

## Estimation of Heritability and Genetic Advance for Quantitative Traits in Tomato (*Lycopersicon esculentum* Mill.)

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### Abstract

Genetic studies were conducted for yield and physiological traits in  $F_2$  generation involving six crosses. Among the progenies of six crosses studied in  $F_2$  generation high heritability, genetic advance as percent of mean was exhibited by the crosses  $CO\ 3 \times$  Arka Meghali and  $CO\ 3 \times$  CLN 1462 AG for plant height, flowering duration, number of fruits per plant, single fruit weight, style elongation, chlorophyll stability index, dry matter accumulation and fruit yield per plant. Based on the heritability the crosses,  $P_3 \times P_6$ ,  $P_4 \times P_5$  and  $P_3 \times P_4$  performed well in  $F_2$  generation for number of fruits per plant. The crosses  $P_3 \times P_4$  and  $P_4 \times P_8$  accounted the highest genetic advance as per cent of mean for fruit yield per plant.

**Key words :**  $F_2$  generation, Heritability, Genetic advance, Quantitative traits, Tomato.

Tomato (*Lycopersicon esculentum* Mill.) a solanaceous vegetable, widely grown throughout including the world India. Crop improvement of tomato is a continuous task since various production problems are eventually met with, especially when cultivation is taken up more as a commercial venture. Further, in any crop improvement program, it is obvious to have development of new varieties and hybrids with high productivity. The initial assessment of nature and magnitude of variability in the germplasm stock is one of the important pre-requisite for formulating effective breeding methods as the genetic improvement of any crop depends on the magnitude of variability and the extent of heritability of economically important characters. Hence, selection based on high heritability and genetic advance would be more useful for a successful breeding program. In the tropical plains where tomato is grown, temperature often rises above 34 C, which exceeds the optimum temperature for fruit set. In general the rise in night temperature (exceeding the temperature of 20 C) decreases fruit set and fruit size. Unfortunately, the minimum temperature of Tamil Nadu also, never falls below 20C during summer months. Hence

attempts were made in recent past to evolve a variety with potentiality of high yield and also tolerance for heat. Based on these objectives parents of heat tolerants were selected in this study.

### Methods

The present study on tomato (*Lycopersicon esculentum* Mill.) was carried out at the Agricultural College and Research Institute, Madurai during 2005-2006 involving  $F_2$  generation of six intervarietal crosses, with an aim to select the best crosses/families and promising progenies in each cross, for yield and physiological characters.

The experimental materials included were six crosses of  $F_2$  viz.,  $P_3 \times P_4$  ( $CO\ 3 \times$  Arka Meghali),  $P_3 \times P_6$  ( $CO\ 3 \times$  CLN 1462 AG),  $P_4 \times P_6$  (Arka Meghali  $\times$  CLN 1462 AG),  $P_4 \times P_5$  (Arka Meghali  $\times$  Paiyur 1),  $P_4 \times P_8$  (Arka Meghali  $\times$  H 24),  $P_5 \times P_8$  (Paiyur 1  $\times$  H 24) involving five parents viz.,  $P_3$  (CO 3),  $P_4$  (Arka Meghali),  $P_5$  (Paiyur 1),  $P_6$  (CLN 1462 AG) and  $P_8$  (H 24). The selfed seeds of  $F_1$  generation from the previous study conducted by Rahul Marik (1) were used raising the  $F_2$  progenies.

**Table 1.** Mean performance of parents involved in intervarietal crosses of tomato in  $F_2$  generation.

Parents	Plant height (cm)	Flowering duration (days)	Number of fruits/plant	Number of primary branches/plant	Single fruit weight (g)	Style length (mm)	Chlorophyll stability index (%)	Root length (cm)	Root : shoot ratio	Dry matter accumulation (g)	Fruit yield per plant (kg)
P <sub>3</sub> (CO 3)	54.89	56.60	35.32	13.99	35.12	6.42	67.00	11.45	0.35	48.38	1.17
P <sub>4</sub> (Arka Meghali)	54.34	53.56	29.65	10.82	51.69	8.10	67.53	12.89	0.28	41.44	1.47
P <sub>5</sub> (Paiyur 1)	49.96	54.67	32.45	11.61	34.84	6.44	73.95	14.70	0.37	38.45	1.08
P <sub>6</sub> (CLN 1462 AG)	56.46	59.38	50.97	13.25	18.75	5.64	72.92	16.20	0.36	44.73	1.09
P <sub>8</sub> (H 24)	50.35	53.98	31.96	13.79	33.11	6.77	69.69	15.50	0.28	39.86	1.12
Mean	53.23	55.63	36.07	12.69	34.70	6.67	70.21	14.14	0.32	42.57	1.18
SE	1.15	0.95	3.42	0.56	4.67	0.35	1.25	0.77	0.01	1.60	0.07

### Study of $F_2$ Generation

The  $F_2$  generation was raised during June—October, 2005. A total of 250 plants of each cross were maintained in all the six crosses. Forty plants in each of five parents involved in the above crosses were also maintained. The progenies were evaluated for 11 characters on single plant basis for yield and physiological contributions.

