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Production of New F_1 Hybrids Cucumber (*Cucumis sativus*, L.) in Open Field

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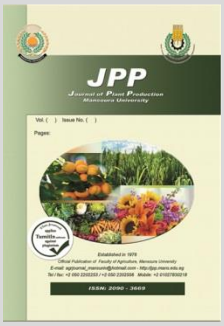

ABSTRACT

This investigation was carried out at Kaha Vegetable Research Farm, Kalubia Governorate, Egypt 2015 and 2016 to study heterosis percentage over mid and better parents, potence ratio and correlation coefficient between traits for some important economical characters in cucumber. Five different parental lines of cucumber obtained from Cornell University which included parental line"1380-1"(P_1); parental line"87-674-1"(P_2); parental line"99-340"(P_3); parental line"99-357"(P_4) and parental line"99-347"(P_5) were carried out by 5 x 5 half diallel mating design, the experimental design was randomized complete block with three replicates. The obtained results generally that the utilized parental lines appeared to have wide ranges of diversity in the different studied traits and their indicated differences were found significant in the most situations. The results exhibited that the highest significant heterosis (47.30%) was reported for early yield per feddan(ton) followed by total yield per feddan (45.81%) and fruit shape index (40.78%), while the largest significant heterosis over better parent (33.97 and 32.86%) was recorded for early yield per feddan followed by (31.53 and 31.50%) for total yieldThe results illustrated that plant length(cm) and number of leaves per plant exhibited significant and positive genotypic and phenotypic correlation with fruit length(cm), fruit shape index(cm), early yield per feddan(ton), average fruit weight(g), number of fruits per plant and total yield per feddan (ton). These positive correlations indicated that a selection programme based on any of these traits will be resulted in increasing yield. Negative and significant association was estimated with days to anthesis first female flower and fruit diameter(cm).

Keywords: *Cucumber, heterosis, F_1 hybrids, potence ratio, correlation, yield.*

INTRODUCTION

Cucumber (*Cucumis sativus*, L.) pertains to the *Cucurbitaceae* family, which contains of 825 species and 117 genera (Gopalakrishnan 2007), is one of the most worthy quick maturing vegetable grown all over the world. Heterosis breeding using good combiner is one of the best methods to improve the existing cultivars. The phenomenon of hybrid vigour resulting from the hybridizations among genetically dissimilar parents from an important means of vegetable improvement, particularly in cross pollinated crops. Vegetable improvement entails techniques for growing quality as inherent capacity of yield, quality and can be improved over exploitation of heterosis breeding (Madhu, 2010). Adequately informed on the heterosis of parents in hybridizations to produce suitable segregating population for selection, half diallel analysis had often been used. The nature of gene action related in expression of quantitative traits is important for effective development of vegetable cultivars and right choice of parents for crosses is crucial for development of varieties (Ene *et al*., 2016a). Development of high yielding crosses mainly depends on genetically superior parents with desirable breeding methodology. The success of selection depends on the magnitudes of genetic variation present in the parental lines used. Therefore, a broad genetic base should be utilized for higher magnitudes of success Jat *et al.* (2016).Singh *et al.* (2016) found that the use of diverse genotypes in hybridization programme creates such broad genetic base. Hayman (1954); Hayman (1958) and Griffing (1956) offered an excellent mean of obtaining information on value and direction of dominance and over dominance. Shashikumar and Pitchaimuthu (2016) they found that the F_1 hybrid, exhibited 44.54% and 15.89 % higher heterosis over the better parent for total yield and commercial check, respectively. In cantaloupe, Pouyesh *et al.* (2017) noticed that the high heterosis percentage to the extension of 181.5% and 97.52 % for total yield, 150 % for number of fruits and 68.7% for average fruit weight. Ene *et al.* (2019) obtained that desirable hybrid vigour versus the better parent for average fruit weight and total yield / plant.

