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THE UTILIZATION OF HETEROSIS IN THE BREEDING OF TOMATO

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ABSTRACT

After being self pollinated up to the (S_4) generation , two tomato cultivars , spread in Egyptian agriculture i,e Money Maker and Super Marmand were crossed with three imported hybrids i,e TY 70, Facolta 38 and G.S 12 . The parents and the F,, made including reciprocals were transplanted on the third of March (2004) at the Farm of El.Kassasin. Hort. Res. Station. Ismailia Governorate. A complete randomized block design with three replicates was used to performe the yeilding pofntial and some quality traits. The following results were recorded

1- The yield of TY 70 & Facolta 38 was extremely high and was found to be two times as high as the level of production in Super Marmand. Moreover, the behavior of number of flowers per plant recorded the same trend. Thus these hybrids might be imported for direct cultivation of high yielding tomato production inspite of their highest cost.
2- Total soluble solids and ascorbic acid traits showed insignificant differences for all the genotypes
3- The crosses made between the (S_4) of Money Maker & Super Marmand and the imported hybrids were superior with highly significances for number of flowers and total yield per plant.
4- The best combinations having more than 90 flowers per plant and the yield exceeded six kg per plant that were identified as the crosses involving Money Maker as a male or female parent.
5- An extremely high levels of heterosis for total yield reached in some instances , more than 50% above the better parent" the three imported hybrids ". This was attributed to the possible effect of some adaptability genes inherited by the F, hybrids from ihe cultivars spread and considered as local in Egyptian agriculture. Thus, seeds of the foreign hybrids could be imported in lesser quantities and can be utilized in the production of cheeper local hybrid seeds when crossed with Money Maker and Super Marmand.

INTRODUCTION

Tomato, *lycopersicon esculantum* , as a vegetable crop, ranks the first position among vegetables and solanaceae family .Improvement of the agronomic and quality traits of the cultivated tomato varieties can be achieved either through conventional breeding methods including various crossing and selection or in hybrid programs. Many developed countries are now superior in producing high yielding Fj hybrids having higher qualities. Our steps in this scale are quite limited in Egypt, thus , it is the time to be or .not be in producing such hybrid varieties . The constant increase in the cultivated area of tomato requires either to import big quantities of the hybrid seeds or to produce them

The success in growing them under local conditions may be of many hazard or restrictions owing to the lack of knowledge to their special

requirements and their adaptation in their field . Another explanation is the initial high costs of the imported hybrid seeds.

In view of the above mentioned situation, the present investigation aims to study the possibility of making use of some known commercial hybrids in developing one or more varietal hybrids that can be produced locally . This would make it possible to produce hybrids at cheeper coasts . Thus number of the imported hybrids was crossed with fourth selfed pollination generation of two cultivars , spread in Egyptian agriculture , Money Maker and Super Marmand . such situation indicates tiiat, we can reduce the imported Ft seeds to the limit sufficient to make crossing onfy. Many investigators utilized with hybridization to improve the agronomic and quality traits in tomato (Alice *et al.*(2001), Bahatt *et al.*(2001), El.Ghareeb *el al* (2004) and El.Ghareeb(2005).

MATERIALS AND METHODS

The present investigation was conducted at the Experimental Farm of El.kassasin Research . Station. Esmailia Governorate.Firstly, two cultivars , Money Maker and Super Marmend were self pollinated to obtain the fourth selfed generation (S_4) .Secondly: the previous (S_4) of such two cultivars was crossed to the three improted hybrids i,e : TY 70 , Facolta 38 and G.S 12 as follows

I- Money Maker * Super Marmand	2- Super MarmandxMoney Maker
3- Money Maker * TY 70	4- TY 70 x Money Maker
5- Money Maker * Facolta 38	6- Facolta 38 * Money Maker
7- Money Maker « G.S.12	8- G.S. 12 *Money Maker
9- Super Marmand * TY 70	10- TY 70 * Super Marmand
I1-Super Marmand* Facolta 38	12-Facolta 38*Super Marmand
13- Super Marmand x G.S.12	14-G.S.12' Super Marmand

In the third of March(2004), transplants of the parents and the $Fi_{,s}$ were grown in hills (35 cm apart) using a complete randomized block design with three replicates . Irrigation system was used . where each line was ten meters in length for each genotype in each replicate and one meter in width . All agricultural practices were carried out according to the guidance of Ministry of Agriculture in Egypt The following date were recorded :

1 - Number of flowers per plant.
2- Fruit weight (g $_s$*).*
3- Total yield per plant (kg).
4- Totai soluble solids (T.S.S) using a hand refractometer .
5- Ascorbic acid : was measured as mg per 100 gram of fruit juice of the parents and the **Fl,s** using the titration method.

