International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(4): 1333-1336

Received: 06-05-2020
Accepted: 10-06-2020

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Studies on heritability in narrow sense and genetic advance in Tomato (*Solanum lycopersicum* L.) crops

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DOI: https://doi.org/10.22271/chemi.2020.v8.i4l.9785

Abstract
The present investigation entitled "Studies on heritability in narrow sense and genetic advance in Tomato (*Solanum lycopersicum* L.) crop." was conducted during *Rabi* seasons of *2017*-18 (E_1) and 2018-19 (E_2) heritability and genetic advance using diallel mating design at the Main Experiment Station (MES) of the Department of Vegetable Science, Narendra Deva University of Agriculture & Technology, Narendra Nagar, Kumarganj, Ayodhya (U.P.) India. Ten diverse parents of tomato were crossed in a diallel fashion (excluding reciprocals) for generating experimental material. All the Ten parents and their 45 hybrids were grown in Randomized Block design with three replications. Observations were recorded on the 16 characters *viz*., Days to 50 per cent flowering, Days to first fruit harvest, Plant height (cm), Number of primary branches per plant, Number of fruits per cluster, Number of fruits per plant, Average fruit weight (g), Pericarp thickness (mm), Number of locules per fruit, Fruit length (cm), Fruit diameter (cm), Marketable fruit yield per plant (kg), Total fruit yield per plant (kg), Total soluble solids (%), Titrable acidity (%), Ascorbic acid content (mg/100 g fresh fruit).
High heritability (narrow sense) along with high genetic advance in per cent of mean were observed for most of the important economic traits showing ample scope of improvement.

Keywords: Tomato, heritability, genetic advance, yield

Introduction
Tomato (*Solanum lycopersicum* L.) is one of the most popular solanaceous vegetable crop, having chromosome number 2n=2x=24.Tomato universally treated as "Protective Food" is being extensively grown as annual plant all over the world. Tomato ranks second in importance next to potato in many countries including India (Bose and Som 1993) [3]. It is a highly worked crop by the horticulturists and breeders. Tomato is used as fresh as well as processed vegetable. It is also very important for processing industries as it ranks first as processing vegetable crop in the world. It is a very good source of income for small and marginal farmers. Ripe fruits are widely used for preparation of several items like paste, syrup, juice, ketchup, puree and drinks etc.
Fresh fruits of tomato are in great demand round the year throughout the country. Tomato is a rich source of vitamins, minerals and organic acid. There are various types of flavoring compounds found in the fruits, which enrich the taste. The hundred gram mature tomato fruits contains 94 g moisture, 3.6 g carbohydrates, 0.9 g protein, 0.2 g fat, 585 IU vitamin A, 48 mg calcium, 26 mg vitamin C & Vitamin B (Thiamine 0.12 mg and Riboflavin 0.06 mg) (Choudhary *et al*., 2009) [4].
Tomato is an herbaceous sprawling plant growing up to 1-3 m in height with weak woody stem. The flowers are yellow in colour and the fruits of cultivated varieties vary in size from cherry tomatoes, about 1–2 cm in size to tomatoes, about 10 cm or more in diameter. Most cultivars produce red fruits when ripe. The plants have taproot system and two types of growth habit, determinate & indeterminate. Fruits bearing of different types. Determinate or bush types bear a full crop at once and top off at a specific height. They are often good choices for container growing and determinate types are preferred by commercial growers who wish to harvest a whole field at one time, or home growers which are interested in canning.

Indeterminate cultivars develop into vines that never top off and continue producing until killed by frost they are preferred by home growers who wish ripe fruit throughout the season. As an intermediate form, there are plants sometimes known as "vigorous determinate" or "semi-determinate"; these top off like determinates but produce a second crop after the initial crop. Many, if not all, heirloom tomatoes are indeterminate.

The estimate of narrow sense heritability provides the index of transmissibility of characters and serves as a useful guide to the breeders for practicing selection. Genetic advance give more clear view about overall efficiency of the selection for improvement of the characters.

Material and Methods

The present research work entitled "Studies on heritability in narrow sense and genetic advance in Tomato (*Solanum lycopersicum* L.) crop." was conducted during *Rabi* seasons of *2017*-18 (E_1) and 2018-19 (E_2) heritability and genetic advance using diallel mating design at the Main Experiment Station (MES) of the Department of Vegetable Science, Narendra Deva University of Agriculture & Technology, Narendra Nagar, Kumarganj, Ayodhya (U.P.) India.