On cucumber, Soliman (2015) showed that, heterosis over high parents were significant with positive magnitudes in most hybrids for plant length, number of leaves, number of fruits / plant, average fruit weight, fruit length and total yield / plant. These results are in agreement with those of Gograj *et al.* (2015); Jat *et al.* (2015); Kalidas *et al.* (2015) and Ene *et al.* (2016a) on cucumber and on squash, Marie *et al. (* 2012) and Karipcin and Inal 2017.

Correlation among characters and with yield is important in indirect selection of genotypes for vegetables yield improvement. Positive and significant correlation between two traits proposes that these traits can be improved simultaneously in a selection program (Hossain *et al.*, 2010; Kumar *et al.*, 2010; Arunkumar *et al.*, 2011; Kumari *et al.*, 2018) on cucumber and Moharana *et al.* (2017) on bitter gourd, selection for one will translate to selection and improvement of the other (Fayeun *et al.*, 2012 on pumpkin). However, selection resolution based on

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correlation coefficient alone may give a misleading impression as it only mensuration's the degree of exchange correlation among two variables without regard to causation. Correlation studies help for deciding which trait contribute towards yield positively or negatively. With this background present investigation is taken to determine available cucumber genotypes for assessing genetic variability and correlation present in various growth and yield related traits. The present investigation was the first information for assessing heterosis in cucumber for yield and yield attributing traits.

MATERIALS AND METHODS

The present experiment was carried out during the successive years of 2015 and 2016, consequently at Kaha Agriculture Research Station, Kalubia governorate Egypt. The genetic materials in this study were five parental lines of cucumber (*Cucumis sativus*, L.), as parental line "1380-1" (P_1); parental line "87- 674-1" (P_2); parental line "99-340" (P_3); parental line "99-357" (P_4) and parental line "99-347" (P_5) acquired from Cornell University. The parental lines were sown at the first of February 2015 and crossed in the greenhouse according to 5 x 5 half diallel mating design to obtain 10 F_1 hybrid combinations. Sufficient quantity of F_1 seeds were obtained for evaluation in the summer 2016. Fifteen genotypes (five parental lines and 10 F_1 hybrids) in addition to check hybrid (Regina) were grown under field condition in a randomized complete block design with three replicates. Each plot was one ridge of 2 meters width and 5 meters in length so the plot area was 10 m^2, the distance between plants was 50 cm.

Variables measurements:

Data were registered on five plants in plot for measuring the growth characters of cucumber. The following reproductive traits were measured: plant length (cm); number of leaves per plant; days to anthesis first female flower (day); fruit length (cm); fruit diameter (cm); fruit shape index (cm); number of fruits per plant, average fruit weight (g), early yield per feddan (ton) and total yield per feddan (ton).

Genetical analysis:

The Performance of the parental lines and their F_1 hybrids were determined according to Mather and Jinks (1971) and Uguru, (2005).

Heterosis versus mid parent (%) = F_1- M.P. / M.P X 100.

Heterosis versus better Parent (%) = F_1- B.P. / B.P X100.

Heterosis versus check hybrid (%) = F_1- C.H. / C. H. X100.

Test of significance was recorded as described by Kumar *et al.*, 2011:

$$LSD= (2EMS/r \; X \; t)^{1/2}.$$

Potence ratio was calculated accordance to Smith (1952) to measure the degree of dominance as:

$$P = F_1 – M.P / 0.5 (P_2 – P_1),$$

Where: P: relative potence of gene set, P_1: The mean of lowest parent, P_2: The mean of largest parent, F_1: first generation mean, and

$$M. P: (P_1 + P_2) / 2.$$

Where: complete dominance is indicated when (P) = +1; while partial dominance is indicated when (P) is between (-1 and +1); while, zero which indicates obscurity of dominance and over dominance is regarded when (P) exceeds +1.

The negative and positive sign indicated the direction of dominance of either parental line.

