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NATURE OF GENE ACTION, HETEROSIS AND INBREEDING DEPRESSION OF YIELD AND YIELD COMPONENT TRAITS IN SQUASH (*Cucurbita pepo*, L.)

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ABSTRACT: The genetic materials used in the present investigation included five parental varieties of squash. These five varieties were crossed according to a complete diallel crosses mating design to produce 20 $F_{1,\,1r}$ hybrids and their 20 $F_{2,\,2r}$ generations. All genotypes were evaluated in a randomized complete blocks design. The obtained results could be summarized as follows:

Tests of significance of the mean squares of all 45 genotypes showed highly significance for all studied traits. The parental variety Eskandarani (P_1) showed the highest mean for number of fruits/plot, fruits yield/plot (kg) and fruits yield/plant (kg), whereas Zucchino striato d'Italia (P_3) was the highest parent for first picking date, fruit length (cm) and fruit shape index. The performances of the F_1 and F_{1r} hybrids were variable and there was no hybrid that gave the best performance for all studied traits. However, most F_1 hybrids exceeded their parental varieties.

The estimated values of heterosis over the mid-parents ($H_{M.P.}$%) showed highly significance for all studied traits and ranged in F_1 hybrids from - 9.43 to 19.2% for fruit diameter (cm) and fruits yield/plot (kg), respectively. In the case of heterosis over mid-parents versus $F_{1,\,1r}$ hybrids the estimated values ranged from - 6.74 to 19.4% for fruit diameter (cm) and fruits yield/plot (kg), respectively. Whereas, the estimates of heterosis versus the better parent ($H_{B.P.}$%) were highly significance for most studied traits. Concerning heterosis ($H_{B.P.,\ F1,1r}$), the obtain values ranged from - 21.36 for fruit diameter (cm) to 7.38% for first picking date. On the other hand, the results

also indicated the presence of inbreeding depression for most studied traits.

Estimates of GCA and SCA showed significance for all studied traits in the F_1 hybrids and F_2 generations. The results also showed that the magnitudes of GCA values were larger than their corresponding values of SCA for all studied traits at both $F_{1,1r}$ hybrids and $F_{2,2r}$ generations. Reciprocal effects (r) were significant for most studied traits.

The estimated values of h^2_n % ranged in F_1 hybrids from 0.00 % for first picking date to 60.38 % for fruit shape index and ranged from 0.00 to 67.5 % for first picking date and fruit length (cm) for F_2 generations, respectively. The highest estimated values of h^2_b % were 94.8 % in the F_1 hybrids for fruits yield/plant (kg) and 98.8 % in the F_2 generations for fruits yield/plot (kg).

INTRODUCTION

Heterosis over both mid-parents and better parent, heritability, nature of gene action and genetic parameters give useful informations regarding the choice of the parents which develop superior F_1 hybrids through suitable breeding programs. GCA is an indication for additive genetic variance, while SCA is an indication for non-additive genetic variance including dominance. The complete diallel crosses mating design give useful information concerning the relative importance of genetic parameter which enable vegetable breeders to start a useful squash breeding program.

In squash and other cucurbits, heterosis was investigated aiming to increase yield and quality traits. In this respect, El–Adl *et al.* (1988) obtained heterosis values ranged from 11.23 to 83.41% for total weight of fruits per plot and total number of fruits per plot, respectively. In cucumber, Farid (1990) showed that the estimated values of heterosis for yield traits were 31 and 1.4% versus the mid-parents and the better parent, respectively.

In agoor, El-Adl *et al.* (1996) showed that heterosis values versus the mid-parents were 4.78 and 50.02% for taste and yield per plant, respectively. They also reported that heterosis values versus the better parent were 26.40 and- 11.76% for yield per plant and fruit weight, respectively. El-

Gendy (1999) cleared that heterosis values versus the mid-parents were 9.79, 17.88, 17.18, 12.98 and 11.76% for number of fruits per plant, fruits weight per plant, fruit length, fruit diameter and fruit shape index, respectively. She also added that, estimates of heterosis versus the better parent were:- 10.20, - 6.11, -1.55, 28.32 and –13.28% for the same traits, respectively. In this respect, Abd El-Hadi *et al.* (2001) cleared that the values of heterosis versus the (M.P.), in sweet melon, ranged from 6.11 to 51.2% for L.F. (cm) and Y./P. (kg), respectively. Abd El-Maksoud *et al.* (2003) found that the estimated values of heterosis versus mid-parents were highly significant for all studied traits with respect to F_1, F_{1r} and all $F_{1,1r}$ hybrids.

Inbreeding depression (I.D.) was reported by Metwally (1985) in squash. He obtained highly significant I.D. for total yield. He also added that I.D. values were 17.7and 19.7% for number of fruits per plot and weight of fruits per plot, respectively. In the same time, Abd El-Hadi (1995) mentioned that all studied traits of agoor showed highly significant values of I.D., which were - 8.23, - 14.92 and 4.59% for fruit weight, yield per plant and shape index, respectively. In squash, El-Gendy (1999) estimated I.D. and observed that the estimates were: - 21.49, 20.97, - 1.71,- 2.49 and - 3.98% for number of fruits per plant, weight of fruits per plant, fruit length, fruit diameter and fruit shape index, respectively. On the other hand, Abd El-Rahman *et al.* (2000) investigated the presence of I.D. in pumpkins for fruit weight trait and found that the estimated values were 4.23 kg and 3.93 kg for F_1 hybrid and F_2 generation, respectively.

Concerning GCA, Farid (1990) showed that the magnitudes of dominance and additive genetic variances were larger than the reciprocal effects for all studied traits. In this respect, in *Cucumis melo var. Chate,* El-Adl *et al.* (1996) cleared that additive and non-additive genetic variances were important. They also added that additive genetic variances were important and composed the largest portion of genetic viability for all hybrids.