The experimental materials for the present investigation was comprised of ten promising and diverse pure lines/varieties of tomato selected on the basis of genetic variability from the germplasm stock maintained in the Department of Vegetable Science, N.D. University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) India. The selected parental lines *i.e*. NDT-Sel-1, NDT-Sel-2, NDT-Sel-3, NDT-Sel-5, NDT-Sel-6, NDT-Sel-8, NDT-Sel-9, Narendra Tomato-7, NDT-Sel-10 and Narendra Tomato-4 were crossed in the all possible combinations, excluding reciprocals, during the *Rabi* season of 2016-17. These 45 F_1s along with their parents were evaluated for the study of heterosis, combining ability, gene action, heritability and genetic advance for 18 fruit yield and quality attributing traits. The ten diverse parental line selected their characteristics and crossed in diallel mating design as suggested by Griffing (1956 b) [6] to produce 45 hybrids in *Rabi* season of 2016-17 and evaluated during *Rabi* season of 2017-18 and 2018-19. The experiment laid out in randomized block design with three replication and 55 treatment including 10 parents.

The observation were recorded Days to 50 per cent flowering, Days to first fruit harvest, Plant height (cm), Number of primary branches per plant, Number of fruits per cluster, Number of fruits per plant, Average fruit weight (g), Pericarp thickness (mm), Number of locules per fruit, Fruit length (cm), Fruit diameter (cm), Marketable fruit yield per plant (kg), Total fruit yield per plant (kg), Total soluble solids (%), Titrable acidity (%), Ascorbic acid content (mg/100 g fresh fruit).

Result and Discussion

Heritability in narrow sense (h^2ns) and genetic advance in per cent of mean were estimated for all the sixteen characters and results have been presented in Table-1 In respect to facilitate the description of the estimates of heritability (h^2ns), the observed values of the estimates were classified according to Robinson (1966), as (i) High (> 30%), (ii) Moderate (above 10% to 30%) and low (< 10%).

The higher values of heritability (h^2ns) estimates (> 30) were observed only for days to 50% flowering (72.67%, 72.67% and 72.66%), plant height (36.12%, 34.90% and 35.48%), fruits per plant (86.79%, 86.78% and 86.73%), average fruit weight (86.29%, 86.31% and 86.26%), pericarp thickness (90.74%, 90.77% and 90.75%), locules per fruit (91.20%, 89.51% and 90.34%), fruits per cluster (75.99%, 75.98% and 75.93%), length of fruits (79.92%, 79.92% and 79.87%), diameter of fruits (84.97%, 84.94% and 84.90%), marketable fruit yield per plant (86.82%, 86.77% and 86.74%), total fruit yield per plant (89.79%, 89.79% and 89.73%), total soluble solids (41.50%, 41.54% and 41.52%), titrable acidity (44.15%, 44.80% and 44.95%) and ascorbic acid content (96.53%, 96.54% and 96.53%) during both the seasons and pooled, respectively. However, moderate heritability (10-30%) were not observed for any characters during both the seasons and pooled. Whereas, low heritability was estimated only for days to first fruit harvest (3.07%, 2.99% and 3.035).

The high estimates of heritability in broad sense (> 75%) were observed for days to 50% flowering (77.95%, 78.01% and 77.98%), plant height (96.40%, 96.27% and 91.79%), primary branches per plant (88.40%, 89.04% and 75.43%), fruits per plant (99.71%, 99.71% and 99.24%), average fruit weight (98.88%, 98.71% and 97.08%), pericarp thickness (97.74%, 97.89% and 94.96%), locules per fruit (94.47%, 93.36% and 86.88%), fruits per cluster (92.67%, 92.83% and 85.08%), length of fruits (93.50%, 93.93% and 86.08%), diameter of fruits (88.12%, 88.06% and 76.79%), marketable fruit yield per plant (98.37%, 98.36% and 96.20%), total fruit yield per plant (98.06%, 98.02% and 95.58%), total soluble solids (85.25%, 83.48% and 84.37%), titrable acidity (95.46%, 93.76% and 88.30%) and ascorbic acid content (87.20%, 86.67% and 86.93%) during both the seasons and pooled, respectively. However, moderate heritability (50-75%) were observed for days to first fruit harvest (53.94%, 53.86% and 42.67%) whereas, low heritability were not observed for any characters during both the seasons and pooled. High genetic advance in per cent of mean were estimated for plant height (30.70%, 30.46% and 31.25%), fruits per plant (168.76%, 168.58% and 168.89%), average fruit weight (66.64%, 65.79% and 66.64%), pericarp thickness (47.94%, 47.82% and 48.52%), locules per fruit (29.40%, 28.76% and 30.13%), fruits per cluster (27.52%, 27.59% and 28.80%), length of fruits (25.14%, 25.09% and 26.15%), marketable fruit yield per plant (77.64%, 77.62% and 78.36%), total fruit yield per plant (68.82%, 68.83% and 69.59%) and titrable acidity (32.26%, 32.05% and 33.22%) during both the seasons and pooled.

