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ESTIMATE OF HETEROSIS IN TOMATO *(Solanum lycopersicum* L.)

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Abstract

A study was conducted to estimate heterosis of 21 tomato cross combinations involving seven parents at the experimental field of Olericulture Division of HRC, BARI during the winter season of 2005-2006. Analysis of variance indicated highly significant differences for all the characters suggesting the presence of genetic variability among the studied materials. Three combinations (P2 × P3, P3 × P4, P3 × P5) showed significant early flowering, while two P1 × P7 (16.67%) and P1 × P2 (12.44%) for individual fruit weight. In the study, the cross combinations P4 × P7 (62.31%), P2 × P6 (37.44%), P4 × P6 (34.77%), P2 × P7 (33.67%), P3 × P7 (32.09%), and P3 × P4 (29.82%) manifested higher heterosis over better parent for yield per plant.

Keywords: Heterosis, tomato, genetic variability.

Introduction

Tomato *(Solanum lycopersicum* L.) is one of the most important vegetables of Bangladesh. But it's national average yield is 6.6 tons/ha which is very low compared to that in other countries. It is reported that heterosis in tomato resulted in increased yield of 20 to 50% (Chowdhury *et al.*, 1965). Tesi *et al.* (1970) reported that apart from high total yield the F_1 hybrid has specific advantage of higher early yield, number of fruits, fruit size, improved quality, uniformity, and adaptation to adverse conditions. It is further mentioned that exploitation of hybrid vigour in tomato is economical because each fruit contains larger number of seeds as compared to other vegetables. Now a days, farmers of Bangladesh is very much inclined to grow hybrid variety for having high yielding and to get early harvest (short duration) and good quality fruit. But there is lacking of good hybrid. So, development of hybrid variety of tomato is needed to support farmer's interest. Therefore, the study was undertaken to estimate the heterosis in tomato inbreds for development of hybrid varieties.

Materials and Method

The experiment was carried out at the experimental field of Olericulture Division of HRC, BARI during winter season of 2005-2006. Seven parents along with their 21 crosses were seeded in the seedbed on 20 October 2005. Thirty days old seedlings were transplanted in the main plot on 20 November 2005. The experiment was laid out in RCB design with three replications having plot size of

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4.0 sq m providing a spacing of 60 × 40 cm on 1 m wide bed. Data on days to 50% flowering, plant height at last harvest (cm), fruits per cluster, fruits per plant, individual fruit weight (g), yield per plant (kg), fruit length (cm), fruit breadth (cm), brix %**,** locule per fruit were recorded. The collected data were statistically analyzed. The significance of increase or decrease in F_1 hybrids over their corresponding better parent were tested by comparing their means with the help of appropriate standard error values in percentage. For estimation of heterosis in each character, the mean values of the 21 F_1s have been compared with better parent (BP).

Results and Discussions

Analysis of variance for genotypes i.e. parents and crosses showed highly significant differences for all the characters studied (Table 1). The estimates of percent heterosis observed in F_1 generation over better parent is presented in Table 2 and discussed character wise.

Table 1. Analysis of variance for 10 quantitative characters in tomato.

Source of variation	d.f.	Mean sum of square				
		Days to 50% flowering	Plant height at last harvest (cm)	Fruits/ cluster	Fruits/ plant	Individual fruit wt (g)
Blocks	2	16.75	89.69	0.79	18.62	19.60
Genotypes (Parents & F_1s)	27	32.45**	2273.06**	3.59**	739.48**	210.50**
Error	54	1.98	48.94	0.47	18.83	4.69

Table 1 Contd.

Source of variation	d.f.	Mean sum of square				
		Yield/ plant (kg)	Fruit length (cm)	Fruit breadth (cm)	Brix %	Locule/ fruit
Blocks	2	44238.84	0.09	0.42	0.39	4.40
Genotypes (Parents & F_1s)	27	96749.00**	1.53**	1.09**	0.52**	123.73**
Error	54	14849.05	0.06	0.16	0.03	8.90

** Significant at 1% level of probability.

Days to 50% flowering

No cross combinations showed significant negative heterosis among 21 combinations, but only three combinations (P2 × P3, P3 × P4, P3 × P5) showed simple negative heterosis (Table 2). Ahmed *et al.* (1988) and Singh and Singh (1993) also reported negative heterosis for days to flowering over the better parent in many of the hybrids in their diallel progenies.

Plant height at last harvest (cm)

It is evident from the Table 2 that better parent heterosis for plant height was significant and positive in 16 crosses. Range of positive heterosis was 0.70 to 70.16 percent, while the highest positive heterosis percent were observed in the cross P1 × P2 followed by P1 × P4. Ahmed *et al.* (1988) also reported that most hybrids in their study showed positive heterosis over the better parent for plant height in tomato.

