ESTIMATE OF COMBINING ABILITIES, HETEROSIS AND HERITABILITY OF SOME IMPORTANT CHARACTERS OF TOMATO (*Lycopersicon esculentum*, Mill.)

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ABSTRACT

Five tomato cultivars were crossed in a diallel system in one direction. Seeds of the 10 F_1's as well as the 5 parental cultivars were produced and the various genotypes were grown at two locations (Abbies and El-Noubaria) for evaluation, in four winter and summer seasons during the years of 1996 to 1999. Combined analyses of variance for important vegetative and yield characters were conducted. General and specific combining abilities, heterosis, and heritability in both the narrow and broad senses were estimated. Results proved the existence of marked heterosis, either over the mid-parental value or that of the best parent for the studied characters of yield components. The estimates of heritability in broad and narrow senses reflected relatively more importance for the non-additive gene effects than the additive ones, in the inheritance of yield characters. Results of GCA and SCA indicated that a particular cultivar or hybrid can not be used to evaluate all interesting characters with equal efficiency.

Key words: Tomato, Combining Ability, Heritability, Heterosis, Combine analysis.

INTRODUCTION

In recent years, hybrid tomato cultivars were extensively used in commercial production. With increasing the land reclamation and productive cultural area in Egypt, and due to increase the changeable demands of both growers and customers; breeders directed their attention to keep introducing new hybrids. Therefore, breeders have to develope, test and evaluate great numbers of cultivars and inbreds in cross combinations at different seasons and locations. Selected genotypes must be characterized as good combiners and can surpass all other evaluated inbreds for important characteristic values when crossed with any particular one; which recognized from their high values of general and specific combining abilities, that reflect the additive, and both the additive and non-additive gene action, respectively (Welsh 1981).

The main objectives of the present investigation were to estimate and evaluate both general and specific combining abilities in a half-diallel cross among five parental tomato cultivars at two locations in four seasons. Also, to estimate heritability and heterosis values for the studied characters, to provide more understanding for the various gene effects contributing to their genetic variation.

MATERIALS AND METHODS

This study was conducted during the winter and summer seasons of 1996 to 1999 at two locations. The first location was the Experimental Station Farm Faculty of Agriculture, Alexandria University (at Abbies); meanwhile, the second one was at Bangar El-Sokker region.

In the first season, seeds of the five parental tomato cvs.: Castlerock, Money maker, Strain-B., Supermarmand and V.F.N.8 were sown on October 3, 1996. Seedlings were transplanted on the 1st. of November. Fertilization, irrigation, plant protection and other cultural practices were performed in such season, as well as in the other seasons, as recommended for the commercial tomato production. Selfing and hybridization, among the 5 parental cultivars were carried out in a diallel meeting system in one direction. By the end of March, enough selfed seeds were obtained from plants of the true type of each cultivar, as well as the 10 F_1's hybrids.

In the second season, seeds of the S1 parental cultivars and the 10 F_1's hybrid were sown on April 2nd., 1997 and transplanted on May 10th. The best growing plants of S1's from parental cultivars were selfed and the plants of the F_1's were backcrossed to their both parents. In addition, new F_1's seeds were again reproduced.

Finally, seeds of the 15 populations (5 cvs. and 10 F_1's) were obtained for planting and evaluation at the two locations in four successive winter and summer seasons during the years of 1997 to 1999. New seeds of the 15 populations were reproduced in a greenhouse in each season to be ready for evaluation in the next one.

The sowing dates of the 15 populations were on October 5th, 1997; May 6th, 1998; October 1st, 1998, and May 10th, 1999 for the four seasons, espectively. Seedlings were transplanted after about 40 and 35 days in the first location, and after 34 and 30 days in the second one, in the winter and summer seasons, respectively.

The 15 populations were evaluated in experiments designed as Randomized Complete Blocks (R.C.B.D.), with four replications. Each population was represented by a plot of 22 plants in two rows per replicate. Seedlings were transplanted in rows 4m long, 1m wide, with 40cms between plants. The growing plants were fertilized with NPK and

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Greenzate foliar application three times after 35, 50 and 65 days from transplanting; with the recommended doses. Other cultural practices were conducted whenever they were found necessary and as recommended for the commercial tomato production.

