Heterosis and Correlations Studies for Flowering Characters, Yield and Yield Components in Squash (*Cucurbita Pepo* L.)

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Abstract

The main goal of this study is to investigate inheritance of some economic characters of squash genotypes and its hybrids and reciprocals. This experiment was carried out during 2017 and 2018 seasons. Ten advanced inbred lines of summer squash (*Cucurbita pepo* L.) named MHSQ-1= P1, MHSQ-2= P2, MHSQ-3= P3, MHSQ-4= P4, MHSQ-5= P5, MHSQ-6= P6, MHSQ-7= P7, MHSQ-8= P8, MHSQ-9= P9 and MHSQ-10= P10 were planted in Misr Hytech seed int. Co. research farm. The advanced 10 inbred lines were used in complete diallel mating design to study genetic parameters of some economic characters viz., number of days to first female flower (D.F.F.F.), sex ratio, fruit weight (F.W. g), total soluble solids percentage (T.S.S %), number of fruits per plant (N.F.P.) and total yield per plant (T.Y.P. g) of resulted ninety straight and reciprocal F1 hybrids relative to mid and better parents and two commercial check cultivars "Aziad and New Eskandarani". **Results** of mean squares for (D.F.F.F.) traits exhibited that significant or high significant for all types of variations. Moreover, sex ratio was high significant for all types of variations. Mean squares for fruit weight (F.W.) was significant or high significant for all types of variations except reciprocal effect. T.S.S recorded insignificant values of mean squares. Mean squares for (N.F.P.) and (T.Y.P.) characters were found high significant. Heterosis for (D.F.F.F.) and sex ratio traits showed different levels of significance with positive and negative values except some hybrids. Heterosis (F.W) and (T.S.S.) exhibited some hybrids with significant or high significant positive or negative values. Heterosis for (N.F.P.) and (T.Y.P.) showed several hybrids having different heterotic effects. Phenotypic Correlation coefficient analysis showed different degrees of correlations between all studied traits.

Keywords: heterosis , correlations, squash, flowering, yield.

Introduction

The Cucurbitaceae is a remarkable plant family, deserving of attention because of its economic, aesthetic, cultural, medicinal, and botanical significance.

Summer squash having somatic chromosome number 2n = 40 of small, dot like chromosomes. The term" squash" was evidently derived from a north eastern American Indian word indicating a fruit, apparently *cucurbita pepo* L., eaten Raw (uncooked) as an immature fruit or consumed for the mature seed. (**Whitaker and Robinson, 1986**).

Summer squash are the edible young (several days after anthesis) fruit of cucurbita *pepo*, a highly divers species. Easy to grow, short-season crop. There are six extant horticultural groups of summer squash: cocozelle, croocknek, straightneck, scallop, vegetable marrow and zucchini. Summer squash is adapted to temperate and subtropical climates and grown in many regions. The acceptable fruit size range is belongs to the market demand and it differs among markets. A conservative estimate of the worldwide value of this crop is several billion dollars annually, ranking summer squash relatively high among vegetable crops in economic value. Production and per capita consumption appeared to be risen during last decade. Among the largest producers of summer squash are Turkey, Italy, Egypt, Spain, U.S.A., and Mexico. **(Paris, 1996)**.

China, India, Iran, Turkey, Egypt, and the U.S. are among the world's largest producers of cucurbits. China remains the world's leading producer of the major cucurbits, exporting fresh fruits, watermelon, and squash seeds (**Maynard, 2001**).

Eskandarani type is the most adapted zucchini summer squash cultivar planted in Egypt compared to accessed cultivars and hybrids (**Waly and Nassar, 1978** ; **Damarany et al., 1995 ; Hassan, 1988)**.

The estimated area of summer squash in Egypt was 56.696 feddan with total yield 462.654 tons and average yield 8.16 tons per feddan (**Department of Agriculture Economics and Statistics, Ministry of Agriculture and land reclamation A.R.E. 2017.**

The prices of imported squash hybrids are very high. So, the recommendation of producing local hybrid seeds is an urgent need to reduce the cost for the farmers and saving hard currency.

The costs of hybrid seed production in summer squash are very low when compared with that of the hybrid seed production from other vegetable crops **(Metwally, 1985)**.

The main goal of this study is to select the best combinations of squash genotypes which reflect desired characters for consumer depending on estimation of genetic parameters for all studied traits.

Materials and Methods

The parental lines were planted in Misr Hytech seed Int. Co. research farm during 2017 season on twenty of February to make all possible crosses as straight and reciprocal hybrids to obtain ninety hybrids which sowed on 4/3/2018 for evaluation with their parents and two check varieties Aziad and New Eskandarani. The experimental design was randomized complete block design with three replicates each replicate consists of 102 genotypes divided into two ranges contains 51 genotypes for each range. Plot measurements were 4.0m length, 0.85 m width and 0.50 m apart between plants therefore, the plot area was 3.4 m^2.

Data were recorded for number of days to first female flower opening (DFFF), sex ratio as number of male to female flowers per plant, fruit weight (FW) g , total soluble solids (TSS) %, number of fruits per plant (NFP) and total yield per plant (TYP) g. Genetic statistical analysis was performed according to the method described by **Gomez and Gomez (1984)**. LSD test were used for comparisons (Table 1).

Table 1. Sources of variance, degree of freedom and expected mean squares for F1 crosses.

Source of variance (S.O.V)	D.f	E.M.S
Blocks	b-1	δ_e^2 ak_b^2
Genotypes	a-1	δ_e^2 bk_a^2
Parents	p-1	δ_e^2 bk_p^2
Crosses	c-1	δ_e^2 bk_c^2
Parent vs. hybrids	1	δ_e^2 bk_h^2
Error	(a-1) (b-1)	δ_e^2

Where:
b = Number of replicates.
a = Number of genotypes.
p = Number of parent.
c = Number of hybrids.
h = Average heterosis.
K^2 = Greek Kappa
δ_e^2 = Error variance

Genetic parameters were:

1- Heterosis as follow:

Mid parent heterosis % = $\frac{F1-MP}{MP}$ X100

Better parent heterosis % = $\frac{F1-BP}{BP}$ X 100

Standard heterosis % = $\frac{F1-check}{check}$ x 100

2- Phenotypic correlation coefficient estimated according to **Steel and Torrie (1980)** as follow:

$$r = \frac{Cov\ xy}{C\sqrt{VX.VY}}$$

Where: x and y are two characters
Cov. Xy = covariance between each pair of characters.

Results and Discussions

Analysis of variance

Results in Table 2 showed that mean squares for (D.F.F.F.) traits exhibited that significant or high significant for all types of variations. Moreover, sex ratio was high significant for all types of variations. Mean squares for fruit weight (F.W.) was significant or high significant for all types of variations except reciprocal effect. T.S.S recorded insignificant mean squares except replicates found high significant. Mean squares for (N.F.P.) and (T.Y.P.) characters were found high significant.

Table 2. Analysis of mean squares for yield and yield components.

