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Variability, heritability and genetic advance for yield and quality traits in tomato (*Solanum lycopersicum* L.)

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Abstract
Studies on genetic variability in F_1 population of tomato along with their parents and standard checks showed that high PCV, GCV was noticed for the traits like plant height, average fruit weight, fruit yield per plant, number of locules per fruit, pericarp thickness, ascorbic acid content and lycopene content, indicating scope for selection. Association of high heritability with high genetic advance as per cent of mean were recorded for plant height, number of primary branches, number of fruits per cluster, fruit length, average fruit weight, fruit yield per plant, number of locules per fruit, pericarp thickness, titrable acidity, ascorbic acid content and lycopene content. It is indicated that additive gene effects were more important for these traits. Therefore improvement in these traits would be more effectively done through selection.

Keywords: Tomato, variability, PCV, GCV, genetic advance, F_1 generation

Introduction
Tomato (*Solanum lycopersicum* L.) is an important solanaceous vegetable grown round the year in many parts of the country for use as fresh vegetable and for processing. Tomato meant for processing should confirm to certain minimum standards of quality parameters (Thomson *et al*.) [10]. The effectiveness of selection is dependent upon nature and magnitude of the variability present in the material for the desired characters and the extent to which it is heritable. Burton *et al*. (1952) [2] suggested that genetic variation together with heritability estimates would give the best estimate of advance expected from selection. Johnson *et al.* (1955) [5] also reiterated the above fact and stressed the need for genetic advance to assess the maximum effect of selection. Since the heritable and non- heritable components of variance are important to assess the true breeding nature of a character, such information on heritability is a prerequisite for improving the trait and the productivity of the crop in general, through a planned breeding programme. An attempt is therefore made with the objective of estimating genetic variability, heritability and genetic advance for yield and quality traits in tomato.

Materials and Methods
The present experiment was carried out at the Vegetable Research Station, Dr. Y.S. R. Horticultural University, Rajendranagar, Hyderabad during 2010 – 2011. The experimental material comprised of 9 parents (6 lines and 3 testers), 18 F_1 hybrids and 3 standard checks (Lakshmi, US-618 and Arka vikas), raised in a randomized block design with three replications. Data on plant, flower and fruit characters were recorded on five randomly selected plants in case of parents, F_1 hybrids and standard checks. Genotypic and phenotypic coefficients of variation were calculated following the procedure of Burton and Devane (1953) [3]. Heritability in broad sense and genetic advance were estimated by the formulae suggested by Allard (1960) [1] and Johnson *et al.* (1955) [5] respectively. The characters studied were Plant height (cm), Number of primary branches per plant, Days to 50% flowering, Number of flowers per cluster, Number of fruits per cluster, Fruit length (cm), Fruit width (cm), Average fruit weight (g) Fruit yield per plant (kg), Number of locules per fruit, Pericarp thickness (mm), Total soluble solids (°Brix), Titrable acidity (%), Ascorbic acid content (mg 100 g^{-1}) and Lycopene content (mg 100 g^{-1}).

Results and Discussion
The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), heritability, genetic advance and genetic advance as per cent of mean were estimated for eighteen crosses along with their parents and standard checks. The results obtained for various characters are furnished in Table 1.

For plant height the estimates of genotypic and phenotypic coefficients of variation recorded high *i.e.* 20.09 and 23.84 respectively. The observed heritability for plant height was high (71) with high genetic advance as per cent of mean (34.88). These results are in accordance with the findings of Singh (2009) [9] in tomato. The observed genotypic and phenotypic coefficients of variation for number of primary branches per plant were moderate *i.e.* 12.95 and 14.31 respectively. Number of primary branches per plant recorded a high heritability of 82% and high genetic advance as per cent of mean of 24.13. Similar results were reported by Mehta and Asati (2008) [7] in tomato.

The genotypic and phenotypic coefficients of variation for days to 50% flowering were low *i.e.* 4.84 and 6.82 respectively. The heritability estimates for this character was moderate (50) with low genetic advance as per cent of mean (7.07). Similar findings were reported by Mehta and Asati (2008) [7] in tomato. The observed genotypic and phenotypic coefficients of variation for number of flowers per cluster were low (8.68) and moderate (10.02) respectively. This character recorded a high heritability of 75% and moderate genetic advance as per cent of mean of 15.47.

The genotypic and phenotypic coefficients of variation for number of fruits per cluster were moderate (18.22) and high (21.36) respectively. The character number of fruits per cluster recorded a high heritability of 73% and high genetic advance as per cent of mean (32.01).

The estimates of genotypic and phenotypic coefficients of variation recorded for fruit length (cm) were moderate *i.e.* 12.67 and 14.09, respectively. The observed heritability for this character was high (81) with high genetic advance as per cent of mean (23.47). These results are in accordance with the earlier findings of Golani *et al.* (2007) [4] in tomato.