In sweet melon, Abd El-Hadi *et al.* (2001) evaluated 16 F_1 hybrids and the results revealed that the magnitudes of non-additive variances including dominance (σ^2D) were larger than their corresponding estimates of additive genetic variance (σ^2A) for all studied yield traits except taste trait.

Concerning heritability, in melon Kosba and El-Diasty (1991) cleared that the values of h^2_n% in F_1 hybrids were 14.08, 6.66, 29.41, 40.03 and 20.83% for fruit length, fruit diameter, fruit shape index, taste and thickness of flesh, respectively. They also added that the values of h^2_b % were 49.09, 44.72, 26.47, 88.87 and 41.67% for the same traits, respectively. In agoor, El-Adl *et al.* (1996) obtained high values of heritability in broad sense in F_1 hybrids. These values were 94.74, 77.33, 80.19 and 38.09% for fruit weight, yield per plant, fruit shape index and taste, respectively. They also added that the highest value of h^2_n % was 81.26% for fruit weight. In squash similar results were obtained by El-Gendy (1999). She mentioned that the estimated values of heritability in broad sense in F_1 and F_2 were (78.66 and 94.47%), (89.76 and 90.75%), (98.72 and 84.13%), (94.02 and 74.13%) and (97.05 and 90.73%) for number of fruits per plant, weight of fruits per plant, fruit length, fruit diameter and fruit shape index, respectively. Also, in sweet melon, Abd El-Hadi *et al.* (2001) indicated that the estimated values of h^2_b% were 97.31, 95.71, 92.38, 98.6 and 82.12% for N.F./P, W.F kg, Y./P. (kg), L.F. cm and D.F. (cm), respectively. On the other hand the h^2_n % ranged from 37.27 to 98.61% for N.F./P. and TSS%, respectively. Abd El-Maksoud *et al.* (2003) showed that H^2_b% were larger than their corresponding estimates in H^2_n% for all studied traits.

Therefore, the main objectives of this investigation were to estimate: heterosis over both mid-parents and better parent, inbreeding depression, heritability in both broad and narrow senses. Finally to use the hybrids obtained from a complete diallel crosses mating design to determine the important genetic parameters which enable vegetable breeders to start a useful squash breeding program.

MATERIALS AND METHODS

The genetic materials used in the present investigation included five squash parental varieties belongs to *Cucurbita pepo*, L. These varieties were Eskandarani (P_1), Bianco di sicilia (P_2), Zucchino striato d'Italia (P_3), Zucchino mezza lungo bianco (P_4)

and Libanese phoma (P_5). All these parental varieties are representing a wide range of variability in most of traits under study.

Plants from each parental variety were selfed for three generations to insure the purity of each variety. In the summer growing season of 1999, the five parental varieties were crossed according to a complete diallel crosses mating design to produce 20 $F_{1,1r}$ hybrids. In addition, the five parental varieties were also selfed to obtain enough seeds from each variety. In the summer season of 2000, all the 25 genotypes were cultivated. The 20 $F_{1,\ 1r}$ hybrids were selfed to produce new seeds of the F_2 and F_{2r} generations. Similarly, the five parental varieties were also selfed to produce sufficient seeds from each parental variety and crossed to produce the seeds of F_1 hybrids and their F_{1r} hybrids.

In 2001 growing season, all the 45 genotypes were evaluated in the field trial experiment. The experiment was executed in a private farm near by the Experimental Station of the Faculty of Agriculture Mansoura University. The Faculty Board has issued a permission for that purpose.

The experimental design used was the randomized complete blocks design with three replications. Each block consisted of 45 plots. Each plot was one ridge 5.0m. long and 1.0 m wide. The distance between hills was long 0.50 m apart, therefore each ridge contained 10 hills.

Data were recorded on several randomly chosen plants within each plot for the following traits:- first picking date (1^{st}. P.D.), number of fruits per plot. (N.F./Pt.), fruits yield per plot (F.Y./Pt. kg), weight of fruits per plant (W.F./P. kg), fruit length in centimeters (F.L. cm), fruit diameter in centimeters (F.D. cm), fruit shape index (F.Sh.I.), fruit weight in grams (F. W.g)

Differences among genotypic means for all studied traits were tested for significance according to F-test. The form of analysis of variance and the expectations of mean squares were outlined by Steel and Torrie (1960).

The amounts of heterosis were determined as the percentage increase of the over all mean of the F_1 hybrids (F_1), F_1 reciprocal hybrids (F_{1r}) and $F_{1,\ 1r}$ hybrids over the average of all parents mid-parents ($H_{M.P.}$%) or above the better parent ($H_{B.P.}$%).

Inbreeding depression (I.D.) was determined as the reduction of the mean of the F_2 generations (F_2) the mean of the F_2 reciprocal generations (F_{2r}) and the average means of F_2 and F_{2r} reciprocal generations ($F_{2,2r}$) below the mean of the F_1 hybrids (F_1), mean of F_1 reciprocal hybrids (F_{1r}) and the average means of F_1 and F_{1r} reciprocal hybrids ($F_{1,1r}$), respectively.

The significance of observed differences of these comparisons was determined by comparing the differences between them with the corresponding least significant difference values (L.S.D.)

General combining ability (G.C.A.) and specific combining ability (S.C.A.) in addition to the variances of reciprocal effect (r) were obtained. The procedures of these analysis were described by Griffing's (1956) method I and outlined by Singh and Chaudhary (1985). The estimates of GCA variance (σ^2 g) and SCA variance (σ^2 s) were expressed in terms of genetic variances according to Matzingar and Kempthorne (1956) and Cocherham (1963) with the assumption that there was no epistasis. The estimates of heritability in broad and narrow senses were determined for F_1 hybrids as well as F_2 generations.

RESULTS AND DISCUSSION

In this investigation, many yield and yield component traits were studied. The results of the analyses of variance and the mean squares for yield and yield component traits for all genotypes are presented in Table 1. The results cleared that the mean squares of the genotypes showed highly significance for all studied traits. These results indicated the presence of variability among all studied traits. These results were expected where the studied genotypes in this investigation included variable genetic materials of parental varieties, F_1 hybrids, F_{1r} hybrids, F_2 and F_{2r} generations.