Genotypic (r_g) and Phenotypic (r_{ph}) correlations between pairs of the studied characters were calculated as according to Singh and Chaudhary, 1985.

$$r_g= cov. g_{1.2} / (\sigma^2_{g1}. \sigma^2_{g2})^{1/2} \quad r_{ph} = cov.ph_{1.2} / (\sigma^2_{ph1}. \sigma^2_{ph2})^{1/2}.$$

RESULTS AND DISCUSSION

Analysis of variance:

The analysis of variance and mean squares for all studied characters in addition to genotypes were made and the results are revealed in Table 1.

Table 1. Analysis of variance and mean squares for all studied characters of cucumber.

Char. Para.	df	Plant length	Number of leaves per plant	Days to anthesis first female flower	Fruit length	Fruit diameter	Fruit shape index	Early yield per feddan	Average fruit weight	Number of fruits per plant	Total yield per feddan
Replication	2	1.12^{ns}	1.36^{ns}	0.28^{ns}	0.03^{ns}	0.001^{ns}	0.04^{ns}	0.02^{ns}	0.12^{ns}	7.61^{ns}	0.02^{ns}
genotypes	14	131.58**	17.28**	8.94**	5.97**	0.178**	1.47**	2.74**	330.33**	687.22**	13.36**
Error	28	1.351	0.450	0.456	0.026	0.013	0.054	0.033	0.526	5.163	0.032

****: significant at 0.01 level of probability.**

The mean squares of genotypes for characters plant length, number of leaves per plant, days to anthesis first female flower, fruit length, fruit diameter, fruit shape index, early yield per plant, average fruit weight, number of fruits per plant and total yield per feddan were appeared highly significant. These results are reflected the presence of true differences among them. The significance of mean squares of all genotypes proposed that, the planned comparisons to understanding the nature of variation and determinate the values of heterosis for all studied traits of the present study.

Mean performance of the parents and their F_1 hybrids:

The results of the comparison among the mean performance of 15 tested genetic populations (five lines and 10F_1 hybrids) in addition check hybrid (Regina) for the aforementioned studied characters of cucumber are recorded in Table 2. The results of the mean values of the parental lines for the studied traits found relatively wide ranges of genetic variation among the parental lines studied traits under this study. The differences between the means of parental lines in most studied traits appeared to be significant. The parental line "99- 340"(P_3) showed the highest mean values for all studied traits expect for number of leaves per plant, fruit diameter and number of fruits per plant. On the other hand, the parental line "99 – 347" (P_5) gave the lowest mean values for all studied traits expect for fruit length and fruit shape index. Concerning the plant length, the highest mean value was reflected by parental line " 99 -340" (P_3) while, the parental line "99-347" (P_4) showed the lowest mean magnitude for the same trait.

Also, the results showed that the plant length was ranged from 141.63(P_5) to 149.87cm (P_3). Their 10 F_1 hybrids ranged from 142.97 (P_1x P_2) to 164.47 cm (P_3x P_4), while check hybrid (Regina) recorded 151.30 cm. For number of leaves per plant the parental lines values ranged from 39.33(P_5) to 40.67(P_2) and their F_1 hybrids ranged from 39.33 (P_1x P_5) to 48.33 (P_3 x P_4), while check hybrid (Regina) recorded 40.67. Values for days to anthesis first female flower ranged from 29.67 (P_5) to 23.33 (P_3) and their F_1 hybrids ranged from 27.67 (P_4x P_5) to 24.00 days (P_3x P_4). On the other hand check hybrid (Regina) recorded 27.00 days. Regarding fruit characteristics, the parent values for fruit length (P_3) had the highest value 15.47 cm followed by (P_2)14.57cm, also, the lowest parents of this trait was 11.77 cm (P_4). The check hybrid (Regina) for fruit length recorded 12.64 cm. Regarding for fruit diameter the parent (P_5) recorded the lowest mean value (2.65 cm) and the parent (P_4) exhibited the highest mean value (3.27 cm), their F_1 hybrids (P_3x P_4) gave the lowest mean value (2.43 cm), while the F_1 hybrids (P_4x P_5) gave the highest mean value (3.07 cm), while check hybrid (Regina) recorded 2.97 cm. For fruit shape index the parent (P_3) showed the highest mean value (5.58 cm) while, the F_1 hybrids P_3x P_4 gave the highest mean value (6.08 cm).

