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INHERITANCE OF SOME ECONOMICAL TRAITS IN SQUASH (*Cucurbita pepo*, L.)

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ABSTRACT

Mode of gene action for some economical traits in squash was examined by 4 x 4 diallel crossing using two American squash varieties as well as two local varieties. All these varieties belong to the species *Cucurbita pepo* L. All 16 entries, which included 4 parents and 12 F_1 hybrids were evaluated at Experimental Station, Faculty of Agriculture, Mansoura University. Data were recorded on plants within plots on thethree types of economical traits (vegetative, earliness and yield traits). The obtained results revealed that the mean squares of genotypes and its components, GCA, SCA and reciprocal effects were highly significant for all studied traits, indicating additive and non-additive genetic variance in addition to cytoplasmic genetic factors contributed in the inheritance of studied traits.

Also the results showed that the average means of the F_1 hybrids, F_{1r} reciprocal hybrids and the average overall hybrids ($F_{1\ 1r}$) were exceeded their mid parents (MP) for all studied traits except for sex ratio and days to first female flower, which were desirable lower forward increasing in female flower and earliness, respectively. Although, White Bush is the best combiner among this set of varieties for vegetative traits, Eskandarani variety was the best combiner among the studied set for earliness and total yield traits.

Most pairs of traits exhibited negative genotypic and phenotypic correlations coefficient, while the following pairs of traits showed positive and significant correlations: sex ratio (SR) with days to the first female flower (DFFF); position of the first female flower (NFFF) with days to the first female flower (DFFF); early yield (WF7P/P and NF7P/P) with total yield (TNF/P and TWF/P). Therefore, it seemed that selection for improving one or more of these traits would improve the others.

Therefore, plant breeders would design programs, which make use of these advantages to select superior lines from the advanced segregating generations of the high yielding F1 hybrids.

Keywords: Squash, Combining ability, Heterosis, Genetic parameters.

INTRODUCTION

Summer squash is belonging to the genus Cucurbitacea having a wide range of variability. It is an interesting crop plant for genetical studies. In Egypt, there are only two local varieties of squash namely, the Balady which is totally discarded for its prostrated growth habit and low yield, and Eskandrani which is characterized with high production beside the satisfaction of both producers and consumers at the present time, but may not in future. So, knowledge about the mode of gene action of economical traits, which directly contributes towards yield, in any crop like summer squash (*Cucurbita pepo*, L.) helps to formulate the genetic basis for breeding. When the additive genetic variance is the main component of the total genetic variation, a maximum progress would be expected through selection programs. On the other hand, the presence of a relatively high non-additive (including dominance) genetic variance indicate that the production of hybrids should be the ultimate improvement as a result of the direct relationship between non-additive gene action and heterotic affects.

Additive and non-additive genetic variance could be derived from the combining ability analysis. Therefore, the estimates of general and specific combining abilities are of great value in establishing the most proper breeding approach. In this respect, El-Gendy (1999) reported that general combining ability (GCA) and specific combining ability (SCA) as well as reciprocal effects were significant for days to first female flower, numbers of fruits in the first 7 pickings, total number and weight of fruits per plant. While, it wasn't significant for the number of nodes to the first female flower. In a diallel cross system among seven inbred lines derived from Eskandrani cultivar, El-Sharkawy (2000) regarded that a parental inbred line L_2 could be considered as a good general combiner for harvesting early yield. His results also indicated that the two crosses L_2 x L_6 and L_2 x L_5 gave the earlier F_1 hybrids and these crosses possessed the highest estimates of SCA effect. Mohanty (2000) on pumpkin, reported that the mean squares due to general (GCA) and specific combining ability (SCA) effects were significant for number of fruits per plant and yield per plant.

Thus, this investigation aimed to present further information dealing with nature of gene action and heterosis for some economical traits as well as genotypic and phenotypic correlations among pairs of these traits in squash.

MATERIALS AND METHODS

Four squash varieties belong to the species *Cucurbita pepo* L. were used in this investigation. These genetic materials included two American varieties (White Bush and White Bush Scallop), as well as two local varieties (Eskandrani and Balady). In order to insure the purity of these varieties, some plants from each variety were selfed pollinated for three successive generations at the Experimental Station, Faculty of Agriculture, Mansoura University.

Selfed seeds from each variety were planted during the summer season of 2001 at the Experimental Station, Faculty of Agriculture, Mansoura University. At the flowering time, all single crosses including reciprocal were made among these varieties according to a complete diallel crosses mating design. The crosses yielded six F_1 hybrids (F_1) and six F_1 reciprocal hybrids (F_{1r}). Therefore, the genetic materials included four parents and 12 F_1 hybrids (6 F_1 & 6 F_{1r}). All 16 entries were evaluated in a field trial at the Experimental Station, Faculty of Agriculture, Mansoura University, in the summer season of 2002.