Characters of plant height and branch's number were measured from five random plants/plot; whereas, number of days to first flower was recorded as the average of days number to first flower on 50% of the grown plants/plot. Early yield per plant was measured from the first four harvestings/plot divided by harvested plants number/plot; whereas, the total yield was estimated from all harvestings by the same manner. Samples of 40 random ripe fruits/plot were used to measure fruit shape index (length/diameter of fruit).

The statistical analysis of data was carried out as the method of combined analysis of variances for a series of similar experiments at several locations in several years, as illustrated by Al-Rawi and Kalf-Allah (1980). *Multiple* comparisons among population means were conducted through Duncan's Multiple Range Test (L.S.R.).

Combined analysis of the 5 parents and their 10 F_1's over the eight experiments (Table 1), were used to estimate the variance components of the general and specific *combining* abilities (σ^2_{gca} and σ^2_{sca}), and to illustrate their relations with types of gene action.

Estimate of variance components of GCA and SCA were calculated according to *Griffing's* (1956) method two, which depends on parental cultivars and their F_1's in one direction as follow:

GCA variance = $\sigma^2_{gca} = (M_{gca} - M_{sca}) / (n+2)\,RLS$

SCA variance = $\sigma^2_{sca} = (M_{sca} + M_{gls}) - M_{gl} + M_{gs} / RLS$

$\sigma^2_g = (M_{gs} + M_{gls}) - (M_{gl} + M_{gs}) - (M_{gl} + M_{gs}) / RLS$

$\sigma^2_{gs} = (Mgs - Mgls)/RL$, $\sigma^2_{gl} = (M_{gl} - M_{gls})RS$

$\sigma^2_{gls} = (M_{gls} - M_e)/r$

Phenotypic variance = $\sigma^2_p = \sigma^2_g + \sigma^2_{gls}/LS + \sigma^2_{gl}/L + \sigma^2_{gs}/S + \sigma^2_e/RLS$

Where n = no. of parents, M_{gca} = mean square (M.S.) of GCA, M_{sca}= M.S. of SCA, M_{gls} = M.S. of genotype X locations X seasons, M_{gl} and M_{gs} are mean squares of genotype X location, and genotype X seasons, respectively, RLS = number of replicates by locations by seasons.

Heterosis over mid-and better- parent was recorded for the most *important* characters. Also, heritability in both broad and narrow senses (h^2_{bs} and h^2_{ns}) were calculated as follows:

$h^2_{bs} = (\sigma^2_{gca} + \sigma^2_{sca} / \sigma^2_p) \times 100$

$h^2_{ns} = (\sigma^2_{gca} / \sigma^2_p) \times 100$

Table 1. Combined analysis of variance of the 15 genetic (five parents and their ten F_1 hybrids).

S.O.V.	D.F		M.S.	E.M.S.
Replicates (R)	SL(R-1)	24		
Locations (L)	(L-1)	1	M_L	$\sigma^2_e+R\sigma^2_{gls}+RG\sigma^2_{ls}+RS\sigma^2_{lg}+RSG\sigma^2_l$
Seasons (S)	(S-1)	3	M_S	$\sigma^2_e+R\sigma^2_{gls}+RL\sigma^2_{gs}+RG\sigma^2_{ls}+RGL\sigma^2_s$
S x L	(S-1)(L-1)	3	M_{LS}	$\sigma^2_e+R\sigma^2_{gls}+RG\sigma^2_{ls}$
Genotypes (G)	(G-1)	14	M_G	$\sigma^2_e+R\sigma^2_{gls}+RL\sigma^2_{gs}+RS\sigma^2_{gl}+RLS\sigma^2_g$
(gca)	(n-1)	4	$M_{(gca)}$	$\sigma^2_e+R\sigma^2_{gls}+RL\sigma^2_{gs}+RS\sigma^2_{gl}+RLs\sigma^2_{(sca)}$ $+(n+2)RLS\,\sigma^2_{(gca)}$
(sca)	2(n-1)/2	10	$M_{(sca)}$	$\sigma^2_e+R\sigma^2_{gls}+RL\sigma^2_{gs}+RS\sigma^2_{gl}+RLS\sigma^2_{(sca)}$
G x L	(G-1)(L-1)	14	M_{gl}	$\sigma^2_e+R\sigma^2_{gls}+RS\sigma^2_{gl}$
G x S	(G-1)(S-1)	42	M_{gs}	$\sigma^2_e+R\sigma^2_{gls}+RL\sigma^2_{Gs}$
G x L x S	(G-1)(S-1)(L-1)	42	M_{gls}	$\sigma^2_e+R\sigma^2_{gls}$
Error	SL(R-1)(G-1)	336	M_e	σ^2_e
Total	SLGR-1	479		