SOV	df	D.F.F. F.	Sex ratio ♂/♀	F.W. g	TSS %	N.F.P.	T.Y.P. g
rep	2	6.94*	0.05**	68.88	1.07**	1.93	1937.13
genotypes	99	15.31**	0.21**	126.33**	0.13	16.78**	153293.93**
Parents	9	24.29**	1.09**	222.45**	0.1	35.60**	122153.10**
Crosses	89	12.54**	0.10**	114.48**	0.13	14.16**	140177.87**
Pxf1	1	180.86**	1.53**	316.38**	0.01	80.46**	1600890.75**
Error	198	1.98	0.01	22.56	0.1	1.98	8886.32
GCA	9	27.46**	0.48**	324.17**	0.04	25.09**	188737.22**
SCA	45	4.09**	0.05**	18.13*	0.04	4.93**	50741.94**
Reciprocal	45	1.64*	0.01**	9.68	0.05	2.36**	23926.17**
Error	198	0.66	0	7.52	0.03	0.66	2962.11
GCA/SCA		6.71	10.58	17.88	0.97	5.09	3.72

1- Flowering characters:

2.1. Number of days to first female flower:

Results in Table (3) showed that the highest significant negative heterosis was recorded in the straight hybrid P1 X P6 (- 18.62%)(- 20.64%) and the lowest values were found in the hybrids P3 X P4 (- 4.96%) and P2 X P6 (- 4.69%) compared to mid and better parents, respectively.

Heterosis belonged to check varieties showed that the highest significant negative heterosis was recorded in the hybrid P1 X P6 (- 14.51%)(- 14.65%) and the highest positive values were found in the hybrid P6 X

P8 (6.62%)(6.46%) compared to check variety 1 and 2, respectively. While, the lowest negative values were appeared in the hybrid P2 X P3 (- 5.05%)(- 5.20%) relative to check 1 and 2. In addition, the lowest positive value was noticed in the hybrid P3 X P7 (5.05%). For reciprocals, the highest negative heterosis was exhibited in the hybrid P2 X P1 (- 14.35%) over mid-parent and P5 X P3 (- 16.16%) over better parent, and the lowest negative values were appeared in the hybrids P10 X P8 (- 4.77%) and P9 X P7 (- 5.21%) compared to mid and better parents, respectively. For check varieties, the highest significant negative heterosis was found in the hybrid P4 X P1 (- 11.36%)(- 11.50%). While, the highest significant positive values were noticed in the hybrid P8 X P6 (6.62%)(6.46%). On the contrary, the lowest negative values were recorded in the hybrid P8 X P1 (- 4.89%)(- 5.04%) against check 1 and 2, respectively. These data were presented by **Hussien (2015)**, **Hussien and Hamed (2015)**, **El-Tahawey *et al*., (2015**), **Mohamed (2016b), Marxmathi *et al*., (2018 a)**.

Table 3. Estimation of heterosis percentage of F1 hybrids and their reciprocals relative to mid and better parents and two commercial checks for number of days to first female flower.

F1	H. Mp	H. Bp	H. CV 1	H. CV 2	F1r	H. Mp	H. Bp	H. CV 1	H. CV 2
P1XP2	-12.07**	-13.32**	-8.68**	-8.82**	P2XP1	-14.35**	-15.57**	-11.04**	-11.18**
P1XP3	-12.80**	-16.99**	-5.99*	-6.14**	P3XP1	-10.17**	-14.48**	-3.15	-3.31
P1XP4	-9.66**	-13.56**	-11.51**	-11.65**	P4XP1	-9.50**	-13.41**	-11.36**	-11.50**
P1XP5	-8.98**	-9.33**	-6.47**	-6.61**	P5XP1	-7.75**	-8.10**	-5.21*	-5.35*
P1XP6	-18.62**	-20.64**	-14.51**	-14.65**	P6XP1	-10.96**	-13.18**	-6.47**	-6.61**
P1XP7	-9.52**	-12.17**	-10.09**	-10.24**	P7XP1	-10.48**	-13.10**	-11.04**	-11.18**
P1XP8	-16.17**	-19.17**	-10.88**	-11.02**	P8XP1	-10.53**	-13.73**	-4.89*	-5.04*
P1XP9	-10.37**	-11.40**	-9.31**	-9.45**	P9XP1	-2.88	-4.01	-1.74	-1.89
P1XP10	-6.83**	-10.63**	-8.52**	-8.66**	P10XP1	-7.31**	-11.09**	-8.99**	-9.13**
P2XP3	-13.13**	-16.16**	-5.05*	-5.20*	P3XP2	-8.23**	-11.42**	0.32	0.16
P2XP4	-3.25	-8.68**	-3.79	-3.94	P4XP2	-7.22**	-12.43**	-7.73**	-7.87**
P2XP5	-5.45*	-6.44**	-1.42	-1.57	P5XP2	-8.02**	-8.98**	-4.1	-4.25
P2XP6	-3.63	-4.69*	2.68	2.52	P6XP2	-4.96*	-6.00**	1.26	1.10
P2XP7	-8.84**	-12.72**	-8.04**	-8.19**	P7XP2	-8.99**	-12.87**	-8.20**	-8.35**
P2XP8	-1.68	-3.86	5.99*	5.83*	P8XP2	-9.14**	-11.16**	-2.05	-2.20
P2XP9	-2.30	-4.79*	0.32	0.16	P9XP2	-0.77	-3.29	1.89	1.73
P2XP10	-0.79	-6.14**	-1.10	-1.26	P10XP2	-0.63	-5.99**	-0.95	-1.10
P3XP4	-4.96*	-13.23**	-1.74	-1.89	P4XP3	-7.40**	-15.46**	-4.26	-4.41
P3XP5	-8.31**	-12.40**	-0.79	-0.94	P5XP3	-12.24**	-16.16**	-5.05*	-5.20*
P3XP6	-7.07**	-9.33**	2.68	2.52	P6XP3	-5.21*	-7.52**	4.73*	4.57
P3XP7	0.23	-7.24**	5.05*	4.88*	P7XP3	-2.03	-9.33**	2.68	2.52
P3XP8	-5.72**	-6.96**	5.36*	5.20*	P8XP3	-5.15*	-6.41**	5.99*	5.83*
P3XP9	-7.99**	-13.37**	-1.89	-2.05	P9XP3	-10.36**	-15.60**	-4.42	-4.57
P3XP10	-0.76	-9.19**	2.84	2.68	P10XP3	-5.63*	-13.65**	-2.21	-2.36
P4XP5	-6.17**	-10.55**	-7.73**	-7.87**	P5XP4	-3.45	-7.95**	-5.05*	-5.20*
P4XP6	-7.05**	-13.18**	-6.47**	-6.61**	P6XP4	-3.92	-10.25**	-3.31	-3.46
P4XP7	-6.15*	-7.53**	-10.88**	-11.02**	P7XP4	-0.33	-1.80	-5.36*	-5.51*
P4XP8	-3.72	-11.02**	-1.89	-2.05	P8XP4	1.55	-6.15**	3.47	3.31
P4XP9	-5.30*	-8.36**	-8.36**	-8.50**	P9XP4	0.73	-2.52	-2.52	-2.68
P4XP10	-1.77	-2.01	-7.89**	-8.03**	P10XP4	-5.13*	-5.37*	-11.04**	-11.18**
P5XP6	-9.05**	-10.98**	-4.10	-4.25	P6XP5	-5.61*	-7.61**	-0.47	-0.63
P5XP7	-1.50	-4.74*	-1.74	-1.89	P7XP5	-8.30**	-11.31**	-8.52**	-8.66**
P5XP8	-10.27**	-13.16**	-4.26	-4.41	P8XP5	-4.95*	-8.01**	1.42	1.26
P5XP9	-2.02	-3.52	-0.47	-0.63	P9XP5	-0.16	-1.68	1.42	1.26
P5XP10	-1.12	-5.50*	-2.52	-2.68	P10XP5	-5.12*	-9.33**	-6.47**	-6.61**
P6XP7	-4.33	-9.37**	-2.37	-2.52	P7XP6	-5.26*	-10.25**	-3.31	-3.46
P6XP8	-2.17	-3.29	6.62**	6.46**	P8XP6	-2.17	-3.29	6.62**	6.46**
P6XP9	-5.69*	-9.08**	-2.05	-2.20	P9XP6	-6.61**	-9.96**	-3.00	-3.15
P6XP10	-1.49	-7.76**	-0.63	-0.79	P10XP6	-4.93*	-10.98**	-4.10	-4.25
P7XP8	-9.47**	-15.16**	-6.47**	-6.61**	P8XP7	-1.68	-7.87**	1.58	1.42
P7XP9	-5.22*	-6.94**	-6.94**	-7.09**	P9XP7	-3.45	-5.21*	-5.21*	-5.35*
P7XP10	-0.58	-1.80	-5.36*	-5.51*	P10XP7	-4.89*	-6.06*	-9.46**	-9.61**
P8XP9	-11.31**	-14.49**	-7.89**	-8.03**	P9XP8	-6.30**	-9.66**	-2.68	-2.83
P8XP10	-3.99	-10.10**	-3.15	-3.31	P10XP8	-4.77*	-10.83**	-3.94	-4.09
P9XP10	7.64**	4.42	4.42	4.25	P10XP9	-3.09	-5.99*	-5.99*	-6.14**

