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Assessment of genetic variation for growth and economic traits among the genotypes of tomato [*Solanum lycopersicum* (Mill.) Wettsd.]

Rohit Kumar Bajpai, GC Yadav, Vishal Tripathi, Devraj Singh and Prateek Kumar

Abstract
The present study was conducted with the objective to assess the extent of variability among the genotypes of tomato. The experimental material comprising forty six genotypes were evaluated during *Rabi* season of 2014-15. The experiment was conducted in randomized complete block design with three replications and observations were recorded on yield and quality attributes. The analysis of variance revealed that wide ranges of variation were found among the genotypes for all the traits. The estimates of phenotypic coefficients of variation (PCV) were higher than genotypic coefficients of variation (GCV) for all the characters. The estimates of high PCV as well as GCV were observed for number of locules per fruit (25.27 and 24.42) and plant height (21.12 and 20.66), while the high PCV (20.33) was noted for Pericarp thickness. High heritability coupled with high genetic advance in percent of mean was estimated for plant height (95.69 and 41.64), number of locules per fruit (78.67 and 40.96), primary branches per plant (80.67 and 29.73), number of fruits per plant (89.51 and 23.50) and fruit circumference (82.37 and 22.63), which showed ample scope of improvement in these traits through selection.

Keywords: Tomato, PCV, GCV, heritability and genetic advance

Introduction
Tomato (*Solanum lycopersicum* (Mill.) Wettsd.), 2n=2x=24 is one of the most versatile vegetable crop grown throughout the world because of its wider adaptability, high yielding potential and suitability for uses either fresh or processed as the consumers. The red pigment (lycopene) in tomato is now being considered as the world's most powerful natural antioxidant. Therefore, tomato is one of the most important "protective foods" because of its special nutritive value.

Keeping in 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 end use. A thorough knowledge regarding the amount of genetic variability existing for various characters is essential for initiating the crop improvement programme. May research workers such as Ahmed *et al.* (2006), Dhar and Sharma (2012) and Prema *et al.* (2011) also worked on the same theme? But the estimates of coefficients of variation, heritability and genetic advance varied with environmental situation and genetic materials used under study therefore, the present experiment was conducted with the objective to estimate the extent of variability present in the available germplasm and the degree of inheritance of the traits to adjudged the expected gain after selection.

Materials and Methods
The experiment was conducted during *Rabi*, 2014-2015 at Main Experiment Station, Department of Vegetable Science, Narendra Deva University of Agriculture and Technology Narendra Nagar (Kumarganj), Faizabad (U. P.). Geographically this area falls under humid sub-tropical climate and is located in between 24.47^0 and 26.56^0 N latitude and 82.12^0 and 83.98^0 E longitude at an altitude of 113 m above the mean sea level in the Genetic alluvial plains of Eastern Uttar Pradesh.

The experiment was laid out in Randomized Block Design with three replications to assess the performance of 46 genotypes of tomato including three check varieties H-24, H-86 and DVRT-2 taken from IIVR, Varanasi. Seed were sown in nursery bed on 07 October 2014 and 31 days old healthy seedling were transplanted in the experimental field on 07 November 2014 in two row of 4.5 m length with inter and intra row spacing of 60 cm x 45 cm respectively. Fertilizer @ 120kgN: 80kgP_2O_5: 50kg K_2O/ha were applied to the crop.

A light irrigation was given immediately after transplanting. All recommended cultural practices were followed to maintain good crop stand and growth of the plant.

The analysis of variance for the design of experiment was carried out according to the procedure outlined by Panse and Sukhatme (1967). The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were computed following Burton and De Vane (1953). Heritability in broad sense (h^2_{bs}) was calculated using the formula suggested by Burton and de Vane (1953). Genetic advance (Ga.) was estimated by the method suggested by Johnson *et al*. (1955).