The parents and their F_1 hybrids were arranged in a randomized complete blocks design with three replications. Each replicate (block) contained 16 experimental units or plots, which included four parents and their 12 F_1 hybrids. The experimental unit was one ridge 5 m long and 0.90 m wide. Hills were spaced at 0.35 m apart. Seeds were hand planted at the rate of three seeds per hill. At seedling stage, plants were thinned to one plant per hill. Land preparation, fertilizer applications and other field practices were carried out according to the recommendations of the Egyptian Ministry of Agriculture.

Data were recorded on individual plant within plots of the three replicates for the following traits: Plant height (PH cm), Leaf area (LA cm^2) and Sex ratio (SR) as a vegetative traits Number of nodes to the first female flower (NFFF), Days to the first female flower (DFFF), Number of fruits per plot for the first seven pickings (NF7P/p)and Weight of fruits per plot for the first seven pickings (WF7P/p) as earliness traits, Total number of fruits per plot (TNF/P) and Total weight of fruits per plot (TWF/P), as a total yield.

Statistical analysis:

Analysis of variance was made to test the significance of differences among the four parental varieties, 6 F_1 hybrids, 6 F_{1r} reciprocal hybrids. The differences between any two means were tested for significance using the least significance difference values (L.S.D.) at both 5% and 1% levels of probability according to Steel and Torrie (1960).

The estimated amounts of heterosis were determined as the percentage increase of the overall mean of F_1 hybrids, F_1 reciprocal hybrids (F_{1r}) and the average overall mean of the F_1 hybrids and their reciprocal hybrids ($F_{1,1r}$) over the average of the mid parents (MP) or above the better parent (BP).

To determine general (GCA) and specific (SCA) combining ability as well as reciprocal effects, the analysis of combining ability was made for all studied traits. The procedures of this analysis were described by Griffing's method I (1956) and outlined by Singh and Chaudhary (1985).

The mathematical model for combining ability analysis is:

$Y_{ij} = m + g_i + g_j + S_{ij} + r_{ij} + 1/bc \sum\sum eijk$

Where:

Y_{ij}: is the mean of i x j^{th} genotypes over k,

g_i : is the general combining ability (gca) effect of i^{th} parent,

g_j : is the general combining ability (gca) effect of j^{th} parent,

S_{ij}: is the specific combining ability effect for each cross,

r_{ij}: is the reciprocal effect and $1/bc \sum\sum$ eijk is the mean error effect.

Furthermore, the general combining ability effects (g_i) for each line and specific combining ability effects (S_{ij}) for each cross were determined for all the studied traits.

On the basis of the expected mean squares, estimates of GCA variance (σ^2g), SCA variance (σ^2s) and variance due to reciprocal effect (σ^2r) were obtained for all studied traits. These estimates could be expressed in terms of the covariance among the two types of relative in a diallel cross. However, general combining ability variance (σ^2g) is equivalent to the covariance among half-sibs, and specific combining ability variance is equivalent to the covariance among full-sibs minus twice of covariance among half sibs (Hallaur and Miranda, 1988). The covariance of relative were translated into appropriate genetic compounds of variance as outlined by Matzinger and Kempthorne (1956) and Cocherham (1963).

In addition, the dominance degree ratio as well as the heritabilities were determined.

Genotypic (r_g) and phenotypic (r_{ph}) correlations among *pairs of studied* traits were calculated according to Singh and Chaudhry (1985). The *significance of* r_g *and* r_{ph} were tested using the T-test at 0.05 and 0.01 levels of significance according to Cochran and Cox (1957).

RESULTS AND DISCUSSION

Squash shows a wide range of variation for vegetative, earliness and yield traits. Plant breeders are interested in an understanding the nature and causes of variations in order to design the proper breeding programs to improve those characters. Therefore *in this investigation, four different* parental varieties, in addition to all possible combinations among them including reciprocal hybrids were evaluated for the important economical traits in squash. Then, the obtained data for these genotypes were setup in different statistical analysis and comparisons to understand the nature of variation which *is present in these genetic materials.*

Analysis of variance was made for the parents and F_1 hybrids and the obtained results for all studied traits are presented in Table 1. Test of significance of the mean squares of genotypes, indicated the presence of highly significant differences among these genotypes. This finding was *obtained for all studied traits* with no exceptions. These traits were plant height (PH), leaf area (LA) and sex ratio (SR), which represent vegetative traits; number of node to the first female flower (NFFF), number of days to the first female flower (DFFF), number of fruits per plot *for the first seven pickings* (NF7P/P) and weight of fruits per plot for the first seven pickings (WF7P/P), which *represent* earliness traits; total number of fruits per plot (TNF/P) and total weight of fruit per plot (TWF/P), which represent total yield.