Table 2. Mean performances of the five parental lines and F_1 hybrid combinations for studied characters of cucumber.

Char. Geno.	Plant length	Number of leaves per plant	Days to anthesis first female flower	Fruit length	Fruit diameter	Fruit shape index	Early yield per feddan	Average fruit weight	Number of fruits per plant	Total yield per feddan
P_1	146.97	40.67H	24.00	14.13	3.10	4.57	5.33	101.20	118.47^H	11.99
P_2	142.17	40.67	26.00	14.57	3.23	4.65	4.60	98.94	104.57	10.34
P_3	149.87^H	40.33	23.33^H	15.47^H	2.83	5.58^H	5.35^H	117.35^H	103.00	12.03^H
P_4	142.67	40.33	28.67	11.77^L	3.27^H	3.61^L	4.30	94.18	100.33	9.67
P_5	141.63^L	39.33^L	29.67^L	11.90	2.65^L	4.49	3.66^L	93.08^L	85.66^L	8.47^L
P_1X P_2	142.97^L	39.67	26.67	13.97	2.87	4.88	4.03L	110.96	82.23^L	8.95^L
P_1X P_3	157.87	44.00	25.33	15.23	2.77	5.51	4.99	125.02^H	93.63	14.36
P_1X P_4	157.40	44.33	25.33	12.87	2.77	4.65	6.34	117.29	124.20	14.70
P_1X P_5	144.87	39.33^L	26.67	11.60^L	2.84	4.08	4.30	99.09	100.93	10.87
P_2X P_3	151.57	41.33	25.33	14.40	2.93	4.91	5.48	99.30	132.97^H	12.40
P_2X P_4	153.77	41.67	25.67	15.83^H	2.73	5.80	6.16	112.77	122.97	13.60
P_2X P_5	151.27	42.33	27.00	12.97	2.47	5.25	4.79	109.01	100.92	11.63
P_3X P_4	164.47^H	48.33^H	24.00^H	14.70	2.43^L	6.08^H	7.10^H	124.37	126.87	15.82^H
P_3X P_5	150.17	40.67	26.33	14.47	2.77	5.21	5.58	105.88	113.34	12.21
P_4X P_5	150.03	40.33	27.67^L	12.23	3.07^H	2.98^L	4.21	98.65^L	101.44	11.01
Regina	151.30	40.67	27.00	12.64	2.97	4.26	5.29	95.07	140.73	11.98
LSD at 5 %	1.94	1.12	1.13	0.27	0.19	0.17	0.30	1.32	3.77	0.30
LSD at 1 %	2.62	1.51	1.52	0.36	0.25	0.51	0.40	1.79	5.09	0.40

On the other side, the parent (P4) recorded the lowest mean magnitude (3.61 cm); the F1 hybrid (P4 x P5) exhibited the lowest mean value (2.98 cm), while check hybrid (Regina) recorded 4.26 cm. With respect to yield and its component, data of early yield per feddan for genotypes ranged from 3.66 (P5) to 5.35 to (P3) and their F1 hybrids ranged from 4.03 (P1 x P2) to 7.10 ton (P3x P4), while check hybrid (Regina) recorded 5.29. On the other side, the parents (P3) recorded the highest value mean 117.35 g and 12.03 ton for average fruit weight and total yield per feddan, respectively while the parent (P1) exhibited the highest magnitude mean for number of fruits per plant. In addition, the parent (P5) showed the lowest values means 93.08 g, 85.66 and 8.47 ton for average fruit weight, number of fruits per plant and total yield per feddan, respectively. On the other side, check hybrid (Regina) exhibited the highest value for number of fruits per plant (140.73). Concerning, the crosses (P1 x P3), (P2 x P3) and (P3 x P4) exhibited the highest values means 125.02 g, 132.97 and 15.82 ton for the previous traits while the F1hybrid (P4x P5) recorded the lowest value for average fruit weight (98.65g), at the same trend the F1hybrid (P1x P2) exhibited the lowest magnitude for number of fruits per plant and total yield per feddan (82.23 and 8.95 ton, consequently). These results are in general accordance with the finding of on cucumber (Gograj et al., 2015; Soliman, 2015; Ene et al., 2016a) and Abo Kamer et al. (2015) on melon.

