A DIALLEL ANALYSIS OF YIELD AND YIELD COMPONENTS OF SOME TOMATO GENOTYPES GROWN IN ARID CONDITIONS

Wahb-Allah, M.A.

Vegetable Dept., Fac. Agric.,
Alexandria Univ., Egypt

Accepted 11/12/2007

ABSTRACT: Six tomato cultivars (Strain B, Pakmore VF, Super Marmand. Shohba, Indian and Tnshet Star) were evaluated and crossed in a diallel system in one direction. The twenty-one F_1 and parental genotypes were grown during the summer seasons of 2003 and 2004 to evaluate general and specific combining abilities and to estimate heritability and heterosis values for yield traits (average fruit weight, number of fruits per plant, early yield and total yield).

The results proved the existence of marked heterosis, either over the mid-parental value or that of the better parent for yield and yield components. Estimation of heritability percentages in broad and narrow sense indicated that additive gene effects appeared to be relatively more important in the inheritance of average fruit weight. For other traits, greater importance for the non-additive gene effects was observed relative to those for the additive gene effects. The best general combiner parents were the two cultivars Strain B and Pakmore VF, which can be selected as tester parents and involved in hybrid combinations to predict the best hybrids. The best hybrid combinations for yield and yield components traits were the crosses Strain B x Pakmore VF, and Pakmore VF x Indian, which could be generally considered the most important ones for yield related traits.

Key words: Combining ability, heritability, heterosis, potence ratio.

INTRODUCTION

In recent years, hybrid tomato cultivars were utilized in commercial production. They are used to maximize the net return of their investment, irrespective of their relatively high priced seeds. Accordingly, tomato breeders directed most of their efforts to introducing new hybrids to meet the increased and changeable demands of both growers and customers. Breeders have to test and evaluate cultivars and inbred lines in cross combinations at different seasons, to be able to pick up those which can combine well with others to produce good hybrids. Heterosis breeding is an important genetic tool that can facilitate yield enhancement from 30 to 400% and help enrich many other desirable quantitative and qualitative traits in crops (Verma and Srivastava, 2004; Topal *et al*., 2004). Heterosis in the F_1 hybrids of tomato was reported by many researchers such as Ahmed *et al*. (1988), Suresh *et al*. (1995), Ajeet *et al*. (1996), Pratta and Picardi (2003) and Khalf-Allah *et al*. (2005). From their studies, clear heterotic effects were observed in some important tomato yield traits.

Breeders are always interested in selecting lines with high average performances; i.e. high general combining ability (GCA); which estimates the additive gene action. To determine which hybrid to produce, breeders have to direct their attention to particular combination that surpasses all others; i.e. which has the highest specific combining ability (SCA) that estimates the non-additive gene action. Therefore, the parents of this particular cross can combine well to produce a hybrid with a superior general performance.

The analysis of crosses involving (n) homozygous lines in all possible combinations is known as a diallel analysis. Such analysis evaluates both the general and specific combining abilities for the involved lines. Also, it is usually used for estimating some other important genetic parameters, such as additive variance, dominance variance and heritability percentages. The four methods of Griffing (1956 a,b) for diallel analysis have usually been used to obtain genetic information on the basis of data from one year or one location, although multiple environment data were suggested to provide more reliable genetic information on tested material (Zhang and Kang, 1997). In addition, the diallel crossing technique was reported to provide early information on the genetic behaviours of these attributes in the first generation (Chowdhry *et al*., 1992). Several investigators used a diallel crossing system to study the inheritance of some quantitative traits in tomato such as Das *et al.* (1988), Moya *et al.* (1988), Omara *et al.* (1988), Hassan *et al.* (1995), Ghosh *et al.* (1996), Kurian and Peter (1997) and Wahb-Allah (2000). Heritability percentages of some important tomato traits were estimated by many researchers such as Khalil *et al.* (1988), Omara *et al.* (1988), Singh *et al.* (1988), Hegazi *et al.* (1995), Abdel-Ati (1999), Wahb-Allah (2000) and Khalf-Allah *et al.* (2005)

The main objectives of the present investigation were: (a) to estimate and evaluate both the general and specific combining ability in a diallel cross among six parental tomato cultivars, (b) to select few cultivars as tester parents and determine the best hybrids for yield and yield components traits, and (c) to estimate heritability and heterosis values for the studied traits, in order to understand gene effects contributing to the genetic variation.