2.2. Sex ratio ♂/♀

Results in table (4) indicated that the highest significant negative heterosis was recorded in the straight hybrid P3 X P6 (- 62.38%)(- 73.97%). While, the lowest negative values were appeared in the hybrid P1 X P8 (- 21.26%)(- 22.07%) over mid and better parents, respectively. the hybrid P6 X P8 gave the only highest significant positive heterosis (23.02%) over mid-parent. For check varieties, the hybrid P2 X P3 shoed the highest significant positive heterosis (148.11%). While, the hybrid P1 X P4 gave the only significant negative value (- 33.66%) over check1. In addition, the highest significant positive heterosis (80.70%) was appeared in the hybrid P6 X P8 and the lowest positive value (23.90%) was noticed in the hybrid P1 X P9). On the contrary, the highest significant negative value was showed in the hybrid P1 X P4 (- 49.54%) and the lowest value was noticed in the hybrid P4 X P7 (- 23.87%) over check 2. relative to reciprocal hybrids, the highest significant positive heterosis was found in the hybrid P5 X P4 (55.13%) and the lowest positive value was (29.28%) in the hybrid P10 X P1. On the contrary, the highest significant negative heterosis was recorded in the hybrid P2 X P1 (- 52.24%) and the lowest negative value (- 16.84%) was in the hybrid P8 X P6 over mid-parent. The highest significant negative heterosis was found in the hybrid P5 X P3 (-70.59%) and the lowest negative value was found in hybrid P5 X P1 (- 20.12%), the only significant positive value was recorded in the hybrid P5 X P4 (30.63%) better parent.

Table 4. Estimation of heterosis percentage of F1 hybrids and their reciprocals relative to mid and better parents and two commercial checks for sex ratio ♂/♀.

F1	H. Mp	H. Bp	H. CV 1	H. CV 2	F1r	H. Mp	H. Bp	H. CV 1	H. CV 2
P1XP2	-9.61	-21.38**	59.85**	21.59	P2XP1	-52.24**	-58.46**	-15.54	-35.76**
P1XP3	-46.42**	-66.56**	102.52**	54.04**	P3XP1	-51.79**	-69.91**	82.23**	38.61**
P1XP4	-41.90**	-55.89**	-33.66*	-49.54**	P4XP1	-31.21*	-47.77**	-21.45	-40.25**
P1XP5	-19.87	-29.57**	5.93	-19.43	P5XP1	-9.13	-20.12*	20.13	-8.63
P1XP6	-50.34**	-59.12**	-4.89	-27.66*	P6XP1	-45.23**	-54.91**	4.91	-20.20
P1XP7	-18.21	-22.50*	16.56	-11.34	P7XP1	-32.28**	-35.83**	-3.50	-26.60*
P1XP8	-21.26*	-22.07*	19.66	-8.98	P8XP1	-43.91**	-44.49**	-14.77	-35.17**
P1XP9	-3.83	-13.53	62.89**	23.90*	P9XP1	-24.92**	-32.49**	27.17	-3.27
P1XP10	-22.66	-36.66**	-4.74	-27.54*	P10XP1	29.28*	5.88	59.23**	21.12
P2XP3	-38.65**	-59.03**	148.11**	88.72**	P3XP2	-49.77**	-66.45**	103.16**	54.53**
P2XP4	-15.36	-41.45**	19.04	-9.45	P4XP2	-37.87**	-57.02**	-12.61	-33.53**
P2XP5	-30.95**	-46.12**	9.55	-16.67	P5XP2	-40.55**	-53.61**	-5.68	-28.26*
P2XP6	-50.73**	-53.84**	7.41	-18.30	P6XP2	-53.61**	-56.53**	1.13	-23.07*
P2XP7	-28.47**	-40.55**	20.86	-8.07	P7XP2	-2.95	-19.35**	63.98**	24.73*
P2XP8	-38.94**	-46.41**	8.95	-17.13	P8XP2	-31.66**	-40.03**	21.93	-7.25
P2XP9	-26.31**	-29.02**	44.31**	9.77	P9XP2	-4.62	-8.12	86.80**	42.09**
P2XP10	-15.18	-37.58**	26.91	-3.47	P10XP2	0.30	-26.18**	50.08**	14.16
P3XP4	-30.11**	-60.55**	138.87**	81.69**	P4XP3	-47.47**	-70.35**	79.54**	36.56**
P3XP5	-44.81**	-67.21**	98.58**	51.05**	P5XP3	-50.50**	-70.59**	78.08**	35.46**
P3XP6	-62.38**	-73.97**	57.66**	19.92	P6XP3	-49.50**	-65.05**	111.64**	60.98**
P3XP7	-52.64**	-71.06**	75.28**	33.32**	P7XP3	-27.75**	-55.84**	167.39**	103.39**
P3XP8	-46.41**	-66.41**	103.41**	54.73**	P8XP3	-37.60**	-60.89**	136.83**	80.14**
P3XP9	-42.65**	-62.41**	127.65**	73.16**	P9XP3	-45.46**	-64.25**	116.49**	64.67**
P3XP10	-42.25**	-66.55**	102.55**	54.06**	P10XP3	-36.99**	-63.50**	121.02**	68.12**
P4XP5	-2.86	-18.20	-6.76	-29.08*	P5XP4	55.13**	30.63*	48.90**	13.26
P4XP6	-39.97**	-59.92**	-6.76	-29.07*	P6XP4	-7.54	-38.27**	43.62**	9.24
P4XP7	-5.85	-25.66*	0.08	-23.87*	P7XP4	-8.62	-27.84*	-2.86	-26.11*
P4XP8	1.54	-23.44*	17.55	-10.59	P8XP4	23.02	-7.25	42.42**	8.33
P4XP9	-18.31	-42.25**	8.79	-17.25	P9XP4	7.93	-23.69**	43.74**	9.34
P4XP10	-8.51	-17.08	-20.43	-39.48**	P10XP4	-29.5	-36.10*	-38.68*	-53.36**
P5XP6	-38.25**	-54.00**	7.04	-18.58	P6XP5	-27.40**	-45.92**	25.84	-4.28
P5XP7	-22.14	-28.11*	-3.21	-26.38*	P7XP5	-21.21	-27.25*	-2.06	-25.50*
P5XP8	-5.09	-17.31	26.96	-3.43	P8XP5	7.24	-6.57	43.46**	9.12
P5XP9	0.13	-19.64*	51.38**	15.15	P9XP5	-14.69	-31.53**	28.97	-1.90
P5XP10	-24.28	-30.27*	-20.51	-39.54**	P10XP5	-18.69	-25.13	-14.65	-35.08**
P6XP7	-42.15**	-54.34**	6.23	-19.20	P7XP6	-48.13**	-59.06**	-4.74	-27.54*
P6XP8	23.02**	2.10	137.57**	80.70**	P8XP6	-16.84*	-30.98**	60.59**	22.15
P6XP9	-33.62**	-39.94**	39.75**	6.30	P9XP6	-49.58**	-54.38**	6.14	-19.26
P6XP10	-48.58**	-63.68**	-15.50	-35.73**	P10XP6	-38.99**	-56.92**	0.25	-23.75*
P7XP8	6.64	0.07	53.65**	16.88	P8XP7	-6.16	-11.94	35.21*	2.85
P7XP9	-13.88	-26.16**	39.09**	5.80	P9XP7	-28.01**	-38.28**	16.26	-11.57
P7XP10	5.28	-9.84	21.37	-7.68	P10XP7	-12.76	-25.29*	0.58	-23.50*
P8XP9	-55.22**	-59.49**	-5.74	-28.30*	P9XP8	-48.48**	-53.39**	8.46	-17.5
P8XP10	-33.39**	-52.96**	9.45	-16.75	P10XP8	-33.63**	-53.13**	9.05	-17.05
P9XP10	-14.59	-35.54**	21.42	-7.64	P10XP9	-11.57	-33.26**	25.72	-4.37

