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APPRAISAL STUDIES ON VARIABILITY, HERITABILITY AND GENETIC ADVANCE IN TOMATO (*SOLANUM LYCOPERSICON* L.)

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Abstract

Fifty genotypes of tomato were evaluated for yield and various yield attributing characters at the Main Experiment Station, Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.), India; during 2011-2012. The experiment was laid out in Randomized Complete Block Design with three replications. Observations were recorded on ten quantitative characters *viz*., days to 50 per cent flowering, plant height (cm), number of primary branches per plant, fruit diameter (cm), number of locules per fruit, pericarp thickness (mm), average fruit weight (g), total soluble solids, number of fruits per plant and fruit yield per plant (kg). High magnitude of phenotypic as well as genotypic coefficients of variation were observed in case of fruit yield per plant followed by average fruit weight, number of locules per fruit, number of fruits per plant, plant height and number of primary branches per plant. High amount of GCV and PCV were observed for all the traits except days to 50 per cent flowering which showed very low variability. High heritability along with high genetic advance in per of mean were estimated for all the traits except days to 50 per cent flowering. Fruit yield per plant followed by average fruit weight, number of locules per fruit, number of fruits per plant and plant height were the top five traits which showed high level of genetic advance indicating opportunity for better selection response.

Key words : Genetic advance, GCV, PCV, climate conditions, tomato (*Solanum lycopersicon* L.).

Introduction

Tomato (*Solanum lycopersicon* L.) is one of the most important solanaceous vegetable crop having diploid chromosome number 2n = 2x = 24. It is herbaceous, annual to perennial, prostrate and sexually propagated crop plant with bisexual flowers. There are four to eight flowers in each compound inflorescence. Tomato is a typical day neutral plant and is mainly self-pollinated, but a certain per cent of cross-pollination also occurs. It is a warm season crop reasonably resistant to heat and drought and grows under wide range of soil and climatic conditions. All the species of tomato are native to Western South America (Rick, 1976). Tomato is used as fresh vegetable and is also very important for processing purposes like soup, ketchups, sauces, concentrates, purees, juices etc. Unripe green fruits are used for preparation of pickles and chutney. Tomatoes are important source of lycopene (an antioxidant), ascorbic acid and β-carotene and valued for their colour and flavour. One hundred gram of ripe tomato fruit contains 93.1 per cent moisture, 3.6g carbohydrate, 1.9g protein, 1.9g fat, 320 IU vitamin-A, 31 mg vitamin B, 15-30 mg ascorbic acid and other minerals. It is one of the most popular and widely cultivated vegetable throughout the world and ranking second in importance after potato in many countries including India (Anonymous, 2010-11). The total area of world in tomato under cultivation is 4.58 m ha and total production is 150.51 m tonnes with 32.8 tonnes per hectare productivity. Whereas, in India, total area is 0.86 m ha and production is 16.82 m tonnes with 19.5 tonnes/ha productivity. Considering the potentiality of this crop, there is a need for improvement and to develop varieties suited to specific agro-ecological conditions and also for specific use.

Materials and Methods

Present investigation was conducted at the Main Experiment Station, Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.), India during 2011-2012. The experiment was conducted to evaluate 50 genotypes of tomato. Seeds were sown in nursery bed on 10th October 2011 and 30 days old healthy

Table 1 : Analysis of variance (mean squares) for ten quantitative characters in tomato.

S. no.	Characters	Source of variation		
		Replications	Treatments	Error
	Degree of freedom	**2**	**49**	**98**
1.	Days of 50 per cent flowering	0.240	11.442**	0.641
2.	Plant height (cm)	5.731	872.564**	8.902
3.	Number of primary branches per plant	0.039	2.860**	0.083
4.	Fruit diameter (cm)	0.244*	1.694**	0.068
5.	Number of locules per fruit	0.073	4.422**	0.031
6.	Pericarp thickness (mm)	0.001	1.013**	0.040
7.	Average fruit weight (g)	2.612	443.148**	5.451
8.	Total Soluble Solids (TSS)	0.075	1.842**	0.035
9.	Number of fruits per plant	0.809	33.963**	2.732
10.	Fruit yield per plant (kg)	0.001	0.118**	0.001

*- Significant at 5 per cent probability level.
**- Significant at 1 per cent probability level.