Heterosis types:

Mid parents and better parent heterosis for all studied characters under this study are listed in Tables 3, 4 and 5.

The mean performance of the parental lines and hybrids for characters revealed the presence of sufficient variation between the parental lines and their F1 hybrids. The results showed that positive and negative significant heterosis for all studied traits. None of the F1 hybrids had shown highest heterosis for all studied characters, generally, a significant and suitable value of heterosis versus mid parents and better parents was obtained in many hybrids. Likewise, the estimated potence ratios reflected generally the appearance of partial and over- dominance for the higher levels of the above mentioned characters over those of the lower ones. According to (Kalidas et al., 2015; Soliman, 2015 and Ene et al., 2019) on cucumber, they found that the most of the F1hybrids are larger and more hybrid vigour than their parental lines, indicating that maximum heterotic effects supported the role of dominance (non – additive) gene effects for these traits. The other F1 hybrid reflected negative and un - desirable heterotic effects for these aforementioned traits. The concluded results are indicated that the appearance of the various degree of recessiveness; i.e., partial – to under- recessiveness, which seemed to be involved in the inheritance of these traits in particular populations. This results was also confirmed by the potence ratios, which emerged to have negative magnitudes for the most of these F1, indicating the appearance of partial to under recessiveness effects (Gograj et al., 2015; Soliman, 2015).The maximum positive and significant mid parent heterosis are noticed in F1 hybrids (P3 × P4) and (P1 × P4) (12.44 and 8.69%), (19.84 and 9.46 %) for both plant length and number of leaves per plant, respectively. While, the

F1hybrid P2 x P4 and P3 x P4 exhibited the best favorable heterotic effect for days to anthesis first female flower, early yield per plant and total yield per feddan, consequently. The range of check hybrid heterosis ranged from – 30.05 % (P4 × P5) to 60.30 % (P2 × P3) for fruit shape index and early yield per feddan traits, respectively. While the highest negative and desirable of days to anthesis first female flower ranged from 2.48 % to -1.22 % for crosses (P4 × P5) and (P1 × P2) consequently.

Table 3. Estimates of heterosis percentage based on mid parents of some traits for F_1 hybrids of cucumber.