The selected  $F_2$  progenies were selfed with an idea of forwarding them to the next generation. Care was taken to maintain a healthy crop by adopting all the recommended cultural practices. Observations were recorded on single plant basis in  $F_2$  populations on plant height, number of primary branches

per plant, number of fruits per plant, single fruit weight, fruit yield per plant, flowering duration and physiological characters viz., style length, chlorophyll stability index, root length, dry matter accumulation, root/shoot ratio.

Heritability in the broad sense was estimated using the formula as suggested by Lush (2). Genetic advance (GA) for each character under this study was estimated by the formula given by Johnson et al. (3). Heritability and GA as per cent of mean classified into groups based on the classification given by Johnson et al. (3).

### Results and Discussion

The observations made on individual plants of

**Table 2.** Estimates of heritability and genetic advance in  $F_2$  generation of six intervarietal crosses of tomato for plant height (cm), flowering duration (days) and number of fruits/plant.

Crosses	Plant height (cm)		Flowering duration (days)			Number of fruits/plant			
	Heritability (percent)	Genetic advance	Genetic advance as percent of mean	Heritability (percent)	Genetic advance	Genetic advance as percent of mean	Heritability (percent)	Genetic advance	Genetic advance as percent of mean
P <sub>3</sub> × P <sub>4</sub>	92.73	27.13	39.06	98.07	12.09	33.95	97.56	13.07	38.44
P <sub>3</sub> × P <sub>6</sub>	78.06	7.41	15.1	99.7	31.15	59.21	99.53	27.57	61.89
P <sub>4</sub> × P <sub>6</sub>	97.37	18.07	26.56	98.81	14.12	31.79	4.8	0.11	0.99
P <sub>4</sub> × P <sub>5</sub>	80.02	5.99	11.39	98.54	14.94	38.03	97.61	12.29	38.73
P <sub>4</sub> × P <sub>8</sub>	88.57	6.8	13.26	59.89	1.8	3.52	1.86	0.032	13.46
P <sub>5</sub> × P <sub>8</sub>	82.28	5.35	10.8	91.15	5.82	11.03	87.85	3.95	14.56

**Table 3.** Estimates of heritability and genetic advance in F<sub>2</sub> generation of six intervarietal crosses of tomato for number of primary branches/plant, single fruit weight (g) and fruit yield/plant (kg).

Crosses	Number of primary branches/plant			Single fruit weight (g)		Fruit yield/plant (kg)			
	Heritability (percent)	Genetic advance	Genetic advance as percent of mean	Heritability (percent)	Genetic advance	Heritability (percent)	Genetic advance	Genetic advance as percent of mean	
P <sub>3</sub> × P <sub>4</sub>	88.61	3.5	25.77	97.54	14.45	33.46	95.88	1.06	70.02
P <sub>3</sub> × P <sub>6</sub>	91.83	4.23	33.48	91.42	5.78	26.05	86.69	0.61	46.71
P <sub>4</sub> × P <sub>6</sub>	99.64	23.51	69.52	92.38	6.43	16.39	83.37	0.71	39.82
P <sub>4</sub> × P <sub>5</sub>	63.85	1.4	12.67	99.48	27.9	75.46	92.74	0.5	44.52
P <sub>4</sub> × P <sub>8</sub>	52.3	0.94	8.93	99.5	26.55	67.75	97.99	0.9	65.92
P <sub>5</sub> × P <sub>8</sub>	68.83	1.64	15.06	95.4	7.72	24.33	72.93	0.27	30.75

F<sub>2</sub> generation of six crosses along with their five parents for 11 characters viz., plant height, flowering duration, number of fruits per plant, number of primary branches per plant, single fruit weight, style length, chlorophyll stability index, root length, root/shoot ratio, dry matter accumulation and fruit yield per plant were statistically analyzed. The results revealed that significant differences existed between the crosses (Tables 1 to 5). Hence, the experimental material offers excellent scope for further improvement through selection.

*Heritability and Genetic Advance*

The estimate of heritability measures ability of expression of trait. High genetic coefficient of variation alone will not form the basis for selection. Ac-

cording to Burton (4) heritability estimates also have a bearing on the population response to selection. However, the heritability indicates the effectiveness with which selection of genotype can be done based on the phenotypic performance, but it fails to indicate the genetic progress expected. Hence, the heritability along with the genetic advance is more reliable than heritability alone in predicting the selection advance (5). High estimates of heritability for certain traits suggest that they are under genetic control. High heritability was accompanied with high genetic gain indicates the predominance of additive gene components in controlling the expression of such characters. Therefore high heritability with high genetic advance as percent of mean serve as a meaningful criterion for selection.