RESULTS AND DISCUSSION

Table (2) revealed significant estimated mean squares in the all studied characters with some exceptions. Insignificant variances were detected for location (L) in case of TSS% and fruit shape index characters. For the first degree interaction, the same notice was observed for the characters of TSS%, fruits/plant and total yield. Also, number of branches, earliness, T.S.S., average fruit weight and fruit shape index; and for plant height and fruits number/plant in the cases of the L x S and G x L interactions, respectively. Variances of the branches number, T.S.S. and fruit shape index were not significant for the second degree (G x L x S) interactions.

Table 2. Combined analyses of variance of the eight experiments (4 seasons x 2 locations) for all studied characters for the evaluation of 15 tomato' entries.

Sources of variance	D.F.	Mean Squares (M.S.)								
		Plant height	No. of branches	Days to 1^{st} flower	T.S.S. %	Average fruit wt.	Fruit shape index	No. of fruits/plant	Early yield	Total yield
Replicates	24	8.05	8.24**	4.12**	0.03	15.85	0.021**	2.1*	0.010**	00.05
Locations (L)	1	151.11**	10.83**	113.16**	0.01	954.00**	0.001	4814.6**	5.930**	55.49**
Seasons (S)	3	248.48**	38.89**	16.27**	2.57**	3541.90**	0.012**	886.8**	1.870**	1.19**
Genotypes (G)	14	537.57**	28.45**	391.67**	9.72**	8531.80**	0.681**	1596.0**	1.690**	8.97**
GCA	4	1823.65**	91.91**	1242.18**	32.81**	26319.16**	2.384**	2111.5**	2.354**	3.99**
SCA	10	39.89**	2.49**	25.21**	0.68**	1378.86**	0.008**	1399.0**	1.508**	9.03**
L x S	3	14.76**	0.83**	71.98**	0.20	701.40**	0.003*	23.0	0.980**	0.34
G x L	14	12.24**	0.16	2.52	0.06	6.60	0.001	46.4*	0.020*	0.15
G x S	42	33.09**	2.38**	34.59**	0.32**	229.20**	0.003*	123.4**	0.360**	0.97**
G x L x S	42	14.69**	0.21	2.05**	0.08	20.80**	0.001	19.5**	0.020*	0.18**
Error	336	3.78	0.15	0.44	0.08	11.7	0.001	0000.6	0.001	0.02

* Significant at 0.05 level.

** Significant at 0.01 level

The high values of variances due to genotypes (G) over those of the three interactions (G X S, G X L and G X S X L) reflected high-performances for the various genotypic populations under the different locations and seasons or both. Such a stability for the various genotypes, suggested the possibility of successful selection and recommendation of superior genotypes in most characters for the commercial production. The same findings were noticed by several investigators with another genotypes (Khalf-Allah, 1970; Cuartero and Cubero, 1981; Khalil *et al.*,1983; Khalf-Allah and Kassem 1985; Younis *et al.*, 1987 and 1988; Omara *et al.*, 1988; Ghosh *et al.*, 1996; Kurian and Peter, 1997).

Table (3) shows the means of the various studied characters of the five parental cultivars and their F_1 hybrids. Grand mean of each parent in all crosses was detected to compare the general combining ability (GCA) of the parental cultivars. The means of the F_1 hybrids were used to compare the specific combining ability (SCA) of the various hybrid combinations as well as to calculate the GCA of the involved parents over the eight experiments as mentioned by Welsh (1981).

