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Short communication

Gene action in Tomato (*Lycopersicon esculentum* Mill) under open and protected environments

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Tomato (*Lycopersicon esculentum* Mill) is one of the most important vegetable grown world wide. Besides fresh consumption, tomato ranks first among processed vegetables in the world. There is tremendous scope for growing tomato in main as well as during off-season both under open as well as protected environments and at present it becomes a major cash crop of hill farmers in India. Hence, the present investigation was undertaken in 12 x 12 diallel cross set to gather genetic information on some of the important quantitative and qualitative traits and to suggest breeding approaches for developing specific genotypes suitable for cultivation under open and protected conditions.

Sixty six cross of tomato along with their parents viz; Azad T-2 (1), Pusa Ruby (2), DARL-64 (3), Hawaii-7998 (4), EC 386032 (5), EC 386037 (6), BL-342 (7), Sel-7 (8), EC386019 (9), EC386023 (10), Mani Thoiba (11), and Mani Leima (12) were evaluated in a randomized block design with three replications. The study was conducted at Defence Institute of Bio-Energy, Field Station, Pithoragarh during 2001-2003 under two environments i.e. open field and polyhouse conditions. Recommended package of practices were adopted during the cropping period. Observations were recorded on 5 randomly-selected plants per entry for yield per plant (kg), fruits per plant (nos.), fruit weight (g), early maturity (days), and plant height (cm). For ascorbic acid (mg/100g) determination, red ripened fruits were selected randomly, extracted with metaphosphoric acid and estimation was done by 2,6, dichloro-phenol indophenol, titration method (AOAC, 1990). Total soluble solids (%) of fruits were recorded with a hand refractometer calibrated in 0 brix and values were corrected at 20^0c. Lycopene content was estimated as per the method of (Ranganna, 1976) and genetic parameters by (Hayman, 1954).

Data depicted in Table 1 and 3 revealed that the additive genetic variance (D) had showed highly significant values for fruit weight, fruit maturity, plant height, ascorbic acid, lycopene content and total soluble solids under open conditions, however, fruit weight, fruit maturity and plant height under polyhouse environment, indicated that the additive gene effects played a major role in the inheritance of these characters. Significant dominance variance (H_1) for all traits under both the environments in F_1s indicated the importance of the gene action in the inheritance. H_2= H_1 [l-(u-v) 2], where u and v are the proportions of positive and negative genes, respectively in parents, had significant for all traits and smaller than the H_1 values under both environments for all traits indicated unequal allelic frequency in the parents. Higher values of H_1 and H_2 compared to D showed that non- additive gene effects had a greater role than additive gene effects in the genetic control which, also confirmed in earlier findings (Bhatt *et al*; 2001). The positive estimates of H_2 for all traits under both environments suggested that the dominant genes were in the favourable direction and the significant positive H_1 values confirmed the positive direction of dominance.

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Table 1: Estimates of genetic components in 12 x 12 diallel of tomato under open environment.

Characters	D (Additive)	H_1 (Dominance)	H_2 (Non-additive)	F	E
Yield/plant	0.08	0.79**	0.67**	0.12	0.01
	±0.06	±0.13	±0.11	±0.15	±0.06
Fruits/plant	207.72	1496.51 **	1250.83**	-336.86	8.22
	±210.82	±421.75	±350.82	±477.80	±58.47
Weight/fruit	180.05**	287.43**	222.64**	20.85	0.24
	±36.61	±73.24	±60.92	±82.97	±10.15
Maturity	22.05**	46.88**	34.87**	27.61*	6.22**
	±3.07	±6.14	±5.10	±6.95	±0.85
Plant height	541.11**	2692.92**	2483.20**	-188.43	3.44
	±119.83	±399.78	±332.55	±452.91	±55.42
Ascorbic acid	27.30**	116.11 **	91.88**	29.24	0.06
	±7.42	±14.85	±12.35	±16.82	±2.06
Lycopene	1.86**	9.20**	6.70**	3.93*	0.02
	±0.57	±1.15	±0.96	±1.30	±0.16
Total soluble solids	0.36**	2.29**	2.00**	0.60*	0.00
	±0.11	±0.22	±0.19	±0.25	±0.03

*, ** Significant at P=0.05, P=0.01 respectively

Table 2: Components ratio and heritability (ns)

Characters	$(H_1/D)^{1/2}$	$H_2/4H_1$	$4DH_1^{1/2}+F/4DH_1^{1/2}-F$= KD/KR	h^2/H_2	Heritability (ns) %
Yield/plant	3.22	0.21	1.63	0.34	9.83
Fruits/plant	2.68	0.21	0.53	0.35	10.02
Weight/fruit	1.26	0.19	1.09	0.16	40.23
Maturity	1.46	0.19	2.50	0.35	52.24
Plant height	2.23	0.23	0.85	0.08	15.74
Ascorbic acid	2.06	0.20	1.70	0.005	23.86
Lycopene	2.22	0.18	2.81	0.003	25.88
Total soluble solids	2.52	0.22	2.34	0.42	17.43

Table 3: Estimates of genetic components in 12 x 12 diallel in tomato under polyhouse environment.

