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J. Bangladesh Agril. Univ. 13(1): 65–69, 2015 **ISSN 1810-3030**

Variability and inter relationship studies in tomato (*Solanum lycopersicum* L.)

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Abstract

Twenty parental genotypes of tomato were planted and observed of yield and yield attributing traits to measure genetic variability, character association and path coefficient analysis. Parent TM 371 ranked first with respect to yield (4.73 kg fruit yield per plant) followed by TM 390. In terms of average fruit weight TM 390 also was better performer. Analysis of variance for each trait showed significant differences among the genotypes. High genotypic and phenotypic coefficients of variation were recorded for fruits per plant, locule number per fruit and fruit yield per plant. Heritability was observed high for flowers per cluster, fruits per plant, fruit weight and fruit length. fruit per plant (52.30), followed by fruit weight (46.32).High heritability associated with high genetic advance was observed for fruits per plant (52.30) and fruit weight (46.32) and flower per cluster (33.50). Selection for such traits might be effective for the fruit yield improvement of tomato. Significant positive genotypic and phenotypic correlation was observed of fruits per plant, fruit weight, fruit diameter and locule number per fruit with fruit yield per plant indicated that selection strategies must be focus on these traits. Fruit diameter showed the highest positive direct effect (3.25) on fruit yield per plant followed by fruits per plant (1.54). Direct selection may be executed considering these traits as the main selection criteria to reduce indirect effect of the other characters during the development of high yielding tomato variety.

Keywords: Variability, Correlation, Genetic advance, Heritability

Introduction

Tomato is one of the most important and popular winter vegetable in Bangladesh. Tomato is an introduced crop in Bangladesh and provides less genetic variability. It is estimated that the genomes of tomato cultivars contain <5% of the genetic variation of their wild relatives. Since the 20th century, human beings have created a huge array of morphologically different cultivars and forms from the single species *S. lycopersicum* via plant breeding. Through domestication, research and breeding activities that were implemented by scientists and breeders worldwide, modern tomato varieties (mostly hybrids) have been developed with all shapes, colors and sizes.

(Bai and Lindhot, 2007). In Bangladesh most of the tomato varieties are of inbred type, those are low yielder. Average yield of tomato is very low (7.51 t/ha) in Bangladesh compared to other tropical countries (15.1 t/ha in India) in the world (Anon, 2004).

Variability in tomato is expected to be immense as the fruits vary greatly in shape and size (Dixit and Dubey, 1985; Bhardwaj and Sharma, 2005). Studies on genetic parameters and character associations provide to select and help to develop optimum breeding procedure. Many researchers (Kamruzzahan *et al*., 2000) have reported different genetic parameters in tomato based on few traits. As yield is the main object of a breeder, it is important to know the relationship between various characters that have direct and indirect effect on yield. The degree of relationship or association of these characters with yield can be ascertained by correlation studies. This would aid in formulating an efficient breeding program for improving the yield potential via its components (Frageria and Kokli, 1997). Considering all the facts described above the present investigation was undertaken with the following objectives: (1) To estimate genetic variability of inbreed parental lines(2) To study the character association and (3) To study path coefficient analysis showing direct and indirect effects

Materials and Methods

Twenty genotypes of tomato comprising fifteen female and five male parents were evaluated in RCBD in three replications during Rabi season 2012at Research & Development Farm of Energypac Agro Ltd., Gazipur. The observations were taken on ten competitive plants from each replicationfor days to 50% flowering, flowers per cluster, fruits per cluster, fruits per plant, plant height, fruit weight, fruit length, fruit diameter, pericarp thickness, locule number and fruit yield per plant. The collected pool data were subjected for statistical analysis as per the methodof Panse and Sukhatme (1978). Genotypic and phenotypic coefficient of variances (GCV &PCV) was calculated according to Burton and De Vane (1953). Heritability and genetic advance were calculated according to Hanson *et al.* (1956) and Johnson *et al.* (1955), respectively. The correlation coefficient was estimated according to formulae of Al-Jibouri *et al.* (1958).