The results showed generally that the Strain-B cultivar (P_2) appeared to be the first or the second good combiner for the characters of branches/plant, early yield, total fruits/plant, total fruit weight/plant, fruit shape index and TSS percentage. It could be observed that the lowest number of days to first flower did not assure the earliest number of fruits/plant. However, Moneymaker cv. (P_5) was the best combiner for the characters plant height and number of fruits/plant, and might be considered the second good combiner for the characters total fruits weight/plant and TSS of fruit's juice. The Supermarmand cultivar was the best combiner for the characters branches number, average fruit weight and TSS of tomato juice. These results agreed, in general, with those reported by Wahb-Allah (1995).

The highest specific combining ability (SCA) values were reflected by the means of the F_1 cross between Strain-B x Moneymaker (P_2 x P_5) for the characters of early fruits/plant and total number and weight of fruits/plant. An insignificant difference was detected between the means of the two crosses Strain-B x V.F.N.8 (P_2 x P_4) and Strain-B x Moneymaker (P_2 x P_5) for the total fruits weight/plant. Means of some crosses reflected moderate SCA values, such as Strain-B with each of Castelrock and Supermarmand (P_2 x P_1 and P_3) and Supermarmand x Moneymaker (P_3 x P_5) without any significant differences among their means of total fruit weight. Also, the F_1 crosses of P_2 x P_1 and P_1 x P_5 gave the second highest values for the characters of early fruits/plant and total fruits/plant, respectively. The results, generally, reflected the relatively more importance of the non-additive gene effects than the additive ones in the inheritance of such characters. On the other hand, the higher means of the parental cultivars than their crosses, reflected the relatively higher importance of general combining ability (GCA) of gene action than the SCA ones, in particular characters, such as plant height, number of branches, average fruit weight and TSS percentage. These results agreed to a great extent with those reported by Ibarbia and Lambeth (1969), Khalil *et al.* (1983), Khalf-Allah *et al.* (1985) and Wahb-Allah (1995).

Table 3. Character means for the five parental tomato cultivars and their F_1's over eight experiments.

Genotypes	Plant height cm	No. of branches	Days to 1st flower	Early yield kg/plant	Total fruit no./plant	Total fruit wt./plant (kg)	Average fruit wt. (g)	Fruit shape index (L/D ratio)	T.S.S. %
P_1*	52.28 i	7.02 ef	25.13 h	1.10 i	21.84 l	1.88 g	86.65 i	1.26 a	5.42 i
$P_1 \times P_2$	53.99 h	7.32 d	24.13 ij	1.50 b	33.62 c	3.00 b	89.67 i	1.23 b	5.93 fg
$P_1 \times P_3$	56.73 e-f	8.74 b	26.38 f	1.31 f	25.61 i	2.63 e	102.79 d	1.06 e	6.53 cd
$P_1 \times P_4$	56.96 e-g	7.32 d	28.30 e	1.33 e	28.27 g	2.83 d	100.86 e	1.08 d	5.51 j
$P_1 \times P_5$	60.82 d	7.05 ef	24.23 l	1.43 c	36.14 b	2.83 d	78.52 l	1.14 c	5.67 l
Grand mean**	57.12 C	7.61 B	25.76 D	1.39 B	30.91 C	2.82 D	92.96 D	1.13 A	5.91 D
P_2	54.71 h	6.97 ef	25.34 gh	1.18 h	21.59 l	2.05 f	96.20 f	1.15 c	6.23 e
$P_2 \times P_3$	57.50 e	8.64 b	26.31 f	1.39 d	27.73 h	2.97 bc	107.51 c	0.98 g	6.83 b
$P_2 \times P_4$	55.89 g	7.19 de	30.94 b	1.34 e	29.72 f	3.14 a	106.18 c	1.01 f	5.94 fg
$P_2 \times P_5$	62.53 c	6.99 ef	23.81 j	1.52 a	38.33 a	3.13 a	82.31 k	1.09 d	6.08 f
Grand mean	57.47 C	7.53 BC	26.30 C	1.44 A	32.35 B	3.06 A	95.17 C	1.08 B	6.19 B
P_3	60.11 d	9.67 a	28.66 d	0.86 l	13.79 n	1.79 h	125.53 a	0.77 k	7.12 a
$P_3 \times P_4$	60.10 d	8.83 b	31.00 b	1.10 l	23.75 k	2.90 cd	122.24 b	0.83 j	6.44 d
$P_3 \times P_5$	64.33 b	8.44 c	25.47 gh	1.26 g	30.97 e	2.97 bc	94.04 g	0.91 i	6.64 c
Grand mean	59.66 B	8.66 A	27.29 B	1.27 E	27.01 E	2.87 CD	106.64 A	0.94 E	6.61 A
P_4	56.35 fg	7.01 ef	36.63 a	0.73 m	14.72 m	1.84 gh	125.03 a	0.83 i	5.18 k
$P_4 \times P_5$	62.62 c	6.91 f	29.94 c	1.17 h	31.76 d	2.88 d	91.52 h	0.94 h	5.84 gh
Grand mean	58.89 B	7.56 B	30.04 A	1.23 D	28.37 D	2.94 BC	103.95 B	0.96 D	5.93 CD
P_5	66.78 a	6.57 g	25.59 g	1.00 k	25.05 j	1.84 gh	73.37 m	1.00 g	5.76 hi
Grand mean	62.57 A	7.35 C	25.86 D	1.35 C	34.30 A	2.95 B	86.60 E	1.02 C	6.06 BC