In the present study heritability value was com-

**Table 4.** Estimates of heritability and genetic advance in F<sub>2</sub> generation of six intervarietal crosses of tomato for style length (mm), chlorophyll stability index and root length (cm).

Crosses	Style length (mm)			Chlorophyll stability index		Root length (cm)			
	Heritability (%)	Genetic advance	Genetic advance as percent of mean	Heritability (%)	Genetic advance	Heritability (%)	Genetic advance	Genetic advance as percent of mean	
P <sub>3</sub> × P <sub>4</sub>	97.14	2.36	34.09	96	8.15	11.42	72.22	2.38	18.3
P <sub>3</sub> × P <sub>6</sub>	95.81	0.91	14.08	97.04	8.93	13.38	97.39	10.77	36.98
P <sub>4</sub> × P <sub>6</sub>	91.86	1.14	17.63	85.34	4.96	7.66	82.36	3.54	25.38
P <sub>4</sub> × P <sub>5</sub>	91.1	1.28	19.51	75.61	2.46	3.87	86.21	3.88	27.88
P <sub>4</sub> × P <sub>8</sub>	92.55	1.21	18.56	92.81	5.7	8.51	82.13	3.07	24.65
P <sub>5</sub> × P <sub>8</sub>	98.84	1.69	26.26	97.59	10.83	16.04	89.72	3.78	26.13

**Table 5.** Estimates of heritability and genetic advance in  $F_2$  generation of six intervarietal crosses of tomato for root/shoot ratio and dry matter accumulation (g).

Crosses	Heritability (%)	Root/shoot ratio		Dry matter accumulation (g)		
		Genetic advance	Genetic advance as percent of mean	Heritability (%)	Genetic advance	Genetic advance as percent of mean
$P_3 \times P_4$	68.71	0.021	10.69	97.58	10.65	28.41
$P_3 \times P_6$	87.64	0.053	23.79	98.38	12.67	32.81
$P_4 \times P_6$	79.87	0.037	18.25	89.31	4.5	15.3
$P_4 \times P_5$	95.3	0.069	28.84	94.98	8.91	28.3
$P_4 \times P_8$	99.45	0.23	115.1	92.89	7.96	25.31
$P_5 \times P_8$	95.62	0.072	30.67	99.12	16.05	43.18

puted in broad sense in  $F_2$ . The heritability estimate of broad sense was high in  $F_2$  generation for all the characters except for number of fruits per plant in cross  $P_4 \times P_6$  and  $P_4 \times P_8$ . This is in consonance with Dudi et al. (6).

The estimate of high heritability does not always signify an increased genetic advance (3). In order to plan envisage the relative utility of genetic progress among fruit yield, its component genetic advance as percent of mean was computed. It was observed that the estimates of genetic advance as percent of mean in  $F_2$  generation were high for plant height in cross  $P_3 \times P_4$  and  $P_4 \times P_6$ ; for flowering duration in the cross  $P_3 \times P_6$  and  $P_4 \times P_5$ ; for number of fruits per plant in the cross  $P_3 \times P_4$ ,  $P_3 \times P_6$  and  $P_4 \times P_5$ ; for number of primary branches per plant in the cross  $P_3 \times P_6$  and  $P_4 \times P_6$ ; for single fruit weight in the crosses  $P_4 \times P_5$ ,  $P_4 \times P_8$  and  $P_3 \times P_4$ ; for dry matter accumulation in cross  $P_3 \times P_6$  and  $P_5 \times P_8$ .

The high estimates could be ascribed to additive genetic effect (7). These results are in consistency with findings of high genetic advance for plant height by Padmalatha and Reddy (8); for number of primary branches per plant by Joshi and Singh (9); for number of fruits per plant by Nandpuri et al. (10); for single fruit weight by Gadekar et al. (11); and for fruit yield per plant by Joshi et al. (12). Thus there is ample scope for improving these characters based on direct selection.

Further, the genetic advance expressed as percent of mean was high for fruit yield per plant in cross I and cross V. This should indicate genetic advance was a dependable, for selection in segregating population. This was also reported by Singh and Singh (13).

### Conclusion

All the six crosses for most of the characters observed high heritability except the character number of fruits per plant in the cross  $P_4 \times P_6$  (Arka Meghali  $\times$  CLN 1462 AG) and  $P_4 \times P_8$  (Arka Meghali  $\times$  H 24) where these two crosses registered low heritability. Most probably low genetic advance was observed in all the crosses for entire physiological trait and moderate genetic advance was recorded for flowering duration, number of fruits per plant and single fruit weight. Fruit yield per plant had the highest genetic advance as percent of mean for all the crosses.

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