Results and Discussion

Twenty genotypes of tomato were evaluated for eleven yield and yield contributing characters to work out the extent of variability, correlation, heritability and genetic gain (Table 1). Parent TM 371 ranked 1stwith 4.73 kg fruit yield per plant followed byTM 390. In terms of fruit weight, parents TM 390 was better having average fruit weight of 121.63g TM 392, TM 422, TM 409 and TM 419 were other varieties having fruit weight in the desirable range.

Table 1. Phenotypic attributes of tomato varieties

Genotypes	D50%F	FPC	FRPC	FPP	PH (cm)	FW (g)	FL (cm)	FD (cm)	PT (mm)	LN	FYP (Kg)	Rank
Female												
TM 356	54.33	6.72	4.73	29.66	114.33	63.19	4.56	5.47	6.83	2.67	1.84	XIX
TM 361	61.66	6.82	5.08	58.66	118.33	53.89	4.33	4.57	6.83	2.00	3.62	IV
TM 368	54.33	6.02	4.62	43.66	78.00	83.80	5.43	6.63	8.00	3.67	4.25	III
TM 371	57.66	5.19	4.16	59.66	81.33	89.91	5.43	6.00	6.97	4.33	4.73	I
TM 377	62.33	5.10	4.55	32.33	67.67	65.96	5.23	5.40	7.00	2.33	2.12	XVIII
TM 382	57.00	5.29	4.01	36.67	97.00	89.53	5.06	6.27	7.00	4.33	3.25	XI
TM 384	56.33	7.73	6.10	36.67	78.33	73.04	5.66	5.33	7.00	2.67	2.67	XV
TM 388	62.00	5.43	4.05	39.67	88.67	85.25	5.40	5.70	7.33	3.00	3.54	VI
TM 390	59.66	4.66	3.83	35.33	68.33	121.63	5.23	6.40	7.13	4.33	4.44	II
TM 392	56.33	4.64	4.32	28.67	71.67	115.72	5.63	6.27	6.33	3.67	3.50	VIII
TM 410	68.33	5.79	4.90	41.33	97.67	83.16	5.40	5.77	6.67	3.00	3.40	X
TM 419	56.00	6.41	5.08	23.33	76.67	95.33	5.63	5.77	7.33	4.00	2.21	XVI
TM 422	63.33	4.04	2.54	33.33	125.33	102.24	5.46	5.93	7.83	3.33	3.44	IX
TM 423	60.66	5.76	3.59	41.00	102.33	71.99	5.06	6.20	6.50	5.33	3.23	XII
TM 360	64.66	6.50	4.60	41.33	88.67	76.76	4.66	5.10	7.67	3.67	3.21	XIII
Male												
TM 349	60.00	6.36	3.93	40.33	61.33	77.26	5.80	4.93	9.90	2.00	3.13	XIV
TM 528	62.00	8.21	6.44	29.67	85.67	75.00	5.93	5.33	8.67	2.00	2.17	XVII
TM 403	53.00	4.41	3.86	75.33	88.33	49.00	5.23	4.40	6.33	2.67	3.57	V
TM 386	70.00	7.13	4.28	33.00	91.00	39.36	6.26	4.03	6.77	2.00	1.29	XX
TM 409	59.66	6.54	5.01	37.00	75.33	100.76	7.26	5.33	7.33	2.67	3.51	VII

Analysis of variance indicated that highly significant variation was observed among the studied parental lines(Table 2). Range indicating high variability for fruits per plant, plant height, fruit weight and fruit yield per plant. High genotypic and phenotypic coefficients of variation were recorded for fruits per plant, locule number per fruit and fruit yield per plant. Heritability was observed high for flowers per cluster, fruits per plant, fruit weight and fruit length. High heritability associated with high genetic advance was observed for fruits per plant (52.30) and fruit weight (46.32) and flower per cluster (33.50). Mohanty (2003)reported high genotypic coefficient of variation and heritability in 18 tomato varieties. Vikram and Kohli (1998) in their study on 25 tomato genotypes recorded high heritability and genetic advance for mean fruit weight and suggested that improvement for fruit weight is possible by simple selection method. Similar results were also reported by Singh and Narayan (2004) in an investigation conducted on 10 tomato varieties.