The observed genotypic and phenotypic coefficients of variability for fruit width (cm) were low *i.e.* 9.09 and 9.88 respectively. This character recorded a high heritability of 85% and moderate genetic advance of 17.24.

The genotypic and phenotypic coefficients of variation for average fruit weight (g) were high *i.e.* 21.53 and 23.07, respectively. The observed heritability estimate was high (87) with high genetic advance as per cent of mean (41.41). Similar results were reported by Kumar and Thakur (2007) [6] in tomato.

For fruit yield per plant (kg) recorded high genetic (20.88) and phenotypic (22.25) coefficients of variation and also observed heritability estimate was high (88) and the genetic advance as per cent of mean was also high (40.35). This result is supported with the findings of Singh (2009) [9] in tomato.

Number of locules per fruit was expressed high genotypic and phenotypic coefficients of variation *i.e.* 20.31 and 22.04, respectively. The heritability estimate was high (85) with high genetic advance as per cent of mean (38.56). Similar results were observed by Golani *et al.* (2007) [4] in tomato. The estimates of genotypic (23.76) and phenotypic (25.19) coefficients of variation for pericarp thickness (mm) were found to be high. The heritability estimate was very high (89) with high genetic advance as per cent of mean (46.15). The present results are in line with the earlier reports of Kumar and Thakur (2007) [6] in tomato.

The estimates of genotypic and phenotypic coefficients of variation recorded for TSS (^{o}Brix) were low (9.64) and moderate (11.01), respectively. The observed heritability for this character was high (77) with moderate genetic advance as per cent of mean (17.40). The genotypic and phenotypic coefficients of variation for the titrable acidity (%) were moderate *i.e.* 13.92 and 17.31 respectively. The observed heritability estimate was high (65) with high advance as per cent of mean (23.06). Similar findings were reported by Mohan *et al.* (2007) [11] in tomato.

The observed genotypic and phenotypic coefficients of variation for ascorbic acid content (mg 100 g^{-1}) were high *i.e.* 26.91 and 28.60, respectively. This character recorded a high heritability of 89 and high genetic advance as per cent of mean of 52.17. The estimated genotypic and phenotypic coefficients of variation for lycopene content (mg 100 g^{-1}) were high *i.e.* 22.70 and 24.04, respectively. This character recorded a high heritability of 89 and high genetic advance as per cent of mean of 44.17. These results are in accordance with the findings of Nair and Thamburaj (1995) [8] in tomato.

Table 1: Estimates of genotypic and phenotypic coefficient of variation, heritability, genetic advance for different characters in tomato

S. No.	Characters	PCV (%)	GCV (%)	Heritability (Broad Sense) (%)	Genetic Advance (%)	GAM
1	Plant height (cm)	23.84	20.09	71	33.91	34.88
2	No. of primary branches/ plant	14.31	12.95	82	1.96	24.13
3	Days to 50% flowering	6.82	4.84	50	2.28	7.07
4	No. of flowers / cluster	10.02	8.68	75	0.83	15.47
5	No. of fruits / cluster	21.36	18.22	73	0.84	32.01
6	Fruit length (cm)	14.09	12.67	81	0.93	23.47
7	Fruit width (cm)	9.88	9.09	85	0.79	17.24
8	Avg. fruit wt. (g)	23.07	21.53	87	23.71	41.41
9	Fruit yield per plant (kg)	22.25	20.88	88	0.84	40.35
10	Number of locules per fruit	22.04	20.31	85	1.28	38.56
11	Pericarp thickness (mm)	25.19	23.76	89	2.10	46.15
12	TSS (^{o}Brix)	11.01	9.64	77	0.92	17.40
13	Titrable acidity (%)	17.31	13.92	65	0.10	23.06
14	Ascorbic acid (mg/100 g)	28.60	26.91	89	14.46	52.17
15	Lycopene (mg/100 g)	24.04	22.70	89	2.93	44.17

GAM = Genetic Advance as per cent of Mean.

In the present study, in general, phenotypic coefficients of variation (PCV) was higher than genotypic coefficient of variation (GCV) indicating the role of environment in the expression of genotypes. Among the yield, yield components and quality parameters plant height, average fruit weight, fruit yield per plant, number of locules per fruit, pericarp thickness, ascorbic acid content and lycopene content having high phenotypic and genotypic coefficients of variability. The

characters having high genotypic coefficient of variation possessed better potential for further gain and improvement through selection.

In the present experiment, among the yield, yield components and quality parameters high heritability coupled with high genetic advance as percent of mean was recorded for plant height, number of primary branches, number of fruits per cluster, fruit length, average fruit weight, fruit yield per plant, number of locules per fruit, pericarp thickness, titrable acidity, ascorbic acid content and lycopene content. It is indicated that additive gene effects were more important for these traits. Therefore improvement in these traits would be more effectively done through selection. High heritability and moderate genetic advance as percent of mean values were noticed for number of flowers per cluster, fruit width, TSS indicating non-additive gene action.

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