MATERIALS AND METHODS

This study was conducted during years 2002 to 2004 at the Agricultural Research and Experiment Station at Dirab of the Faculty of Food and Agricultural Sciences, King Saud University, Riyadh, Saudi Arabia.

Development of Genetic Materials

The development of genetic materials was carried out during summer and autumn seasons of 2002. The genetic materials of the present investigation started with seeds of six tomato cultivars which were chosen as original parental genotypes. These cultivars were: Strain B, Pakmore VF, Super Marmand, Shohba, Indian and Tnshet Star. In the first season, seeds of the six tomato cultivars were sown on January 15, 2002. Seedlings were transplanted into the open field on February 20, 2002. Fertilization, irrigation, plant protection and other cultural practices were performed as recommended for the commercial tomato production in Saudi Arabia. Evaluation and selfing for the parental cultivars were carried out during this season.

In the second season, hybridization and selfing among the six parental cultivars in a half diallel crossing system were carried out in a controlled greenhouse on August 20, 2002 to obtain enough seeds of the fifteen F_1-hybrids and new seeds of the six selfed parents. By the end of January, 2003, enough seeds were obtained for all genetic materials.

Evaluation of Genetic Materials

The six parental cultivars and their fifteen F_1-hybrids (21 genetic populations) were evaluated at two summer seasons of 2003 and 2004. The sowing dates were January 10, 2003 and January 12, 2004 for first and second seasons, respectively. Seedlings were transplanted into the open field on February 10, 2003 and February 12, 2004, respectively.

The studied yield and yield component traits were: early yield (the total weight of all harvested fruits/plot in the first four harvests), total yield (the total weight of all harvested fruits/plot in the whole season), number of fruits per plant (the total number of all harvested fruits from each plot divided by the number of growing plants per plot), and average fruit weight (total weight of all harvested fruits per plot divided by total number of fruits).

Experimental Design, Analyses and Estimation of Genetic Parameters

The experimental design was a randomized complete block design with four replicates. Each experimental unit consisted of three rows, 4 m long and 1 m wide with a spacing of 40 cm between plants. Fertilization, irrigation and other cultural practices were conducted as recommended in commercial tomato production. The statistical analyses of the recorded data were carried out as illustrated by Ray and Sall, (1982). The multiple comparisons among the means of the various genetic populations were conducted using revised LSD, at 0.05 levels according to Steel and Torrie (1980).

Combined analysis of the 21 genetic populations over the two seasons were used to estimate the different genetic parameters (heterosis, potence ratio, effects of general and specific combining ability and heritability percentage). Heterosis was determined as the percentage of the deviation of the F_1 mean from the better parent mean, and from the mid parent mean.

Potence (P) ratio was estimated to determine the nature and direction of dominance. It was calculated according to Smith (1952), as follows:

$$P = (F_1 - M.P) / 0.5\,(P_2 - P_1) \quad [1]$$

Where: P is relative potence of gene set, F_1 is first generation mean, M.P is the mean of the two parental values, P_1 is the mean of lower parent, and P_2 the mean of the higher parent.

Estimates of variance components of general and specific combining ability (GCA and SCA) were calculated according to Griffing's (1965 a) "model II of method II" which depends on parental cultivars and their F_1 s in one direction. The model is illustrated by the analysis of variance presented in Table 1.

Table 1. Analysis of variance for the estimation of GCA and SCA components

Sources of variation	Degree of freedom	Mean squares	Expected mean squares
GCA	n-1=5	M_g	$\sigma^2_e + \sigma^2_{gca} + (n+2)\sigma^2_{sca}$
SCA	n(n-1)/2=15	M_s	$\sigma^2_e + \sigma^2_{sca}$
Error	(r-1)(p-1)=140	M_e	σ^2_e

M_g = mean square of GCA p = number of populations = 21
M_s = mean square of SCA r = number of replicates = 8
M_e = mean square of error n = number of parental cultivars = 6

From the EMS given in Table 1 the estimations of variance components of GCA (σ^2_{gca}) and SCA (σ^2_{sca}) were calculated.