Fruits per cluster

Eight crosses showed significant positive better parent heterosis for fruits per cluster while highest heterosis was 23.73 percent and lowest was 1.33 percent. All other combinations except P1 × P3 (0.00) showed significant negative heterosis over better parents. El-Ahmadi and Stevens (1979) reported that mean of all F_1s was lower than the mean of the parents in respect of fruits per cluster.

Fruits per plant

More than 50% of the cross combinations studied showed significant positive better parent for heterosis fruit number per plant. The range of positive heterosis for the trait was 3.76 to 83.88 percent over better parent. Maximum positive heterosis was observed in the cross P4 × P7 (83.88 percent). More than 30 percent heterosis over better parent was observed in 4 crosses viz., P2 × P6, P3 × P4, P3 × P5, P4× P7. Similar findings for higher fruit number per plant were reported by Legon *et al.* (1984) and Jamwal *et al.* (1984).

Individual fruit weight (g)

Positive better parent heterosis was observed in only 3 combinations, while 2 crosses showed significant positive heterosis for this trait. Percent positive heterosis ranged from 4.76 to 16.67. Highest positive heterosis exhibited in the cross P1 × P7, while lowest was in P1 × P6. Heterosis for the trait fruit weight was reported by many authors as Scott *et al.* (1986).

Yield per plant (kg)

Eleven cross combinations exhibited significant positive heterosis for yield per plant over better parent. Whereas, percent of positive heterosis ranged from 0.56 to 62.31 percent. Highest significant positive heterosis were found in cross P4 × P7 followed by P2 × P6 (37.44). More than 25% heterosis over better parent was observed in 6 combinations for yield per plant viz., P2 × P6 (37.44), P2 × P7

(33.67), P3 × P4 (29.82), P3 × P7 (32.09), P4 × P6 (34.77), P4 × P7 (62.31). Sidhu and Singh (1993) reported 71.7% heterobeltiosis for yield per plant. Singh and Singh (1993) and Ahmed *et al.* (1988) also reported heterosis over better parent in yield per plant or total yield in tomato.

Table 2. Percent heterosis of 2l tomato hybrids over better parent.

Crosses	Days to 50% flowering	Plant height at last harvest (cm)	Fruits/ cluster	Fruits/plant	Individual fruit wt (g)
PI × P2	14.28**	70.16**	-15.28**	-22.61**	12.44**
P1 × P3	0.00	59.10**	0.00	-8.27**	-30.95**
P1 × P4	374**	65.05**	1.39**	-22.89**	-30.47**
P1 × P5	16.0**	53.10**	-9.72**	-26.32**	-11.43**
PI × P6	345*	33.72**	-4.17**	-12.83**	4.76
P1 × P7	0.00	60.08**	1.39**	-10.56**	16.67**
P2 × P3	-2.00	13.75**	-13.33**	l0.98**	-34.67**
P2 × P4	1.90	ll.14**	-3.39**	12.80**	-33.33**
P2 × P5	12.0**	16.83**	18.46**	0.31	-l5.55**
P2 × P6	10.48**	47.01**	20.69**	45.28**	-6.67
P2 × P7	6.67**	33.l1**	2.99**	29.04**	-11.11**
P3 × P4	-2.00	-10.40**	-5.33**	36.09**	-4.17
P3 × P5	-2.00	-7.84	-5.33**	38.05**	-45.0**
P3 × P6	0.00	25.49**	-6.67**	3.76*	-10.81**
P3 × P7	0.00	0.72	1.33**	26.92**	-5.08
P4 × P5	7.00**	-11.14**	-6.15*	17.32**	-27.I**
P4 × P6	4.67**	22.81**	23.73**	23.64**	-13.51**
P4 × P7	4.67**	8.92**	19.40**	83.88**	-19.77**
PS × P6	20.0**	-6.22*	4.61**	-17.96**	-2.4
P5 × P7	20.0**	28.16**	1l.94**	-2.63*	-24.5**
P6 × P7	3.45*	9.44**	20.90**	-1.65	-2.16
Heterosis mean	5.82	24.90	0.41	9.64	-14.04
SE	1.445	2.818	0.495	1.542	4.105
LSD (0.05)	2.461	4.799	0.843	2.626	6.990
LSD (0.01)	3.573	6.970	1.225	3.813	10.151

* Significant at *5%* level of probability; * * Significant at 1% level of probability.

Fruit length (cm)

All the cross combinations studied showed significant positive heterosis in fruit length. The range of positive heterosis for the trait was 0.56 (P6 × P7) to 24.1l (P3 × P4) percent over better parent. More than 20 percent heterosis over better parent was observed only in 3 crosses viz., P2 × P3 (22.71), P3 × P4 (24.11), and P3 × P7 (23.01). Scott *et al.* (1986) reported heterosis over better parent for fruit size in few cases in tomato.