Table 1: Analyses of variance and mean squares for all 45 genotypes for all studied traits in squash.

S.V.	d.f	1st P.D.	No.F./Pt.	F.Y/Pt. (kg)	F.Y./P. (kg)	F.L. (cm)	F.D. (cm)	F.Sh.I.	F.W. (g)
Reps	2	2.456	6.136	0.590	0.123	0.837	0.302	0.556	18.78
Gen.	44	24.11**	337.89**	11.39**	0.446**	11.529**	0.623**	3.222**	498.5**
Error	88	2.365	17.314	0.136	0.008	0.349	0.037	0.136	143.07

** Significant at 0.01 level.

The photographs pictures represented the fruit characteristics, fruit shape, size and colour for the five parental varieties, their F_1, F_{1r} hybrid and their F_2, F_{2r} generations are presented in Figures 1 and 2, respectively.

The means of yield and yield component traits were obtained for parental varieties, F_1, F_{1r} hybrids and their F_2, F_{2r} generations and the results are presented in Table 2. The results indicated that the obtained mean values showed that there was no single parent exceeded the other parents for all studied traits. It was regarded from the results that the parental variety (P_5) was the better (lowest) parent for 1^{st} P.D. In the same time, P_1 was the highest parent for F.Y./Pt (kg), No.F./Pt and F.Y./P. (kg) while the variety P_3 was the highest parent for F.L. (cm) and F.Sh.I. traits. On the other hand, the parental variety (P_2) showed the lowest mean values for No.F./Pt., Y./Pt. (kg), F.Y./P. (kg), F.D. (cm) and F.W. (g). The parental variety (P_5) was the lowest parental variety for F.L. (cm) and F.Sh.I. traits. It is also noticed that the differences between the means of the lowest and the highest parents were always significant. This finding indicated the presence of genetic differences between these parents. Photographs in Figure 1 represent the F_1 and F_{1r} hybrids which showed a large deel of uniformity in fruit shape, size and colour.

The results indicated that the highest F_1 hybrids were P_1 x P_4 and P_3 x P_5 with the same mean of 3.07, whereas the highest F_{1r} hybrid was P_5 x P_3 with the mean of 3.20 for F.Y./P. (kg). On the other hand, the hybrid P_2 x P_3 was the lowest with the mean of 1.98, while the F_{1r} hybrid P_3 x P_2 was the lowest with the mean of 1.61 for the same trait.

The results also, indicated that the means of F_1 hybrids ranged from 41.3 to 47.7, 54.3 to 88.3, 11.35 to 15.7, 1.98 to 3.07, 15.3 to 22.0, 2.51 to 4.10, 3.73 to 7.18 and 140.8 to 189.0 for 1^{st} P.D., No. F./Pt., Y./Pt. (kg), F.Y./P. (kg), F.L. (cm), F.D. (cm), F.Sh.I. and F.W. (g) respectively. On the other hand, the mean values of the F_{1r} hybrids ranged from 40.667 to 48.3, 55.0 to 93.0, 8.03 to 16.0, 1.61 to 3.20, 15.80 to 20.83, 2.95 to 4.37, 4.07 to 6.58 and 147.51 to 188.5 for the same obvious traits.

The obtained results revealed that the magnitudes of the means of F_1, F_{1r} hybrids were close to

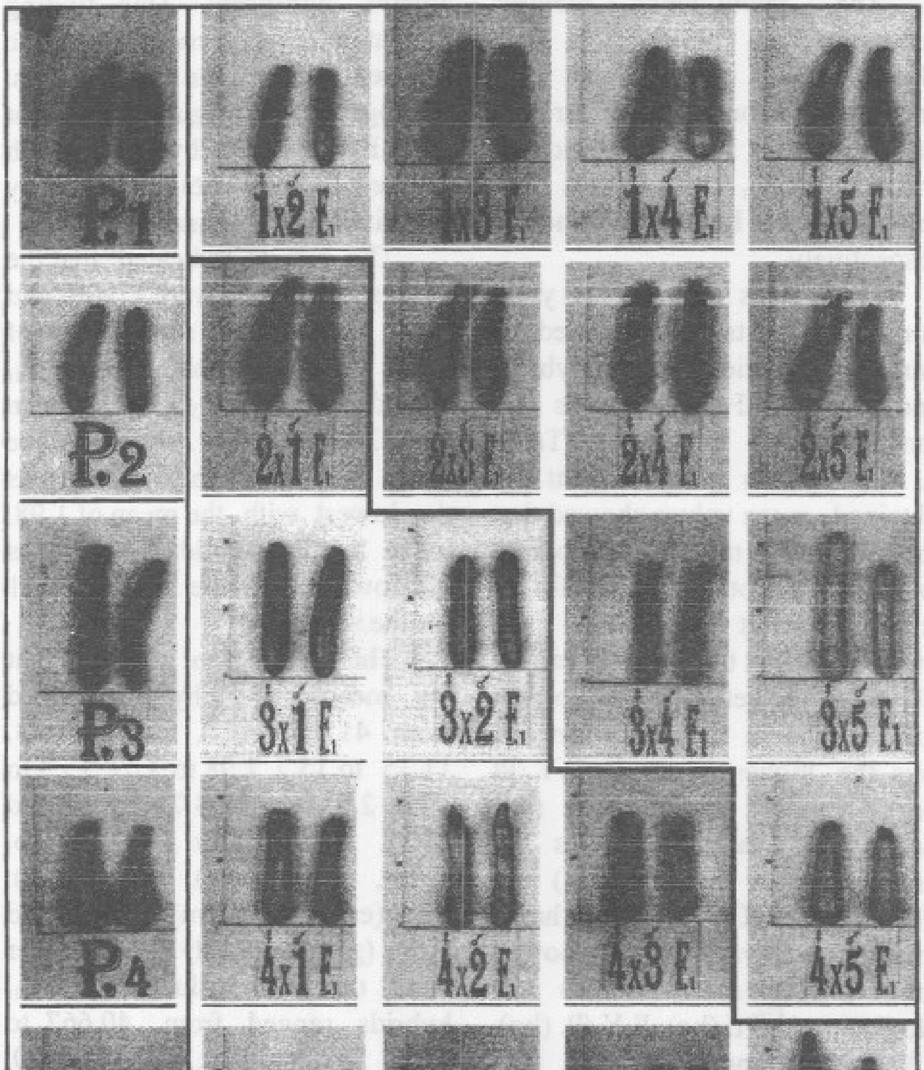

Figure 1.Photographs represent the differences between the fruits length, diameter, shape and size of the five parents, F_1 hybrids and F_{1r} (reciprocal) hybrids.