The standard error (S.E) of the estimated general and specific combining ability effects were calculated as follows:

$$S.E\,(G_i - G_j) = [2\sigma^2_e/(n+2)]^{1/2} \quad [2]$$

$$S.E\,(S_{ij} - S_{ik}) = [2\,(n+1)\sigma^2_e/(n+2)]^{1/2} \quad [3]$$

$$S.E\,(S_{ij} - S_{kl}) = [2\,n\,\sigma^2_e/(n+2)]^{1/2} \quad [4]$$

Where: $(G_i - G_j)$: difference between two GCA estimates of two parental cultivars.

$(S_{ij} - S_{ik})$: difference between two SCA estimates of two hybrids, with a common parent.

$(S_{ij} - S_{kl})$: difference between two SCA estimates of two hybrids, with non-common parent.

Heritability in both broad (h^2_{bs}) and narrow (h^2_{ns}) senses were calculated using the following formulas (Gibrel *et al.*, 1982):

$$h^2_{bs} = (2\,\sigma^2_{gca} + \sigma^2_{sca}) / (2\,\sigma^2_{gca} + \sigma^2_{sca} + \sigma^2_e) \quad [5]$$

$$h^2_{ns} = (2\,\sigma^2_{gca}) / (2\,\sigma^2_{gca} + \sigma^2_{sca} + \sigma^2_e) \quad [6]$$

RESULTS AND DISCUSSION

Means of the parental cultivars showed a wide range of variability in all studied traits (Table 2). Means for average fruit weight of different populations varied from 72.0 for Indian to 135.6 g/fruit for Super Marmand at first season and from 79.8 for Indian to 150.3 g/fruit for Super Marmand at the second season. The first generation hybrid produced an average fruit size that tended to deviate towards the smaller fruit parental cultivar, reflecting the partial dominance or dominance of small fruit size over large fruit size. These results agreed, in general, with those

Table 2. Mean performances of the six tomato cultivars and their hybrid combinations for yield and its components characters at the two summer seasons 2003 and 2004

Genetic populations	Average fruit weight (g)		Fruit number /plant		Early yield (kg/plant)		Total yield (kg/plant)	
	Summer 2003	Summer 2004	Summer 2003	Summer 2004	Summer 2003	Summer 2004	Summer 2003	Summer 2004
Strain B (P1)	114.0 de	126.3 e	23.1 k	23.2 i	1.449 c	1.544 c	2.625 h	2.897 i
Pakmore VF (P2)	121.2 c	134.3 c	20.3 l	20.4 sk	1.323 def	1.409 cd	2.455 i	2.712 j
Super Marmand (P3)	135.6 a	150.3 a	11.6 o	11.7 l	1.288 ef	1.369 de	1.565 k	1.732 l
Shohba (P4)	91.2 i	101.1 l	22.9 k	23.0 jj	0.562 m	0.598 j	2.082 j	2.300 k
Indian (P5)	72.0 l	79.8 o	38.2 c	38.5 bc	0.937 sk	0.957 gh	2.745 gh	3.027 hi
Tnshet Star (P6)	109.2 f	121.0 g	14.1 n	14.2 l	0.712 l	0.758 jj	1.545 k	1.705 l
P1 X P2	116.4 b	129.0 d	35.8 e	36.05 cd	2.662 a	2.194 a	4.157 a	4.552 a
P1 X P3	117.0 d	129.6 d	25.1 j	25.2 hi	1.324 cf	1.409 cd	2.950 ef	3.227 fg
P1 X P4	101.4 g	112.4 i	36.3 de	36.57 dc	1.437 cd	1.529 cd	3.680 bc	4.062 bc
P1 X P5	90.6 i	100.4 l	40.4 b	40.7 ab	1.412 cde	1.502 cd	3.655 c	4.039 c
P1 X P6	111.0 ef	123.0 f	28.4 h	28.6 efg	1.837 b	1.954 b	3.125 d	3.482 d
P2 X P3	127.2 b	140.9 b	23.3 k	23.4 i	1.267 fg	1.369 de	2.557 ef	3.272 efg
P2 X P4	103.2 g	114.3 h	35.1 f	35.2 d	1.384 cf	1.476 cd	3.610 c	3.982 c
P2 X P5	93.6 i	103.7 k	40.7 ab	40.9 ab	1.3224 cf	1.409 cd	3.900 b	4.200 b
P2 X P6	114.6 d	127.0 e	26.8 i	27.0 fgh	1.812 b	1.928 b	3.067 de	3.392 de
P3 X P4	110.4 f	122.0 fg	26.7 i	26.9 gh	0.974 jj	0.787 i	2.947 ef	3.255 efg
P3 X P5	100.2 gh	111.0 i	30.1 g	30.3 e	1.042 hjj	1.050 gh	3.010 e	3.32 ef
P3 X P6	120.6 c	133.6 c	19.4 m	19.5 k	0.837 k	0.890 hi	2.340 i	2.580 j
P4 X P5	77.4 k	85.7 n	41.3 a	41.5 a	0.937 sk	0.997 gh	3.190 d	3.520 d
P4 X P6	97.2 h	107.7 j	29.4 g	29.6 ef	1.162 gh	1.236 ef	2.852 fg	3.147 gh
P5 X P6	86.4 j	95.7 m	36.5 d	36.8 cd	1.087 hi	1.156 fg	3.152 d	3.527 d

