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Genetic Evaluation of some Economical Traits in Summer Squash

Abd El-Hadi, A. H.[1]; M. H. Abd El-Aziz[1*]; Manal A. Abd Alla[2] and Mariam G. Ashak[1*]

[1]Genet. Dept. Fac. of Agric., Mansoura Univ., Mansoura, Egypt.
[2]Hort. Res. Ins. A.R.C., Sakha, Kafr El-Sheikh, Egypt.

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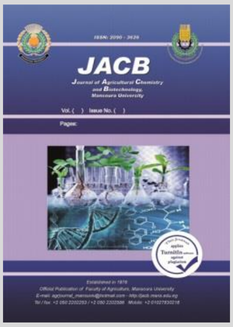

ABSTRACT

This study aimed to estimate significance of heterosis, combining ability, genetic parameters and heritability for vegetative, flowering, yield and fruit quality traits using15 F_1 hybrids obtained from 6×6 half diallel mating system without reciprocals. The results indicated that analysis of variance exhibited highly significant for the mean squares of the genotypes for all traits, except for, parents which was significant for fruit diameter and parents *vs.* hybrids was insignificant for average fruit weight and fruit diameter, but it gave significant for fruit length. None of the F_1 hybrids had the highest values for all traits. The maximum significant desirable heterosis values over mid-parent were -17.19, 61.36, 44.14, -5.46, 17.26, 308.83, 296.41, -23.58 and -12.79% for stem length, number of branches/plant, leaves/plant, days to opening the first female flower, average fruit weight, number of fruits/plant, yield/plant, fruit length and fruit diameter, respectively. Also, the heterosis over better parent were recorded the following values;-18.18, 32.47, 37.66, -6.97, 14.77, 205.54, 204.98, -32.63 and -14.48% for same traits listed before. The analysis of variance for both GCA and SCA revealed highly significant estimates for all traits. The GCA was higher than SCA for all the traits. The inbred lines P_1, P_2,P_3, P_4, P_5 and P_6 were the good combiner for number of branches/plant ,fruit length, days to opening the first female flower and fruits/plant, yield/plant, average fruit weight, number of leaves/plant and stem length, respectively. The estimates of heritability in broad sense ($h^2_{b.s.}$%) were higher than their corresponding in narrow sense($h^2_{n.s.}$%) for all traits.

***Keywords**: Squash, Heterosis, Combining ability , Heritability, Half diallel.*

INTRODUCTION

Summer squash (*Curcurbita pepo*,L.) is one of species under genus *Cucurbita* in the gourd family *Cucurbitaceae*. The *Cucurbita* genus native to and originally cultivated in the Andes and Mesoamerica. Some *Cucurbita* species were brought to Europe after the discovery of America and are now used in many parts of the world. *C. pepo* used mainly for its fruits. *C. pepo* has varieties are pumpkin, gourd, acorn squash, marrow, cocozelle, crookneck, scallop, straight neck and zucchini. There are other four species under genus *C. argyrosperma* and *C. Maxima* types are called winter squash; *C. moschata* fruit are called squash or pumpkin and *C. ficifolia*. The *Cucurbita* genus has important source of human food and the fruits are good sources of several nutrients. In the same time, they are free of fat and cholesterol. However, the plants contain toxins called cucurmosin and cucurbitacin. Also, *C. pepo* plants have medical uses as they used for treating skin conditions and improving visual acuity (Burrows and Tyrl, 2013). *C. pepo* has the constant and relatively high chromosome number (2x=40) (Al-Ballat, 2008). Breeding for increase yields in summer squash has been one of the important objectives of many summer squash breeding programs since1900s.Yield of summer squash has also been improved by breeding for diseases resistance and increasing yield in summer squash cultivars has also been due to the improvement of qualitative traits such as gynoecious sex expression, improved fruit color and direct yield improvement through development of high yielding varieties or F_1 hybrids, so genetic improvement of different crops have very often been attempted with great success, particularly through a proper understanding of the mode of inheritance of economic traits. Moreover, it is important to have acknowledge of the genetic architecture as the parental material at hand in order to plan a successful breeding program. When the additive gene action revealed the main component of the total genetic variation, a maximum progress would be expected in selection programs. On the other hand, the presence of a relatively high non-additive gene action indicates that the production of F_1 hybrid should be considered as a result of the direct relationship between the non-additive gene action and heterosis (El-khatib, 2013). Heterosis, combining ability, variance components and heritability have great important role to help plant breeders in determining breeding program which must be used .Therefore, over the past two decades, several researches focused on studying different diallel crosses designs in many vegetable crops among them cucurbits. Diallel cross analysis obtain information on genetic effects for a fixed set of parental lines or to estimate general combining ability (GCA), specific combining ability (SCA), variance components and heritability for a population from randomly chosen parental lines. So, it is frequently used in plant breeding research (Becker, 1978). Hussien (2015) studied heterosis in squash and reported that the maximum significant true heterosis (BP)in desirable direction (179.9%) was showed for total yield (106.9%), fruits number/plant(57.0%),plant height (40.9%), average fruit weight (32.5%) and days to female flowering date (-17.2%). El-Shoura and Abed (2018) found

[*] Corresponding author.
E-mail address: mohahassan2005@gmail.com
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in squash general combining ability (GCA) was significant or highly significant for all traits. In addition, the GCA estimates were larger than their corresponding estimates of SCA for most of the studied traits. Also, both additive and non-additive gene actions revealed positive for all studied trait. Hassan *et al.* (2016) in squash revealed that broad sense heritability estimates were ranged from 80.47 % to 90.36 % for plant length, 66.84 % for number of branches/plants. While, narrow sense heritability estimates were ranged from 39.77 % to77.39 % for plant length,

This study aimed to estimate the heterosis, genetic parameters, combining ability and heritability to produce superior summer squash hybrids suitable for Egyptian cultivation, which may replace the imported ones.