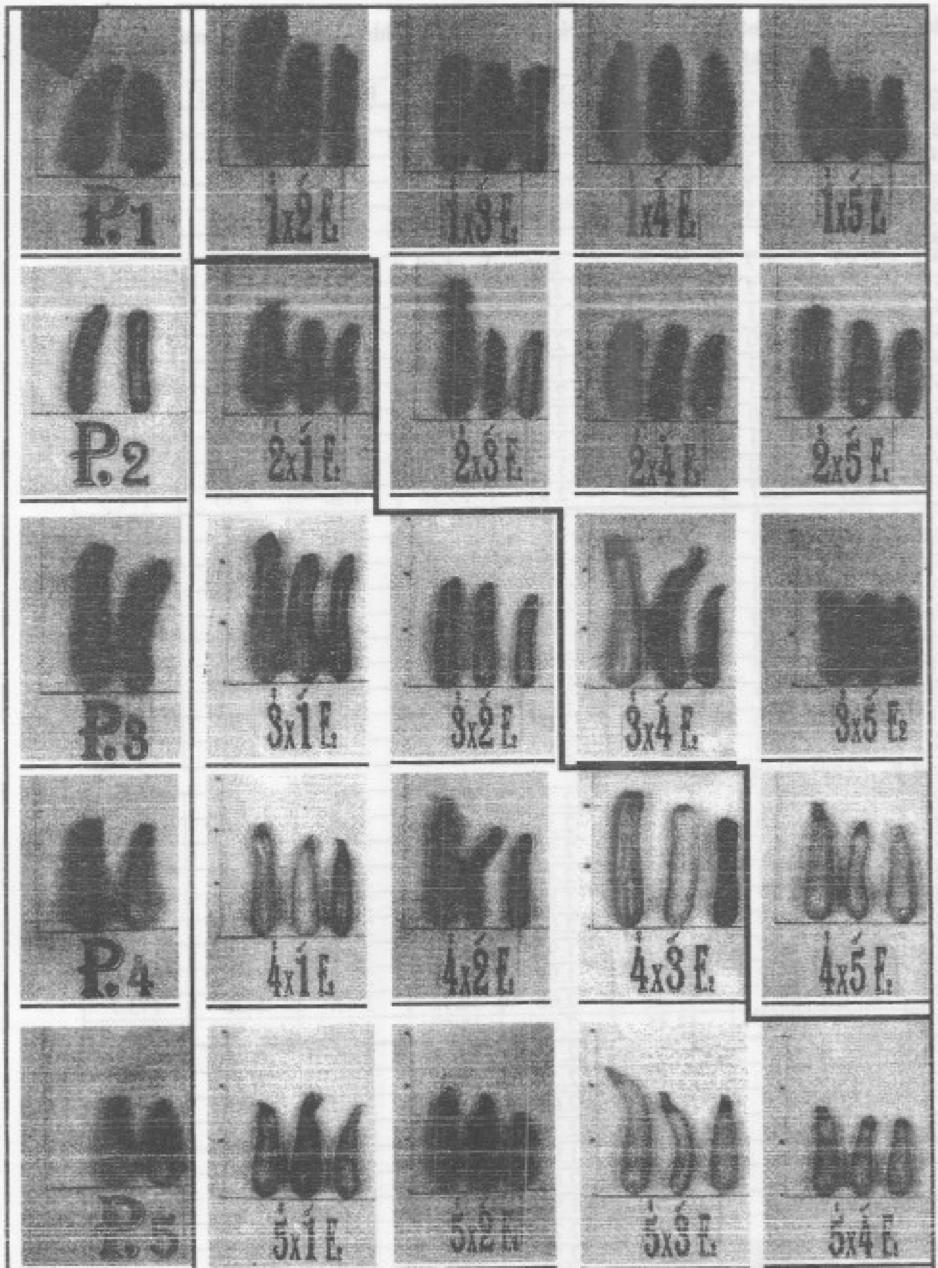

Figure 2. Photographs represent the differences between the fruits length, diameter, shape and size of the five parents, F_2 generations and F_{2r} (reciprocal) generations.

Table 2: The means of five parental varieties, F_1, F_{1r} hybrids, F_2 and F_{2r} generations for all studied traits in squash.