Values followed by the same alphabetical letter(s) in each column do not differ significantly from each other using revised LSD Test at 0.05 level.

reported by Suresh *et al.* (1995), Ajeet *et al.* (1996) and Khalf-Allah *et al.* (2005), who indicated the presence of partial dominance of small fruit size over large fruit size.

The general performance of the various populations in the two seasons were similar with respect to number of fruits per plant, early yield and total yield. The significant highest fruit number was reflected by the crosses Shohba x Indian and Pakmore x Indian, while the significant highest early and total yield was shown by F_1 hybrids of the cross Strain B × Pakmore VF in both seasons. Pronounced hybrid vigour occurred in all populations of the single crosses, since most of F_1 hybrids showed significant superiority in number of fruits and both early and total productivity over their best respective parents. These results also suggested that pronounced degrees of dominance and over inheritance of these traits. The results confirmed the findings of Gibrel *et al.* (1982), Abdel-Ati (1999), Wahb-Allah (2000) and Khalf-Allah *et al.* (2005), who reported that non-additive gene effects and genotype-environmental interactions were more important in determination of high yield than the additive gene effects.

Low negative heterosis values are found for average fruit weight, and the potence ratio was negative and less than one in all crosses (Table 3). This result indicated the importance of additive gene action in inheritance of this trait, and existence of partial dominance for smaller fruit. On the other hand, heterosis percentages were high and positive in most crosses for number of fruits per plant, early yield and total yield, indicating the importance of non-additive gene action in the inheritance of these traits. Also, the potence ratios were positive and ranged between -1 and +1 or more than one in most crosses, indicating that partial dominance and over dominance were existing in the inheritance of these traits. The results agreed with those reported by Ahmed *et al.* (1988), Suresh *et al.* (1995), Ajeet *et al.* (1996), Pratta and Picardi (2003) and Khalf-Allah *et al.* (2005).

The cultivar Super Marmand was the best general combiner parent for average fruit weight (Table 4). In addition, the cultivar Indian was the best general combiner for total fruit number, and the cultivar Strain B followed by Pakmore VF for early and total yield. The best hybrid combinations which reflected the highest positive estimate (Table 5) were that of Strain B x Shohba for average fruit weight, Strain B x Pakmore VF, followed by Strain B x Shohba for total number of fruit and total yield. The cross Pakmore VF x Super Marmand was the best hybrid combination for early yield

Table 3. Estimates of heterosis percentage based on mid parents (MP), better parent (BP) and potence ratio for yield and its components traits of crosses among six tomato cultivars