Characters	Plant length	Number of leaves per plant	Days to anthesis first female flower	Fruit length	Fruit diameter	Fruit shape index	Early yield per feddan	Average fruit weight	Number of fruits per plant	Total yield per feddan
$P_1 \times P_2$	-1.11	-2.46**	6.68**	-2.65**	-9.32**	5.86**	-18.75**	10.88**	-26.26**	-19.84**
Regina	-5.51	-2.46	-1.22	10.26	-3.37	14.55	-23.87	16.71	-41.57	-25.29
$P_1 \times P_3$	6.37**	8.64**	7.01**	2.91**	-6.58**	8.46**	-6.45**	15.41**	-15.45**	19.57**
Regina	4.34	8.18	-6.19	20.49	-6.73	29.34	-5.67	31.50	-33.47	19.87
$P_1 \times P_4$	8.69**	9.46**	-3.83**	-0.62*	-13.03**	13.69**	31.70**	20.06**	13.53**	35.73**
Regina	4.03	9.00	-6.19	1.82	-6.73	32.63	19.85	23.37	-11.75	22.7
$P_1 \times P_5$	0.40	-1.68*	-0.63	-10.87**	-1.22**	-9.93**	-4.23**	2.01*	-1.12	6.26**
Regina	-4.25	-3.29	-1.22	-8.45	-4.38	-4.23	-18.71	4.23	-28.28	-9.27
$P_2 \times P_3$	3.80**	2.05**	2.68**	-4.13**	-3.30**	-4.10**	10.18**	-8.18**	28.11**	10.81**
Regina	0.18	1.62	-6.19	13.65	-1.35	15.26	60.30	4.45	-5.51	3.51
$P_2 \times P_4$	7.97**	2.89**	-6.11**	20.20**	-16.00**	40.78**	38.49**	16.79**	20.03**	35.86**
Regina	1.62	2.46	-4.93	24.94	-8.08	36.15	16.45	18.62	-12.62	13.52
$P_2 \times P_5$	6.60**	5.83**	-3.02**	-2.00**	-15.99**	14.88**	16.04**	13.54**	6.10**	23.59**
Regina	-0.02	4.08	0.00	2.37	-16.84	23.24	-9.45	12.56	-28.29	-2.92
$P_3 \times P_4$	12.44**	19.84**	-7.69**	7.93**	-20.33**	32.17**	47.30**	17.59**	24.79**	45.81**
Regina	8.70	18.83	-11.11	16.02	-18.18	42.72	34.22	30.82	-89.85	32.05
$P_3 \times P_5$	3.03**	2.11**	-0.64	5.74**	1.09*	3.37**	24.01**	0.63	20.15**	19.12**
Regina	-0.75	0.00	-2.48	14.21	-6.73	23.30	5.48	11.37	-19.46	1.92
$P_4 \times P_5$	5.54**	1.26*	-5.14**	3.34**	3.72**	-21.19**	5.91**	5.36**	9.08**	21.39**
Regina	-0.84	0.84	2.48	-3.47	3.37	-30.05	-20.42	3.77	-27.92	-8.10
LSD at 5%	1.68	0.46	0.97	0.23	0.16	0.33	0.26	1.05	3.29	0.25
LSD at 1%	2.27	1.31	1.31	0.31	0.22	0.45	0.34	1.41	4.43	0.35

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

Table 4. Estimates of potence ratios of some characters for F_1 hybrids of cucumber.

Characters Hybrids	Plant length	Number of leaves per plant	Days to anthesis first female flower	Fruit length	Fruit diameter	Fruit shape index	Early yield per feddan	Average fruit weight	Number of fruits per plant	Total yield per feddan
$P_1 \times P_2$	-0.67	0.00	1.67	-1.73	-4.29	6.75	-2.51	9.64	-4.21	-2.67
$P_1 \times P_3$	6.52	20.69	4.88	0.64	41.00	0.87	-43.00	1.95	-2.21	117.50
$P_1 \times P_4$	5.85	22.53	-0.11	-0.07	-4.67	1.17	2.93	5.59	1.63	3.34
$P_1 \times P_5$	0.21	-1.00	-0.06	-1.27	-0.17	-11.25	-0.23	0.49	-0.07	0.36
$P_2 \times P_3$	1.44	4.88	0.49	-1.38	-0.50	-0.44	1.48	-0.96	36.94	1.42
$P_2 \times P_4$	45.40	6.88	-1.25	1.90	-0.26	3.21	11.41	6.81	9.68	10.56
$P_2 \times P_5$	34.70	3.48	-0.46	-0.20	-1.62	8.50	1.41	4.44	0.61	2.36
$P_3 \times P_4$	5.06	0.00	-0.75	0.58	-2.82	1.49	4.34	1.60	18.81	4.21
$P_3 \times P_5$	1.10	1.68	-0.05	0.44	0.33	0.31	1.28	0.05	2.20	1.10
$P_4 \times P_5$	15.15	1.00	-3.00	5.57	0.36	-0.16	0.74	9.13	1.15	3.23

Table 5. Estimates of heterosis percentage based on bitter parents of some characters for F_1 hybrids of cucumber.