Table 1. Analysis of variances and mean squares for all studied traits obtained from all genotypes

S.O.V	df	Vegetative traits			Earliness traits				Yeild	
		PH	LA	SR	NFFF	DFFF	NF7P/P	WF7P/P	TNF/P	TWF/P
Reps.	2	52.4	3335	0.206	0.28	0.603	2.1	0.21	99.72	0.87
Genc.	15	701.0**	114086**	1.16**	3.93**	39.5**	675.8**	9.38**	?472**	46.9**
Error	30	18.0	7914	0.071	0.26	2.36	14.6	0.55	72.69	1.37

****, Significant at 0.01 level of probability.**

The significance of mean squares of genotypes suggested that the presence of large variations among these traits and the *planned comparisons* for the understanding of the nature of variation and the determination of the *amounts* of heterosis for all traits are valid, and therefore could be made. Thus, the partition of the genetic variation to its components could be made through the analysis of complete diallel crosses. Similar results were obtained by El-Gendy *(1999) and El-Sharkawy (2000).*

The means of the four parents and their F_1 hybrids for all the studied traits are presented in Table 2. The means showed that no specific parent was superior for all studied traits. Regarding vegetative traits, White Bush (P_1) was the best one for plant height and sex ratio, while Balady (P_3) variety *exhibited the highest mean for leaf area.* With respect earliness traits, the results revealed that position of the first female flower (NFFF) ranged from 3.42 to 4.40 for Balady and White Bush Scallop varieties, respectively. These results indicated that Balady variety followed by Eskandrani started to flowering earlier than other studied varieties. This finding would be confirmed by the means of days to the first female flower (DFFF), which ranged from 42.93 to 50.95 days for Eskandrani and White Bush varieties, respectively. Furthermore, number of fruits per plot for the first seven pickings (NF7P/P) ranged from as low as 5.67 fruits per plot up to 28.33 fruits per plot for White Bush and Eskandarani varieties, respectively, indicated that White Bush is a very late variety, while Eskandrani followed by Balady are early maturing varieties. Similar trend was noticed for weight of fruits per plot for the first seven pickings (WF7P/P), which ranged from 0.90 and 3.38 kgs for White Bush and Eskandrani, respectively. The values of the means indicated that Eskandrani (P_2) variety gave the highest number of fruits followed by Balady (P_3) variety and these two parents also gave the highest weight of fruits. Therefore, it could be indicated that these varieties were not only the earliest varieties, but also the highest yielding varieties.

Table 2. Mean performance of the parental varieties and their F_1 hybrids for all studied traits

Geno.	Vegetative traits			Earliness traits				Yield	
	PH	LA	SR	NFFF	DFFF	NF7P/P	WF7P/P	TNF/P	TWF/P
P_1	85.07	2661.00	4.72	4.00	50.95	5.67	0.903	46.90	5.62
P_2	46.87	2176 67	2.72	3.93	42.93	28.33	3 38	125.00	13.45
P_3	78.01	2769.67	3.00	3.42	46.08	20.67	2.55	80.37	10.78
P_4	37.40	1213.33	3.85	4.40	47.07	13.33	1 09	58.00	5.69
$P_1 \times P_2$	79.93	3265.66	2.02	3.18	40.67	42.08	4.50	138.15	15.92
$P_1 \times P_3$	74.07	2837.33	3.51	5.85	49.90	23.17	2.26	68.73	9.09
$P_1 \times P_4$	63.20	2733.33	3.07	5.72	44.70	15.09	2.38	91.93	11.29
$P_2 \times P_3$	79.27	2262.66	2.70	3 07	39.00	52.66	5.58	123.73	14.76
$P_2 \times P_4$	86.50	1936.33	2.86	4.47	42.77	26.18	6.72	114.37	19.30
$P_3 \times P_4$	86.20	2373.33	2.75	5.07	42.07	23.40	3.36	77 53	12.30
$P_2 \times P_1$	71.40	2204.33	2.81	3.53	41.47	48.52	3.62	100.93	12.69
$P_3 \times P_1$	79.07	2517.00	2.87	3.07	41.87	35.03	4.09	92.20	11.66
$P_4 \times P_1$	79.33	3480.66	3.79	6.27	44.43	20.52	2.39	91.75	11.74
$P_3 \times P_2$	59.27	1647.33	2 96	3.20	38.38	60.56	7.08	142.27	19.10
$P_4 \times P_2$	46.87	2398.66	3.25	5.67	45 87	25.06	2.96	105 77	14.24
$P_4 \times P_3$	66.47	3456.33	2.73	5.70	47.37	24.47	2.98	132.43	16.20
LSD 0.05	7.07	468.60	0.22	0 85	2.56	6.37	1.24	14.20	1.95
0.01	9 54	631.69	0.60	1.45	3.45	8.95	1.67	19.14	2.63