Genotypes	Average fruit weight (g)			Fruit number/plant			Early yield (kg/plant)			Total yield (kg/plant)		
	Heterosis M.P%	Heterosis B.P%	Potence ratio	Heterosis M.P%	Heterosis B.P%	Potence ratio	Heterosis M.P%	Heterosis B.P%	Potence ratio	Heterosis M.P%	Heterosis B.P%	Potence ratio
P1 X P2	- 0.9	- 3.9	- 0.02	65.1	55.4	1.30	48.7	42.2	0.97	63.7	58.4	1.27
P1 X P3	- 6.2	- 13.7	- 0.12	44.2	8.6	0.88	- 3.1	- 8.6	- 0.06	39.7	11.5	0.79
P1 X P4	- 1.2	- 11.1	- 0.02	58.2	57.5	1.16	42.8	- 0.8	0.85	56.3	40.2	1.12
P1 X P5	- 2.5	- 20.4	- 0.05	31.9	5.7	0.63	18.3	- 2.6	0.36	36.1	33.2	0.72
P1 X P6	- 0.5	- 2.5	- 0.01	52.8	23.3	1.05	69.8	26.6	1.39	51.2	20.1	1.02
P2 X P3	- 0.9	- 6.1	- 0.02	45.8	14.7	0.91	- 2.1	- 3.5	- 0.04	47.2	20.6	0.94
P2 X P4	- 2.8	- 14.8	- 0.05	62.1	53.3	1.24	46.9	4.6	0.93	59.0	46.9	1.18
P2 X P5	- 3.1	- 72.7	- 0.06	39.0	6.5	0.78	17.1	0.1	0.34	46.2	38.6	0.92
P2 X P6	- 0.5	- 5.4	- 0.01	55.5	31.8	1.11	78.0	36.9	1.56	53.5	25.1	1.07
P3 X P4	- 2.6	- 18.6	- 0.05	54.9	17.0	1.09	- 7.6	- 33.6	- 0.15	61.5	41.5	1.23
P3 X P5	- 3.1	- 26.1	- 0.06	20.8	- 21.1	0.41	- 8.8	- 21.2	- 0.17	39.6	9.6	0.79
P3 X P6	- 1.4	- 11.0	- 0.03	50.5	37.3	1.01	- 16.3	- 35.0	- 0.32	50.3	49.3	1.00
P4 X P5	- 5.1	- 15.1	- 0.10	35.3	8.1	0.70	25.0	0.01	0.50	32.1	16.2	0.64
P4 X P6	- 2.9	- 10.9	- 0.06	59.1	28.8	1.18	82.3	63.1	1.64	57.2	36.9	1.14
P5 X P6	- 4.6	- 20.8	- 0.09	39.4	- 4.4	0.79	32.2	16.0	0.64	48.1	15.7	0.96

Table 4. Estimates of general combining ability (GCA) effects on the various studied traits of the six tomato cultivars

Cultivars	Average fruit weight (g)	Fruit number /plant	Early yield (kg/plant)	Total yield (kg/plant)
Strain B (P1)	3.639	1.290	0.290	0.305
Pakmore VF (P2)	7.987	0.043	0.234	0.264
Super Marmand (P3)	14.464	- 6.777	- 0.049	-0.420
Shohba (P4)	- 8.539	1.601	- 0.219	-0.008
Indian (P5)	-19.052	7.965	- 0.140	0.235
Tnshet Star (P6)	1.500	- 4.124	- 0.071	- 0.376
S.E (G_i - G_j)*	0.521	0.226	0.011	0.018

* (G_i - G_j): difference between two GCA estimates of two parental cultivars.

Table 5. Estimates of specific combining ability (S.C.A) effects on the various studied traits of F1 crosses among the six tomato cultivars

crosses	Trait			
	Average fruit weight (g)	Fruit number /plant	Early yield (kg/plant)	Total yield (kg/plant)
P1 X P2	0.111	5.632	0.320	0.727
P1 X P3	- 1.728	1.652	0.114	0.110
P1 X P4	0.838	4.637	0.116	0.493
P1 X P5	- 0.012	2.359	0.023	0.225
P1 X P6	0.898	2.449	0.392	0.306
P2 X P3	0.686	1.174	0.096	0.189
P2 X P4	- 1.623	4.559	0.133	0.459
P2 X P5	- 1.236	3.868	- 0.011	0.418
P2 X P6	0.363	2.055	0.423	0.258
P3 X P4	- 0.512	3.092	0.035	0.448
P3 X P5	- 0.738	0.076	- 0.032	0.267
P3 X P6	0.198	1.442	- 0.256	0.172
P4 X P5	- 1.159	2.885	0.042	0.045
P4 X P6	- 1.448	3.101	0.205	0.302
P5 X P6	- 2.336	3.898	0.048	0.375
S.E (S_{ij} - S_{ik})*	0.942	0.598	0.029	0.049
S.E (S_{ij} - S_{kl})**	0.872	0.554	0.027	0.045

* (S_{ij} - S_{ik}): difference between two S.C.A estimates of two hybrids, with a common parent.