MATERIALS AND METHODS

The genetic materials used in the present investigation included six summer squash inbred lines belong to species *Cucurpita pepo,* L. The seeds of these inbred lines were obtained from different resources: Lungo ditoscan (P_1), CGN11916 (P_4) and PI/512788 (P_5) from Fac. of Agric., Kafr El-sheikh Univ., Egypt; S26 (P_2) and S24(P_3) from Sakha Hort. Station, Hort. Res. Ins., Agric. Res. Center, Giza, Egypt and Eskandrani (P_6) as a commercial variety. This work has been performed in the farm of Sakha Horticulture Research Station, Kafr El-Sheikh Governorate.

The experiment was performed during summer growing season of 2013 to produce 15 F_1 hybrids of squash with good genetic qualities superior to their parents. The crosses were done among the six parental varieties based on a partial diallel crosses mating design without reciprocals to produce 15 F_1 crosses. Parental genotypes and their 15 F_1 hybrids were evaluated at the summer growing season of 2014.

a. Experimental design

A randomized complete block design (R.C.B.D) was the experimental design used in this study with three replicates. Each of replication was block consisted of 21 plots (six parental lines and their 15 F_1 hybrids), each plots was one ridge 5.0m long and 3.0m wide, the distance between hills were 50cm long apart and plots contained 10 plants per plot (one plant per hill). Land preparation, fertilizer application and other field practices for squash crop were applied according to the recommendation of the Egyptian Ministry of Agriculture (El-khatib, 2013).

b. Estimated traits

Vegetative traits [stem length(cm)(S.L.), number of branches per plant (N.B./P.), number of leaves per plant (N.L./P.), flowering traits[number of days to opening the first opening female flower(day) (D.O.F.), yield traits [average fruit weight (g) (F.W.), number of fruits (N.F./P.), fruit yield/plant (g) (Y./P.)] and fruit quality traits [fruit length (cm) (F.L.) and fruit diameter (cm) (F.D.)].

C. Statistical methods

1- Estimation of heterosis

Heterosis was estimated as the percentage increase of F_1 hybrid means over their mid-parent and/or their better parent according to Mather (1949) and Mather and Jinks (1982).

2 - Estimation of combining ability

Combining ability analysis was performed according to the Model I and Method 2 of Griffing (1956).

3- Genetic parameters

They are estimated using Hayman's procedure (1954)

4- Heritability:

Broad and narrow senses heritability were calculated according to the diallel analysis system (Hussien, 2015).

RESULTS AND DISCUSSION

Analysis of variance

The results presented in Table 1 showed that the analysis of variance for all genotypes which revealed highly significant values estimates for the mean squares of the genotypes, parents, hybrids and parents *vs.* crosses for all traits, except for parents which was significant for F.D. and parent *vs.* crosses which appeared insignificant results for F.W. and F.D. Furthermore, it was significant for F.L., indicating the wide diversity between the parental genotypes used herein. These results agreed with those obtained by Abd El-Maksoud *et al.* (2003); Abd El-Hadi *et al.* (2005) and Abd El-Hadi *et al.* (2014a and b) in squash.

Table 1. Analysis of variances for vegetative, flowering, yield and fruit quality traits of summer squash.

S.O V.	d. f.	S.L.	N.B./P.	N.L./P.	D.O.F.	F.W.	N.F./P.	Y. /P.	F.L.	F.D.
Replications	2	0.20	0.01	0.73	0.60	4.11	0.15	61.76	1.07	0.02
Genotypes	20	46.27**	0.40 **	18.05**	11.93**	125.74**	407.55**	2687224.04**	6.54**	0.32**
Parents	5	31.05**	0.20**	25.73**	16.73**	86.26**	126.45**	716919.52**	12.14**	0.11*
Hybrids	14	46.03**	0.37**	11.37**	8.99**	148.76**	339.38**	2376956.26**	4.84**	0.40**
P *vs.* C	1	125.87**	1.70**	73.04**	29.05**	0.93	2767.30**	16882495.59**	2.33*	0.12
Error	40	1.31	0.01	0.26	0.20	3.95	0.30	111.21	0.47	0.04