Means of genotypes, and grand means of each character not having common letters differ significantly, using Duncan's Multiple Range Test at 0.05 level.

* P_1 = Castlerock, P_2 = Strain B, P_3 = Supermarmand, P_4 = V.F.N-8 and P_5 = Mneymaker

** Grand mean of crossings between the first parent with the other 4 ones.

Values of estimated heterosis percent over mean-parental and best parental values for the important studied tomato characters are listed in Table (4). The relatively high values of heterosis over mid-parent were noticed for the characters of early yield/plant by the F_1's of $P_1 \times P_4$ and $P_2 \times P_4$, total fruits/plant by the F_1's of $P_3 \times P_4$, $P_2 \times P_5$ and $P_2 \times P_4$, and total fruits weight/plant by the F_1's of $P_3 \times P_5$, $P_2 \times P_4$, $P_2 \times P_5$ and $P_3 \times P_4$. The best values of heterosis over the best parent were observed for the character total fruits/plant by the F_1's of $P_3 \times P_4$ and $P_2 \times P_5$ and total fruit weight/plant from $P_3 \times P_5$, $P_3 \times P_4$ and $P_4 \times P_5$. Results of the previous characters proved the high importance of the non-additive gene action, comparing with the additive effects in controlling the inheritance of such characters. However, the relatively low positive values of heterosis for the characters plant height, branches/plant, fruit shape index and TSS, reflected the importance of both the additive and non-additive gene action in controlling the inheritance of such characters.

The presence of heterosis for these characters were also reported by Jamwal *et al.* (1984), Arndt and Skiebe (1988) and Pratta *et al.* (2003). Moreover, the obtained results confirmed generally the finding of Gibrel *et al.* (1982) who reported the superiority of the non-additive gene effects over the additive ones in determining the inheritance of tomato high yield.

The results in Table (5) showed that the estimates of the general combining ability variance (σ^2_{gca}) reflected relatively higher values than those of the specific combining ability variance (σ^2_{sca}) in the cases of the three characters; fruit size, plant height and earliness of flowering; suggesting that additive gene effects seemed to be more important in the inheritance of these characters than the non-additive ones. The closely estimated values of both (σ^2_{gca} and σ^2_{sca}) for the characters of branches number, TSS%, and fruit shape index, proved the equal importance of both additive and non-additive gene action in the inheritance of such characters. On the other hand, the σ^2_{sca} was observed to have higher estimated values than those of σ^2_{gca} for the rest three characters, which indicated clearly the superiority of non-additive gene effects over the additive ones on their inheritance. These results agreed, in general, with those reported by Khalf-Allah and Mousa (1972), Khalil *et al.* (1983),Khalf-Allah and Kassem (1985) and Omara *et al.* (1988).