seedlings were transplanted in the experimental field on 10th November 2011 in two rows of 4 m length with inter and intra row spacing of 60 and 50 cm, respectively. Four check varieties (determinate H-86, H-24, NDT-8 and indeterminate NDT-4) along with 46 genotypes were planted in two rows, keeping 8 plants in each row. The 50 genotypes were planted in Randomized Block Design with three replications. All the recommended cultural practices were followed to maintain good crop stand and growth of the plants. Data were recorded for ten characters *viz* days to 50 per cent flowering, plant height (cm), number of primary branches per plant, fruit diameter (cm), number of locules per fruit, pericarp thickness (mm), average fruit weight (g), total soluble solids, number of fruits per plant, fruit yield per plant (kg). The were analyzed as per methods suggested by Panse and Sukhatme (1967) for analysis of variance, Burton (1952) for variability. Lush (1940) for heritability (Broad Sense) and Johnson *et al.* (1955) for genetic advance in per cent of mean.

Results and Discussion

The mean performance of fifty genotypes of tomato for ten characters had been presented in table 2. A very wide range of variations in mean performance of genotypes were observed for all the characters under study. The comparison of mean performance genotypes for ten traits using critical differences revealed existence of very high level of variability among the genotypes. The eight genotypes NDT-7 (1.14), NDT 454 (0.89), NDT-451 (0.85), NDT-455 (0.759), NDT-445 (0.758), NDT-462 (0.733), NDT-446 (0.693) and NDT-453 (0.690) significantly out yielded than the check H-86 (0.684). Eight genotypes produced significantly higher fruit yield per plant in case of determinate group, while only one genotype NDT-472 (1.23) produced significantly higher fruit yield per plant than the best check NDT-4 (1.024) in case of indeterminate group. The genetic variability is the raw material in the plant breeding industry on which selection act to evolve superior genotypes. Thus, higher the amount of variation presents for a character in the breeding materials, greater the scope for its improvement through selection. The genotypic and phenotypic coefficients of variation were computed to assess the exiting variability in the germplasm (table 3). High magnitude of phenotypic as well as genotypic coefficients of variation were observed in case of fruit yield per plant followed by average fruit weight, number of locules per fruit, number of fruits per plant, plant height and number of primary branches per plant. This indicates possibility of obtaining higher selection response in respect of these six traits. The high estimates of PCV and GCV for these characters were also reported by Dar and Sharma (2011) and Rani & Anitha (2011). Moderate variations were noted in case of pericarp thickness, total soluble solids (TSS) and diameter of fruits. While, low GCV and PCV were observed for days to 50 per cent flowering. Moderate and low variability for these traits in tomato were also reported by Sahanur *et al.* (2012) and Madhurina and Paul (2012).

Heritability estimates the information which helps the breeders for selecting the genotypes for further use. Higher magnitude of heritability suggests the measure of genotypic factors in the expression of the characters. The highest estimates of heritability were observed in case of number of locules per fruit. High heritability and high genetic advance in per cent of mean were observed for most of traits except days to 50 per cent flowering. While highest genetic advance in per cent of mean was observed for fruit yield per plant. The high estimates of heritability, genetic advance and genetic advance in per cent of mean for these characters were also reported earlier by several workers (Joshi and Singh, 2003; Singh *et al.*, 2006; Maurya *et al.*, 2011 and Tasisa *et al.*, 2011).

The degree of success in selection depends upon the magnitude of the heritability value. Furthermore, the progress in the selection is also directly proportional to the amount of genetic advance. Therefore, the effect of

Table 2 : Mean performances of fifty genotypes of tomato.