**(S_{ij} - S_{kl}): difference between two S.C.A. estimates of two hybrids, with non-common parent.

The estimated values of the various components of the total variance as well as those of broad and narrow sense heritability percentages of the various studied traits are presented in Table 6. In the case of average fruit weight, the general combining ability variance (σ^2_{gca}) had higher values than specific combining ability variance (σ^2_{sca}). This result indicated that additive gene effects appeared to be relatively more important in the inheritance of this trait than the non-additive gene effects. On the other hand, σ^2_{sca} had higher estimated values than those of σ^2_{gca} for number of fruits per plant, early yield and total yield. The relatively high values of (σ^2_{sca}) clearly indicated that non-additive gene effects played more important role than additive gene effects on the inheritance of these three traits.

Estimates of heritability percentages in the narrow sense (h^2_{ns}) for the various studied traits were found in the range of 18.5% for total yield and up to 94.0% for average fruit weight. The estimated values of heritability percentages in the broad sense (h^2_{bs}), ranged from 59.5% for early yield to 96.3 % for average fruit weight.

The estimated values of h^2_{ns} and h^2_{bs} appeared to be relatively closer in the case of average fruit weight. This result indicated that most of the variances detected among the performances of the various genotypes were actually due to the additive gene effects; the non-additive effects reflected a relatively minor role in the inheritance of this trait. On the other hand, the percentages of broad sense heritability were estimated with highly pronounced values, relative to the low narrow sense heritability values for number of fruits per plant, early yield and total yield. Such a result clearly reflected greater importance for the non-additive gene effects than those for the additive gene effects in the inheritance of these quantitative and genetically complicated traits. The obtained results confirmed the findings of Gibrel *et al.* (1982), who reported that the estimated value of heritability in broad sense for fruit size was high enough indicating that a good progress in improving fruit size by phenotypic or genotypic selection could be achieved, since environmental factors did not restrict the efficiency of the selection process. Also, the results agreed with those reported by Khalil *et al.* (1988), Omara *et al.* (1988), Singh *et al.* (1988), Hegazi *et al.*(1995), Abdel-Ati (1999), Wahb-Allah (2000) and Khalf-Allah *et al.* (2005).

Table 6. Estimates of the various components of total variance and heritability percentages for the studied traits

Traits	Total variance			Heritability percentage	
	σ^2_e	σ^2_{gcs}	σ^2_{sca}	h^2_{bs}%	h^2_{ns}%
Average fruit weight	57.00	73.83	30.64	96.3	94.0
Fruit number/plant	20.40	8.87	17.62	63.4	31.8
Early yield	0.04	0.010	0.039	59.5	20.2
Total yield	0.15	0.045	0.245	69.1	18.5

σ^2_e : environmental 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

In conclusion, the best hybrid combinations for yield and yield components traits was found to be that of the cross Strain B x Pakmore VF, followed by Pakmore VF x Indian, which could be generally, considered the most important ones for yield related traits. Also, the best general combiner parents were the two cultivars Strain B and Pakmore VF, which can be selected as tester parents and for the involvement in hybrid combinations to predict the best hybrids. Therefore, this finding provided a good tool for testing the combining ability of numerous cultivars and selected strains.

ACKNOWLEDGMENT

The author thanks Prof. Abdulaziz M. Assaeed for reviewing the manuscript and Dr. Safwat O. Khalil for technical help.

REFERENCES

Abdel-Ati, K. E. A. 1999. Evaluation of some tomato cultivars and their F_1 hybrids for some economic characters using diallel analysis. Egypt J. Plant Breed. 3:313-328.

Ahmed, S. U., H. K. Sahs, and K. F. Sharfdin. 1988. Study of heterosis and correlation in tomato. Thai J. Agric. Sci. 21(2):117-123.