P1, P2, P3 and P4 are White Bush, Eskandrani, Balady and White Bush Scallop, respectively

Regarding F_1 hybrids and their reciprocal hybrids, the means showed that most of them generally exceeded their two parents, which were involved in the hybridization. It also appeared that some crosses exceeded their better parent, such as Eskandarani x White Bush Scallop ($P_2 \times P_4$) combination for plant height as well as White Bush x Balady ($P_1 \times P_3$) for leaf area. In addition, the earlier F_1 hybrids and/or F_1 reciprocal hybrids were obtained when the hybridization included any one of the earlier parents or both two varieties [Balady (P_3) and Eskandrani (P_2)] with respect to all the studied earliness traits. For instance, the crosses $P_2 \times P_3$, $P_3 \times P_1$ and $P_3 \times P_2$ exhibited the lowest nodes to the first female flower and days to the first female flower and these crosses exhibited also the highest number and weight of fruits in the first seven pickings. The best combination for yield as number and weight of fruits per plot were observed when the hybridization involved at least one of the highest two parents [*Balady* (P_3) *and Eskandarani* (P_2)]. Therefore, the means of total number of fruits per plot ranged from 68.73 to 142.27 for P_1 x P_3 and P_3 x P_2, respectively. While, it ranged from *9.09 to 19.30 kg for* fruits weight per plots. Indicating the best combination for total yield was Balady (P_3) x Eskandrani (P_2).

Heterosis relative to mid parents and better parent for all studied traits were determined and the obtained results are presented in Table 3. The results showed that the average means of the F_1 hybrids, F_{1r} reciprocal hybrids and the average overall hybrids ($F_{1,\ 1r}$) were exceeded their mid parents (MP) for all studied traits except for sex ratio and days to first female flower, *which were desirable lower forward increasing in female* flower and earliness, respectively. Therefore, the amount of heterosis relative to mid parents (MP) were desirable highly significant for all studied traits with respect to F_1, F_{1r} and $F_{1,\ 1r}$ hybrids. On the other hand, although the amount of heterosis relative to better parent were negative in all occasion with respect to plant height, number of leaves per plant and leaf area, some hybrids were highly exceeded their better parent, such as Eskandarani (P_2) x White Bush Scallop (P_4) for plant height and *White Bush Scallop* (P_4) *x White* Bush (P_1) for leaf area as observed earlier from the means of genotypes.

Table 3. *Estimates of heterosis from the mid-parent (MP) and better parent (BP) for all studied traits*

	Vegetative traits			Earliness traits				Yield	
	PH	LA	SR	NFFF	DFFF	NF7P/P	WF7P/P	TNF/P	TWF/P
MP	61.84	2205.2	3.57	3.94	46.76	17.00	1.98	77.48	8.88
BP	85.07	2769.6	2.72	4.40	42.93	28.33	3.38	125.00	13.45
F_1	78.19	2568.1	2.82	4.56	43.18	30.43	4.13	102.41	13.77
F_{1r}	67.07	2617.5	3.07	4.58	43.23	35.69	3.85	110.89	14.27
$F_{1,1r}$	72.63	2592.7	2.94	4.57	43.21	33.06	3.99	106.65	14.02
H (F_1, MP) %	26.44**	16.5**	-21.01**	15.74**	-7.66**	79.0**	108.6**	32.18**	55.1**
H (F_{1r}, MP) %	8.46**	18.7**	-14.01**	16.24**	-7.55**	109.9**	94.4**	43.12**	60.7**
H($F_{1,\ 1r}$, MP) %	17.45**	17.6**	-17.65**	15.99**	-7.59**	94.5**	101.5**	37.65**	57.9**
LSD $_{0.05}$ F_1orF_{1r}	3.23	213.89	0.20	0.39	1.17	2.91	0.57	6.48	0.89
$_{0.01}$ F_1 or F_{1r}	4.35	288.33	0.27	0.52	1.53	3.92	0.76	8.74	1.20
LSD $_{0.05}$ $F_{1,1r}$	2.89	191.31	0.18	0.35	0.26	2.60	0.51	5.80	0.80
$_{0.01}$ $F_{1,1r}$	3.89	257 89	0 24	0.47	0.72	3.51	0.68	7.82	1.07
H (F_1, BP) %	-8.09*	-7.28	3.68	3.63	0.58	7.41	22.19	-18.1**	2.40
H (F_{1r}, BP) %	-21.2**	-5.49	12.86	4.09	0.69	25.99*	13.91	-11.3*	6.14
H ($F_{1\ 1r}$, BP) %	-14.2**	-6 39	8.09	3.86	0.63	16.70*	18.05	-14.7**	4.29
LSD $_{0.05}$ F_1 or F_{1r}	5.40	357.90	0.35	0.65	1.95	4.86	0.95	10.85	1.49
$_{0.01}$ F_1 or F_{1r}	7.28	482.46	0.46	0.87	2.63	6.56	1.28	14.62	2.01
LSD $_{0.05}$ $F_{1,1r}$	5 20	344.88	0.33	0.63	1.74	4.69	0.91	10.45	1.43
$_{0.01}$ $F_{1,1r}$	7.02	464.91	0.33	0.84	2.54	6.32	1.23	14.09	1.93