Group	S. no.	Character / Genotypes	Days to 50 percent flowering	Plant height (cm)	No. of primary branches per plant	Fruit diametr (cm)	No. of locules per fruit	Pericarp thickness (mm)	Average fruit weight (g)	Total soluble solids (TSS)	No. of fruits per plant	Fruit yield per plant (kg)
Contd...	1.	NDT-442	56.66	54.53	4.00	6.70	4.86	4.06	42.80	4.58	21.35	0.41
	2.	NDT-443	55.33	66.73	5.40	6.75	6.26	3.86	40.86	5.80	39.40	0.59
	3.	NDT-444	57.00	55.86	3.80	5.23	3.60	3.80	27.66	5.92	32.80	0.55
	4.	NDT-445	55.33	70.33	5.46	6.20	2.86	4.00	31.53	6.15	40.56	0.75
	5.	NDT-446	56.33	59.46	5.20	5.51	3.13	3.86	38.93	5.33	43.66	0.69
	6.	NDT-447	56.66	38.66	4.00	5.15	2.46	4.06	24.13	5.83	35.91	0.47
	7.	NDT-448	58.66	45.26	2.80	6.01	2.86	4.33	37.86	6.48	24.20	0.44
	8.	NDT-449	62.33	74.80	5.00	6.88	5.06	3.33	31.86	5.84	23.20	0.47
	9.	NDT-450	61.66	59.53	3.60	6.13	3.86	3.40	29.80	6.62	26.60	0.41
	10.	NDT-451	57.66	72.26	4.60	5.97	2.60	3.86	42.53	4.18	45.06	0.85
	11.	NDT-452	55.00	58.13	3.40	6.18	5.93	4.53	40.46	6.44	35.60	0.5
	12.	NDT-453	58.66	54.00	5.20	6.03	2.80	3.60	32.66	6.77	41.73	0.69
	13.	NDT-454	55.66	67.53	5.33	6.60	3.86	3.53	41.13	5.77	41.93	0.89
	14.	NDT-455	56.33	56.06	4.86	6.21	2.86	4.53	41.66	5.18	50.13	0.75
	15.	NDT-456	56.66	50.06	2.40	5.45	3.80	3.20	19.86	4.34	26.66	0.42
	16.	NDT-457	57.33	80.80	3.60	5.80	3.86	4.00	37.00	6.20	25.51	0.58
	17.	NDT-458	60.33	67.66	4.86	6.61	5.46	4.73	34.93	5.48	29.66	0.55
	18.	NDT-459	56.66	56.33	3.80	6.62	5.20	2.26	42.86	6.11	40.26	0.43
	19.	NDT-460	57.33	65.06	3.80	6.46	4.33	3.60	34.46	4.32	36.60	0.65
	20.	NDT-461	61.66	61.53	3.60	6.29	2.33	3.86	37.40	6.35	29.79	0.47
	21.	NDT-462	56.66	68.06	3.80	5.46	2.13	4.40	40.46	5.65	47.33	0.73
	22.	NDT-463	55.66	48.40	3.53	6.31	3.73	3.86	40.86	4.47	23.60	0.50
	23.	NDT-464	59.33	53.46	3.40	5.88	3.06	3.80	31.13	4.51	39.60	0.65
	24.	NDT-465	59.00	35.10	4.00	7.45	3.73	2.73	36.73	4.92	33.60	0.36
	25.	NDT-466	58.66	37.60	3.20	6.07	3.66	3.20	29.20	5.62	28.73	0.44
	26.	NDT-467	59.33	32.80	2.60	4.86	2.86	3.60	23.46	6.35	31.53	0.43
	27.	NDT-468	60.33	67.80	3.40	5.08	3.86	2.66	41.13	5.21	40.46	0.39
	28.	NDT-6	58.66	65.60	4.33	7.40	5.80	3.40	45.86	6.12	30.40	0.50

Table 2 continued....

Table 2 continued....

