



Variability and Character Association in F₂ Segregating Population of Different Commercial Hybrids of Tomato (*Solanum lycopersicum* L.)

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ABSTRACT: The F₂ segregating generations of exotic tomato hybrids were studied to measure variability, character association and path coefficient analysis. Analysis of variance for each trait showed significant differences among the genotypes. Very little differences were observed between phenotypic coefficients of variation (PCV) and genotypic coefficients of variation (GCV) for the traits days to first flowering (pcv=9.21, gcv=7.82), fruit length (pcv=17.14, gcv=14.84) and fruit diameter (pcv=17.10, gcv=14.92). High heritability (>50%) was observed for all the yield contributing characters except flowers per cluster (47.83%). High heritability associated with high genetic advance was observed for fruit clusters per plant (105.11), fruits per plant (103.43), branches per plant (34.49), fruits per cluster (47.43), individual fruit weight (77.73) and fruit yield per plant (108.25). Selection for such traits might be effective for the fruit yield improvement of tomato. Significant positive genotypic and phenotypic correlation was observed between plant height at first flowering, flowers per plant, fruits per cluster, fruit clusters per plant, fruits per plant with fruit yield per plant. Fruits per plant showed the highest positive direct effect (1.096) on fruit yield per plant followed by individual fruits per plant (0.674). 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. @ JASEM

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 (Annon., 2004). Very recently exotic hybrid varieties are being introduced due to their high yield potentiality. Seed costs of those hybrid varieties are very high. Moreover, due to unique nature of hybrid variety, the tomato growers need to buy seeds every year. The local cultivars of tomato are more or less susceptible to *Fusarium sp.*, *Ralstonia solanacearum*, Leaf Curl Virus and Leaf Yellowing Virus. Due to infestation of these pathogens singly or simultaneously, yield decreases in some degrees (Opena *et al.*, 1990).

In the past, very little efforts have been taken for development of inbred lines of tomato through the exploitation of genetic variability present in the exotic hybrids. F₂ generation obtained from the selfing of F₁ hybrid provides all possible variations. So selection with particular objectives in F₂ generation is very much effective and selfing of those selected genotypes generation after generation helps to develop inbred lines (similar to the parental lines of the exotic hybrids). These inbreds with desired

characters including high yield potential can be used as High Yielding Variety (HYV) as well as the parents for hybrid variety. To increase the genetic yield potential, the maximum utilization of the desirable characters for synthesizing of any ideal genotypes is essential. 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 in the first segregating generation obtained from the exotic hybrids, (2) To develop inbred lines with high yield potential and tolerant to wilts and viruses AND (3) To study the character association.

MATERIALS AND METHODS

The experiment was conducted at the experimental field, Department of Genetics and Plant Breeding, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur during the winter season (September'07 to March'08) on an upland soil. The location of the site is the center of Madhupur Tract (24^o 05' N latitude and 90^o 25' E longitudes) characterized by more or less rainfall free during October to February and heavy rainfall during

the month from May to September with an elevation of 8.4 meter from the sea level. The soils of BSMRAU farm belongs to Salna series of Shallow Red-Brown Terrace soil type (Brammer, 1971; Shaheed, 1984) with silty clay in surface and silty clay loam in sub-surface region. The soil was silty clay loam with pH 6.5, CEC 25.58 and C:N ratio 10:3. Seeds of first segregating generation of 40 exotic tomato hybrids were used as experimental materials. Supreme Seed Company (Bangladesh) Ltd tested field performance of 40 hybrid varieties of

tomato collected from exotic sources. F₂ seeds of each hybrid were collected from that trial. The hybrids were Abhiruchi-1, Abhiruchi-3, Abhiruchi-4, Abhiruchi-6, Abhiruchi-9, Abhiruchi-10, Udayan Plus, Udayan, Unnayan, Aradhana, New Improve Aditi, Winall-01, Winall-06, Sonali, IHT, PS-058, WHT-03, WHT-04, PS-052, PS-053, PS-059, PS-060, Epoch, Mintoo, Deepam, TyKing-5, Bankim-206, Supera, Noven, Indian-531, Nidhi, TyQueen, Akash, TH-10, Disha, Jamuna, Alpona, Ruchi, TyRex, Hanyest Grace-02.