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

Regarding earliness traits, it appeared that although the position of female flower in F_1 hybrids were higher than their parents, it showed earlier yield and days to the first female flower than mid-parents (MP). Thus, the amount of heterosis relative to mid-parents (MP) and better parent (BP) were undesirable positive and highly significant for the position of the first female flower (NFFF). However, it was desirable negative and highly significant for days to the first female flower, when F_1, F_{1r} and $F_{1, 1r}$ were compared with their mid-parents. Furthermore, the amounts of heterosis relative to mid-parents and better parent (BP) for early yield as number and weight of fruits were desirable positive in the three cases (F_1, F_{1r} and $F_{1, 1r}$).

The amount of heterosis were -7.59, 94.47 and 101.51 for days to the first female flower (DFFF), number of fruits in the first seven picking (NF7P/P) and weight of fruits in the first seven pickings (WF7P/P), respectively.

Concerning the total yield, the amounts of heterosis for these traits were positive and highly significant. Although, the heterotic value ranged from 32.18% (F_1) to 43 12% (F_{1r}) for total number of fruits per plot, it was ranged from 55.07% (F_1) to 60.70% (F_{1r}) for weight of fruits per plot. The estimates of heterosis from the comparison of F_1, F_{1r} and $F_{1,1r}$ with their better parent showed negative significant values for total fruit number per plot. The heterosis value were positive and insignificant for total fruit weight per plot relative to better parent. They were 2.40, 6.14 and 4.29% for F_1, F_{1r} and $F_{1,1r}$, respectively. This finding is confirmed by the results obtained from other studies made by, El-Gazar and Zaghloul (1984), Abd El-Maksoud (1986), Korzeniewska and Niemirowicz (1993), Ghai *et al.* (1998), Firpo *et al.* (1998) and El-Gendy (1999) who observed heterotic effect in most of economical traits in squash.

The results obtained from analysis of combining ability and the mean squares of complete diallel crosses for all studied traits are presented in Table 4. Tests of significance of the mean squares of general combining ability (GCA) and specific combining ability (SCA) showed that there are highly significant differences for all studied traits. However, general combining ability (GCA) mean squares were larger in magnitudes than the corresponding values of specific combining ability (SCA) and reciprocal effects (Rec) mean squares with respect to all studied traits. This fact could be confirmed by the ratio of GCA/SCA, as well as GCA/REC mean squares, which exhibited values more than one in all studied traits. These results suggest that both additive and non-additive genetic variances contributed in the genetic expression of these traits. Also, the results revealed that reciprocal effects mean squares were highly significant for all studied traits, suggesting that the variation observed in these traits was not only due to nuclear genetic factors, but also the cytoplasmic factors contributed in the inheritance of them. The present results are in agreement with those reported by El-Gendy (1999) and El-Sharkawy (2000).

General combining ability effects (g_1) for each parental variety were estimated and the obtained results for all studied traits are shown in Table 5. It could be seen from this table that the variety White Bush (P_1) showed positive significant GCA effects for all vegetative traits [Plant height (PH), leaf area (LA) and sex ratio (SR)], while Eskandrani variety (P_2) contributed significant negative (GCA) for these characters. Suggesting that White Bush is the best combiner among this set of varieties for vegetative traits.