*** and ** Significant differences at 0.05 and 0.01 levels of probability, respectively.**

Performance of the parents and their F_1 hybrids

The results presented in Table 2 appeared that there was no specific parent revealed superior performance for all traits. It is exhibited that the parental inbred lines S24 (P_3)and Eskandrani (P_6) revealed the lowest desirable mean values for S.L. with mean values of 18.27 ,19.80cm and D.O.F. (35.53 and 36.00day).The highest desirable mean values for N.F./P. was expressed the mean values of 17.07 and 22.38 fruits per plant. Lungo ditoscan (P_1) and S26 (P_2) revealed the highest desirable mean values for N.B./P. which express the mean values of 1.80 and 1.28.Concerning number of leaves per plant, S26 (P_2) and PI/512788 (P_5) revealed the highest desirable mean values of 17.33 and 15.40 leaves. The differences between the means of the lowest and the highest parent revealed highly significant indicating the presence of genetic differences between the parental inbred lines. The results of F_1 hybrids between the six parental inbred lines cleared that the F_1 hybrids ($P_1 \times P_3$), ($P_2 \times P_5$), ($P_2 \times P_6$) and ($P_4 \times P_6$) appeared the lowest desirable mean values for S.L. with mean values of 21.80 , 20.40, 21.33 and 20.93cm. The F_1 hybrids ($P_1 \times P_2$), ($P_1 \times P_3$), ($P_1 \times P_4$) and ($P_1 \times P_5$) revealed the highest desirable mean values for N.B/P. The F_1 hybrids ($P_1 \times P_2$), ($P_2 \times P_3$), ($P_2 \times P_4$) and ($P_3 \times P_6$) revealed the highest desirable mean values for N.L./P. The F_1 hybrids ($P_2 \times P_3$), ($P_3 \times P_4$), ($P_3 \times P_6$) and ($P_4 \times P_6$) revealed the lowest desirable mean values for D.O.F. The F_1 hybrids ($P_2 \times P_4$), ($P_3 \times P_4$), ($P_3 \times P_5$) and ($P_4 \times P_5$) revealed the highest desirable mean values for N.F./P. F_1 hybrids between($P_1 \times P_3$), ($P_1 \times P_4$), ($P_3 \times P_4$) and ($P_4 \times P_5$) expressed the highest desirable mean values for F.W. Furthermore, F_1 hybrids between ($P_2 \times P_3$), ($P_2 \times P_5$),

(P_2×P_6) and (P_5×P_6) revealed the lowest desirable mean values for F.L. The F_1 between hybrids (P_1×P_2), (P_1×P_5), (P_1×P_6) and (P_3×P_4) appeared the lowest desirable mean values for F.D. with mean values 2.47, 2.49, 2.42 and 2.52cm. Concerning the performances of the F_1 hybrids for all traits, the results revealed the magnitudes of these traits. Moreover, the presence of significant differences for many studied traits when the hybrids were compared with each or other parents the results indicated. The results indicated that there were quite heterosis values versus the mid-parent. So, some F_1 hybrids exceeded the better parent. The results were in agreement with those obtained by El-Khatib (2013); Abd El-Hadi *et al.* (2014a and b) and Abdeine *et al.* (2017)

Table 2. Mean performance of vegetative and yield by six inbred lines of summer squash and their 15 F_1 hybrids.

Genotypes	S.L. (cm)	N.B./P.(branch)	N.L./P.(leaf)	D.O.F.(day)	Y./ P.(g)	N.F./P.(fruit)	F.W.(g)	F.L.(cm)	F.D. (cm)
Parents									
Lungoditoscan (P_1)	26.47	1.80	13.10	41.00	352.00	4.75	74.05	15.47	2.70
S26 (P_2)	24.93	1.28	17.33	39.30	1237.40	16.07	77.00	10.85	2.83
S24 (P_3)	18.27	1.23	15.13	35.53	1210.53	17.07	70.91	10.90	2.95
CGN11916 (P_4)	21.27	1.18	17.00	37.00	688.80	7.95	86.65	11.60	2.48
PI/512788 (P_5)	24.33	1.13	21.73	40.53	1278.60	16.05	79.67	10.53	2.47
Eskandrani (P_6)	19.80	1.10	15.40	36.00	1736.26	22.38	77.58	10.73	2.71
Hybrids									
P_1xP_2	29.60	2.25	21.93	39.53	1983.13	24.49	80.97	16.25	2.47
P_1xP_3	21.80	1.94	15.80	37.00	1949.47	22.94	84.99	11.61	2.67
P_1xP_4	32.33	2.05	20.27	37.33	1540.33	18.08	85.21	15.14	3.47
P_1xP_5	29.73	2.37	16.87	39.33	1596.07	19.96	79.95	12.91	2.49
P_1xP_6	24.33	1.76	16.20	37.00	1381.47	16.86	81.94	14.17	2.42
P_2xP_3	23.40	1.70	20.87	35.20	2187.80	32.11	68.13	11.27	2.66
P_2xP_4	28.67	1.65	20.67	37.07	3720.40	49.09	75.79	13.48	2.69
P_2xP_5	20.40	1.40	19.27	39.07	1193.80	17.03	70.07	11.53	2.65
P_2xP_6	21.33	1.33	17.33	37.00	1524.80	21.00	72.60	10.65	2.53
P_3xP_4	30.40	1.51	18.67	34.57	3377.60	38.72	87.24	12.07	2.52
P_3xP_5	26.73	1.32	19.07	36.80	3253.73	42.19	77.13	12.29	2.85
P_3xP_6	24.27	1.37	21.20	34.20	1983.80	29.39	67.49	11.78	2.75
P_4xP_5	22.80	1.40	20.53	36.07	3899.47	44.78	87.08	12.40	3.49
P_4xP_6	20.93	1.45	19.27	34.03	2215.73	31.25	70.90	14.44	3.42
P_5xP_6	27.87	1.30	17.07	36.67	1639.87	23.06	71.12	11.35	2.77
L.S.D 0.05	1.89	0.12	0. 83	0.73	17.40	0.91	3.28	1.13	0.34
L.S.D 0.01	2.53	0.16	1.12	0.98	23.28	1.22	4.39	1.52	0.35