Table 4. Heterosis over mid parents (M.P.) and best parents (B.P.) for some characters in crosses among 5 tomato cultivars.

Genotypes	Plant height		No. of branches		Days to 1st flower		Early fruit wt (g)		Fruits/plant		Fruits wt./plant (g)		Fruit wt. (g)		Fruit shape index (L/D)		T.S.S. %	
	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.
$P_1 \times P_2$	0.83	-1.32	4.65	4.27	4.51	-3.98	33.19	26.97	7.13	7.05	52.93	46.80	-1.92	-6.79	1.65	-2.38	1.72	-4.81
$P_1 \times P_3$	0.86	-5.62	4.73	-9.62	1.93	4.97	36.45	22.92	43.80	17.26	43.42	39.82	3.11	-18.12	3.92	-15.87	4.15	-8.29
$P_1 \times P_4$	4.78	1.10	4.35	4.27	-8.36	12.61	48.44	24.22	54.65	29.44	52.20	50.50	-4.71	-19.33	2.86	-14.29	3.96	1.66
$P_1 \times P_5$	2.08	-8.92	3.75	0.43	-4.46	3.58	37.80	33.68	54.12	44.27	52.12	50.35	-1.89	-9.38	0.88	-9.52	1.43	-1.56
$P_2 \times P_3$	0.16	-4.34	3.85	-10.65	-2.56	3.87	36.15	17.56	56.76	28.44	54.96	45.18	-3.03	-14.36	2.08	-14.78	2.25	-4.07
$P_2 \times P_4$	0.66	-0.80	2.86	2.67	-0.13	22.15	40.29	13.40	63.66	37.66	61.74	53.59	-4.01	-15.08	2.02	-12.17	4.03	-4.66
$P_2 \times P_5$	2.94	-6.34	3.25	0.29	-6.48	-6.00	39.38	29.09	64.37	53.01	61.31	53.10	-2.92	-14.44	0.93	-5.22	1.33	-2.41
$P_3 \times P_4$	3.22	-0.02	5.88	-8.69	-5.05	8.16	38.76	28.24	66.67	61.35	60.07	57.90	-2.43	-2.62	3.75	0.00	4.72	-9.55
$P_3 \times P_5$	1.39	-3.66	3.94	-12.72	-6.12	-0.47	35.55	25.70	59.47	23.63	64.07	61.84	-5.44	-25.09	2.25	-9.00	3.11	-6.74
$P_4 \times P_5$	1.71	-6.24	1.77	1.43	3.76	17.00	34.80	16.13	59.63	26.75	56.42	56.42	-7.74	-26.80	2.17	6.00	6.76	1.39

P_1 = Castlerock, P_2 = Strain B, P_3 = Supermarmand, P_4 = V.F.N-8 and P_5 = Moneymaker

Table 5. Estimates of total variance components and heritability percentages for the studied characters

Characters	σ^2_p	σ^2_{gca}	σ^2_{sca}	h^2_{bs}%	h^2_{ns}%
Plant height	016.768	007.960	00.290	79.20	47.47
No. of branches/plant	000.895	000.399	00.005	45.14	44.58
Earliness of flowering	012.235	005.165	01.565	55.02	42.21
Total soluble solids%	000.305	000.143	00.011	50.50	46.88
Fruit size	266.600	111.340	36.370	55.41	41.76
Fruit shape index	000.021	000.011	00.0002	50.47	49.76
No. of fruit/plant	049.900	003.181	39.020	84.57	06.37
Early yield	000.053	000.004	00.036	74.90	06.98
Total yield	000.282	000.022	00.095	41.50	07.80

σ^2_p : total variance (phenotypic variance).
σ^2_{gca} : general combining ability variance.
σ^2_{sca} : specific combining ability variance.
h^2_{bs}% : heritability in the broad sense.
h^2_{ns}% : heritability in the narrow sense.