Characters	D (Additive)	H_1 (Dominance)	H_2 (Non-additive)	F	E
Yield/Plant	0.12	1.55**	1.24**	0.12	0.01
	±0.13	±0.26	±0.22	±0.30	±0.04
Fruits/plant	810.67	3397.82**	2543.39**	-449.28	20.76
	±370.65	±741.50	±616.80	±840.46	±102.80
Weight/fruit	295.40**	238.40**	154.24**	92.39	0.13
	±20.58	±41.17	±34.24	±46.64	±5.71
Maturity	28.18**	37.69**	30.31 **	25.50**	0.30
	±2.45	±4.91	±4.08	±5.56	±0.68
Plant height	1008.41**	3964.06**	3376.88**	-548.55	15.57
	±282.96	±566.07	±470.87	±641.31	±78.48
Ascorbic acid	22.50	140.96**	114.02**	34.86	0.02
	±10.93	±21.87	±18.19	±24.77	±3.03
Lycopene	2.34	19.49**	17.30**	4.00	0.01
	±1.24	±2.47	±2.06	±2.80	±0.34
Total soluble solids	0.40	3.27**	3.23**	0.83	0.00
	±0.34	±0.49	±0.57	±0.78	±0.10

*, ** Significant at P=0.05, P=0.01 respectively

Table 4: Components ratio and heritability (ns)

Characters	$(H_1/D)^{1/2}$	$H_2/4H_1$	$4DH_1^{1/2}+F/$ $4DH_1^{1/2}-F=$ KD/KR	h^2/H_2	Heritability (ns) %
Yield/Plant	3.59	0.20	1.16	0.03	7.57
Fruits/plant	2.05	0.19	0.76	0.21	17.09
Weight/fruit	0.90	0.16	1.42	0.93	66.85
Maturity	1.16	0.20	2.28	0.92	67.77
Plant height	1.98	0.21	0.75	0.08	18.06
Ascorbic acid	2.50	0.20	1.01	0.09	17.48
Lycopene	2.88	0.22	1.89	0.002	13.12
Total soluble solids	3.04	0.22	2.03	0.32	12.13

The component ratio presented in Table 2 and 4 indicated that the average degree of dominance (H/D) over all loci was more than unity for all traits except fruit weight suggested the prevalence of over dominance. For fruit weight under polyhouse this value was less than unity, indicating complete or partial dominance. The F value was non-significant for most of the traits except maturity, lycopene and total soluble solids under open and for maturity under polyhouse environment indicated symmetrical distribution of dominant and recessive genes among parents. The F values were negative for fruits/plant, plant height both under open and polyhouse conditions signified prevalence of recessive alleles in parents, however (Bhutani, 1980 and 1983) found over dominance for lycopene content.

The $H_2/ 4H_1$ index estimates the frequency of positive and negative alleles showed dominance in parents. The index value was less than unity for all traits indicated unequal combinations of genes with positive and negative effect at loci exhibiting dominance among the parents. The ambi directional dominance effect and the uncorrelated distribution of genes among the parents may be one of the causes for low estimate of this ratio for the traits (Mather & Jinks, 1971). The proportion of the KD/KR ratio that represents dominant and recessive genes in parents was found greater than unity except fruits/plant, plant height indicated an excess of dominant than recessive genes among the parents.

Low heritability (narrow sense) was recorded for yield per plant (9.83,7.57), fruits per plant (10.02,17.09), plant height (15.74,18.06), ascorbic acid (23.86,17.48), lycopene (25.88,13.12) and total soluble solids (17.43,12.13) under open field and polyhouse environments, respectively. However moderate or high heritability and was recorded for fruit weight (40.23,66.85), maturity (52.24,67.77).

Components analysis has indicated that yield and its related important components were largely controlled by non-additive variances under open and polyhouse environment, hence heterosis breeding can be used efficiently to improve yield coupled with quality, similar to the findings of (Roopa *et al*; 2001 and Kumar *et al;* 1997). Majority of the traits exhibited low heritability values with preponderance of dominant effects, also suggested the heterotic breeding in present materials. These results also confirmed the major contribution of non-additive gene action and influence of environmental variation in the expression of the traits studied. Characters had high heritability can be improved by simple selection procedures (Singh *et al;* 2002).

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