Heterosis of vegetative and flowering traits

Data illustrated in Table 3 showed the two types of heterosis. For S.L. (cm), only one out of 15 F_1 hybrids exhibited negative significant heterosis over the mid-parent. The hybrid between S26 (P_2) × PI/512788 (P_5) had the highest value over the mid-parent heterosis (-17.19%). On the other hand, four out of 15F_1 hybrids revealed significant negative heterosis over the better parent. The hybrid between S26 (P_2) × PI/512788 (P_5) had the highest negative significant value (-18.18%). For N.B./P., all hybrids revealed significant positive heterosis over the mid-parent. The hybrid between (P_1) × (P_5) had the highest significant value (61.36%). While, 12 out of 15 F_1 hybrids revealed significant positive heterosis over the better parent. Regarding N.L./P. 11 out of 15 F_1 hybrids revealed significant positive heterosis over the mid- parent. On the other hand, seven out of 15 F_1 hybrids revealed significant positive heterosis over the better parent. For D.O.F. five out of 15 F_1 hybrids revealed significant negative heterosis over the mid-parent. On the other hand, 14 out of 15 F_1 hybrids showed significant negative heterosis over the better parent. The results were in agreement with those obtained by Sirohi *et al.* (2002) in pumpkin; Abd El-Maksoud *et al.* (2003); Abd El-Hadi *et al.* (2005) in squash; Kosba *et al.*(2007) in watermelon; Al-Ballat (2008) in squash; Masry (2009) in watermelon, Mohamed (2011) in melon; Omran *et al.*(2012) in watermelon; El-Khatib (2013) in squash and Hussien and Hamed (2015) in pumpkin

Table 3. Percentage of heterosis over the mid ($H_{M.P}$%) and better parent ($H_{B.P}$%) for vegetative and flowering traits.

Hybrids	S.L.		N.B./P.		N.L./P.		D.O.F	
	$H_{M.P}$%	$H_{B.P}$%	$H_{M.P}$%	$H_{B.P}$%	$H_{M.P}$%	$H_{B.P}$%	$H_{M.P}$%	$H_{B.P}$%
P_1xP_2	15.18**	11.84**	45.95**	25.00**	44.14**	26.54**	0.59	-1.54
P_1xP_3	-2.53	-17.63**	28.13**	7.96*	11.92**	4.41	4.13**	-3.31**
P_1xP_4	35.48**	22.17**	37.43**	13.89**	34.66**	19.22**	0.90	-4.27**
P_1xP_5	17.06**	12.34**	61.36**	31.48**	-3.16	-22.39**	-2.96**	-3.52**
P_1xP_6	5.19	-8.06*	21.61**	-2.04	13.68**	5.19	2.78**	-3.91**
P_2xP_3	8.33*	-6.15	35.10 **	32.47**	28.54**	20.38**	-0.94	-5.92**
P_2xP_4	24.10**	14.97**	33.78**	28.57**	20.39**	19.23**	0.18	-2.84**
P_2xP_5	-17.19**	-18.18**	15.86**	9.09*	- 1.37	-11.35**	-0.59	-2.13**
P_2xP_6	- 4.62	-14.44**	11.89**	3.90	5.91**	0.00	2.78**	-1.73**
P_3xP_4	53.79**	42.95**	24.97**	22.43**	16.18**	9.80**	-2.72*	-4.69**
P_3xP_5	25.51**	9.86*	11.27*	6.76	3.44	-12.27**	3.56**	-3.24**
P_3xP_6	27.50**	22.56**	17.14**	10.81*	38.87**	37.66**	-3.75**	-4.38**
P_4xP_5	0.00	- 6.30	20.86**	18.31**	6.02**	-5.52**	-2.52*	-6.97**
P_4xP_6	1.95	- 1.57	27.01**	22.54**	18.93**	13.33**	-5.46**	-6.76**
P_5xP_6	26.28**	14.52**	16.42**	14.71**	- 8.08**	-21.47**	1.85	-4.18**
L.S.D 5%	1.64	1.89	0.11	0.12	0.72	0.83	0.73	0.63
L.S.D 1%	2.19	2.53	0.14	0.16	0.97	1.12	0.98	0.85

*** and ** Significant differences at 0.05 and 0.01 levels of probability, respectively.**

Heterosis of yield and fruit quality

Concerning fruit fresh weight data presented in Table 4 appeared that. Seven out of 15 F_1 hybrids revealed significant positive heterosis over the mid-parent. The hybrid resulted from the mating (P_1) × (P_3) appeared the highest heterosis (17.26%). On the other hand, three hybrids out of 15 revealed significant heterosis over the better parent.