Heterosis belonged to check varieties, the highest significant positive heterosis was recorded in the hybrid P7 X P3 (167.39%)(103.39%) over check 1 and 2. While, the only significant negative value was in the hybrid P10 X P4 (- 38.68%) over check 1. On the contrary, the highest significant negative heterosis over check 2 was appeared in the hybrid P10 X P4 (- 53.36%) and lowest negative value was in the hybrid P10 X P7 (- 23.50%). These data were presented by **Obiadalla-Ali (2006)**, **Tamil et al., (2012)**, **Mohamed (2016b), Marxmathi *et al*., (2018 a).**

2- Fruit characters:

3.1. Fruit weight (g)

Data from table (5) exhibited that only positive effects, the highest significant positive heterosis was in the straight hybrid P8 X P9 (34.36%)(32.82%) over mid and better parent, respectively. The highest significant negative heterotic effect was in the hybrid P3 X P7 (- 15.53%) and the lowest value was in the hybrid P4 X P8 (- 7.21%) over better parent. Heterosis related to check varieties revealed that the highest significant positive effects were in the hybrid P3 X P8 (19.31%)(20.04%) over check 1 and 2, respectively. While, the lowest positive value was in the hybrid P1 X P2 (8.21%) over check 1. While, the hybrid P4 X P8 (7.86%) over check 2.

Table 5. Estimation of heterosis percentage of F1 hybrids and their reciprocals relative to mid and better parents and two commercial checks for fruit weight (g).

F1	H. Mp	H. Bp	H. CV 1	H. CV 2	F1r	H. Mp	H. Bp	H. CV 1	H. CV 2
P1XP2	11.72**	10.75**	8.21*	8.87*	P2XP1	12.93**	11.95**	9.38*	10.05*
P1XP3	3.06	-3.76	8.36*	9.02*	P3XP1	2.36	-4.41	7.62	8.28*
P1XP4	-0.55	-2.16	-4.41	-3.82	P4XP1	3.12	1.46	-0.87	-0.27
P1XP5	-1.12	-3.31	-5.53	-4.95	P5XP1	8.56*	6.16	3.71	4.35
P1XP6	11.87**	5.38	2.96	3.59	P6XP1	12.13**	5.62	3.19	3.82
P1XP7	3.89	-2.07	-4.32	-3.73	P7XP1	6.92	0.79	-1.53	-0.93
P1XP8	2.60	-5.31	9.39*	10.06*	P8XP1	-4.04	-11.45**	2.31	2.93
P1XP9	13.00**	7.61	5.13	5.78	P9XP1	18.19**	12.56**	9.97*	10.64**
P1XP10	4.17	0.88	-1.44	-0.84	P10XP1	-2.74	-5.82	-7.98*	-7.42
P2XP3	-1.89	-9.11**	2.33	2.96	P3XP2	-2.92	-10.07**	1.25	1.87
P2XP4	4.72	3.93	-0.22	0.39	P4XP2	-2.73	-3.47	-7.32	-6.76
P2XP5	2.35	0.94	-3.09	-2.49	P5XP2	-0.34	-1.70	-5.63	-5.05
P2XP6	6.29	0.95	-3.08	-2.49	P6XP2	0.00	-5.02	-8.82*	-8.26*
P2XP7	2.03	-3.03	-6.9	-6.33	P7XP2	8.22	2.86	-1.25	-0.65
P2XP8	-2.38	-10.63**	3.25	3.88	P8XP2	4.19	-4.61	10.20**	10.88**
P2XP9	2.35	-1.72	-5.64	-5.07	P9XP2	2.17	-1.89	-5.81	-5.23
P2XP10	3.05	0.64	-3.37	-2.78	P10XP2	3.45	1.03	-3.00	-2.41
P3XP4	-2.39	-10.21**	1.10	1.72	P4XP3	-9.61*	-16.85**	-6.38	-5.81
P3XP5	-5.14	-13.23**	-2.31	-1.71	P5XP3	0.33	-8.23*	3.33	3.96
P3XP6	7.93*	-4.64	7.37	8.03*	P6XP3	4.27	-7.87*	3.73	4.36
P3XP7	-4.46	-15.53**	-4.90	-4.31	P7XP3	-1.04	-12.50**	-1.49	-0.89
P3XP8	4.60	3.27	19.31**	20.04**	P8XP3	4.30	2.98	18.97**	19.70**
P3XP9	-1.20	-11.82**	-0.72	-0.11	P9XP3	5.96	-5.43	6.48	7.13
P3XP10	3.79	-5.92	5.92	6.57	P10XP3	-0.70	-9.99**	1.34	1.96
P4XP5	-0.14	-0.76	-6.17	-5.60	P5XP4	7.02	6.36	0.56	1.18
P4XP6	10.58*	5.79	0.02	0.63	P6XP4	4.12	-0.39	-5.82	-5.24
P4XP7	-2.27	-6.43	-11.53**	-10.99**	P7XP4	1.02	-3.28	-8.55*	-8.00*
P4XP8	2.06	-7.21*	7.21	7.86*	P8XP4	0.52	-8.61*	5.59	6.23
P4XP9	1.72	-1.59	-6.96	-6.39	P9XP4	17.41**	13.58**	7.38	8.04*
P4XP10	-1.00	-2.58	-7.89*	-7.33	P10XP4	-2.51	-4.07	-9.30*	-8.75*
P5XP6	6.07	2.09	-4.67	-4.09	P6XP5	8.66*	4.58	-2.34	-1.75
P5XP7	1.28	-2.45	-8.91*	-8.36*	P7XP5	3.05	-0.74	-7.32	-6.75
P5XP8	5.33	-4.77	10.02*	10.70**	P8XP5	-1.25	-10.72**	3.15	3.78
P5XP9	5.52	2.70	-4.10	-3.51	P9XP5	0.39	-2.30	-8.77*	-8.21*
P5XP10	0.65	-0.35	-6.95	-6.38	P10XP5	7.00	5.94	-1.08	-0.47
P6XP7	12.01**	11.92**	-3.19	-2.60	P7XP6	8.86	8.77	-5.92	-5.34
P6XP8	9.00*	-4.76	10.03*	10.71**	P8XP6	9.73*	-4.12	10.77**	11.45**
P6XP9	9.21*	7.96	-4.58	-4.00	P9XP6	17.75**	16.40**	2.88	3.51
P6XP10	5.36	2.39	-6.29	-5.71	P10XP6	8.87*	5.80	-3.17	-2.57
P7XP8	5.05	-8.15*	6.11	6.76	P8XP7	10.18**	-3.67	11.29**	11.97**
P7XP9	6.81	5.67	-6.61	-6.04	P9XP7	9.94*	8.77	-3.87	-3.28
P7XP10	8.19	5.22	-3.70	-3.11	P10XP7	0.49	-2.27	-10.55**	-10.01*
P8XP9	34.36**	32.82**	17.39**	18.11**	P9XP8	30.70**	29.21**	14.20**	14.90**
P8XP10	23.61**	20.12**	9.94*	10.61**	P10XP8	28.57**	24.94**	14.35**	15.05**
P9XP10	6.09	4.27	-4.57	-3.99	P10XP9	-0.72	-2.42	-10.69**	-10.15*