Table 2. Estimation of genetic parameters in eleven characters of 20 genotypes in tomato

Parameters	Range	Mean	MS	CV (%)	PCV	GCV	ECV	Heritability	Genetic advance (5%)	Genetic advance (% mean)
D50%F	50.00-72.00	59.96	61.54**	5.67	8.86	6.81	5.67	59.03	6.46	10.77
FPC	3.67-9.13	5.94	3.71**	8.71	20.04	18.04	8.72	81.08	1.99	33.50
FRPC	2.33-6.67	4.48	2.20**	12.45	21.65	17.71	12.45	66.92	1.34	29.91
FPP	18.00-84.00	39.83	446.26**	16.38	33.41	29.12	16.38	75.97	20.83	52.30
PH	59.00-159.00	87.80	901.06**	13.37	22.56	18.17	13.37	64.86	26.46	30.14
FW	37.10-131.30	80.64	1315.58**	12.16	27.80	25.00	12.16	80.86	37.35	46.32
FL	4.20-7.60	5.43	1.18**	4.11	12.05	11.32	4.11	88.35	1.19	21.92
FD	3.80-7.80	5.54	1.44**	9.17	14.59	11.35	9.17	60.48	1.01	18.23
PT	5.50-10.00	7.27	2.14**	9.92	14.16	10.11	9.92	50.96	1.08	14.86
LN	2.00-6.00	3.18	2.75**	24.14	35.97	26.67	24.14	54.98	1.30	40.88
FYP	1.00-5.80	3.16	2.31**	19.47	32.03	25.42	19.48	63.00	1.31	41.46

**, * Correlation is significant at the 0.01 and 0.05 level, respectively.

MS = mean sum of square, CV (%) = Coefficient of variation, PCV = Phenotypic Coefficient of Variation, GCV= Genotypic Coefficient of Variation and ECV= Environmental Coefficient of Variation, D50%F= Days to 50% flowering, FPC= Flower per luster, FRPC= Fruit per cluster, FPP= Fruit per plant, PH= Plant height (cm), FW=Fruit weight (g), FL=Fruit length (cm), FD= Fruit diameter (cm), PT= Pericarp thickness (mm), LN = Locule number per fruit and FYP= Fruit yield per plant (Kg).

Character association: Association analysis for five yield-contributing attributes revealed that genotypic correlations were higher than phenotypic correlations in general (Table 3). Similar findings were reported by Yadav and Singh (1998) in a study on 28 tomato varieties stated that genotypic correlations were higher than phenotypic correlations. Days to 50% flowering showed negative relationship with fruit diameter at both genotypic and phenotypic level and significantly negative phenotypic correlation with locule number. Flower per cluster was significantly and positively associated with fruits per cluster but negative significantly associated with fruit weight, fruit diameter and locule number per fruit. Highly significant negative correlation was observed of fruits per plant with fruit weight at both levels. Plant height had significantly negative correlation with fruit length at both level and significant genotypic correlation with fruit weight and pericarp thickness but non-significantly positive correlation with fruits per plant. Significant positive relationship was observed fruit weight with fruit diameter and locule number per fruit. Fruit diameter has positive significant association with locule number per fruit. Significant negative relationship of pericarp thickness with locule number per fruit. Finally fruit yield was positively significant associated with fruits per plant, fruit weight, fruit diameter and locule number per fruit. Similar result shave also been reported by Agong *et al*. (2008),Haydar *et al*. (2007), Mohanty (2003), Harer *et al.*(2003), Mohanty (2002a), Mohanty (2002b) intomato.