Table 4. Analysis of combining abilities and mean squares of F_1 hybrids for all studied traits

S.O.V.		Vegetative traits			Earliness traits				Yield	
	Df	PH	LA	SR	NFFF	DFFF	NF7P/P	WF7P/P	TNF/P	TWF/P
GCA	3	414.6**	463602**	0.77**	2.74**	24.05**	561.51**	6.86**	2106.0**	33.84**
SCA	6	150.4**	422846**	0.44**	1.07**	12.24**	259.38**	2.67**	560 02**	15.74**
Rec	6	226.5**	296069**	0.15**	0.83**	8.61**	23.04**	1.72**	447.28**	6.40**
Error	30	6.01	26383	0.02	0.09	0.78	4.87	0.18	24.23	0.46
GCA/ SCA		2.76	1.10	1.75	2.56	1.96	2.16	2.57	3.76	2.15
GCA/ Rec		1 83	1.56	5.13	3.30	2.79	24.37	3.99	4.71	5.29

**, Significant at 0.01 level of probability.

Table 5. General combining ability effects (gi) of each parental lines for all studied traits

Var.	Vegetative traits			Earliness traits				Yield	
	PH	LA	SR	NFFF	DFFF	NF7P/P	WF7P/P	TNF/P	TWF/P
(P_1)	7.21**	299.19**	0 338**	0.0437	1.52*	-4.58**	-0.859**	-14.69**	-2.29**
(P_2)	-5.31**	-237.31*	-0.346**	-0.536**	-2.34**	9.92**	1.162**	22.52**	2.62**
(P_3)	5.11**	83.31	-0.159*	-0.310*	-0.25	3.53*	0.317	0 33	0.345
(P_4)	-7.01**	-145.19	0.167*	0.802**	1.07*	-8.87**	-0.619*	-8.16*	-0.682*
SE	0.750	49.73	0.047	0.090	0.271	0.676	0.132	1.507	0.207

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

Therefore, this parent posses favorable genes for improvements of these traits by its use in hybridization program. However, Eskandarani variety was the best combiner among the studied set of squash variety, which exhibited highly significant positive GCA effects values for early yield as number (NF7P/P), and weight (WF7P/P) of fruits in the first seven pickings, as well as desirable negative and highly significant GCA effect (g_i) values for the position of the first female flower (NFFF) and days to the first female flower (DFFF). Balady variety (P_3) ranked the second one after Eskandarani variety for earliness traits, which showed the same trend with respect to early yield as well as position and days to the first female flower. Suggesting that Eskandrani followed by Balady could be used in breeding program for improvement of earliness traits. In addition, Eskandrani variety (P_2) showed positive and highly significant general combining ability effects (g_i) for total yield as number (TNF/P) and weight (TWF/P) of fruits per plot. This indicates that this parent posses favorable genes and the improvement in yield could be attained by its use in hybridization program.

Specific combining ability effects (S_{ij}) of each cross for studied vegetative traits were determined and the obtained results are presented in Table 6. The results revealed that positive values of SCA effects (sij) for vegetative traits were observed in some crosses. The P_3 x P_4 had high estimates for plant height (PH); leaf area (LA), while it was desirable negative significant (Sij) effects for sex ratio (SR). This finding indicated the best combination for vegetative traits is Baladi by White Bush Scallop followed by the combination Wh e Bush x Eskandrani (P_1 x P_2).

The three combinations (Eskandrani x Balady), (White Bush x Eskandrani) and (White Bush x White Bush Scallop) had high negative SCA estimates for the first female flower anthesis.

Table 6. Specific combining *ability effects* (S_{ij}) *of each cross* for all studied traits

Crosses	Vegetative traits			Earliness traits				Yield	
	PH	LA	SR	NFFF	DFFF	NF7P/P	WF7P/P	TNF/P	TWF/P
$P_1 \times P_2$	3 84	177.27	-0.68**	-0.56	-2.21*	10.91**	0.27	12.33*	1.23
$P_1 \times P_3$	-5.69*	-201.18	-0.09	0.32	0.52	1.10	0.23	-4.55	-0.42
$P_1 \times P_4$	1.14	457.15*	-0.18	0.74*	-2.12*	2.21	0.37	15.31**	1.74*
$P_2 \times P_3$	-0.47	-386.85*	0.24	-0.43	-2.81**	14.11**	1.36**	10.77*	1.22
$P_2 \times P_4$	9.07**	54.15	0.13	0.39	1 49	-4.48*	0.81	-3.68	2.09**
$P_3 \times P_4$	8.30**	480.85*	-0 37*	0.48	-0.20	0.23	-0.02	13.44*	1.85*
SES_{ij}	1.84	121.82	0.116	0.22	0.66	1.66	0.32	3.69	0.51

*, **, *Significant* at 0.05 and 0.01 levels of probability, respectively.
P1, P2, P3 and P4 are White Bush, Eskandrani, Baladi and White Bush Scallop, respectively