Table 1. Genetic parameters for 12 yield contributing characters in F₂ segregating population of exotic tomato hybrids

Characters	Range	Mean	σ^2_g	σ^2_p	GCV	PCV	h^2_b	GA	GA (%Mean)
Days to first flowering	33.00 - 52.00	42.38	10.99	15.24	7.82	9.21	72.14	13.69	32.29
Plant height at first flowering (cm)	22.74 - 68.50	41.28	26.20	51.30	12.40	17.35	51.08	18.26	44.22
Branches per plant (no.)	5.00 - 22.00	11.27	5.96	9.99	21.68	28.06	59.68	34.49	306.20
Flowers per cluster (no.)	4.00 - 11.00	6.66	0.80	1.66	13.39	19.35	47.83	19.07	286.18
Flowers per plant (no.)	60.00 - 544.00	189.92	3697.10	6671.93	32.02	43.01	55.41	49.10	25.85
Fruits per cluster (no.)	1.00 - 5.07	2.72	0.64	1.03	29.29	37.26	61.80	47.43	1741.86
Fruit clusters per plant (no.)	1.67 - 31.00	10.98	40.82	53.05	58.17	66.31	76.95	105.11	957.00
Fruits per plant (no.)	11.86 - 114.00	38.42	484.48	630.92	57.30	65.38	76.79	103.43	269.23
Fruit length (mm)	32.00 - 77.90	49.50	54.00	72.01	14.84	17.14	74.97	26.48	53.49
Fruit diameter (mm)	32.00 - 80.65	49.05	53.58	70.32	14.92	17.10	76.20	26.84	54.72
Individual fruit weight (g)	22.13 - 230.80	69.96	942.37	1274.32	43.88	51.03	73.95	77.73	111.11
Fruit yield per plant (Kg)	0.64 - 9.11	2.70	2.65	3.50	60.39	69.40	75.71	108.25	4016.15

Seeds of experimental materials were sown in the tray on 08.10.2007, 15 days old seedlings were transplanted in the poly bag and after another 15 days seedlings were transplanted in the field. The experiment was conducted using the Randomized Complete Block Design (RCBD) with three replications. The genotypes were grown in a single row where row to row distance was 70 cm and plant to plant distance was 50cm. Each row consisted of ten plants. No pesticides were applied in the experimental plots. Data were recorded on Days to First Flowering (DFF), Plant Height at First Flowering (PHFF), Branches Per Plant (BPP), Flowers Per Cluster (FPC), Flowers Per Plant (FPP), Fruits Per Cluster (FrPC), Fruit Clusters Per Plant (FCPP), Fruits Per Plant (FrPP), Fruit Length (FL), Fruit Diameter (FD), Individual Fruit Weight (IFW) and Fruit Yield Per Plant from all the plants in each genotype. Genotypic and phenotypic co-efficient of variation was calculated according to Burton (1952). Broad sense heritability was estimated (defined by Lush, 1949) by the formula, suggested by Hanson *et al.* (1956) and Johnson *et al.* (1955). The expected genetic advance for different characters under selection was estimated

using the formula suggested by Lush (1949) and Johnson *et al.* (1955). For calculating the genotypic and phenotypic correlation coefficient for all possible combination the formula suggested by Johnson *et al.* (1955) and Hanson *et al.* (1956) were adopted. Correlation coefficient were further partitioned into components of direct and indirect effects by path coefficient analysis originally developed by Wright (1921) and later described by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The estimates of range, mean, genotypic (σ^2_g) and phenotypic (σ^2_p) variance, genotypic (GCV) and phenotypic (PCV) coefficients of variation, heritability (h^2_b) and genetic advance (GA) as percentage of mean for 12 characters are presented in Table 1. The range of variation was much pronounced in most of the characters. The phenotypic variance and phenotypic coefficient of variation were higher than genotypic variance and genotypic coefficient of variation, respectively for most of the yield contributing characters studied except days to first flowering, fruit length and fruit diameter. The results indicated that most of the yield attributes were

under the influence of environment. High heritability (>50%) was observed for all the yield contributing characters except flowers per cluster. The high heritability coupled with high genetic advance in percent mean was observed for fruit clusters per plant, fruits per plant, branches per plant, fruits per cluster, individual fruit weight and yield per plant suggested that effective selection may be done for these characters. Similar results have also been reported by Haydar *et al.* (2007), Mariame *et al.* (2003), Singh *et al.* (2002), Bharti *et al.* (2002), Pradeepkumar *et al.* (2001), Prasad and Rai (1999), Phookan *et al.* (1998), Padmini and Vadivel (1997), Singh *et al.* (1997), Pujari *et al.* (1995), Mishra and Mishra (1995).