Ajeet, S., P. K. Singh, and J. Dixit. 1996. Heterosis and inbreeding depression in tomato. J. Res. Birsa Agric. Univ. 8 (1) 8990.

Chowdhry, M. A., M. Rafiq, and K. Alam. 1992. Genetic architecture of grain yield and certain other traits in bread wheat. Pak. J. Agric. Res. 13:216-220.

Das, N. D., S. S. Ghosh, and T.K. Chatopadhya. 1988. Genetics of quantitative characters in tomato (*Lycopersicon esculentum*). Indian J. Agric. Sci. 58(1):64-65.

Ghosh, P. K., M. M. Syamal, and A. K. Joshi. 1996. Graphical analysis of gene effects in tomato (*Lycopersicon esculentum* Mill.). Adv. Plant Sci. (1):55-59.

Gibrel, G. A. A., W. R. Simpson, and D. O. Everson. 1982. Evaluation of F_1 hybrid tomato cultivars for earliness, fruit size and yield using diallel analysis. J. Amer. Soc. Hort. Sci. 107(2):243-247.

Griffing, B. 1956a. Concept of general and specific combining ability in relation to diallel crossing systems. Aust. J. Biol. Sci. 9:463-493.

Griffing, B. 1956b. A general treatment of the use of diallel crosses in quantitative inheritance. J. Heredity 10:31-50.

Hassan, H. M., H. H. Hegazi, and A. G. Moussa. 1995. General and specific combining abilities of some tomato cultivars and their hybrid combinations. Alex. J. Agric. Res. 40(2):277-290.

Hegazi, H. H., H. M. Hassan, and A. G. Moussa. 1995. Heterosis and heritability estimation for some tomato cultivars and their hybrid combinations. Alex. J. Agric. Res. 40(2): 265-276.

Khalf-Allah, A. M, E. M. S. Helmy, and Z. Abdel-Aal. 2005. Estimates of combining abilities, heterosis and heritability of some important characters of tomato (*Lycopersicon esculentum* Mill.). Alex. J. Agric. Res. 50(2):137-143.

Khalil, R. M., A. A. Midan, and A. K. Hatem. 1988. Breeding studies of some characters in tomato (*Lycopersicon esculentum*, Mill.). Acta Hort. 220:77-83.

Kurian, A. A. and K. V. Peter. 1997. Association on fruit shape index and quality characters in tomato. Indian J. Genet. and Plant Breed. 57(1):82-86.

Mather, K. and J. L. Jinkes. 1971. Biometrical genetics. 2nd ed. Chapman and Hall Ltd. London.

Moya, C., F. A. Jenckens, and H. Amores. 1988. Estimation of general and specific combining ability in tomato varieties. Ciecias de la Agricultura 28:60-69.

Omara, M. K., S. E. A. Younis, and H. I. Tahany. 1988. A genetic analysis of yield and yield components in tomato. Assiut J. Agric. Sci. 19 (1): 227-240.

Pratta, G. R. and L. A Picardi. 2003. Diallel analysis of production traits among domestic, exotic and mutant germplasms of *Lycopersicon*. Genet and Mol. Res. 2(2):206-213.

Ray, A. A., and J. P. Sall. 1982. SAS user's guide: Statistics. SAS Institute, Cary. NC.

Singh, P. K., R. K. Singh, and B. C. Saha.1988. Genetic variability in tomato (*Lycopersicon esculentum*). Indian J. Agric. Sci. 58(9):718-720.

Smith, H. H. 1952. Fixing transgressive vigour in *Nicotiana rustica*. pp161-174 in. J. W. Gowen (Ed). Heterosis. Iowa State Collage Press. Ames, Iowa.

Steel, R. G. and J. H. Torri. 1980. Principles and procedures of statistics. McGraw-Hill Co., New York.

Suresh, K., M. K. Banerjee, and P. S. Partap. 1995. Studies on heterosis for various characters in tomato. Haryana J. Hort. Sci. 24(1):54-60.

Topal, A., C. Aydin, and N. Akgun. 2004. Diallel cross analysis in durum wheat (*Triticum durum* Desf.): identification of best parents for some kernel physical features. Field Crop Res. 87:1-12.