This indicates that these crosses produced female flowers earlier than those crosses having positive SCA effects. In general, the best combination for earliness traits was Eskandrani x Balady which exhibited desirable negative values for position of the first female flower and number of days to the first female flower as well as desirable positive Sij values for early yield as number and weight of fruits in the first seven pickings. Therefore, it could be observed that the best SCA effect was obtained from the cross between parents with good x good GCA effect. *The best combinations for total yield as* number (TNF/P) and weight (TWF/P) of fruits per plot were: White Bush x White Bush Scallop ($P_1 \times P_4$), Balady x White Bush Scallop ($P_3 \times P_4$), White *Bush x Eskandrani* ($P_1 \times P_2$) *and Eskandrani* x Balady ($P_2 \times P_3$) in their order, which showed positive values for SCA effect (Sij). Suggesting that the best SCA effects combination resulted from the crossing parents with poor x poor, good x poor and good x good GCA effects with respect to total yield as presented earlier from GCA effects for each parental lines. This findings refers to not necessary to crossing the high GCA effects varieties (good combiners) to obtain the highest SCA effects hybrids. In this respect, many authors obtained variable estimates for *both GCA and SCA effects in squash*, among them, El-Gendy (1999) and El-Sharkawy (2000) for vegetative traits, Dhillon and Sharma (1987), El-Gendy (1999) for earliness traits, Abd El-*Maksoud (1986) Helmy (1993), Arora et al.* (1996) and El-Sharkawy (2000) for total yield.

Understanding the nature of gene action with respect to the relative magnitudes of additive and non additive genetic variances requires the determination of the different variance components due to general specific combining ability variances. Thus, the variance components obtained from the complete diallel mating design could be translated into genetic parameters with respect to additive genetic *variances* (σ^2A) *and none additive* genetic variances including dominance (σ^2D) and reciprocal variances (σ^2r). Therefore, genetic parameters, which included additive (σ^2A), dominance (σ^2D) and *reciprocal effect* (σ^2r) *variances in addition to heritability* in broad (h_b%) and in narrow (h_n%) sense, as well as dominance degree ratio (Dd) were determined for all studied traits and the obtained results are presented in Table 7.

Table 7. The relative magnitudes of different genetic parameters for all studied traits

	Vegetative traits			Earliness traits				Yield	
	PH	LA	SR	NFFF	DFFF	NF7P/P	WF7P/P	TNF/P	TWF/P
σ^2A	68.85	17813	0.090	0.438	3.17	80.43	1.10	396.81	4.82
σ^2D	88.83	243977	0.255	0.603	7.05	156.62	1.53	329.72	9.41
σ^2r	110.26	134843	0.062	0.375	3.91	9.08	0.77	211.52	2.97
D.d	1.14	3.70	1.68	1.17	1.49	1.40	1.18	0.91	1.40
h^2_b%	57.55	61.89	80.05	69.26	68.50	94 44	73.46	75.50	80.58
h^2_n%	25.13	4 21	20.89	29.14	21.25	32 04	30 72	41.24	27.29

The results indicated that the magnitudes of dominance genetic variances were larger than their corresponding estimates of additive genetic variances for all studied traits. Suggests that both additive and non-additive (dominance) genetic variance contributed in the inheritance of these traits, while the dominance genetic variance predominant and played the major role in their inheritance. This findings could be confirmed by the dominance degree ratio (Dd), which were more than unity for these traits, revealing the major role of over dominance in the inheritance of them. This fact may explain the presence of heterosis for these traits. The results also illustrated that the importance of reciprocal variances (σ^2r), which were positive for all studied traits, suggesting that these traits not only controlled by nuclear genetic factors, but also the cytoplasmic genetic factors play an important role in the inheritance of these traits

The estimates of heritability in broad sense (h_b%) were larger in magnitudes than their corresponding estimates in narrow sense for all studied traits. These results insure again the major role of over dominance gene effects in the genetic expression of these traits. These results were in agreement with the results which were obtained by El-Gendy (1999) and El-Sharkawy (2000).

Genotypic (r_g) and phenotypic (r_{ph}) correlations among different pairs of the studied traits were studied and the obtained results are presented in Table 8. The results showed that both phenotypic and genotypic correlation coefficient values were close with respect to most of studied traits. Total weight of fruits per plot (TWF/P) trait showed highly significant genotypic and phenotypic positive correlation with

weight of fruits for the first seven pickings per plot (WF7P/P) and total yield as total number of fruits per plot (TNF/P). The correlation coefficients were 0.95 and 0.93 for genotypic correlations and 0.780 and 0.85 for phenotypic correlation (r_{ph}), respectively.

In general, most pair of traits exhibited negative genotypic and phenotypic correlations coefficient, while the following pairs of traits showed positive and significant correlations: sex ratio (SR) with days to the first female lower (DFFF); position of the first female flower (NFFF) with days to the first female flower (DFFF); early yield (WF7P/P and NF7P/P) with total yield (TNF/P and TWF/P). Therefore, it seemed that selection for improving one or more of these traits would improve the others. In this respect, the results obtained by many investigators, such as Ragab (1984) in cucumber, Kosba *et al.* (1993) in cantaloupe and Dhaliwale *et al.* (1996) in muskmelon were in agreement with the results obtained in our investigation in squash.