Correlation Coefficient Analysis: Significant positive genotypic and phenotypic correlation was observed between flowers per cluster and flowers per plant, flowers per plant and fruit clusters per plant, fruits per cluster and fruit clusters per plant, fruits per cluster and fruits per plant, fruits per cluster and fruit yield per plant, fruit clusters per plant and fruits per plant, fruit clusters per plant and fruit yield per plant, fruits per plant and fruit yield per plant, fruit length and individual fruit weight, and fruit diameter and individual fruit weight. Plant height at first flowering showed significant and positive correlation with fruit clusters per plant, fruits per plant, yield per plant; branches per plant with flowers per plant; flowers per plant with fruits per plant and fruit yield per plant. Significant negative genotypic correlation was observed between flowers per cluster and fruit diameter, and flowers per cluster and individual fruit weight. Flowers per plant also showed significant and negative correlation with individual fruit weight. Days to first flowering showed significant positive

genotypic correlation with flowers per plant; plant height at first flowering with flowers per plant; and fruits per cluster with fruit diameter. Similar results have also been reported by Agong *et al.* (2008), Haydar *et al.* (2007), Mohanty (2003), Harer *et al.* (2003), Mohanty (2002a), Mohanty (2002b) in tomato.

Path Coefficient Analysis: Fruits per plant showed the highest positive direct effect (1.096) on fruit yield per plant (Table 2). Flowers per plant also showed positive direct effect on fruit yield per plant. On the other hand, negative direct effect on yield per plant showed by flowers per cluster, fruit clusters per plant, and fruit diameter, where fruits per cluster and individual fruit weight showed positive direct effect. Days to first flowering, plant height at first flowering, branches per plant and fruit length showed negative direct effect on yield per plant. Plant height at first flowering, fruits per cluster, fruit clusters per plant, flowers per plant and fruits per plant showed significant positive genotypic correlation with yield per plant. The highest indirect effect of fruits per plant was observed with fruit clusters per plant. 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. Residual effect was 0.231, which was contributed by characters not used in path analysis. 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) and Linda and Scott, 1992.

Table 2. Partitioning the genotypic correlation into direct (bold) and indirect effects of 11 characters on yield per plant in F₂ segregating population of 40 exotic tomato hybrids

Character	DDF	PHFF	BPP	FPC	FPP	FrPC	FCPP	FrPP	FL	FD	IFW	r _g
DDF	-0.017	0.000	-0.002	-0.002	0.114	-0.128	0.062	-0.064	0.013	0.076	-0.016	0.035
PHFF	-0.002	-0.003	-0.002	-0.014	0.122	0.112	-0.280	0.553	0.083	0.052	-0.131	0.489**
BPP	-0.002	0.000	-0.017	-0.020	0.173	0.029	-0.125	0.281	0.008	0.023	-0.069	0.281
FPC	0.000	0.000	-0.002	-0.138	0.133	0.074	-0.028	0.086	-0.003	0.182	-0.291	0.011
FPP	-0.006	-0.001	-0.008	-0.052	0.352	0.043	-0.205	0.380	0.056	0.168	-0.336	0.391*
FrPC	0.004	-0.001	-0.001	-0.021	0.032	0.483	-0.437	0.882	-0.021	-0.151	0.038	0.807**
FCPP	0.002	-0.002	-0.004	-0.007	0.131	0.382	-0.552	1.060	0.044	-0.041	-0.070	0.944**
FrPP	0.001	-0.002	-0.004	-0.011	0.122	0.388	-0.534	1.096	0.040	-0.060	-0.038	0.999**
FL	0.001	0.001	0.001	-0.002	-0.077	0.040	0.096	-0.170	-0.256	-0.236	0.447	-0.157
FD	0.003	0.000	0.001	0.056	-0.132	0.162	-0.050	0.145	-0.135	-0.449	0.608	0.210
IFW	0.000	0.001	0.002	0.060	-0.175	0.027	0.057	-0.061	-0.170	-0.405	0.674	0.009

DDF= Days to first flowering, PHFF= Plant height at first flowering (cm), BPP= Branches per plant (no.), FPC= Flowers per cluster (no.), FPP= Flowers per plant (no.), FrPC= Fruits per cluster (no.), FCPP= Fruit clusters per plant (no.), FrPP= Fruits per plant (no.), FL= Fruit length (mm), FD= Fruit diameter (mm), IFW= Individual fruit weight (g)
Residual effect: 0.231, ** and * - significant at 1% and 5% level of probability, respectively.

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