Data were statistically analysed following Senedecor and Cochran (1982) method . The differences between means were compared using L.S.D procedure Heterosis

The previous data were used to estimate heterosis over mid and better parent according the formulaes a dopted by Bhatt (1971) as follow:

$$\text{Heterosis over mid parent} = \frac{F_1 - M.P}{M.P} \times 100$$

$$\text{Heterosis over the better parent} = \frac{F_1 - B.P}{B.P} \times 100$$

RESUITS AND DISCUSSION

Performance of some agronomic and quality traits for the (S_4) of Money Maker & Super Marmand and three imported hybrids as well as the possible combinations derived from them are presented in Table(l) . It's clearly observed that there were significant and highly significant differences between the three imported hybrid varieties i ,e TY 70 , Facolta38 G.S 12 as compared with the(S_4> of Money Maker and Super Marmand, for number of flowers, fruit weight and total yield (Vidyasagar *et a!* 1997, Shrivastava 1998 , Sing *et a!* 1998 , Wang *et at* 1998 , Mageswari & Natrajan 1999 and Kurian *et at* 2001) recorded the same trend of results.

Table (1): Mean values of some agronomic and qualitv traits for the Parents and their F_1, s

Genotypes	N. of flowers/ plant	Fruit weight (g)	Total yield/ plant(kg)	Total soluble Sclids (T.S.S)	Ascorbic acid (mg)
Money Maker	53.13	60.33	2.83	4.50	22.86
Super Marmand	40.19	105.22	2.07	4.47	23.01
TY70	75.32	100.20	4.11	4.53	23.07
Facolta 38	80.27	138.50	4.07	4.46	22.93
G.S12	70.02	100.60	3.88	4.48	22.88
Money Maker * Super Marmand	73.70	80.66	4.08	4.51	22.90
Super Mannand x Money Maker	70.83	80.36	4.03	4.39	23.02
Money Makerx TY70	100.29	95.	6.86	4.48	23.03
TY70x MoneyMaker	96.13	96.32	6.79	4.45	23.01
Money Makerx Facolta38	93.16	120.50	6.12	4.52	22.87
Facolta38 * MoneyMaker	91.78	118.26	6.08	4.57	22.95
MoneyMaker *x* GS.12	93.90	90.73	6.17	4.60	22.87
GS.12 * MoneyMaker	91.15	90.12	6.01	4.52	23.05
Super Mannand xTY70	85.70	120.30	5.67	4.57	23.05
TY70 x Super Marmand	83.20	117.90	5.55	4.44	23.02
Super Mannand x Facolta38	88.36	125.25	5.46	4.63	22.98
Facolta38 x Super Marmand	89.11	123.67	5.60	4.57	22.88
SuperMarmand *x* GS.12	85.63	110.41	5.53	4.36	22.83
GS.12 xSuper Mannand	86.00	107.66	5.73	4.43	23.03
L.S-D at 0-05	5.07	7.33	0.70	N.S	N.S
L.S-D at 0-01	6.33	9.62	0.83	N.S	N.S

Concerning the crosses made between the (S_4) of Money Maker & Super Marmand with the three imported hybrids, it can be seen that a

tremendous increase in number of flowers, fruit weight and total yield per plant, was obtained in ihe Fj generation for all crosses. Thus . it can be noticed, that the crosses involved Money Maker as one of the parents were superior having more than 6 kgs for total yield per plant trait , followed by other crosses involved Super Marmand cultivar.. Generally all the crosses exceeded significantly all the imported hybird varieties and (S_4) of Money Maker & Super Marmand , for number of flowers and total yield per plant . Moreover the similarity in the behavior of the F|, $_s$ and their reciprocal forms was observed. Amer *et a!* (1999) in peas , surjan *et a!* (1999) Kurian *et al.*(2001) , and El. Ghareeb (2005) in tomato , recorded the same trend . Reverse results were obtained for total soluble solids and ascorbic acid content, where all the crosses made scored insignificant values.