Verma, O. P. and H. K. Srivastava. 2004. Genetic component and combining ability analyses in relation to heterosis for yield and associated traits using three diverse rice-growing ecosystems. Field Crop Res. 88:91-102.

Wahb-Allah,. M. A. E. 2000. Estimation and efficiency of parameters contributing to genetic variance, combining ability and heritability of growth and yield characters of tomato. Ph.D Thesis, Vegetable Crops Dept., Alexandria Univ. Egypt.

Zhang, Y. and M. S. Kang. 1997. Diallel-SAS: a SAS program for Griffing diallel analyses. Agron. J. 89:176-182.

تحليل الداي أليل للمحصول و مكوناته لبعض أصناف الطماطم النامية في الظروف الجافة

محمود عبادي وهب الله

قسم الخضر- كلية الزراعة – جامعة الإسكندرية – مصر

أجريت هذه الدراسة خلال السنوات من ٢٠٠٢ إلى ٢٠٠٤ م بمحطة الأبحاث والتجارب الزراعية بديراب التابعة لكلية علوم الأغذية والزراعة جامعة الملك سعود بهدف تقييم السلوك العام وتقدير تأثيرات قدرتي التآلف العامة والخاصة لستة أصناف من الطماطم وكل الهجن الممكنة بينهما باستخدام نظام تهجينات الداي أليل في اتجاه واحد، وتقدير قوة الهجين، ودرجة السيادة، و درجة التوريث بمعناها الواسع والضيق وذلك لدراسة وتقدير أهمية التفاعل الجيني المتحكم في السلوك الوراثي لصفات المحصول ومكوناته (متوسط وزن الثمرة، وعدد الثمار للنبات، و المحصول المبكر، والمحصول الكلي) لنبات الطماطم.

تم إعداد التراكيب الوراثية للدراسة خلال الموسمين الصيفي والخريفي لعام ٢٠٠٢ م؛ حيث زرعت بذور ستة أصناف من الطماطم التجارية وهي استرين بي وباكمور في اف وسوبر مارمند وشهبا وهندي وتنشيط ستار في الموسم الصيفي وذلك لتقييمها وإجراء التلقيح الذاتي لها، وفي الموسم الخريفي أجريت كل التهجينات الممكنة بين الأصناف الأبوية بنظام الداي أليل في اتجاه واحد للحصول على بذور كافية لكل الهجن، وكذلك إجراء التلقيح الذاتي للآباء للحصول على بذور جديدة منها.

تم تقييم العشائر الوراثية المختلفة (ستة أصناف وخمس عشر هجين) في تجربة حقلية خلال موسمين (الموسم الصيفي لعامي ٢٠٠٣ و ٢٠٠٤) باستخدام تصميم القطاعات العشوائية الكاملة بأربعة مكررات، وقد أظهرت النتائج بصفة عامة الآتي:

- الأصناف الأبوية المستخدمة تختلف فيما بينها في الصفات موضع الدراسة، وقد ظهرت قوة الهجين بوضوح سواء عند تقديرها على أساس متوسط الأبوين أو للأب الأعلى قيمة وذلك لصفات عدد الثمار والمحصول المبكر والكلي.
- تقديرات النسبة المئوية لدرجة التوريث بالمعنى الواسع والمحدود أوضحت أن تأثيرات التفاعل الجيني الإضافي قد لعبت دورا أكثر أهمية من دور التفاعل الجيني غير الإضافي في ميكانيكية توريث صفة متوسط وزن الثمرة، بينما كان دور التفاعل الجيني غير الإضافي هو الأكثر أهمية بالنسبة لباقي الصفات.
- أوضحت تقديرات القدرة العامة على التآلف أن الصنفين سترين بي وباكمور في اف هما الأفضل من حيث القدرة على التآلف مع مختلف الآباء وبذلك يمكن انتخابهما كآباء اختباريه للتنبؤ بالهجن المتفوقة في برامج التربية، أما بالنسبة للقدرة الخاصة على التآلف فقد أظهر الهجين سترين بي X باكمور في اف والهجين باكمور في اف X هندي أعلي القيم لمختلف صفات المحصول، وبذلك يمكن اعتبارهما أهم الهجن المنتجة بالنسبة للصفات موضع الدراسة.