Path Coefficient Analysis: Fruit diameter showed the highest positive direct effect (3.25) on fruit yield per plant followed by fruits per plant (1.54) (Table 4). Days to 50% flowering also showed positive direct effect on fruit yield per plant. On the other hand, negative direct effect on yield per plant showed by fruit weight, locule number per fruit and flower per cluster. Fruits per plant, fruit weight, fruit diameter and locule number per fruit showed significant positive genotypic correlation with fruit yield per plant. The highest indirect effect of fruit weight was observed with fruit diameter. The characters showing high direct effect on yield per plant indicated that direct selection for these traits might be effective and there is a possibility of improving yield per plant through selection based on these characters. Similar results have also been reported by Dhankar *et al*. (2001), Verma and Sarnaik (2000), Mageswari *et al*. (1999), Prasad and Rai (1999), Yadav and Singh (1998), Singh *et al*. (1997).

Table 3. Genotypic (G)and phenotypic (P) correlation coefficients among different pairs of yield and yield contributing characters for different genotype of mustard

Characters		FPC	FRPC	FPP	PH	FW	FL	FD	PT	LN	FYP
D50%F	G	0.226	-0.078	-0.213	0.247	-0.216	0.147	-0.364**	0.097	-0.352**	-0.313*
	P	0.084	-0.032	-0.172	0.134	-0.165	0.126	-0.286*	0.047	-0.158	-0.207
FPC	G		0.930**	-0.270*	-0.063	-0.480**	0.197	-0.475**	0.344**	-0.520**	-0.637**
	P		0.645**	-0.221	0.028	-0.343**	0.184	-0.312*	0.251	-0.387**	-0.394**
FRPC	G			-0.231	-0.260*	-0.227	0.174	-0.238	0.064	-0.503**	-0.413**
	P			-0.115	-0.198	-0.173	0.168	-0.171	0.106	-0.302*	-0.270*
FPP	G				0.156	-0.383**	-0.292*	-0.363**	-0.276*	-0.035	0.528**
	P				0.124	-0.373**	-0.234	-0.249	-0.129	-0.032	0.529**
PH	G					-0.376**	-0.533**	-0.161	-0.331**	0.050	-0.216
	P					-0.179	-0.360**	-0.043	-0.228	-0.040	0.053
FW	G						0.245	0.861**	0.165	0.614**	0.551**
	P						0.183	0.644**	0.033	0.426**	0.494**
FL	G							-0.138	0.251	-0.258*	-0.134
	P							-0.028	0.216	-0.185	-0.098
FD	G								-0.050	0.849**	0.583**
	P								-0.026	0.635**	0.393**
PT	G									-0.314*	-0.042
	P									-0.303*	-0.005
LN	G										0.612**
	P										0.330*

Table 3. Path coefficient analysis showing direct and indirect effects of different characters on yield of mustard

Characters	Direct effect	D50%F	FPC	FRPC	FPP	PH	FW	FL	FD	PT	LN	Genotypic correlation with yield
D50%F	0.53	-	-0.06	-0.01	-0.33	0.00	0.30	0.11	-1.18	0.03	0.30	-0.313*
FPC	-0.27	0.12	-	0.10	-0.41	0.00	0.66	0.15	-1.55	0.12	0.44	-0.637**
FRPC	0.11	-0.04	-0.25	-	-0.35	0.00	0.31	0.13	-0.77	0.02	0.43	-0.413**
FPP	1.54	-0.11	0.07	-0.03	-	0.00	0.53	-0.22	-1.18	-0.10	0.03	0.528**
PH	-0.01	0.13	0.02	-0.03	0.24	-	0.52	-0.40	-0.52	-0.12	-0.04	-0.216
FW	-1.38	-0.11	0.13	-0.03	-0.59	0.01	-	0.18	2.80	0.06	-0.52	0.551**
FL	0.74	0.08	-0.05	0.02	-0.45	0.01	-0.34	-	-0.45	0.09	0.22	-0.134
FD	3.25	-0.19	0.13	-0.03	-0.56	0.00	-1.19	-0.10	-	-0.02	-0.72	0.583**
PT	0.35	0.05	-0.09	0.01	-0.42	0.00	-0.23	0.19	-0.16	-	0.27	-0.042
LN	-0.85	-0.19	0.14	-0.06	-0.05	0.00	-0.85	-0.19	2.76	-0.11	-	0.612**

Residual effect: 0.423
* = Significant at 5%
** = Significant at 1%.

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