To discuss how this study was undertaker to elucidate the manifestation of utilizing heterosis in breeding of tomato , we can record that these imported hybrids ie, TY 70 , Facolta 38 and G.S 12 are commercial hybrid varieties in their countries and no information could be obtained about the parents development ;Irrespective of whether Ihe parents of these imported hybrids are inbred lines or any other breeding forms. Moreover, varying the environmental conditions in Egypt which under the imported hybrids are developed is usually accompanied by modifications in the phenotypic expression of this cultivar. Nevertheless, there is no evidence that certain tomato F, hybrid combinations are highly stable under adverse and variable environmental conditions. (Levit, 1980, Danailov *et al.*,1997, Raijadhav *et al.*1997 and EL. Ghareeb 2006 who mentioned that yield of the best F, hybrid having highly sigmJic;uu spuciilu combining ability effect decreased under high temperature.

The superiority of the crosses-derived between the (S_4) of Money Maker and the imported hybrids leads to explain the importance of the adaptability genes from the spread cultivars in Egypt.

At the commercial level, these findings are very important for the development of a commercial hybrid variety that produced locally with cheeper coasts. Seeds of the best foreign hybrids must be imported and used only as parents in crosses involving Money Maker *&.* Super Marmand for the production of commercial hybrid seeds

Heterosis

It can be seen that a tremendous increase in yield per plant was obtained in F, generation of all the crosses made. The increase was invariably above the better parent in any cross and was not necessarily influenced in amount by the level of production of the better parent. In some crosses in which yielding ability of the better parent was not particulary high (3.88 kg as in G.S 12) , the mean yield of F, individual plants exceeded six kgs in Money Maker *x* G.S 12 and recorded more than 5 kg in the cross Super Mainland x G.S 12. it can be also observed that the top yielding crosses were identified as the combination between Money Maker and the three imported hybrid varieties the similarity in behavior of F_hs of the crosses and their reciprocal , forms , which was found at the level of total yield was observed.f Table 1) Ismail & El.Ghareeb (2000), El. Sharkawy *et al.*(2001) in egg plants and El.Ghareeb (2005)in tometo , recorded the same

results.

The present study was carried out to find Ihe percent of differences between the parents and their first generation . involving the imported hybrids regarding number of some agronomic and quality traits (Table 2&3).It can be noticed that only number of flowers per plant and total yield recorded significant values of heterosis over mid and better parent . An additional of heterosis in flower number per plant was evaluated in the F|,s and their reciprocals. The heterotic values ranged from 37.60% to 56.14%over mid parent for the crosses Facolta 38" Money Maker and Money Maker *TY 70 , respectively . (Table2) .The same trait recorded an additional IICKTOSIS also over better parent, ranged from 10.08 % to 34.10 % for the crosses Super Marmand x Facolta 38 and Money Maker ■ G.S 12 (Table3) these results could be an indication that a larger yield is expected .

Concerning total yield trait the increase of the F| hybirds was surprisingly very high and ranged over mid parent from 76.23% for the cross Facolta 38 * Money Maker to 97.69 % for the cross Money Maker *TY 70 . (Table2) . moreover this trait recorded heterosis percentage over better parent ranged from 34.15 % to 66.91 % for the crosses Super Marmand x Facolta 38 and Money Maker *TY70, respectively. (Table3).in this connection the presence of such additional amount of heterotic manifestation , besides of its commercial value might be ol'sicnoln: significance .

It seems that the F| plants derived from these crosses maintain vigorous growth potential of the imported hybrids and Ihe adaptability genes of the Egyptians parents.

From Table (2and3), it can be noticed different manifestation of heterosis in the direction of expression in F|,s concerning fruit weight trait . whereas this trait showed positive heterosis over mid parents and negative heterotic values over better parents for most Fi,s . Briefly the ascending arrangement for heterosis was from 1.44 % to 21.21 % for the combinations (Facolta 38 ■ Super Marmand) and (Money Maker x Facolta 38) over mid paren , respectively (Table2) . as for the same percentage over better parent . only two combinations and their reciprocals showed positive heterotic values i,e Super Marmand *G.S 12 having 20.6 % as a best heterotic value and Super Marmend * G.S 12 . These results agree with those reported by Kordus (1991) , Hegazi *et al.*(1995) ,E1. Mighawry *et al.*(1997), Uppal *et at* (1997), Srivastava *et at* (1998), Monforte &Tanksley(2000) , Bhatt *et al.*(2001), Yang *et al.*(2001)and El.Ghareeb (2004)

Concerning total soluble solids and ascorbic acid traits , the insignificant values , recorded for the two traits elucidate slight heterosis in some F,,s in total soluble solids and nearly the absence of heterosis for ascorbic acid .The same trend of results was recorded by Bhurjan *et al.* (1986), Kumar *et al.* (1997), Rego *et al.*(1999), Alice *et al.*(2001) and Yang *et al.* (2001).