Table1: Analysis of variance (mean sum of squares) for thirteen characters in tomato

S. No.	Characters	Source of variation		
		Replications	Treatments	Error
	d. f.	2	45	90
1.	Days to 50% flowering	1.24	9.70**	3.09
2.	Plant height (cm)	12.03	942.58**	13.92
3.	Primary branches per plant	0.16	0.925**	0.06
4.	Number of fruits per plant	12.97	171.96**	6.46
5.	Days to first fruit harvest	0.93	36.38**	12.26
6.	Average fruit weight (g)	2.18	67.75**	4.29
7.	Fruit circumference (cm)	0.26	9.86**	0.65
8.	Pericarp thickness(cm)	0.001	0.017**	0.002
9.	Number of locules per plant	0.21	2.14**	0.17
10.	TSS (%)	0.21	0.98**	0.17
11.	Fruit length (cm)	0.003	0.90**	0.10
12.	Harvesting duration	0.67	10.85**	4.24
13.	Fruits yield per plant (kg)	0.002	0.08**	0.01

Significant at 5% and 1% probability level, respectively.

Table 2: Estimates of range, grand mean, phenotypic and genotypic coefficients of variation, heritability in broad sense(h^2_{bs}) and genetic advance in per cent of mean (Ga) for 13 characters in tomato

S. No.	Characters	Range		Grand mean	P.CV. (%)	G.C.V. (%)	Heritability Broad Sense (%) (h^2_{bs})	Genetic Advance in per cent of mean(Ga)
		Lowest	Highest					
1.	Days to 50% flowering	58.33	67.66	61.97	3.71	2.39	41.53	3.18
2.	Plant height (cm)	59.06	141.93	85.15	21.12	20.66	95.69	41.64
3.	Primary branches per plant	1.86	4.73	3.32	17.89	16.07	80.67	29.73
4.	Number of fruits per plant	34.97	83.80	43.21	18.16	17.19	89.51	23.50
5.	Days to first fruit harvest	78.66	88.30	80.08	5.62	3.53	39.49	4.57
6.	Average fruit weight (g)	29.33	66.66	45.05	11.20	10.21	83.13	19.17
7.	Fruit circumference (cm)	10.86	17.86	14.47	13.33	12.10	82.37	22.63
8.	Pericarp thickness (cm)	0.32	0.63	0.42	20.33	16.86	68.77	28.80
9.	Number of locules per fruit	2.13	5.46	3.61	25.27	22.42	78.67	40.96
10.	TSS (%)	4.86	7.26	5.85	11.42	8.86	60.25	14.17
11.	Fruit length (cm)	6.20	8.66	6.97	8.73	7.39	71.76	12.90
12.	Harvest duration	19.00	26.33	21.86	11.61	6.79	34.16	8.70
13.	Fruits yield per plant (kg)	1.75	2.51	1.94	10.06	7.67	58.07	12.03

Results and Discussion

The analysis of variance for different characters is presented in Table-1. The mean sum of squares due to treatments was highly significant for all the traits. In other words, the differences among the performance of the genotypes with respect to these characters were statistically significant, suggesting that there is ample scope for selection in different traits for the improvement of tomato. Anupam *et al*. (2002), Mahesh *et al.* (2006), Kumara *et al.* (2007), Marim *et al.* (2009) and Shashikantha *et al.* (2010) also reported the high genetic variability among these traits.

The estimates of genetic variability, heritability and genetic advance had been presented in Table-2. Variability is a very important and essential pre-requisite in any breeding programme and such variability will be driving force for improving the crop plants. In general, the phenotypic coefficients of variation were higher than genotypic coefficients of variation for all the 13 characters under study which indicates that environment played a considerable role in the expression of these traits. The high estimates of PCV than GCV for these characters were also reported by Kumar *et al.* (2015). The range of variability of different traits alone does not allow a decision as to which character was showing the highest degree of variability. Therefore, accurate relative comparison can be made with the help of phenotypic and genotypic coefficients of variation. Phenotypic variation was partitioned into genotypic and environmental components.