For N.F./ P., all 15 F_1 hybrids revealed significant positive heterosis over the mid-parent. The hybrid P_2× P_4 had the highest value (308.83%). On the other hand, 11 hybrids out of 15 revealed significant heterosis over the better parent. The hybridP_2×P_4had the highest value (205.54%).

For Y/P, the results revealed that 14 out of 15 F_1 hybrids revealed significant heterosis over the mid-parent. The hybrid between P_4 × P_5 had the highest heterosis (296.41%). On the other hand, 11 hybrids out of 15 revealed significant heterosis over the better parent. The hybrid between P_4 × P_5 appeared the highest heterosis (204.98%).

For F.L., three hybrids out of 15 F_1 hybrids revealed significant and highly significant negative heterosis values over the mid-parent. The hybrid P_1 × P_3 had the highest negative value (-23.58%). While, seven out of 15F_1 showed significant and highly significant negative heterosis values over the better parent. The hybrid P_1 × P_3 had the highest negative value (-32.63%).

For F.D., only one hybrid revealed significant negative heterosis over the mid-parent. The hybrid between P_1 × P_2 revealed the highest heterosis (-12.79). On the other hand, two hybrids out of 15 revealed significant negative heterosis over the better parent. The hybrid between P_3× P_4 had the highest negative heterosis (-14.48%). These results are in agreement with Abd El-Hadi *et al.* (2001); Abd El-Hadi and El-Gendy (2004); Abd El-Hadi *et al.* (2005); Al-Ballat (2008) in squash; Iathet and Piluek (2006) in slicing melon; El-Shoura (2007) in watermelon; Al-Araby (2010); El-Khatib (2013); Abd El-Hadi*et al.* (2014a and b) and Hussien (2015) in squash.

Table 4. Heterosis percentage over mid ($H_{M.P}$ %) and better parents ($H_{B.P}$ %) for yield and fruit quality traits

Hybrids	F.W.		N.F./P.		Y/P		F.L.		F.D.	
	$H_{M.P}$%	$H_{B.P}$%	$H_{M.P}$%	$H_{B.P}$%	$H_{M.P}$%	$H_{B.P}$%	$H_{M.P}$%	$H_{B.P}$%	$H_{M.P}$%	$H_{B.P}$%
P_1xP_2	7.21**	5.15*	135.28**	52.46**	149.55**	60.27**	-14.03**	-27.65**	-12.79*	-12.50*
P_1xP_3	17.26**	14.77**	110.20**	34.39**	149.53**	61.04**	-23.58**	-32.63**	-9.92	- 9.50
P_1xP_4	6.05**	-1.66	184.52**	127.38**	195.99**	123.63**	-0.40	-8.06*	33.85**	28.40**
P_1xP_5	4.03*	0.36	91.34**	23.91**	95.76**	24.83**	-6.65	-21.58**	-3.61	- 7.65
P_1xP_6	8.07**	5.61*	23.97**	-24.85**	32.31**	-20.43**	-0.68	-13.97**	-10.60	-10.59
P_2xP_3	-7.88**	-11.52**	93.72**	88.05**	78.75**	76.81**	-2.58	-7.69	-9.93	- 9.73
P_2xP_4	-7.38**	-12.53**	308.83**	205.54**	286.29**	200.66**	7.07	-3.25	1.51	- 4.72
P_2xP_5	-10.55**	-12.04**	5.85**	5.71	-5.10**	-6.63**	6.03	5.81	-0.13	- 6.37
P_2xP_6	-6.07**	-6.42**	9.18**	-6.25**	2.55**	-12.18**	-5.78	-8.96	-8.43	-10.38
P_3xP_4	10.74**	0.69	209.54**	126.85**	255.66**	179.02**	-8.88*	-13.35**	-7.13	-14.48*
P_3xP_5	2.45	-3.18	154.26**	147.14**	161.44**	154.48**	3.45	-2.18	5.04	- 3.39
P_3xP_6	-9.10**	-13.01**	49.01**	31.28**	34.641**	14.26**	-4.33	-6.26	-2.83	- 6.79
P_4xP_5	4.72**	0.50	272.21**	177.93**	296.41**	204.98**	-3.1	-12.63**	41.05**	40.86**
P_4xP_6	-13.66**	-18.17**	105.98**	39.54**	82.74**	27.62**	11.11**	3.64	27.51**	26.35**
P_5xP_6	-9.55**	-10.73**	19.73**	2.93	8.79**	-5.55**	-2.38	-5.86	2.32	2.22
L.S.D 5%	2.84	3.28	0.79	0.91	15.07	17.40	0.98	1.13	0.30	0.34
L.S.D 1%	3.80	4.39	1.05	1.22	20.16	23.28	1.31	1.51	0.40	0.46

*** and ** Significant differences at 0.05 and 0.01 levels of probability, respectively.**

General and specific combining abilities.

The data in Table 5 revealed that the mean square associated with both general and specific combining abilities showed significant for all studied traits. It is evident that all traits, both additive and non- additive types of gene action were involved in the expression of these traits. A greater ratio of GCA/SCA than unity was detected for S.L., N.B./P., N.L./P., D.O.F., F.W. and F.L., which revealed that the inheritance of these traits mainly controlled by additive and additive by additive gene effects. On the contrary the exceptional traits N.F./P., Y./P. and F.D. reflected that non- additive type of gene action seemed to be more prevalent .These results agreed with El-Mighawry *et al.* (2002) in watermelon; Abd El-Maksoud *et al.* (2003); Abd El-Hadi *et al.*(2005); Al-Ballat (2008); Alarby (2010); El-Khatib (2013) and Abd El-Hadi *et al.*(2014 a and b) in squash**.**

Table 5. General and specific combining abilities for all traits.