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الإستفادة من قوة الهجين فى تربية الطماطم

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Table (2) : Estimates of heterosis over mid parent of some agronomic and quality trait for tomato crosses

Genotypes	N. of flowers/plant		Fruit weight (g)		Total yield/plant(kg)		Total soluble Solids T.S.S)		Ascorbic Acid (mg)	
	M.P	H%	M.P	H%	M.P	11%	M.P	H%	M.P	H%
Money Maker * Super Marmand	46.66	57.95*	82.78	-2.56	2.45	66.53*	4 49	0.45	22.94	-0.17
Super Mannand x Money Maker	46.66	51.80*	82.78	-2.92	2.45	64.49*	4.49	-2.23	22.94	0.35
Money Makerx TY70	64.23	56.14*	80.27	18.56*	3.47	97.69*	4.52	-0.88	22.97	0.26
TY70x MoneyMaker	64.23	49.67*	80.27	20.00*	3.47	95.68*	4.52	-1.55	22.97	0.17
Money Makerx Facolta38	66.70	39.67*	99.42	21.21*	3.45	77.39*	4.48	0.89	22.90	-0.13
Facolta38 * MoneyMaker	66.70	37.60*	99.42	18.95*	3.45	76.23*	4.48	2.01	22.90	0.22
MoneyMaker *x* GS.12	61.58	52.48*	80.47	12.75	3.36	83.63*	4.49	2.45	22.86	0.04
GS.12 * MoneyMaker	61.58	48.02*	80.47	11.99	3.36	81.55*	4.49	0.67	22.86	0.83
Super Mannand xTY70	57.76	48.37*	102.71	17.13*	3.09	83.50*	4.50	-1.33	23.04	0.04
TY70 x Super Marmand	57.76	44.04*	102.71	14.79	3.09	97.61*	4.50	2.88	23.04	-0.09
Super Mannand x Facolta38	60.23	46.70*	121.86	2.78	3.07	77.85*	4.47	2.24	22.97	0.04
Facolta38 x Super Marmand	60.23	47.95*	121.86	1.49	3.07	82.41*	4.47	-2.68	22.97	-0.39
SuperMarmand *x* GS.12	55.11	55.38*	102.91	7.29	2.98	85.57*	4.48	-1.12	22.95	0.52

*** Significant at 0.5**

Table (3): Estimates of heterosis over better parent of some agronomic and quality traits for tomato crosses

Genotypes	N. of flowers/ plant		Fruit weight (g)		Total yield/ Plant (kg)		Total soluble Solids (T.S.S)		Ascorbic acid (mg)	
	B.P	H%	B.P	H%	B.P	H%	B.P	H%	B.P	H%
Money Maker * Super Marmand	53.13	38.72*	105.22	-23.34*	2.83	44.17*	4.50	0.22	23.01	-0.48
Money Maker" TY70	72.32	33.15-	100.20	-5.02	4.11	66.91*	4.53	**-1.01**	23.07	-0.17

TY70 - Money Maker	75.32	27.63*	100.20	-3.87	4.11	65.21*	4.53	-1.77	23.07	-0.26
Money Maker- Fac,)lia38	80.27	16.06*	138.50	-13.00	4.07	50.37*	4.50	0.44	22 93	-0.26
Facolta38 * Money Maker	80.27	14.34	138.50	-14.61	4.07	49.39*	4.50	1.56	22.93	0.09
Money Maker- GS.12	70.02	34.10*	100.60	-9.81	4.88	59.02*	4.50	2.22	22.88	0.04
GS.12- Money Maker	70.02	30.18*	100.60	-10.42	3.88	57.22*	4.50	0.44	22.88	**0,74**
Super Marmand " TY70	75.32	13.78	100.20	20.06*	4.11	37.96*	4.23	0.88	23.07	-0.22
TY70- Super Mannand	75.32	10.46	100.20	17.66*	4.11	35.04*	4.23	-1.99	23.07	-0.22
Super Marmand * Facolta38	80.27	10.08	138.50	-9.57	4.07	34.15*	4.47	3.58	23.01	-0.17 -
Facolta38 ' Super Marmand	80.27	11.01	138.50	-10.71	4.07	37.59*	4.47	2.24 -	23.01	0.57
Super Marmand X GS.12	70.02	22.29*	100.60	9.75	3.88	42.53*	4.48	2.68	23.01	-0.78
GS.12 XSuper Marmand	70.02	22.82-	100.60	7.08	3.88	47.68*	4.48	-1.13	23.01	0.09

***Significant at 0.5**

2105 2106 2107 2108 2109 2110 2111 2112 2113 2114

2117