In addition, some significant or high significant negative effects were detected compared to check 1 and 2. In respect to reciprocals, the highest significant positive heterosis was detected in the hybrid P9 X P8 (30.70%)(29.21%) over mid and better parents, respectively. While, significant and high significant positive lowest values were found in the hybrids P5 X P1 (8.56%) and P9 X P6 (16.40%) over mid and better parents, respectively. Only one significant negative value was recorded in the hybrid P4 X P3 (- 9.61over mid-parent. On the other hand, some significant or high significant negative values were appeared over better parent. Heterosis related to check varieties exhibited that the highest significant positive heterosis was found in the hybrid P8 X P3 (18.97%)(19.70%) over check 1 and 2, respectively. The significant positive lowest value was noticed in the hybrids P2 X P1 (12.93%) and P9 X P4 (8.04%) over check 1 and 2, respectively. In addition some significant or high significant negative values were obtained over check 1 and 2. These data were presented by **Mohamed (2016a) , Marxmathi et al., (2018a), Restrepo (2018)**, **Hikal and Abdein (2018), Gad Allah (2019).**

3.2. Total soluble solids (TSS)

Results illustrated in table (6) revealed that significant negative heterosis was recorded in the straight hybrid P2 X P5 (- 7.21%)(- 8.04%) over mid and better parents, respectively. The only significant positive effect was in the hybrid P4 X P8 (7.64%) over mid-parents. While, another significant negative value was appeared in the hybrid P2 X P9 (- 7.38%) over better parent. The rest of hybrids did not show any significant effects. For check variety 1, only four hybrids showed significant positive values the highest value was in the hybrid P4 X P9 (8.74%) and the lowest value was (7.30%) in the hybrid P6 X P8. On the contrary, no heterotic effects were found over check 2. In respect to reciprocals, the hybrid P8 XP1 showed high significant or significant positive heterosis (9.90%)(8.77%) over mid and better parents. In addition, few hybrids showed significant or high significant positive or negative over mid and better parents. For check variety 1, the highest significant positive value was in the hybrids P8 X P1 (11.17%) and P10 X P1 (9.85%). In addition five hybrids gave significant positive values. Regard to check 2, only two hybrids showed significant positive and high significant negative values over check 2 viz., P8 x P1 (8.18%) and P4 X P2 (-9.36%), respectively. The rest of hybrids did not show any heterotic effects. These data were presented by **Marxmathi et al., (2018a), Hikal and Abdein (2018), Gad Allah (2019)**.

Yield characters

4.1. Number of fruits per plant

Data from table (7) reported that the highest significant positive heterosis was found in the straight hybrid P1 X P3 (42.33%) and the significant positive lowest value was in the hybrid P2 X P10 (12.61%). In addition, only two hybrids showed high significant negative values and some hybrids showed significant or high significant positive values over mid-parent. The highest significant positive heterosis over better parent was found in the hybrid P1 X P7 (32.58%) and the significant positive lowest value was in the hybrid P6 X P10 (11.19%). In addition some hybrids showed significant or high significant positive or negative values over better parent. Belonging to check varieties, the highest significant positive value was in the hybrid P4 X P10 (19.54%) and the significant positive lowest value was in the hybrid P4 X P7 (11.88%). In addition, some hybrids showed significant or high significant positive or negative over better parent. For check varieties, the highest significant positive heterosis was found in the hybrid P4 X P10 (19.54%)(35.65%) over check 1 and 2. While, the significant positive lowest values was in hybrids P4 X P7 (11.88%) and P1 X P5 (14.78%) over check 1 and 2, respectively. In addition, some hybrids showed different levels of heterosis over the two checks. In respect to reciprocal crosses, the highest significant heterosis was appeared in the hybrids P3 X P1 (47.85%) and P2 X P1 (32.42%) over mid and better parents, respectively. While, the significant positive lowest values was found in the hybrids P5 X P7 (13.81%) and P9 X P8 (12.45%) over mid and better parents, respectively. In addition, some hybrids showed significant or high significant positive or negative values. Relative to the checks, the highest significant positive values were found in the hybrid P10 X P8 (28.74%)(46.09%) over check variety 1 and 2, respectively. Moreover, some hybrids showed different levels of heterosis over the two checks. These data were presented by **Marie *et al.*, (2012), Hatem *et al*., (2013), Othman (2016), Chaudhari *et al*. (2017)**, **Marxmathi et al., (2018a), Elsharkawy et al. (2018), Hikal and Abdein (2018), Gad Allah (2019)**.

Table 6. Estimation of heterosis percentage of F1 hybrids and their reciprocals relative to mid and better parents and two commercial checks for TSS (%).