Table 8. Genotypic (above diagonal) and phenotypic (below diagonal) correlations for all pairs of studied traits

	PH	LA	SR	NFFF	DFFF	NF7P/P	WF7P/P	TNF/P	TWF/P
PH		0.48	-0.89	0.23	0.11	-0.12	-0.09	-0.17	0.05
LA	0 42		-0.12	0.43	0.33	-0.24	-0.33	0.09	0.01
SR	-0.05	-0.05		0.32	0.80**	-0.69**	-0.71**	-0.84**	-0.82**
NFFF	0.20	0.33	0.33		0.57*	-0.62*	-0.49	-0.29	-0.19
DFFF	0.12	0.17	0.59*	0.50*		-0.89**	-0.87**	-0.75**	-0.73**
NF7P/P	-0.05	-0.16	-0.53*	-0.52*	-0.76**		-0.84**	0.75**	0.68**
WF7P/P	-0.11	-0.18	-0.50*	-0.40	-0.71**	0.73**		0.81**	0.95**
TNF/P	-0.08	0 01	-0.66**	-0.21	-0.60*	0.68**	-0.08**		0.93**
TWF/P	0.04	0.01	-0.56*	-0.11	0.60	0.62**	0.78**	0.85**	

*, ** significant at 0.05 and 0.01 levels of probability, respectively.

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توريث بعض الصفات الإقتصادية فى قرع الكوسة

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طبيعة الفعل الجينى لبعض الصفات الإقتصادية تم دراسته من خلال ٤ x ٤ للتهجين الدائرى الكامل وذلك بإستخدام إثنين من الأصناف الأمريكية وهى الوايت بوش والويت بوش إسكالوب واثنين من الأصناف المحلية وهى الإسكندرانى والبلدى. تم تقيم الستة عشر تركيب وراثى (٤ آباء و ١٢ هجين شاملة الهجن العكسية) بمحطة البحوث الزراعية بكلية الزراعة- جامعة المنصورة. تم تسجيل البيانات على الصفات التالية: طول النبات، المساحة الورقية و النسبة الجنسية كصفات حضرية، موقع اول زهرة مؤنثة، عدد الأيام لظهور اول زهرة مؤنثة، عدد الثمار فى السبعة جمعات الأولى ووزن الثمار فى السبعة جمعات الأولى كصفات تبكير، عدد الثمار الكلى ووزن الثمار الكلى كصفات المحصول.

ومن التحليل الإحصائى للبيانات كانت النتائج المتحصل عليها كالتالى:

إختبار المعنوية أشار الى أن متوسط المربعات للتراكيب الوراثية ومكوناتها من القدرة العامة على التالف والقدرة الخاصة على التالف بالإضافة الى تأثير التهجين العكسى كانت عالية المعنوية لكل الصفات المدروسة، مما يشير الى أن كل من الفعل الجينى الإضافى والفعل الجينى السيادى بالإضافة الى العوامل الوراثية السيتوبلازمية تلعب دورا فى توريث هذه الصفات

بالمقارنة بين متوسط الهجن والهجن العكسية بمتوسط فانها تبين تفوق الهجن والهجن العكسية على متوسط الآباء فى كل الصفات فيما عدا النسبة الجنسية وعدد الأيام لظهور أول زهرة مؤنثة التى أظهرت نقصا مرغوبا عن متوسط الآباء اى تزيد عنه فى عدد الأزهار المؤنثة وكذلك أكثر تبكيرا.

رغم أن الصنف ويت بوش كان أحسن الأصناف المدروسة قدرة عامة على التالف هى الصفات الخضرية بينما الصنف أسكندرانى كان أكثرهم قدرة عامة على التالف لصفات التبكير وصفات المحصول.

رغم أن معظم أزواج الصفات المدروسة أظهرت إرتباط سالب. إلا أن كانت أزواج الصفات التالية مرتبطة إرتباط معنوى موجب: النسبة الجنسية مع عدد الأيام لظهور أول زهرة مؤنثة؛ موقع أول زهرة مؤنثة وعدد الأيام لظهور أول زهرة مؤنثة؛ المحصول المبكر والمحصول الكلى وبالتالى يمكن الانتخاب الى أى من هذه الصفات يؤدى الى التحسين فى اى من الصفات الأخرى.

ومن النتائج السابقة فيمكن لمربى النبات ان يستخدم هذة المميزات لتصميم برنامج تربية مناسب من أجل انتاج سلالات محسنة فى الأجيال الإنعزالية المتقدمة لاحد الهجن المتفوقة.