Medium Duration	29.	NDT-7	56.66	63.60	5.33	7.40	5.66	3.80	54.46	5.68	42.13	1.14
	30.	Azad T-1	56.66	28.66	3.46	6.05	4.20	3.46	23.13	5.30	17.33	0.43
	31.	Azad T -6	56.33	42.20	3.60	6.07	5.73	3.86	28.53	5.39	28.66	0.52
	32.	Co-3	56.33	57.20	4.50	6.81	3.86	3.13	43.20	6.32	33.46	0.65
	33.	DMT-1	57.33	37.66	2.86	5.90	3.26	3.20	40.46	4.28	28.46	0.43
	34.	DVRT-1	57.66	64.06	3.86	6.40	4.40	3.33	40.66	5.80	30.28	0.47
	35.	Pb Chhuhara	61.33	38.13	3.00	4.64	3.20	2.53	20.66	4.55	24.20	0.33
	36.	Arka Ahuti	59.33	36.20	2.86	4.96	3.00	3.20	19.13	4.12	23.55	0.51
	37.	Arka Abha	56.00	66.06	5.00	5.38	3.13	2.53	33.33	6.08	26.51	0.41
	38.	H-86 (C)	57.66	74.53	4.13	6.97	3.60	3.00	67.93	5.74	37.13	0.68
	39.	H-24 (C)	55.00	49.40	4.80	6.71	3.60	3.40	37.26	6.11	36.61	0.66
	40.	NDT-8 (C)	54.66	54.80	3.60	8.03	5.26	3.40	63.33	6.16	25.53	0.55
Medium Early	41.	NDT-469	56.33	84.13	5.20	6.39	3.73	4.00	44.80	7.08	43.79	0.75
	42.	NDT-470	56.00	75.06	5.00	7.16	2.86	4.53	44.93	6.82	43.86	0.98
	43.	NDT-471	54.66	92.13	5.20	6.13	3.53	3.40	37.93	6.21	67.93	0.77
	44.	NDT-472	60.66	82.73	5.86	6.51	3.86	3.53	44.20	6.04	73.28	1.23
	45.	NDT-1	57.66	69.80	4.26	7.31	6.06	2.73	85.40	6.13	27.26	0.52
	46.	NDT-3	57.66	77.46	4.86	6.08	5.80	4.06	33.33	6.03	35.29	0.54
	47.	Angoor Lata	55.33	81.46	5.20	5.86	2.46	2.53	35.86	6.55	42.20	0.54
	48.	Pusa Rubi	57.66	75.93	5.93	6.01	4.86	3.66	31.60	6.61	42.88	0.54
	49.	HS-7	58.66	89.93	6.60	5.15	3.60	3.60	16.93	4.75	34.74	0.43
	50.	NDT-4 (C)	59.33	110.46	5.46	7.46	7.46	4.40	50.40	6.31	33.00	1.02
Mean			**57.600**	**61.503**	**4.272**	**6.217**	**4.002**	**3.589**	**37.937**	**5.695**	**35.281**	**0.598**
C.V.			**1.390**	**4.851**	**6.751**	**4.203**	**4.409**	**5.589**	**6.154**	**3.321**	**4.685**	**6.783**
SEM±			**0.462**	**1.722**	**0.166**	**0.150**	**0.101**	**0.115**	**1.348**	**0.109**	**0.954**	**0.023**
C.D. at 5%			**1.297**	**4.834**	**0.467**	**0.423**	**0.286**	**0.325**	**3.783**	**0.306**	**2.678**	**0.065**
Range (Lowest)			**54.666**	**28.666**	**2.400**	**4.643**	**2.133**	**2.266**	**16.933**	**4.123**	**17.333**	**0.334**
Range (Highest)			**62.333**	**110.46**	**6.600**	**8.033**	**7.466**	**4.73**	**85.400**	**7.083**	**73.280**	**1.230**

Table 3 : Estimates of range, grand mean, phenotypic (PCV), genotypic (GCV), environmental (ECV), coefficient of variation, heritability in broad sense, genetic advance (Ga) and Ga (in per cent of mean) for ten characters in tomato germplasm.

S. no.	Genetic parameters / Characters	Range		Grand mean	PCV	GCV	ECV	Heritability braod sense (%) (h^2_{bs})	Genetic advance	Genetic advance in per cent of mean
		Lowest	Highest							
1.	Days to 50 per cent flowering	54.66	62.33	57.60	3.58	3.29	1.39	84.88	3.60	6.25
2.	Plant height (cm)	28.66	110.46	61.50	28.01	27.59	4.85	97.00	34.42	55.97
3.	Number of primary branches per plant	2.40	6.60	4.27	23.51	22.52	6.75	91.75	1.90	44.43
4.	Fruit diameter (cm)	4.64	8.03	6.22	12.56	11.84	4.20	88.81	1.43	22.99
5.	Number of locules per fruit	2.13	7.46	4.00	30.55	30.23	4.41	97.92	2.47	61.62
6.	Pericarp thickness (mm)	2.26	4.73	3.59	16.82	15.86	5.59	88.96	1.11	30.82
7.	Average fruit weight (g)	16.93	85.40	37.94	32.43	31.84	6.15	96.40	24.43	64.40
8.	Total soluble solids (TSS)	4.12	7.08	5.70	14.02	13.62	3.32	94.39	1.55	27.27
9.	Number of fruits per plant	17.33	73.28	35.28	30.24	29.87	4.69	97.60	21.45	60.79
10.	Fruit yield per plant (kg)	0.33	1.23	0.60	33.61	32.92	6.78	95.93	0.40	66.42

selection is realized more quickly in those characters, which have high heritability as well as high genetic advance.

Perusal of data (table 3) on heritability and genetic advance revealed that high heritability coupled with high genetic advance (>15%) were recorded for plant height, average fruit weight and number of fruit per plant. Thus, these traits which exhibited high heritability in broad sense and high expected genetic advance as per cent of mean may be considered to be largely governed by additive gene action and therefore, could be effectively improved through selection. High heritability along with high genetic advance have also been reported for most of the yield and yield attributing traits by Mahesha *et al.* (2006), Kumari *et al.* (2007), Saeed *et al.* (2007), Prema *et al.* (2011), Tasisa *et al.* (2011), Madhurin and Paul (2012) and Sahanur *et al.* (2012).

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