The moderate genetic advance (>10 to 20%) were observed for days to 50% flowering (10.00%, 10.00% and 11.70%), primary branches per plant (18.04%, 18.24% and 19.52%), diameter of fruits (18.75%, 18.73% and 18.74%), total soluble solids (13.17%, 12.73% and 14.36%) and ascorbic acid content (12.64%, 12.96% and 14.04%) during both the seasons and pooled, while low genetic advance was observed only for days to first fruit harvest (3.48%, 3.45% and 5.24%) during both the seasons (E_1, E_2) and pooled.

Table 1: Heritability (ns) and genetic advance in tomato over two seasons (E_1, E_2) and pooled

Characters	Seasons	Heritability in broad sense (%)	Heritability in narrow sense (%)	Genetic advance in per cent of mean
Days to 50% flowering	E_1	77.95	72.67	10.00
	E_2	78.01	72.67	10.00
	Pooled	63.24	72.66	11.70
Days to first fruit harvest	E_1	53.94	3.07	3.48
	E_2	53.86	2.99	3.45
	Pooled	42.47	30.34	5.24
Plant height (cm)	E_1	96.40	36.12	30.70
	E_2	96.27	34.90	30.46
	Pooled	91.79	35.48	31.25
Primary branches per plant	E_1	88.40	29.82	18.04
	E_2	89.04	29.89	18.24
	Pooled	75.43	29.83	19.52
Fruits per plant	E_1	99.71	86.79	168.76
	E_2	99.71	86.78	168.58
	Pooled	99.24	86.73	168.89
Average fruit weight (g)	E_1	98.88	86.29	66.64
	E_2	98.71	86.31	65.79
	Pooled	97.08	86.26	66.64
Pericarp thickness (mm)	E_1	97.74	90.74	47.94
	E_2	97.89	90.77	47.82
	Pooled	94.96	90.75	48.52
Locules per fruit	E_1	94.47	91.20	29.40
	E_2	93.36	89.51	28.76
	Pooled	86.88	90.34	30.13
Fruits per cluster	E_1	92.67	75.99	27.52
	E_2	92.83	75.98	27.59
	Pooled	85.08	75.93	28.80
Length of fruits (cm)	E_1	93.50	79.92	25.14
	E_2	93.93	79.92	25.09
	Pooled	86.08	79.87	26.15
Diameter of fruits (cm)	E_1	88.12	84.97	18.75
	E_2	88.06	84.94	18.73
	Pooled	76.79	84.90	20.26
Marketable fruit yield per plant (kg)	E_1	98.37	86.82	77.64
	E_2	98.36	86.77	77.62
	Pooled	96.20	86.74	78.36
Total fruit yield per plant (kg)	E_1	98.06	89.79	68.82
	E_2	98.02	89.79	68.83
	Pooled	95.58	89.73	69.59
Total soluble solids (%)	E_1	85.25	41.50	13.17
	E_2	83.48	41.54	12.73
	Pooled	71.80	41.52	14.36
Titrable acidity (%)	E_1	95.46	44.15	32.26
	E_2	93.76	45.80	32.05
	Pooled	88.30	44.95	33.22
Ascorbic acid content (mg/100g)	E_1	87.20	96.53	12.64
	E_2	86.67	96.54	12.96
	Pooled	73.91	96.53	14.04

This suggested that these characters could be improved through appropriate selection procedures. High heritability along with high genetic advance for these traits are in close agreement with the findings of Rani *et al.*, (2011), Singh *et al.*, (2011), Islam *et al.*, (2012) Reddy *et al.*, (2013), Ahmad *et al.*, (2017).

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