S.O.V	d.f.	S.L.	N.B./P.	N.L./P.	D.O.F	F.W.	Y/P	N.F./P.	F.L.	F.D.
Genotypes	20	46.27**	0.40**	18.05**	11.93**	125.74**	2687224.04**	407.55**	6.54**	0.32**
GCA	5	16.47**	0.32**	7.50**	13.18**	73.71**	765784.28**	128.59**	5.71**	0.05**
SCA	15	15.08**	0.07**	5.52**	0.91**	31.32**	939060.37**	138.27**	1.01**	0.12**
Error	40	0.44	0.00	0.09	0.07	1.32	37.07	0.10	0.16	0.01
GCA/SCA		1.09	4.75	1.36	14.53	2.35	0.82	0.93	5.68	0.43

***and ** Significant difference at 0.05 and 0.01 levels of probability, respectively.**

The data in Tables 6 and 7 appeared that the parental variety Lungo ditoscan (P_1) was significant positive desirable GCA effects for N.B. /P. The S26 (P_2) was significant negative desirable GCA effects for F.L. The S24 (P_3) was significant negative desirable GCA effects for D.O.F and significant positive desirable GCA effects for N.F./P. The parental line P_4wassignificant positive desirable GCA effects for F.W.; Y./P. and P_5 appeared significant positive desirable GCA effects for

N.L./P. The inbred line Eskandrani (P_6) showed significant negative desirable GCA effects for S.L.

Hybriding between specific parents were detected by estimating specific combining ability (SCA) effects of each F_1 hybrid combination. For S.L., six hybrids out of 15 F_1 hybrids revealed significant and highly significant negative SCA effects ranging from -4.72 for S26 × PI/512788 to -0.74 for Lungo ditoscan × Eskandrani. Regarding N.B./P., nine hybrids out of 15 F_1 hybrids had highly significant positive SCA ranging from 0.53 for Lungo ditoscan × PI/512788 to 0.06 for S24 × Eskandrani. With respect to N.L./P., seven out of 15 F_1 hybrids had highly significant positive SCA ranging from 4.17 for Lungo ditoscan×S26 to 0.56 for CGN11916× PI/512788 which showed significant SCA effect values. Ten out of 15 F_1 hybrids, namely Lungo ditoscan × S24; Lungo ditoscan × CGN11916; Lungo ditoscan × PI/512788; Lungo ditoscan × Eskandrani; S26 × S24; S24 × CGN11916; S24 × Eskandrani; CGN11916 × PI/512788; CGN11916 × Eskandrani and PI/512788 × Eskandrani, showed significant desirable negative SCA effects for D.O.F. Six out of 15 F_1 hybrids, namely Lungo ditoscan×S24; Lungoditoscan × CGN1191; Lungo ditoscan × Eskandrani; S24 × CGN1191; S24 × PI/512788 and CGN11916 × PI/512788 revealed significant and highly significant positive SCA effects for F.W. Eleven out of 15 F_1 hybrids had highly significant positive SCA effects for N./F./P. Ten hybrids out of 15 F_1 showed highly significant positive SCA effects ranging from 82.35 for S26 × S24 to 1542.38 for CGN11916 × PI/512788 for Y./P. Six hybrids revealed significant desirable negative values of SCA in case of F.L. and the best combinations were Lungo ditoscan (P_1) × S26 (P_2); Lungo ditoscan (P_1) × S24 (P_3); S26 (P_2) × Eskandrani (P_6); S24 (P_3) × CGN11916 (P_4); CGN11916 (P_4) × PI/512788 (P_5) and PI/512788 (P_5) × Eskandrani (P_6). Regarding F.D., six out of 15 F_1 hybrids were the best hybrids as they showed significant SCA effects, they are included Lungo ditoscan (P_1) × S26 (P_2); Lungo ditoscan (P_1) × PI/512788 (P_5); Lungo ditoscan (P_1) × Eskandrani (P_6); S26 (P_2) × CGN11916 (P_4); S26 (P_2) × Eskandrani (P_6) and S24 (P_3) × CGN11916 (P_4).

Table 6. General combining ability effects (gi) of six parents for all traits.