F1	H. Mp	H. Bp	H. CV 1	H. CV 2	F1r	H. Mp	H. Bp	H. CV 1	H. CV 2
P1XP2	2.09	1.17	5.31	2.48	P2XP1	-0.27	-1.17	2.88	0.11
P1XP3	-3.73	-3.88	-1.44	-4.09	P3XP1	3.62	3.45	6.08	3.23
P1XP4	-3.70	-4.22	-2.10	-4.74	P4XP1	1.52	0.97	3.21	0.43
P1XP5	-1.38	-3.13	2.65	-0.11	P5XP1	-1.28	-3.03	2.77	0.00
P1XP6	0.98	0.00	2.21	-0.54	P6XP1	0.22	-0.76	1.44	-1.29
P1XP7	-2.82	-4.40	1.00	-1.72	P7XP1	0.27	-1.36	4.20	1.40
P1XP8	2.46	1.41	3.65	0.86	P8XP1	9.90**	8.77*	11.17**	8.18*
P1XP9	-2.32	-4.92	2.65	-0.11	P9XP1	-2.21	-4.82	2.77	0.00
P1XP10	-1.43	-3.25	-1.11	-3.77	P10XP1	9.48**	7.47*	9.85**	6.89
P2XP3	-3.75	-4.46	-0.55	-3.23	P3XP2	-4.07	-4.78	-0.88	-3.55
P2XP4	0.38	-1.06	2.99	0.22	P4XP2	-9.22**	-10.52**	-6.86	-9.36**
P2XP5	-7.21*	-8.04*	-2.54	-5.17	P5XP2	0.47	-0.42	5.53	2.69
P2XP6	2.22	0.32	4.42	1.61	P6XP2	-5.04	-6.80	-2.99	-5.60
P2XP7	-1.58	-2.30	3.21	0.43	P7XP2	-0.63	-1.36	4.20	1.40
P2XP8	4.88	2.87	7.08	4.20	P8XP2	3.58	1.59	5.75	2.91
P2XP9	-5.69	-7.38*	0.00	-2.69	P9XP2	-0.68	-2.46	5.31	2.48
P2XP10	1.26	-1.49	2.54	-0.22	P10XP2	3.28	0.48	4.59	1.78
P3XP4	-5.59	-6.26	-3.87	-6.46	P4XP3	4.18	3.45	6.08	3.23
P3XP5	-1.33	-2.92	2.88	0.11	P5XP3	0.27	-1.36	4.54	1.72
P3XP6	5.07	3.88	6.53	3.66	P6XP3	0.82	-0.32	2.21	-0.54
P3XP7	2.44	0.94	6.64	3.77	P7XP3	-1.59	-3.04	2.43	-0.32
P3XP8	-2.40	-3.56	-1.11	-3.77	P8XP3	3.28	2.05	4.65	1.83
P3XP9	2.89	0.31	8.30*	5.38	P9XP3	-3.00	-5.43	2.10	-0.65
P3XP10	3.58	1.51	4.09	1.29	P10XP3	4.13	2.05	4.65	1.83
P4XP5	0.21	-2.09	3.76	0.97	P5XP4	-6.62	-8.77*	-3.32	-5.92
P4XP6	2.64	2.19	3.32	0.54	P6XP4	-0.44	-0.88	0.22	-2.48
P4XP7	-2.62	-4.71	0.66	-2.05	P7XP4	1.44	-0.73	4.87	2.05
P4XP8	7.64*	7.11	8.30*	5.38	P8XP4	3.79	3.28	4.42	1.61
P4XP9	4.02	0.72	8.74*	5.81	P9XP4	-4.55	-7.58*	-0.22	-2.91
P4XP10	4.55	3.17	4.31	1.51	P10XP4	7.76*	6.35	7.52*	4.63
P5XP6	-3.86	-6.47	-0.88	-3.55	P6XP5	-1.29	-3.97	1.77	-0.97
P5XP7	-5.18	-5.32	0.33	-2.37	P7XP5	2.04	1.88	7.96*	5.06
P5XP8	0.81	-1.98	3.87	1.08	P8XP5	1.23	-1.57	4.31	1.51
P5XP9	-1.86	-2.77	4.98	2.15	P9XP5	0.10	-0.82	7.08	4.20
P5XP10	3.03	-0.63	5.31	2.48	P10XP5	5.41	1.67	7.74*	4.84
P6XP7	-1.88	-4.40	1.00	-1.72	P7XP6	-0.27	-2.83	2.65	-0.11
P6XP8	7.12	7.06	7.30*	4.41	P8XP6	7.56*	7.51*	7.74*	4.84
P6XP9	-2.98	-6.45	1.00	-1.72	P9XP6	-7.33*	-10.66**	-3.54	-6.14
P6XP10	-2.67	-3.53	-3.32	-5.92	P10XP6	7.02	6.07	6.31	3.44
P7XP8	1.51	-1.15	4.42	1.61	P8XP7	-2.90	-5.45	-0.11	-2.80
P7XP9	-1.71	-2.77	4.98	2.15	P9XP7	-5.85	-6.86*	0.55	-2.15
P7XP10	1.57	-1.88	3.65	0.86	P10XP7	-1.25	-4.61	0.77	-1.94
P8XP9	-2.34	-5.84	1.66	-1.08	P9XP8	-4.78	-8.20*	-0.88	-3.55
P8XP10	2.67	1.77	1.99	-0.75	P10XP8	4.90	3.97	4.20	1.40
P9XP10	2.04	-2.46	5.31	2.48	P10XP9	5.14	0.51	8.52*	5.60

Table 7. Estimation of heterosis percentage of F1 hybrids and their reciprocals relative to mid and better parents and two commercial checks for number of fruits/plant.

F1	H. Mp	H. Bp	H. CV 1	H. CV 2	F1r	H. Mp	H. Bp	H. CV 1	H. CV 2
P1XP2	29.67**	23.74**	3.83	17.83**	P2XP1	38.76**	32.42**	11.11	26.09**
P1XP3	42.33**	5.94	-11.11	0.87	P3XP1	47.85**	10.05	-7.66	4.78
P1XP4	20.08**	4.76	18.01**	33.91**	P4XP1	18.13**	3.06	16.09**	31.74**
P1XP5	10.92	2.72	1.15	14.78*	P5XP1	-5.88	-12.84*	-14.18*	-2.61
P1XP6	10.43	5.39	-2.68	10.43	P6XP1	20.00**	14.52*	5.75	20.00**
P1XP7	33.18**	32.58**	12.26*	27.39**	P7XP1	16.82*	16.29*	-1.53	11.74
P1XP8	29.30**	26.94**	6.51	20.87**	P8XP1	20.00**	17.81**	-1.15	12.17
P1XP9	10.43	6.39	-10.73	1.30	P9XP1	2.37	-1.37	-17.24**	-6.09
P1XP10	11.29	-0.36	5.75	20.00**	P10XP1	-8.47	-18.05**	-13.03*	-1.30
P2XP3	13.07	-13.07	-33.72**	-24.78**	P3XP2	43.79**	10.55	-15.71**	-4.35
P2XP4	5.07	-11.90*	-0.77	12.61	P4XP2	5.88	-11.22*	0.00	13.48*
P2XP5	8.33	-3.89	-5.36	7.39	P5XP2	10.96	-1.56	-3.07	10.00
P2XP6	2.27	-6.64	-13.79*	-2.17	P6XP2	36.82**	24.90**	15.33**	30.87**
P2XP7	26.67**	20.36**	1.92	15.65*	P7XP2	17.14*	11.31	-5.75	6.96
P2XP8	20.00**	16.59*	-5.75	6.96	P8XP2	32.20**	28.44**	3.83	17.83**
P2XP9	24.88**	23.65**	-3.83	9.13	P9XP2	19.90**	18.72*	-7.66	4.78
P2XP10	12.61*	-3.25	2.68	16.52*	P10XP2	0.00	-14.08**	-8.81	3.48
P3XP4	18.20*	-19.39**	-9.20	3.04	P4XP3	3.24	-29.59**	-20.69**	-10.00
P3XP5	40.11**	-0.78	-2.30	10.87	P5XP3	34.62**	-4.67	-6.13	6.52
P3XP6	34.48**	-2.90	-10.34	1.74	P6XP3	11.21	-19.71**	-25.86**	-15.87*
P3XP7	38.41**	2.71	-13.03*	-1.30	P7XP3	8.54	-19.46**	-31.80**	-22.61**
P3XP8	40.25**	5.69	-14.56*	-3.04	P8XP3	24.53**	-6.16	-24.14**	-13.91*
P3XP9	30.97**	0.00	-22.22**	-11.74	P9XP3	37.42**	4.93	-18.39**	-7.39
P3XP10	25.00**	-13.36*	-8.05	4.35	P10XP3	17.19*	-18.77**	-13.79*	-2.17
P4XP5	-6.35	-12.24*	-1.15	12.17	P5XP4	-21.96**	-26.87**	-17.62**	-6.52
P4XP6	10.65	0.68	13.41*	28.70**	P6XP4	2.24	-6.97	4.79	18.91**
P4XP7	13.40*	-0.68	11.88*	26.96**	P7XP4	1.75	-10.88*	0.38	13.91*
P4XP8	6.53	-8.50	3.07	16.96**	P8XP4	-8.32	-21.26**	-11.30*	0.65
P4XP9	13.88*	-3.74	8.43	23.04**	P9XP4	-22.74**	-34.69**	-26.44**	-16.52*
P4XP10	9.28	6.12	19.54**	35.65**	P10XP4	-0.53	-3.40	8.81	23.48**
P5XP6	3.21	0.00	-1.53	11.74	P6XP5	-7.63	-10.51	-11.88*	0.00
P5XP7	10.88	3.11	1.53	15.22*	P7XP5	13.81*	5.84	4.21	18.26**
P5XP8	7.26	-2.33	-3.83	9.13	P8XP5	6.41	-3.11	-4.60	8.26
P5XP9	10.00	-1.56	-3.07	10.00	P9XP5	-8.26	-17.90**	-19.16**	-8.26
P5XP10	1.87	-1.81	4.21	18.26**	P10XP5	-14.23*	-17.33**	-12.26*	-0.43
P6XP7	3.03	-1.24	-8.81	3.48	P7XP6	12.55	7.88	-0.38	13.04*
P6XP8	-17.26**	-22.41**	-28.35**	-18.70**	P8XP6	-6.64	-12.45*	-19.16**	-8.26
P6XP9	4.05	-4.15	-11.49*	0.43	P9XP6	11.49	2.70	-5.17	7.61
P6XP10	18.92**	11.19*	18.01**	33.91**	P10XP6	8.88	1.81	8.05	22.61**
P7XP8	16.20*	13.57*	-3.83	9.13	P8XP7	0.46	-1.81	-16.86**	-5.65
P7XP9	5.19	0.90	-14.56*	-3.04	P9XP7	21.23**	16.29*	-1.53	11.74
P7XP10	0.00	-10.11	-4.60	8.26	P10XP7	2.21	-8.12	-2.49	10.65
P8XP9	22.07**	12.45*	3.83	17.83**	P9XP8	22.07**	12.45*	3.83	17.83**
P8XP10	15.44**	7.94	14.56*	30.00**	P10XP8	29.73**	21.30**	28.74**	46.09**
P9XP10	-23.75**	-33.94**	-29.89**	-20.43**	P10XP9	-11.25	-23.10**	-18.39**	-7.39