Fruit diameter (cm)

In case of fruit diameter, about 50% combinations (10 crosses) exhibited significant positive heterosis over better parent. Percent positive heterosis ranged from 0.53 to 15.49 percent with the highest value in the cross P1 × P2 followed by P3 X P6 (8.70). Alverez (1985) reported an evaluation trial of tomato hybrids in summer where he also found heterosis in equatorial diameter in the majority of cases.

Table 2. Cont'd.

Crosses	Yield per plant (kg)	Fruit length (cm)	Fruit breadth (cm)	Brix %	Locule per fruit
PI × P2	-12.48**	2.46**	15.49**	14.39**	27.5**
P1 × P3	0.68**	11.24**	-8.45**	-33.81**	-5.41**
P1 × P4	-15.07**	12.86**	-7.75**	-11.51**	-16.22**
P1 × P5	-30.88**	3.75**	-2.59**	10.07**	5.41**
P1 × P6	4.73**	6.77**	2.64**	24.70**	13.51**
PI × P7	23.88**	5.01**	8.10**	31.89**	10.81**
P2 × P3	-7.18**	22.71**	-9.01**	-9.66**	-15.00**
P2 × P4	-3.76**	12.50**	-11.48**	-24.30**	-22.50**
P2 × P5	-2.82**	8.45**	-2.93**	8.10**	7.50**
P2 × P6	37.44**	7.39**	1.94**	6.22**	0.00
P2 × P7	33.67**	11.79**	0.53*	16.26**	7.50**
P3 × P4	29.82**	24.11**	1.49**	-7.87**	-11.11**
P3 × P5	-21.79**	7.36**	17.93**	14.18**	-8.11**
P3 × P6	17.49**	11.28**	8.70**	9.95**	11.11**
P3 × P7	32.09**	23.01**	4.61**	-41.87**	13.89**
P4 × P5	-11.44**	12.14**	10.69**	3.93**	-18.92**
P4 × P6	34.77**	4.28**	0.62**	17.91**	-3.85**
P4 × P7	62.31**	10.18**	-12.36**	4.19**	-25.00**
PS × P6	-19.28**	5.45**	0.86**	20.65**	13.5 1**
P5 × P7	-25.55**	11.13**	-7.09**	13.30**	5.41**
P6 × P7	0.56**	0.56**	0.55*	13.05**	-6.25**
Heterosis mean	6.06	10.21	-2.57	3.80	-0.77
SE	0.162	0.222	0.232	0.302	0.266
LSD(0.05)	0.276	0.379	0.396	0.515	0.452
LSD(0.01)	0.401	0.550	0.575	0.748	0.657

***** Significant at *5%* level of probability; *** *** Significant at 1% level of probability.

Brix percent

Fifteen F_1s out of 21 crosses showed significant positive heterosis ranging from 3.93 to 31.89 percent. Highest positive heterosis was observed in the cross P1 X P7 followed by P1 × P6 (24.70), P5 × P6 (20.65). Higher brix percent is responsible for sweetness of tomato.

Locule per fruit

Out of 21 cross combinations, about 50% combinations (10 crosses) showed significant positive heterosis over better parent. Percent heterosis (positive) ranged from 5.41 to 27.5 percent. Maximum percent positive heterosis was observed in P1 × P2 followed by that in P3 × P7 (13.89) P1 × P6, P5 × P6 (13.51). Higher heterosis percent is responsible for less water content in tomato. Singh and Singh (1993) also reported heterosis for the number of branches per plant over the better parent in tomato.

The results of Table 2 as discussed in detailed that there was considerable heterosis for almost all the 10 characters studied. It also indicated the possibility of increasing yield by exploiting heterosis. The presence of high heterosis indicated genetic diversity between parents. Therefore, with increased diversity between parental stocks of genotypes, higher level of heterosis is expected in F_1 hybrid.

Dharmegowda (1977) observed that the increase in yields of hybrids was mainly due to fruit number and weight, while Balamohan *et al.* (1983) reported that heterosis in yield was attributed to increase in number of branches, fruit number, and length. In this study, maximum heterosis was observed in P1 × P7, P2 × P6, P2 × P7, P3 × P7, P4 × P6, and P4 × P7 in case of yield per plant, which was more or less same to fruits per plant. So it could be concluded that higher percent of heterosis was not responsible to only fruit length or fruit diameter, but also responsible to higher percent heterosis for number of fruits per plant. In the study, the cross combination P4 × P7 (62.31%), P2 × P6 (37.44%), P4 × P6 (34.77%), P2 × P7 (33.67%), P3 × P7 (32.09%) and P3 × P4 (29.82%) manifested the higher heterosis over better parent for yield per plant.

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