Parents	SL	NB	NL	D.O.F	FW	N|F	Y / P	FL	FD
P_1	2.19**	0.39 **	- 1.37**	1.52 **	2.38 **	-7.49 **	-520.32 **	1.24 **	-0.05
P_2	0.01	0.01	0.81**	0.80 **	-2.57 **	0.51 **	-29.04 **	-0.74 **	-0.08
P_3	- 1.26 **	-0.07 **	- 0.30*	-1.41 **	-1.92 **	3.47 **	232.06 **	-0.54 *	0.00
P_4	0.55*	-0.05 *	0.65**	-0.88 **	4.67 **	3.26 **	351.76 **	0.86 **	0.15 *
P_5	0.37	-0.10 **	1.00**	1.12 **	0.32	0.94**	102.89 **	-0.65**	-0.02
P_6	- 1.86**	-0.18 **	- 0.80**	-1.15 **	-2.87 **	-0.68 **	-137.35**	-0.18	-0.00
SE(gi)	0.21	0.01	0.09	0.08	0.37	0.10	1.97	0.13	0.04
LSD (gi-gj)	0.51	0.002	0.10	0.08	1.52	0.12	42.74	0.18	0.02

* and ** Significant differences at 0.05 and 0.01 levels of probability, respectively

Table7. Specific combining ability effects (sij) of 15 F_1 hybrids for all traits.

Parents	S.L.|	N.B.|P.	N.L.|P.	D.O.F	F.W.	N.F.|P.	Y|P	F.L.	F.D.
P_1xP_2	2.66 **	0.30**	4.17**	0.07	3.72 **	6.94 **	630.06 **	-1.20**	-0.15**
P_1xP_3	-3.87 **	0.07 **	-0.85**	-0.26 *	7.08 **	2.43 **	335.29 **	-2.22**	-0.04
P_1xP_4	4.84 **	0.16 **	2.67**	-0.46 **	0.71	-2.23 **	-193.54 **	0.43*	0.60**
P_1xP_5	2.43 **	0.53 **	-1.09**	-0.45 **	-0.19	1.99**	111.07 **	-0.28	-0.20**
P_1xP_6	-0.74 *	0.00	0.05	-0.52 **	4.98 **	0.47 **	136.71 **	0.50**	-0.29**
P_2xP_3	-0.09	0.21**	2.03**	-1.35 **	-4.83**	3.58 **	82.35 **	0.26	-0.02
P_2xP_4	3.36 **	0.15 **	0.89**	-0.01	-3.76**	20.79 **	1495.24**	0.74**	-0.14*
P_2xP_5	-4.72 **	-0.06 **	-0.87**	-0.00	-5.12**	-8.95 **	- 782.49 **	0.68**	-0.01
P_2xP_6	-1.56 **	-0.04 *	-1.00**	0.19	0.59	-3.37 **	-211.24**	-0.72**	-0.14*
P_3xP_4	6.36 **	0.08**	0.00	-0.31 *	7.04 **	7.46 **	891.35 **	-0.86**	-0.40**
P_3xP_5	2.88 **	-0.07 **	0.04	-0.06	1.28 *	13.25 **	1016.36 **	0.87**	0.10
P_3xP_6	2.64 **	0.06 **	3.97**	-0.40 **	-5.18 **	2.08 **	-13.33 **	-0.12	-0.01
P_4xP_5	-2.87 **	0.00	0.56**	-1.33 **	4.64 **	16.05 **	1542.38**	-0.65**	0.60**
P_4xP_6	-2.51 **	0.13 **	1.10**	-1.01**	-8.35 **	4.14 **	98.89 **	1.15**	0.51**
P_5xP_6	4.61 **	0.03	-1.46**	-0.46**	-3.78 **	-1.74 **	-228.10 **	-0.43*	0.03
SE (Sij)	0.59	0.04	0.26	0.23	1.02	6.94	5.40	0.35	0.11
LSD (Sij- Sik)	2.02	0.13	0.89	0.78	3.50	2.43	18.57	1.21	0.37
LSD (Sij – Skl)	1.87	0.12	0.82	0.72	3.24	-2.23	17.19	1.12	0.34

* and ** Significant differences at 0.05 and 0.01 levels of probability, respectively.

Heritability

The data in Table 8 appeared that Estimates of narrow sense heritability (h^2n.s.%) was found to be relatively high for D.O.F. (78.33 %), moderate for N.B./P. (54.05%) and F.L.(57.98 %) which reflecting the greatest role of additive gene effects in the inheritance of such traits. On the other hand, S.L.; N.L./P.; F.W.; N.F./P.; Y./P. and F.D. showed low h^2n.s. values of 21.00, 25.13, 36.63, 18.85, 16.93, 38.80 and 7.58 %, respectively. Indicating the predominant of non-additive gene effects in the inheritance of these traits. In addition, the estimates of heritability in broad sense (h^2b.s. %) showed larger in magnitudes than their corresponding estimates in narrow sense for all traits. The non-additive variance (δ^2D) showed higher than the additive variance (**δ^2A**) for all traits except for D.O.F and F.L., indicated that non-additive variance mainly controlled in these traits. Therefore, hybridization would be successful method for improving these traits. While, the other traits were controlled by additive variance. Therefore, selection would be successful method in improving D.O.F and F.L. The ratio of additive variance to non-additive variance confirmed this observation which was lower than unity in all traits except for D.O.F and F.L. which were higher than unit. These results in agreement with those obtained by EI-Meghawry *et al.* (2001) for S.L. and N.L. in watermelon; El-Lithy (2002); Abd-El-Maksoud *et al.*(2003) in squash; EL-Shimi *et al.* (2003) in melon and El-Hadi and El-Gendy (2004) in squash.

Table 8. Estimates of different genetic parameters and heritability for all traits.