The heritability estimates in the narrow sense (h^2_{ns}) for the various studied characters were found to be in the range of 6.37%, for number of fruits/plant and up to 49.76% for fruit shape index. Concerning heritability in the broad sense (h^2_{bs}), the values ranged from 45.14% for number of branches and up to 84.57% for number of fruits per plant. Such results indicated that a good progress in improving such characters by phenotypic or genotypic selection could be achieved, and the environmental factors can not restrict the efficiency of the selection process (Gibrel *et al.*, 1982).

Finally, it may be concluded from the results of this investigation that the best hybrid combinations for earliness, number of fruits/plant and total yield were found to be that of the cross Strain-B x Moneymaker, followed by Stain-B x VFN-8; which could be generally considered the most important ones for all yield related characters.

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الملخص العربي

تقدير القدرةعلى التآلف وقوة الهجين ودرجة التوريث لبعض صفات الطماطم الهامه

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أجريت هذه الدراسة في أربعة مواسم خلال السنوات من ١٩٩٦– ١٩٩٩ وفي موقعين ، وهما محطة البحوث الزراعية التابعة لكلية الزراعة جامعة الاسكندرية ومنطقة بنجر السكر (احدى مناطق الاستصلاح بالنوبارية بالقرب من الاسكندرية). تناولت الدراسة تقييم خمسة أصناف من الطماطم التجارية والعشرة هجن الفردية الناتجة من تلقيحاتها من خلال نظام الدای الیل في اتجاه واحد ، بالاضافة الى عشرة تراكيب وراثيه ناتجه من التلقيح الرجعي للاب الأول وعشرة أخرين من التلقيح الرجعي للأب الثاني (٤٥ تركيبا وراثيا) وذلك في أربعة مواسم (شتوية وصيفيه). وتم تقييم كل من الـ٤٥ تركيبا وراثيا باستخدام تصميم القطاعات العشوائية الكاملة بأربع مكررات ، حيث مثلت كل عشيرة بقطعة تجريبية من خطين ، واشتمل كل خط على ١٠ نباتات. حللت البيانات المسجلة لكل الصفات المدروسه احصائيا باستخدام طريقة التحليل الاحصائي التجميعي لبيانات سلسلة من التجارب المتشابهه (٨ تجارب) والمستخدم فيها نفس التصميم.

قدرت درجة التوريث بنوعيها الواسع والضيق حيث تبين أهمية الفعل الجيني الاضافي والغير اضافي بدرجات متفاوتـه تختلف باختلاف الصفات المدروسة. كما ثبت وجود قوة هجين فعالة سواء بالمقارنة لمتوسط الآباء أو بأفضل الأبوين ، وخاصة بالنسبة للصفات المحصولية. أيضا أبرزت نتائج تقديرات القدرة العامة والخاصة على التآلف عدم امكانية الاعتماد على صنف واحد من الأصناف الأبوية المدروسة أو على هجين واحد لتقييم كل الصفات بنفس الدرجة من الكفاءة. وعلى الرغم مما سبق ، فقد تميز الصنف سترين بى بقدرة عامة عالية على التآلف بالنسبة لصفتي المحصول المبكر والكلي ، أما الصنف سوبر مارمند فقد تميز بقدرة عامة على التآلف لصفات ارتفاع النبات ومحتوى الثمار من المواد الصلبة الذائبة الكلية وحجم الثمار. أيضا عكس الصنف مونى ميكر كفاءة عالية لصفات عدد الأفرع وعدد الثمار على النبات ، بينما كان أفضلهم لصفة التبكير في الازهار وشكل الثمار هو الصنف كاسل روك. بالنسبة للقدرة الخاصة على التآلف فلقد أظهر الهجين الفردى الناتج من سترين بى x مونى ميكر ، أعلى قيمة لكل من صفات التبكير وعدد الثمار والمحصول المبكر والكلي ، وتميز الهجين الفردى سترين بى x في أف ان–٨ في صفة المحصول الكلي.

ومما سبق يتضح أن هذين الهجينين يمكن اعتبارهما الأهم بالنسبة للصفات المحصولية.