Characters Hybrids	Plant length	Number of leaves per plant	Days to anthesis first female flower	Fruit length	Fruit diameter	Fruit shape index	Early yield per feddan	Average fruit weight	Number of fruits per plant	Total yield per feddan
$P_1 \times P_2$	-2.72**	-2.46**	2.58**	-4.12**	-11.15**	4.95**	-24.33**	9.64**	-30.59**	-25.35**
$P_1 \times P_3$	5.34**	8.19**	5.54**	-1.55**	-10.65**	-1.25*	-6.59**	6.54**	-20.97**	19.37**
$P_1 \times P_4$	7.10**	9.00**	-11.65**	-8.92**	-15.29**	1.75*	18.94**	15.90**	4.84*	22.60**
$P_1 \times P_5$	-1.43	-3.29**	-10.11**	-17.91**	-8.39**	-10.72**	-19.20**	-2.08**	-14.81**	-9.34**
$P_2 \times P_3$	1.13	1.62**	-2.58**	-6.92**	-9.29**	-12.01**	2.47**	-15.38**	27.16**	3.08**
$P_2 \times P_4$	7.78**	2.46**	-10.45**	8.65**	-16.51**	24.73**	33.97**	13.98**	17.60**	31.53**
$P_2 \times P_5$	6.40**	4.08**	-9.00**	-10.98**	-23.53**	12.90**	2.24*	10.18**	-3.49	12.48**
$P_3 \times P_4$	9.74**	19.84**	-16.29**	-4.98**	-25.69**	8.96**	32.86**	5.98**	23.17*	31.50**
$P_3 \times P_5$	0.20	0.84	-11.26**	-6.46**	-2.12**	-6.63**	4.47**	-9.77**	10.04**	1.50**
$P_4 \times P_5$	5.16**	0.00	-6.74**	2.77**	-6.12**	-11.36**	-1.91*	4.75**	1.11	13.86**
LSD at 5%	1.94	1.12	1.13	0.26	0.18	0.39	0.31	1.21	3.81	0.31
LSD at 1%	2.62	1.51	1.52	0.36	0.26	0.52	0.41	1.64	5.13	0.40

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

The same conclusion are reached in the case of negative mid- parent heterotic values recorded in days to anthesis first female flower in all the crosses except F_1 hybrids ($P_1 \times P_2$), ($P_1 \times P_3$) and ($P_2 \times P_3$). Negative heterosis in days to anthesis first female flower has been reported by Moharana *et al.* (2017) in bitter gourd. Besides significant positive mid parent heterosis for fruit length and fruit shape index for crosses (P_2 x P_4) and (P_3 x P_4)20.20 %, 7.93 % and 40.78 % and 32.17 %, respectively. The results are the conclusions of (Munshi *et al.*, 2005; Arunkumar *et al.*, 2011; Kalidas *et al.,* 2015; Kumari *et al.,* 2018) on cucumber. On the other hand, the F_1 hybrids ($P_4 \times P_5$) and (P_3 x P_4) have a significant positive mid parent heterosis for average fruit weight (20.06 and 17.59 %) while the crosses (P_2 x P_3) and (P_3 x P_4) had significant positive mid parents heterosis for number of fruits per plant. These results for studied traits supported the findings of Ullah *et al.* (2012); Golabadi *et al.* (2013); Pal *et al.* (2016) and Ene *et al.* (2019) on cucumber.