4.2. Total yield per plant (g)

Results showed in table (8) exhibited that the highest significant positive heterosis was detected in the straight hybrid P8 X P9 (66.69%)(59.37%) over mid and better parents. While, the significant positive lowest values were in the hybrids P4 X P8 (11.41%) and P2 X P8 (10.48%) over mid and better parents, respectively. The only high significant negative value was in the hybrid P9 X P10 (-19.16%) over mid-parent and most of the rest hybrids showed almost high significant positive effects. In addition, four hybrids over better parent showed different levels of negative heterosis and some hybrids showed significant or high significant positive heterosis. Regard to check 1 and 2, six and seventeen hybrids showed positive effects, the highest significant positive heterosis was appeared in the hybrid P1 X P8 (28.16%)(46.09%) over check 1 and 2, respectively. While, the significant positive lowest values were in the hybrids P4 X P10 (10.06%) and P1 X P6 (10.53%) over check 1 and 2, respectively. On the opposite, some hybrids showed significant or high significant negative heterosis over check 1(Aziad) and only three hybrids showed high significant negative effects over check 2 (New Eskandarani). In respect to reciprocal crosses, the highest significant positive value was in the hybrid P3 X P1 (69.11%) and P10 X P8 (70.27%) over mid and better parents. While, the significant positive lowest values were detected in the hybrids P4 X P1 (12.28%) and P7 X P5 (12.68%) over mid and better parents. In addition, two and four hybrids showed significant or high significant negative heterosis over mid and better parents, respectively. Moreover, some hybrids indicated significant or high significant positive heterosis over mid and better parents. For check varieties, the highest significant positive values was in the hybrid P10 X P8 (49.51%)(70.44%) over check 1 and 2, respectively. In addition, three more hybrids showed high significant positive effects over check 1 and the rest of hybrids reported significant or high significant negative values. On the other hand, some hybrids indicated significant or high significant positive or negative values over check 2. These data were presented by **Marxmathi *et al*., (2018a), Restrepo (2018), Elsharkawy et al. (2018), El - shoura et al. (2018)**, **Hikal and Abdein (2018)**, **Gad Allah (2019)**.

Table 8. Estimation of heterosis percentage of F1 hybrids and their reciprocals relative to mid and better parents and two commercial checks for yield traits - Total yield/plant (g)