Genotypes	1^{st} P.D.	No.F./Pt.	F.Y./Pt. (kg)	F.Y/P. (kg)	F.L. (cm)	F.D. (cm)	F.Sh.I	F.W. (g)
P_1	43.0	81.7	12.80	2.59	15.77	3.66	4.31	158.5
P_2	52.0	57.0	8.60	1.72	16.17	3.08	5.27	151.7
P_3	54.0	63.3	10.27	2.05	21.50	3.49	6.16	162.3
P_4	44.3	65.7	11.40	2.28	18.00	4.40	4.10	173.8
P_5	41.7	73.3	12.20	2.44	13.17	3.90	3.38	166.6
F_1 and F_{1r} hybrids								
P_1*P_2	43.3	76.7	12.00	2.40	17.40	3.08	5.67	157.2
P_1*P_3	41.3	84.7	14.35	2.87	18.00	3.15	5.80	169.8
P_1*P_4	42.7	88.3	15.70	3.07	16.50	3.71	4.51	177.9
P_1*P_5	44.3	83.0	13.60	2.72	17.23	3.49	4.95	164.0
P_2*P_3	47.3	54.3	9.90	1.98	18.10	2.91	6.26	184.2
P_2*P_4	45.0	65.3	12.30	2.46	19.00	3.49	5.45	189.0
P_2*P_5	44.0	74.0	13.00	2.60	17.20	3.26	5.29	176.4
P_3*P_4	47.7	81.3	11.35	2.27	19.67	2.51	7.18	140.8
P_3*P_5	47.7	86.0	15.33	3.07	22.00	3.66	6.01	179.1
P_4*P_5	43.0	83.7	14.55	2.91	15.30	4.10	3.73	174.6
P_2*P_1	48.3	73.3	11.75	2.35	19.90	3.10	6.42	160.6
P_3*P_1	44.0	79.7	13.90	2.78	20.00	3.42	6.58	174.6
P_4*P_1	40.7	84.3	14.04	2.81	17.90	3.95	4.54	167.0
P_5*P_1	44.7	82.0	14.03	2.81	15.80	3.92	4.07	171.4
P_3*P_2	46.3	55.0	8.03	1.61	19.00	3.35	5.69	147.5
P_4*P_2	42.0	79.3	13.20	2.64	18.50	3.50	5.29	166.8
P_5*P_2	43.3	82.7	13.55	2.71	16.60	3.30	5.05	164.6
P_4*P_3	45.7	83.7	12.65	2.53	17.00	2.95	5.77	155.9
P_5*P_3	43.0	93.0	16.00	3.20	17.43	3.68	4.74	188.5
P_5*P_4	43.3	85.0	15.35	3.07	20.83	4.37	4.81	181.2
F_2 and F_{2r} generations								
P_1*P_2	42.3	69.3	11.17	2.23	17.13	3.13	5.50	161.2
P_1*P_3	43.0	73.0	12.75	2.55	17.50	3.21	5.49	174.9
P_1*P_4	42.3	78.3	12.75	2.55	16.00	3.52	4.56	163.0
P_1*P_5	46.3	71.3	12.13	2.42	14.22	3.90	3.68	169.6
P_2*P_3	42.3	51.7	9.43	1.89	17.81	2.90	6.23	182.8
P_2*P_4	47.7	67.7	10.20	2.04	18.00	2.81	6.47	150.7
P_2*P_5	44.3	66.7	10.25	1.99	16.92	3.35	5.07	149.1
P_3*P_4	48.0	60.0	9.75	1.95	20.08	2.78	7.24	162.7
P_3*P_5	42.0	76.3	13.40	2.68	18.12	3.41	5.32	175.7
P_4*P_5	44.0	72.7	13.45	2.69	15.08	4.25	3.55	186.1
P_2*P_1	43.7	65.7	10.50	2.10	16.62	2.88	5.21	160.1
P_3*P_1	45.0	72.7	12.57	2.51	20.06	3.09	6.57	173.8
P_4*P_1	40.0	64.3	13.13	2.63	17.52	3.81	4.61	204.8
P_5*P_1	46.7	76.3	11.73	2.35	14.76	4.10	3.61	153.8
P_3*P_2	44.3	53.7	9.75	1.95	18.12	3.11	5.88	182.9
P_4*P_2	43.0	69.3	10.37	2.07	15.30	3.23	4.74	149.6
P_5*P_2	44.0	59.7	9.85	1.97	15.62	3.81	4.10	165.8
P_4*P_3	44.7	60.0	10.17	2.23	21.14	2.92	7.27	170.8
P_5*P_3	50.0	82.0	13.79	2.77	16.76	3.73	4.41	169.4
P_5*P_4	44.7	85.7	13.67	2.74	16.42	3.95	3.84	160.0
LSD 0.05	2.5	6.8	0.60	0.15	0.96	0.31	0.60	19.4
LSD 0.01	3.3	8.9	0.79	0.19	1.27	0.41	0.79	25.7

each other for most studied traits. In the same time, when the hybrids were compared to each other, the results showed the presence of significant differences for many studied traits. It is also noticed that some F_1 and F_{1r} hybrids exceeded the better parent. Whereas, it could be expected that there were quite heterosis values versus the mid-parents. Photographs in Figure 2 represent the F_2 and F_{2r} generations which showed an obvious variability in fruit shape, size and colour.

The mean performances of yield traits for the F_2, F_{2r} generations indicated that there were no significant differences between the means of F_2 and F_{2r} generations for most studied traits. The results also cleared that the F_2 generation (P_3 x P_4) had the highest means for 1st P.D., F.L. (cm) and F.Sh.I. and had the lowest mean for F.D. (cm). In the same time, the F_2 generation P_4 x P_5 was the highest for F.Y./Pt. (kg), F.D. (cm) and F.W. (g), the same genotype had the lowest mean for F.Sh.I. Concerning the F_{2r} P_4 x P_3 had the highest means for F.L. (cm) and F.Sh.I. and the F_{2r} P_5 x P_3 showed the highest means for 1st P.D., Y./Pt. (kg) and F.Y./P. (kg). On the other hand, the F_{2r} P_3 x P_2 showed the lowest mean for No. F./Pt., F.Y./Pt. (kg) and F.Y./P. (kg).

The mean values of F_2 and F_{2r} generations ranged from 42.0 to 48.0 and 40.0 to 50.0, 51.7 to 78.3 and 53.7 to 85.7, 9.43 to 13.45 and 9.75 to 13.79, 1.89 to 2.69 and 1.95 to 2.77, 14.22 to 20.08 and 14.76 to 21.14, 2.78 to 4.25 and 2.88 to 4.10, 3.55 to 7.24 and 3.61 to 7.27 and 149.1 to 186.1 and 149.6 to 204.8 for 1st P.D., No. F./Pt., F.Y./Pt. (kg), F.Y./P. (kg), F.L. (cm), F.D. (cm), F.Sh.I. and F.W. (g), respectively.