The higher magnitude of coefficient of variation at phenotypic as well as genotypic levels was observed for number of locules per fruit (25.27 and 22.42) and plant height (21.12 and 20.66). Phenotypic variations were highest for pericarp thickness (20.33). Moderate estimates of PCV and GCV were observed for primary branches per plant (17.89 and 16.07), number of fruits per plant (18.16 and 17.19), fruit circumference (13.33 and 12.10) and average fruit weight (11.20 and 1021), TSS (11.42 and 8.86), harvesting duration (11.61 and 6.79) and fruit yield per plant (10.06 and 7.67). Mohanty (2003) have also reported similar results in their study. Low GCV and PCV were observed for days to 50 per cent flowering (3.74 and 2.39) and days to first fruit harvest (5.62 and 3.53). Madhurina (2012), Arya *et al.* (2009), Marim *et al*. (2009), Prema *et al*. (2011), Rani *et al*. (2011) and Dhar

and Sharma (2011) also reported similar result in their studies. Heritability in broad sense of a character is important to the breeder since it indicates the possibility and extent to which improvement is possible through selection. It also indicates direction of selection pressure to be applied for the traits during selection because it measures relationship between parent and their progeny, widely used in determining the degree to which a character may be transmitted from parent to offspring. However, high heritability alone is not enough to make efficient selection in advanced generations unless accompanied by substantial amount of genetic advance (Burton, 1952). High estimates of heritability along with high genetic advance provide good scope for further improvement in advance generations. The result of present investigation (Table-2) revealed that low to high heritability estimates were present in the characters. The heritability estimates for different characters ranged from 34.16 to 95.69 per cent. High heritability was recorded for plant height, number of fruits per plant, average fruit weight, primary branches per plant and number of locules per fruit. Whereas, fruit yield per plant (58.07%), fruit length (71.76%), pericarp thickness (68.77%) and TSS (60.25%), showed moderate level of heritability. Low heritability was recorded for harvest duration (34.16%), days to first fruit harvest (39.49%) and days to 50 per cent flowering (41.53%) indicated more influence of environmental effect which may be due to presence of non-additive gene action in expression of the character. It was obvious that improvement of the character exhibiting high heritability would be more efficient by adopting normal selection procedures and for those having lower value, some other suitable breeding techniques, like population improvement programme would have to be adopted.

The genetic advance is commonly predicted as a product of heritability ratio and selection differentials. Panse and Sukhatme (1967) mentioned that when high heritability value is accompanied by high genetic advance, then progress realized by selection would be most appropriate. In the present study, High heritability coupled with high genetic advance in per cent of mean was recorded for plant height (95.69 and 41.64), primary branches per plant (80.67 and 29.73), number of fruits per plant (89.51 and 23.50), fruit circumference (82.37 and 22.63) and number of locules per fruit (78.67 and 40.96), indicating that these traits were less influenced by environment and are governed by additive gene action which is fixable and heritable and hence selection for these traits will be responsible. Similar results were also reported by Pandit *et al*. (2010), Anupam *et al.* (2002), Ahmad *et al.* (2006) and Patel *et al.* (2015).

On the other hand, the traits namely average fruit weight, TSS, fruit length and fruit yield per plant which showed moderate genetic advance also revealed the additive gene action for these traits. Moderate heritability coupled with moderate genetic advance was recorded for TSS, fruit length and fruit yield per plant with revealed additive as well as dominance gene action for these traits. Low heritability associated with low genetic advance for days to 50% flowering, days to first fruit harvest and harvesting duration, revealed that non-additive gene action was prevailing for these characters and selection will be less effective for these traits.

On the bases of about it could be concluded that there exists ample variability among the availability germplasm for most of the traits. Further high heritability coaled with high genetic advance for the traits like plant height, primary branches per plant and number of locules will indicated the presence of additive gene action which is heritable and fixable and hence selection will be effective for these traits among the available germplasm.

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