be used to further enhance the yield level of the cultivars following the appropriate breeding strategies. Estimates of heritability may be helpfull in selecting superior individuals and successfully utilizing them in breeding programme. The nature and magnitude of genetic divergence available in a species is essential for selection of desirable parents for hybridization.

Materials and methods
The present investigation entitled "Studies on genetic variability in tomato (*Solanum lycopersicum* L.) for growth, yield and quality traits" was carried out at the Experimental Farm, Department of Vegetable Science, Dr YSR Horticulture University, Venkataramannagudem, (AP) during *Rabi* season of 2020-21, to evaluate fourty five diverse genotypes of tomato in RCBD model replicated twice. The spacing followed for row to row and plant to plant distance is 60 × 45 cm. the experimental field was well prepared and standard cultural, fertilizer and plant protection practices were followed to ensure a healthy crop. The observations were recorded on plant height (cm) at 30, 60, and 90 DAT, primary branches at 30, 60 and 90 DAT, days to 50% flowering, number of flowers per cluster, number of fruit per cluster, average fruit weight (g), fruit length (cm), fruit diameter (cm), pericarp

thickness (mm), number of locules per fruit, days to first fruit harvest, days to last fruit harvest, fruit yield per plant (kg/ plant), total soluble solids (◦Brix), fruit firmness (kg/cm^2), fruit p^H, titratable acidity (%), ascorbic acid conent (mg/100g), total sugar (%), reducing sugar (%), lycopene content (mg/100g), shelf life and seed : pulp ratio.

Genetic variability will be estimated by using the method as suggested by Panse and Sukhatme (1967). Genotypic (GCV) and Phenotypic (PCV) coefficient of variations will be calculated by using the formula of Burton (1952). Heritability in broad sense is estimated according to the formula of Burton and De Vane (1953) [4]. The expected genetic advance will be calculated by using the formula as suggested by Lush (1949) [9].

Result and discussion

The estimates of coefficient of variances revealed that magnitude of phenotypic coefficient of variation for all the traits were higher in magnitude than the genotypic coefficient of variation. The estimates of phenotypic as well as genotypic coefficient of variability were observed higher for average fruit weight (43.81 %, 43.74 %) followed by lycopene content (28.60 %, 28.52 %), seed:pulp ratio (26.77 %, 24.93 %), fruit firmness (24.20 %, 24.18 %), shelf life (23.58 %, 23.53 %), number of primary branches per plant at 30 DAT (23.25 %, 20.26 %), number of locules per fruit (23.11 %, 22.24 %) and pericarp thickness (22.18 %, 21.68 %) where as moderate phenotypic coefficient of variances were observed for fruit diameter (19.39 %, 19.19 %), ascorbic acid content (18.92 %, 18.76 %), titratable acidity (18.63 %, 17.01 %), fruit length (18.40 %, 18.20 %), number of primary branches per plant at 60 DAT (17.36 %, 13.83 %), number of primary branches per plant at 90 DAT (16.80 %, 15.47 %), total sugar (16.11 %, 16.05 %), reducing sugar (15.84 %, 15.77 %), total soluble solids (15.62 %, 15.54 %), number of flowers per cluster (14.76 %, 8.55 %), days to 50 percent flowering (14.71 %, 14.69 %), number of fruit per cluster (14.51 %, 9.08 %), plant height at 30 DAT (14.43 %, 12.36 %), plant height at 60 DAT (13.66 %, 12.68 %), fruit yield per plant (13.19 %, 12.69 %), plant height at 90 DAT (10.04 %, 9.90 %), whereas fruit p^H (9.58 %, 9.56 %), days to first harvest (8.29 %, 8.15 %) and days to last fruit harvest (4.80 %, 4.68 %) recorded the lowest phenotypic coefficient of variation. The above results are in consonance with earlier research done by Meena and Bahadur (2010), Dar *et al.* (2011) [6], Dar and Sharma (2011) [6], Shankar *et al.* (2013) [15] and Arun kumar *et al.* (2016) [3].

Estimates of heritability in broad sense (h^2_{bs}) for twenty seven characters in tomato genotypes are shown in Table-4.5. The estimates of heritability in broad sense (h^2_{bs}) ranged from 33.56 per cent (number of flowers cluster^{-1}) to 99.89 per cent (fruit firmness). Highest estimates of heritability (> 70.0%) were observed for all the characters except number of flowers per cluster (33.56 %) and number of fruits per cluster (39.20 %).

However, the degree of enhancement attained through selection is not only depending on heritability but also on the amount of genetic variation present in the breeding material and extent of selection pressure applied by the breeder. The parameter genetic advance in per cent of mean (GA) is more trustworthy index for understanding the effectiveness of selection to improve the character because its estimate is derived by participation of heritability, phenotypic standard deviation and intensity of selection. Thus heritability and genetic advance in per cent of mean in combination gives clear picture about the efficacy of selection for improving the plant trait. Results obtained in present investigation are in agreement with the finding of Singh *et al.* (2002) [16], Mohammed *et al.* (2012) [13], Arun kumar *et al.* (2016) [3], Kumari *et al.* (2020) [8], Anuradha *et al.* (2020) [2].