The results also indicated the presence of differences among the means of F_2 and F_{2r} generations for most studied traits. Significant differences were noticed between the F_2 generations. Most of these differences were obtained when the lowest F_2 generations were compared with the highest F_2 generations for the same traits.

The estimated values of mid-parents (M.P.), better parent (B.P.), means of F_1, F_{1r} hybrids, F_2, F_{2r} and $F_{2,2r}$ generations, heterosis versus the mid-parents ($H_{M.P.}$%), heterosis versus the better parent ($H_{B.P.}$%) and I.D. values were presented in Table 3. The results indicated that the average means of F_1, F_{1r} and $F_{1,1r}$ hybrids

Table 3: Mid-parents, means, percentage of heterosis over both mid-parents ($H_{M.P.}$%) and the better parent ($H_{B.P.}$%), inbreeding depression (I.D) for all studied traits in squash.

Characters	1st. P.D.	No.F./Pt.	F.Y./Pt (kg)	F.Y./P. (kg)	F.L. (cm)	F.D. (cm)	F.Sh.I.	F.W. (g)
M.P.	47.00	68.200	11.08	2.216	16.92	3.71	4.64	162.59
F_1	44.63	77.733	13.208	2.635	18.04	3.36	5.49	171.18
F_{1r}	44.13	79.867	13.252	2.650	18.26	3.55	5.30	167.84
$F_{1,1r}$	44.38	78.800	13.23	2.643	18.15	3.46	5.39	169.51
F_2	44.23	78.580	11.528	2.30	17.086	3.23	5.31	167.59
F_{2r}	44.60	78.08	11.553	2.313	17.232	3.50	5.06	169.10
$F_{2,2r}$	44.42	78.33	11.541	2.307	17.159	3.37	5.19	168.35
$H_{M.P.F1}$ %	-5.0 **	13.978**	19.206**	19.009**	6.619**	-9.43**	18.32**	5.28**
$H_{B.P.F1}$ %	7.11**	6.00**	2.15**	2.126*	-16.093**	-23.6**	-10.9**	-1.48*
L.S.D. 0.05	0.986	3.06	0.13	0.054	0.51	0.13	0.26	8.64
0.01	1.329	4.12	0.177	0.072	0.69	0.18	0.35	11.65
$H_{M.P.F1r}$ %	-6.1 **	17.107**	19.603**	19.369**	7.920**	-5.12**	18.32**	3.23
$H_{B.P.,F1r}$ %	5.9 **	8.910**	2.490	2.435**	-15.070**	-20**	-14.01	-3.4
L.S.D. 0.05	1.08	2.83	0.16	0.029	0.32	0.09	0.18	8.43
0.01	1.46	3.81	0.22	0.039	0.44	0.12	0.28	11.37
$H_{M.P....F1.1r}$ %	-5.6 **	15.54**	19.40**	19.13**	7.27**	-6.74**	16.16**	4.26
$H_{BP.,F1.1r}$ %	7.38**	-3.51	3.04**	1.93	-15.58**	21.36**	-12.5**	-2.44
L.S.D. 0.05	0.84	2.52	0.16	0.18	0.30	0.104	0.19	7.65
0.01	1.12	3.38	0.22	0.24	0.40	0.13	0.26	10.26
I.D(F_1,F_2) %	0.896	11.621**	12.945**	12.983**	5.266**	3.87*	3.17	2.09
L.S.D. 0.05	0.71	2.07	0.12	0.02	0.33	0.10	0.21	5.90
0.01	0.94	2.78	0.16	0.03	0.44	0.14	0.28	7.91
I.D(F_{1r},F_{2r}) %	-1.058	12.76**	12.75**	12.755**	5.641**	1.41	4.53*	-0.75
L.S.D. 0.05	0.88	0.04	0.07	0.029	0.22	0.11	0.19	6.63
0.01	1.18	0.06	0.09	0.039	0.30	0.14	0.25	8.90
I.D($F_{1,1r}$,$F_{2,2r}$) %	-0.09	12.67 **	12.58 **	13.21**	5.45**	2.03*	3.98**	0.68
L.S.D. 0.05	0.556	1.504	0.133	0.032	0.214	0.069	0.133	4.324
0.01	0.735	1.988	0.176	0.043	0.282	0.092	0:176	5.715

*** Significant at 0.05 level. ** Significant at 0.01 level.**

significantly exceeded the mid-parents for all studied traits except for F.W. (g) in F_1 and $F_{1,\ 1r}$ hybrids. The results also cleared that heterosis values versus the mid-parents from F_1, F_{1r} and $F_{1,\ 1r}$ hybrids ranged from –9.43% for F.D. (cm) to 19.21 % for F.Y./Pt. (kg) and from –6.10% for 1st P.D. to 19.6% for F.Y./Pt. (kg) and from –6.74% for F.D. (cm) to 19.40% for F.Y./Pt. (kg).

The results also revealed that the heterosis values from F_1 hybrids versus the better parent were: 7.11, 6.00, 2.15, 2.126, -16.09, -23.6, -10.9 and -1.48% for 1st P.D. , No.F./Pt. , F.Y./Pt. (kg), F.Y./P. (kg), F.L. (cm), F.D. (cm), F.Sh.I and F.W. (g), respectively. It could be regarded that heterosis values from F_{1r} and all F_1 hybrids versus the better parent ranged from -20.0% for F.D. (cm) to 8.91% for No. F./Pt. and from –15.58% for F.L. (cm) to 21.36% for F.D. (cm). These results were in agreement with those obtained by Dhillon and Sharma (1987), Kasrawi (1994), El-Gendy (1999), Abd El-Hadi *et al.* (2001) and Abd El-Maksoud *et al.* (2003).