Genetic parameters	S.L.	N.B./P.	N.L./P.	D.O.F	F.W.	N.F./P.	Y/P	F.L.	F.D.
δ^2E	0.44	0.08	0.09	0.07	1.32	0.10	37.07	0.16	0.01
δ^2g	2.00	0.04	0.93	1.64	9.05	16.06	95718.40	0.69	0.01
δ^2A	4.01	0.00	1.85	3.28	18.10	32.12	191436.80	1.39	0.01
$\delta^2S = \delta^2D$	14.64	0.07	5.44	0.84	29.10	138.17	939023.30	0.85	0.11
δ^2A/ δ^2D	0.27	0.03	0.34	3.89	0.60	0.23	0.20	1.63	0.09
$H^2{}_{bs}$%	97.71	98.65	98.85	98.45	97.33	99.94	99.10	93.48	89.39
$H^2{}_{ns}$%	21.00	54.05	25.13	78.33	36.63	18.85	16.93	57.98	7.58

CONCLUSION

In this investigation, the F_1 hybrid $P_1 \times P_2$ exhibited high estimated heterosis values over the mid-parent for N.L./P. and F.D. The hybrid $P_1 \times P_3$ showed high heterosis over the mid-parent and better parent for F.W. and F.L. The hybrid $P_1 \times P_5$ displayed high heterosis values over the mid-parent for N.B./P. The hybrid $P_2 \times P_3$ showed high estimated heterosis values over better parent for N.B/P. The hybrid $P_2 \times P_4$ showed high estimated heterosis over mid-parent and better parent for N.F./P. The hybrid $P_2 \times P_5$ showed high estimated heterosis values over mid-parent and better parent for S.L. The hybrid $P_3 \times P_4$ showed high heterosis over better parent for F.D. The hybrid $P_3 \times P_6$ showed high estimated heterosis over better parent for N.L./P. The hybrid $P_4 \times P_5$ showed high estimated heterosis over better parent for D.O.F. and over mid-parent and better parent for Y./P. The hybrid $P_4 \times P_6$ revealed high heterosis values over mid- parent for D.O.F. Moreover, these hybrids revealed high specific combing ability for these traits. So, it recommended that the plant breeder could be used these hybrids to improve these traits in squash.

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التقييم الوراثي لبعض الصفات الاقتصادية في قرع الكوسه

أشرف حسين عبد الهادي [1]، محمد حسن عبد العزيز [1]، منال عبد الرحمن عبد الله [2] و مريم جورج اسحق[1]
[1] قسم الوراثة – كلية الزراعة – جامعة المنصورة.
[2] معهد بحوث البساتين – مركز البحوث الزراعية بسخا - مصر.

تهدف هذه الدراسة الى تقدير أهمية قوه الهجين والقدرة العامة والخاصة على التألف ومعامل التوريث في المدي الواسع والضيق للصفات الخضرية والزهرية وصفات المحصول وجودته باستخدام 15 هجين تم الحصول عليهم من نظام التهجين النصف الدائري 6× 6 الغير شامل علي الهجن العكسية. أشارت نتائج تحليل التباين لجميع التراكيب الوراثية الي وجود اختلافات عالية المعنوية لجميع الصفات المدروسة عدا الآباء ذات قيمة معنويه فقط لصفة قطر الثمرة ، بينما اظهرت الاباء × الهجن قيم غير معنوية لصفتي متوسط وزن الثمرة وقطر الثمرة بينما كانت ذات قيمه معنوية لصفه طول الثمرة.لا يوجد هجين ذا قيمة عالية لجميع الصفات المدروسة. كانت أعلي قيم معنويه مرغوبه لقوه الهجين مقارنه بمتوسط الأبوين هي -17,19، 44.14، 61,36، -5,46، 17,26، 296,41 ، 308,83، -23,58، - 12,79% وذلك للصفات طول الساق ،عدد الأفرع، الأوراق لكل نبات، عدد الأيام لظهور أول زهرة مؤنثة، متوسط وزن الثمرة وعدد الثمار لكل نبات وكميه المحصول لكل نبات وطول الثمرة وقطر الثمرة، على التوالي كما كانت قوه الهجين مقارنة بأفضل الآباء هي- 37,66،32,47،18,18، -6,97، 14,77 ، 205,54، 204,98 ، -32,63،- 14,48% لذات الصفات، على الترتيب .أظهر تحليل الاختلافات لكل من القدرة العامة على التآلف (GCA) والقدرة الخاصة على التآلف (SCA) وجود اختلافات عالية المعنوية لجميع الصفات المدروسة . وأن القدرة العامة على التآلف (GCA) كانت أعلي من القدرة الخاصة على التآلف (SCA) لجميع الصفات المدروسة. كما أظهرت سلالات الآباء أن الأب الأول والثاني الثالث والرابع والخامس والسادس قوة تألف عامة عالية لصفات عدد الفروع على النبات ،طول الثمره، عدد الأيام لظهور الزهرة المؤنثة الأولي، عدد ايام ظهور الثمارعلى النبات ،متوسط وزن الثمرة، طول الثمرة، عدد الأوراق ، طول الساق. كانت تقديرات معامل التوريث بمعناها الواسع (h^2b.s.%) أكبر من التقديرات المقابلة لها بالمعنى الضيق(h^2n.s.%) لجميع الصفات المدروسة.