F1	H. Mp	H. Bp	H. CV 1	H. CV 2	F1r	H. Mp	H. Bp	H. CV 1	H. CV 2
P1XP2	33.06**	32.58**	3.78	18.30**	P2XP1	49.38**	48.84**	16.50**	32.81**
P1XP3	56.92**	25.02**	-2.14	11.55*	P3XP1	69.11**	34.72**	5.46	20.22**
P1XP4	28.05**	15.91**	11.95**	27.61**	P4XP1	12.28*	1.64	-1.83	11.90*
P1XP5	13.69*	8.69	-6.71	6.35	P5XP1	6.59	1.90	-12.53**	-0.29
P1XP6	25.27**	23.87**	-3.04	10.53*	P6XP1	48.25**	46.60**	14.75**	30.81**
P1XP7	37.90**	31.85**	3.21	17.65**	P7XP1	31.79**	26.00**	-1.37	12.43*
P1XP8	55.28**	47.67**	28.16**	46.09**	P8XP1	31.76**	25.30**	8.75	23.97**
P1XP9	26.63**	19.79**	-6.23	6.89	P9XP1	15.03*	8.81	-14.83**	-2.91
P1XP10	25.23**	18.43**	4.00	18.55**	P10XP1	-5.21	-10.35*	-21.28**	-10.26*
P2XP3	2.99	-17.73**	-36.07**	-27.12**	P3XP2	44.53**	15.46**	-10.28*	2.27
P2XP4	8.30	-2.28	-5.63	7.58	P4XP2	6.38	-4.01	-7.3	5.68
P2XP5	7.77	2.66	-11.88**	0.46	P5XP2	8.16	3.04	-11.56*	0.82
P2XP6	7.10	6.29	-17.40**	-5.84	P6XP2	32.15**	31.15**	1.91	16.17**
P2XP7	25.96**	20.86**	-6.09	7.06	P7XP2	21.28**	16.36**	-9.58*	3.07
P2XP8	16.58**	10.48*	-4.12	9.3	P8XP2	31.19**	24.32**	7.90	23.00**
P2XP9	16.16**	10.26	-14.32**	-2.33	P9XP2	9.43	3.87	-19.29**	-7.99
P2XP10	19.63**	12.75*	-1.00	12.86*	P10XP2	5.27	-0.79	-12.88**	-0.69
P3XP4	18.66**	-12.14**	-15.15**	-3.27	P4XP3	5.82	-21.65**	-24.33**	-13.74**
P3XP5	28.95**	-0.64	-14.71**	-2.78	P5XP3	42.85**	10.07	-5.52	7.71
P3XP6	58.36**	27.23**	-2.63	11.00*	P6XP3	32.78**	6.68	-18.36**	-6.93
P3XP7	33.04**	9.79	-21.61**	-10.63*	P7XP3	9.20	-9.89	-35.66**	-26.65**
P3XP8	44.22**	10.70*	-3.92	9.52	P8XP3	28.08**	-1.69	-14.67**	-2.73
P3XP9	28.17**	6.72	-25.50**	-15.07**	P9XP3	46.12**	21.67**	-15.06**	-3.17
P3XP10	41.71**	8.33	-4.88	8.44	P10XP3	36.41**	4.28	-8.43	4.38
P4XP5	-4.63	-9.94*	-13.02**	-0.85	P5XP4	15.11**	8.71	4.99	19.68**
P4XP6	21.55**	8.94	5.21	19.93**	P6XP4	16.29**	4.22	0.65	14.74**
P4XP7	15.28**	0.25	-3.18	10.37*	P7XP4	9.28	-4.96	-8.21	4.63
P4XP8	11.41*	5.76	2.14	16.44**	P8XP4	13.30**	7.56	3.88	18.42**
P4XP9	15.53**	-0.48	-3.88	9.57	P9XP4	-45.25**	-52.84**	-54.45**	-48.08**
P4XP10	19.38**	13.97**	10.06*	25.47**	P10XP4	9.89*	4.91	1.32	15.50**
P5XP6	15.66**	9.39	-6.11	7.03	P6XP5	8.19	2.33	-12.17**	0.13
P5XP7	8.58	-0.55	-14.63**	-2.69	P7XP5	23.02**	12.68*	-3.28	10.26*
P5XP8	2.39	1.83	-11.63*	0.74	P8XP5	19.94**	19.28**	3.52	18.01**
P5XP9	15.08**	4.34	-10.44*	2.09	P9XP5	-14.72*	-22.68**	-33.63**	-24.34**
P5XP10	7.14	5.93	-6.98	6.04	P10XP5	3.21	2.05	-10.39*	2.16
P6XP7	17.01**	13.09*	-13.45**	-1.34	P7XP6	32.20**	27.77**	-2.22	11.47*
P6XP8	1.23	-4.75	-17.33**	-5.76	P8XP6	7.09	0.76	-12.55**	-0.31
P6XP9	19.13**	13.90*	-12.83**	-0.63	P9XP6	34.49**	28.58**	-1.59	12.18*
P6XP10	34.68**	26.02**	10.66*	26.15**	P10XP6	31.07**	22.65**	7.70	22.77**
P7XP8	26.62**	15.40**	0.15	14.17**	P8XP7	17.17**	6.79	-7.32	5.65
P7XP9	16.42*	15.12*	-17.80**	-6.29	P9XP7	33.98**	32.49**	-5.40	7.84
P7XP10	19.42**	8.26	-4.93	8.37	P10XP7	12.95*	2.40	-10.08*	2.50
P8XP9	66.69**	59.37**	21.97**	39.04**	P9XP8	66.58**	59.27**	21.89**	38.95**
P8XP10	50.37**	40.71**	23.56**	40.85**	P10XP8	81.95**	70.27**	49.51**	70.44**
P9XP10	-19.16**	-27.44**	-36.29**	-27.37**	P10XP9	14.12*	2.42	-10.06*	2.53

3- Phenotypic correlation

Data illustrated in Table (9) showing the estimation of phenotypic correlation coefficient between the sixteen studied traits.

Table 9. Estimation of phenotypic correlation among studied traits.

	D.F.F.F	Sex ratio	F.W. g	T.S.S. %	N.F.P.	T.Y.P. g
D.F.F.F		0.48**	0.18**	0.03	-0.49**	-0.37**
Sex ratio			0.27**	0.00	-0.67**	-0.50**
F.W. g				-0.01	-0.16**	0.24**
T.S.S. %					-0.05	-0.04
N.F.P.						0.74**
T.Y.P. g						

*Correlation is significant at the 0.05 level (2-taild).
**Correlation is significant at the 0.01 level (2-taild).

For number of days to first female flower, results showed that high significant positive correlation with sex ratio and fruit weight. On the other side, high significant negative correlation between the studied trait with number of fruits per plant and total yield per plant.

Regarding to sex ratio, data showed that high significant positive correlation with fruit weight. While, high significant negative correlation was found with number of fruits per plant and total yield per plant.

Relative to fruit weight, data revealed that high significant negative and positive correlation with number of fruits per plant and total yield per plant, respectively.

For total soluble solids, the correlation with other traits was found insignificant.

Concerning to number of fruits per plant, results revealed that high significant positive correlation was found with total yield per plant. These data were in agreement with **Panigrahi et al., (2018)**, **Raut et al., (2018)** and **Gad Allah (2019)**.

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دراسة قوة الهجين و الإرتباط لصفات للتزهير و المحصول و مكوناتة فى الكوسة

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الهدف الأساسى من هذه الدراسة هو دراسة توريث بعض الصفات الإقتصادية فى بعض التراكيب الوراثية فى الكوسة والهجن العادية والهجن العكسية الناتجة. نفذت هذه التجربة خلال موسمى 2017 و 2018. تم استخدام عشرة سلالات متقدمة وهذه السلالات هى ب1 = MHTSQ-1 ، ب2 = MHTSQ-2 ، ب3 = MHTSQ-3 ،ب4 = MHTSQ-4 ، ب5 = MHTSQ-5 ، ب6 = MHTSQ-6 ، ب7 = MHTSQ-7 ، ب 8 = MHTSQ-8 ، ب9 = MHTSQ-9 ، ب10 = MHTSQ-10. تمت زراعة هذه السلالات بمزرعة أبحاث شركة مصر هاى تك الدولية للبذور . تم استخدام نظام التهجين التبادلى الكامل لدراسة توريث بعض الصفات الإقتصادية مثل عدد الأيام حتى تفتح أول زهرة مؤنثة ، النسبة الجنسية ، وزن الثمرة بالجرام ، نسبة المواد الصلبة الذائبة (%) ، عدد الثمار لكل نبات ، محصول النبات الكلى بالجرام. وذلك لعدد 90 هجين بالمقارنة بمتوسط الأبوين و الأب الأفضل وصنفى مقارنة هما هجين أزياد و نيو إسكندرانى. أوضحت النتائج أن متوسط مجموع المربعات كان معنوى أوعالى المعنوية لصفة عدد الأيام حتى تفتح أول زهرة مؤنثة ، كما أن القيم كانت عالية المعنوية لصفة النسبة الجنسية لكل مصادر التباين. وزن الثمرة أعطى قيم معنوية أو عالية المعنوية ما عدا التهجين العكسى ، كما أن قيم نسبة المواد الصلبة الذائبة كانت غير معنوية. قيم صفة عدد الثمار لكل نبات و المحصول الكلى للنبات كانت عالية المعنوية. قوة الهجين لصفة عدد الأيام حتى تفتح أول زهرة مؤنثة و النسبة الجنسية أوضحت مستويات معنوية مختلفة بقيم موجبة و سالبة ما عدا بعض الهجن. كما أن القيم لصفة وزن الثمرة و نسبة المواد الصلبة الذائبة كانت معنوية أو عالية المعنوية بقيم موجبة و سالبة لبعض الهجن. قوة الهجين لصفة عدد الثمار لكل نبات و المحصول الكلى للنبات أظهرت هجن عديدة تأثيرات مختلفة لقوة الهجين. معامل الإرتباط المظهرى أوضح درجات مختلفة من الإرتباط بين كل الصفات تحت الدراسة.