Concerning inbreeding depression (I.D.), the results showed that most of the studied traits exhibited significant values for I.D. These results were expected, since the presence of heterosis would be followed by the presence of I.D in most cases. The results also revealed that the calculated values of I.D. from F_1 and F_2 were as follows: 0.896, 11.62, 12.95, 12.98, 5.27, 3.87, 3.17 and 2.09% for 1stP.D., No.F./Pt., F.Y./Pt. (kg), F.Y./P. (kg), F.L. (cm), F.D. (cm), F.Sh.I. and F.W. (g), respectively. The results illustrated that the amounts of I.D. estimated from F_{1r} and F_{2r} ranged from –1.058% for 1st P.D. to 12.76% for No.F./Pt. On the other hand, I.D. from $F_{1,1r}$ and $F_{2,2r}$ were -0.09, 12.67, 12.58, 13.21, 5.45, 2.03, 3.98 and 0.68 % for 1st P.D., No.F./Pt., F.Y./Pt. (kg), F.Y./P. (kg), F.L. (cm), F.D. (cm), F.Sh.I and F.W. (g), respectively.

Generally, these results showed reduction in F_2, F_{2r} and $F_{2,\ 2r}$ generations due to inbreeding. Inbreeding depression was greater for those traits which had large estimates of heterosis. It was noticed that the performances of all F_2 generations were better than the parental varieties for yield and its component traits. Similar results were obtained by El-Shawaf and Baker (1981), El-Adl *et al.* (1981 and 1996), El-Gendy

(1999) and Abd El-Rahman *et al.* (2000).

The results of the combining ability analyses were obtained for the F_1 hybrids and their F_2 generations and the results are shown in Table 4. The results showed that both GCA and SCA revealed highly significant values for all studied traits in the F_1 hybrids and F_2 generations except for F.W. (g) in the F_1 hybrids for GCA. In the same time, the mean squares of reciprocal effects were also significant for all studied traits except of F.Y./ pt. (kg), F.Y./p. (kg) in the F_2 generations and F.W. (g) in the F_1 hybrids. The results showed the importance of general (GCA) and specific (SCA) combining abilities in the inheritance of all studied traits. The magnitudes of (GCA) were larger than those of (SCA) for all studied yield and yield component traits for all F_1 ($F_{1,1r}$ hybrids) and all F_2 ($F_{2,2r}$) generations. Similar results were obtained by many authors, among them Sachan and Prem Nath (1976), El-Gazar (1981), El-Gazar and Zaghloul (1983), El-Adl *et al.* (1996) and Abd El-Hadi *et al.* (2001).

The relative magnitudes of the different genetic parameters for yield and yield component traits for $F_{1,1r}$ hybrids and $F_{2,2r}$ reciprocal generations are presented in Table 5. The magnitudes of non additive genetic variances including dominance (σ^2 D) appeared to be positive and larger than those of the additive genetic variance (σ^2 A) in the F_1 hybrids for all studied traits. The same trend was found in the F_2 generations for most studied traits.

Generally, the non additive genetic variances including dominance were the most important sources of genetic variation. Reciprocal effects (σ^2 r) were present for all yield and yield component traits, although they were generally smaller than the additive (σ^2 A) and non additive genetic variances including dominance (σ^2 D). These results indicated the importance of non additive genetic variances and hybridization could be used to produce vigorous F_1 hybrids. In this respect many authors obtained similar results among them Sachan and Prem Nath (1976), El-Gazar (1981), El-Gazar and Zaghloul (1983), Farid (1990), El-Gendy (1999) and Abd El-Hadi *et al.* (2001).

The estimated values of heritability in broad and narrow senses from the F_1 hybrids and F_2

Table 4: Analysis of combining abilities and mean squares of F_1 hybrids and their F_2 generations for all studied traits in squash.

S.V.	d.f.		1st P.D.	No.F./Pt.	F.Y/Pt. (kg)	F.Y./P. (kg)	F.L. (cm)	F.D. (cm)	F.Sh.I.	F.W. (g)
G.C. A.	4	F_1	6.068**	309.64**	11.688**	0.460**	2.097**	0.509**	2.137**	102.18
		F_2	4.621**	197.13**	7.228**	0.299**	10.82**	0.802**	4.960**	192.93**
S.C.A.	5	F_1	6.08**	104.08**	4.449**	0.176**	1.969**	0.265**	0.411**	294.30**
		F_2	6.444**	95.968**	3.121**	0.106**	1.609**	0.081**	0.581**	276.43**
Rec.	10	F_1	3.628**	19.045*	0.529**	0.019**	3.713**	0.039**	0.344**	127.35
		F_2	5.639**	24.572**	0.072	0.006	1.163**	0.042**	0.312**	153.18**
Error	38	F_1	0.856	7.776	0.031	0.001	0.11	0.013	0.045	71.694
		F_2	0.643	3.998	0.037	0.004	0.105	0.014	0.050	30.808

* Significant at 0.05 level. ** Significant at 0.01 level.

Table 5: The relative magnitudes of the different genetic parameters and heritability for F_1 hybrids and F_2 generations for all studied traits in squash.

Genetic parameters		1st P.D.	No.F./Pt.	F.Y./Pt. (kg)	F.Y./P. (kg)	F.L. (cm)	F.D. (cm)	F.Sh.I.	F.W. (g)
$\sigma^2 A$	F_1	-0.004	68.522	2.413	0.0948	0.0426	0.0812	0.575	-64.04
	F_2	-0.810	44.96	1.824	0.086	4.093	0.320	1.946	-37.109
$\sigma^2 D$	F_1	2.6118	48.15	2.2091	0.0874	0.9299	0.1259	0.1832	111.3
	F_2	5.156	81.75	2.741	0.090	1.337	0.0596	0.471	218.332
$\sigma^2 Rec$	F_1	1.386	5.635	0.249	0.009	1.8019	0.0128	0.1496	27.83
	F_2	2.498	10.287	0.0177	0.0013	0.529	0.0142	0.1311	61.1869
$\sigma^2 e$	F_1	0.856	7.776	0.031	0.001	0.1096	0.0133	0.0445	71.694
	F_2	0.643	3.998	0.037	0.0037	0.1045	0.0141	0.0502	30.8081
h^2_b%	F_1	53.771	89.690	94.381	94.797	33.721	88.808	79.618	32.197
	F_2	58.047	89.870	98.816	97.238	89.550	93.062	93.022	66.329
h^2_n%	F_1	0.00	52.676	48.424	49.324	1.477	34.820	60.380	0.00
	F_2	0.00	31.888	39.483	52.376	67.502	19.907	22.130	0.00