Table 1: Estimates of GCV, PCV, Heritability and genetic adavance for different characters in tomato (*Solanum lycopersicum* L.)

Sl. No.	Characters	Mean	GCV	PCV	h^2	GA	GAM
1.	Plant height (cm) at 30 DAT	53.21	12.36	14.43	73.27	11.59	21.79
2.	Plant height (cm) at 60 DAT	74.74	12.68	13.66	86.22	18.14	24.26
3.	Plant height (cm) at 90 DAT	93.68	9.90	10.04	97.27	18.86	20.13
4.	Number of primery branches per plant at 30 DAT	4.15	20.26	23.25	75.91	1.51	36.36
5.	Number of primery branches per plant at 60 DAT	6.02	13.83	17.36	63.40	1.36	22.68
6.	Number of primery branches per plant at 90 DAT	7.98	15.47	16.80	84.83	2.34	29.37
7.	Days to 50 percent flowering	35.63	14.69	14.71	99.70	10.77	30.23
8.	Number of flowers per cluster	4.82	8.55	14.76	33.56	0.49	10.20
9.	Number of fruits per cluster	3.98	9.08	14.51	39.20	0.46	11.71
10.	Average fruit weight(g)	52.41	43.74	43.81	99.67	47.16	89.97
11.	Fruit length (cm)	4.24	18.20	18.40	97.80	1.57	37.08
12.	Fruit diameter (cm)	4.30	19.19	19.39	97.88	1.68	39.11
13.	Pericarp thickness(mm)	4.07	21.68	22.18	95.50	1.77	43.65
14.	Number of locules fruit^{-1}	3.12	22.24	23.11	92.67	1.37	44.12
15.	Days to first fruit harvest	67.77	8.15	8.29	96.55	11.18	16.50
16.	Days to first fruit harvest	123.71	4.68	4.80	94.92	11.62	9.39
17.	Fruit yield plant^{-1}	1.42	12.69	13.19	92.53	0.35	25.14
18.	Total soluble solids (%)	4.33	15.54	15.62	99.06	1.38	31.88
19.	Fruit firmness(kg/cm^2)	8.90	24.18	24.20	99.89	4.43	49.80
20.	Fruit p^H	4.90	9.56	9.58	99.64	0.96	19.67
21.	Titrable acidity (%)	0.36	17.01	18.63	83.42	0.11	32.01
22.	Ascorbic acid content (mg/100g)	17.96	18.76	18.92	98.30	6.88	38.33
23.	Total sugars (%)	3.02	16.05	16.11	99.29	0.99	32.95
24.	Reducing sugars (%)	2.61	15.77	15.84	99.12	0.84	32.35
25.	Lycopene content (mg/100g)	7.34	28.52	28.6	99.45	4.30	58.59
26.	Shelf life	9.80	23.53	23.58	99.61	4.74	48.39
27.	Seed : pulp ratio	0.46	24.93	26.77	86.73	0.22	47.83

The highest estimates of genetic advance as per cent of mean were recorded for the characters average fruit weight (89.97) followed by lycopene content (58.59), fruit firmness (49.90), shelf life (48.39), seed:pulp ratio (47.83), number of locules per fruit (44.12), pericarp thickness (43.65), fruit diameter (39.11), ascorbic acid content (38.33)**,** fruit length (37.08), number of primary branches per plant at 30 DAT (36.36), total sugars (32.95), reducing sugars (32.35), titratable acidity (32.01), total soluble solids (31.88), days to 50 percent flowering (30.23), number of primary branches per plant at 90 DAT (29.37), fruit yield per plant (25.14), plant height 60 DAT (24.26), number of primary branches per plant at 60 DAT (22.68), plant height 30 DAT (21.79), plant height 90 DAT (20.13), fruit pH (19.67), where as moderate estimates of genetic advance as per cent of mean shown by days to first fruit harvest (16.50), number of fruits per cluster (11.71), number of flowers per cluster (10.20) and days to last fruit harvest (9.39) recorded lowest genetic advance as per cent of mean. Results obtained in present investigation are in conformity with the result of Prasanth *et al.* (2007) [14], Mehta and Asati (2008) [11] and Singh *et al.* (2008), Mohamed *et al.* (2012) [13], Ahirwar *et al.* (2013) [1], Arun kumar *et al.* (2016) [3], Kumari *et al.* (2020) [8] and Anuradha *et al.* (2020) [2].

Thus, it may be concluded that high genetic variability demonstrated directional selection could be essential for desired genetic improvement. High heritability coupled with high genetic advance as per cent of mean specify the significance so, that these characters can be utilized for choosing superior genotypes. Moderate genetic advance as per cent of mean with high heritability suggests the action of both additive and nonadditive genes and favorable influence of environment in the expression. Therefore, the breeder should 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.

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