generations are also presented in Table 5. The results showed that the calculated heritability values in broad sense (h^2_b %) were larger than those in narrow sense (h^2_n %) for most studied traits in the F_1 hybrids and F_2 generations. The highest estimated values of h^2_b were 94.797% in the F_1 hybrids for F.Y./P. (kg) and 98.816% in the F_2 generations for F.Y./Pt. (kg). However, it was 60.38% in F_1 hybrids for F.Sh.I. and 67.502% in F_2 generations for F.L. (cm) for h^2_n %. These results were in complete agreement with the results obtained by Metwally (1985), Kosba and El-Diasty (1991), El-Adl *et al.* (1996) and Abd El-Hadi *et al.* (2001).

In conclusion, it appeared that the production of F1 hybrids of squash could be of great economical application to increase yield. However, the choice of parents in hybridization is of great importance.

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طبيعة فعل الجين وقوة الهجين والتدهور الناتج عن التربية الداخلية لصفات المحصول ومكوناته فى قرع الكوسة

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فى هذه الدراسة تم استخدام خمسة أصناف من قرع الكوسة كآباء، وبعد إجـــراء تلقيح ذاتى مستمر لمدة ثلاثة أجيال تم التهجين بين الخمسة آباء فيما بينها بنظام الـــتزاوج الدورى الكامل وذلك لإنتاج ٢٠ هجينا وهجينا عكسيا وكذلك الجيل الثانى والثانى العكســـى لهذه الهجن ، تم تقييم جميع التراكيب الوراثية والتى تشمل ٤٥ تركيبا فى تجربة قطاعـــات كاملة العشوائية من ثلاث مكررات ويمكن تلخيص النتائج المتحصل عليها كما يلى:ـــ

أوضحت نتائج تحليل التباين لجميع التراكيب الوراثية محل الدراسة وجود فـــروق عالية المعنوية لجميع الصفات المدروسة. وكان الأب الأول (Eskandarani) هو الأفضـل

لصفات عدد الثمار لكل وحدة تجريبية ومحصول الوحدة التجريبية ومحصول النبات الواحد بينما كان الأب الثالث (Zucchino Striato d'Italia) هو الأعلى لصفات عدد الأيام حتى أول جمعة (غير مفضلة حيث أنه متأخر) وطول الثمرة ودليل شكلها، ومن ناحية أخرى وجد أن معظم متوسطات هجن الجيل الأول والأول العكسى كانت متباينة. كما أظهرت النتائج أنه لا يوجد هجين معين كان هو الأفضل لجميع الصفات المدروسة بينما كانت معظم هجن الجيل الأول ذات متوسطات أعلى مقارنة بالآباء لمعظم الصفات المدروسة.

أظهرت النتائج أن قيم قوة الهجين مقارنة بمتوسط الآباء قد أظهرت فروقا عالية المعنوية لجميع الصفات محل الدراسة وقد تراوحت هذه القيم مابين -٩,٤٣ إلى ١٩,٢ % لصفتى قطر الثمرة ومحصول الثمار لكل وحدة تجريبية محسوبة من متوسطات الجيل الأول. وعند حساب قوة الهجين ومقارنة متوسط الآباء بمتوسطات هجن الجيل الأول بأكمله (الجيل الأول والأول العكسى) قد تراوح المدى من - ٦,٧٤ إلى ١٩,٤% لذات الصفات سالفة الذكر وبنفس الترتيب. وعند حساب قوة الهجين مقارنة بأعلى الآباء فقد أظهرت النتائج وجود فروق عالية المعنوية لمعظم الصفات المدروسة. وعند مقارنة الجيل الأول بأكمله بأعلى الآباء فقد تراوحت قيم قوة الهجين ما بين -٢١,٣٦ إلى ٧,٣٨% لصفتى قطر الثمرة وعدد الأيام حتى أول جمعة. كما أشارت النتائج إلى ظهور نقص وتدهور ناتج عن التربية الداخلية لمعظم الصفات محل الدراسة ولذا فقد أظهرت النتائج وجود قيم عالية المعنوية لعديد من الصفات محل الدراسة.

أشارت قيم تباين القدرة العامة والخاصة على التآلف إلى وجود قيم عالية المعنوية لجميع الصفات المدروسة لكلا الجيلين الأول والثانى. كما أشارت النتائج إلى أن قيم القدرة العامة على التآلف كانت أعلى من قيم القدرة الخاصة على التآلف لجميع الصفات المدروسة لكلا الجيلين الأول والثانى، كما تم الحصول على قيم معنوية لتأثير التهجين العكسى لمعظم الصفات.

تراوحت قيم معامل التوريث فى المدى الضيق مابين صفر إلى ٦٠,٣٨% لصفة عدد الأيام حتى أول جمعة ودليل شكل الثمرة وذلك لهجن الجيل الأول ولكن عند حسابه للجيل الثانى فقد تراوحت قيمته ما بين صفر إلى ٦٧,٥% لصفتى عدد الأيام حتى أول جمعة وطول الثمرة. وقد كانت أعلى القيم لمعامل التوريث فى مداه الواسع عند حسابه لهجن الجيل الأول هى ٩٤,٨% لصفة محصول الثمار لكل نبات وكانت ٩٨,٨% لصفة محصول الثمار لكل وحدة تجريبية للجيل الثانى.