The heterosis of hybrids over better parents is listed in Table 5 the results indicated that the F_1hybrids (P_3 x P_4) 9.74% and (P_2 x P_4) 7.78% had the highest value of heterotic effects for plant length while, the F_1 hybrids (P_3 x P_4) and (P_1 x P_4) had the highest value of heterotic effects for number of leaves per plant and days to anthesis first female flower. Negative heterosis is actually favorable for days to anthesis first female flower interval implying that these hybrids may mature earlier. These findings are in consonance with (Hossain *et al.,* 2010; Jat *et al.,* 2017); Fayeun *et al.* (2012) on pumpkin. On the other hand, the best desirable heterotic effect for fruit length was exhibited by F_1hybrids P_2 x P_4 (8.65%) and (2.77%) P_4 x P_5 while F_1hybrids P_3 x P_5 and P_4 x P_5 showed the highest positive heterosis effects for fruit diameter. The F_1hybrids P_2 x P_4 (33.97%) and P_3 x P_4 (32.86 %) had the highest high parent heterosis with respect to early yield per feddan. High heterosis values are desirable for number of fruits per plant character in cucumber. This result is in accordance with the findings of (Munshi *et al.*, 2005; Sarkar and Sirohi 2011; Ene *et al.,* 2016$_b$) on cucumber. F_1 hybrids, P_2 x P_4 (31.53%) and P_3 x P_4 (31.50%) exhibited the highest positive heterosis for total yield. This makes them excellent materials for hybridization in developing great yielding varieties of cucumber. Acquaah, (2007) involved maternal cytoplasmic effect for total yield in vegetables. High heterotic values for yield have also been reported in cucumber by (Dogra and Kanwar 2011; Jat *et al.*, 2016; Jat *et al.*, 2017). The extent of heterotic react of the F_1 hybrids highly depends on the breeding magnitude and genetic variance of the parental lines involved in crosses and on the environmental conditions under which the F_1 hybrids are grown. The large or less negative heterosis that occurred in this character in most hybrids could be attributed to a long or short genetic distance, consequently in the character among the parents. In the same time, the negative B.P and M.P heterosis recorded in fruit yield for these F_1 hybrids showed that none of the F_1 hybrids had fruits that yielded more than the B.P or the mean of the parents. Munshi *et al.,* (2005); Madhu, (2010) and Kumar *et al.* (2018) they noticed that negative heterosis in fruit yield had been in cucumber.

Correlation coefficient:

Knowledge of grade of association between traits is of great importance because yield is a complex trait and is resultant of interaction of a number of component characters. The result of the correlation coefficient between some horticultural characters of cucumber genotypes listed in Table 6.

Table 6. Genotypic and phenotypic correlation coefficients among all studied characters in cucumber.

Characters	Number of leaves per plant	Days to anthesis first female flower	Fruit length	Fruit diameter	Fruit shape index	Early yield per feddan	Average fruit weight	Number of fruits per plant	Total yield per feddan
Plant length	0.87**	-0.59**	0.92**	-0.61**	0.85**	0.85**	0.91**	0.59**	0.96**
	0.87**	-0.40	0.95**	-0.56**	0.35*	0.81**	0.60**	0.58**	0.94**
Number of leaves per plant		-0.50**	0.35	-0.57**	0.75**	0.78**	0.73**	0.51**	0.95**
		-0.43	0.32	-0.49**	0.32*	0.78**	0.76**	0.49**	0.91**
Days to anthesis first female flower			-0.76**	0.13	-0.54**	-0.76**	-0.70**	-0.59**	-0.72**
			-0.70**	0.15	-0.57**	-0.66**	-0.59**	-0.53**	-0.66**
Fruit length				-0.18	0.91**	0.58**	0.62**	0.36*	0.53**
				-0.15	0.66**	0.57**	0.64**	0.35*	0.52**
Fruit diameter					-0.62**	-0.45**	-0.61**	0.17	-0.47**
					-0.79**	-0.35*	-0.52**	-0.08	-0.42*
Fruit shape index						0.73**	0.89**	0.37	0.71**
						0.57**	0.63**	0.23	0.54**
Early yield per feddan							0.66**	0.84**	0.91**
							0.67**	0.84**	0.90**
Average fruit weight								0.19	0.77**
								0.21	0.78**
Number of fruits per plant									0.71**
									0.69**

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

Singh *et al.* (2016) on pointed gourd, Moharana *et al.* (2017) in bitter gourd; Ratnakar *et al.* (2018) and Ene *et al.* (2019) on cucumber, reported that the genotypic correlation reveals the presences of true correlation, while phenotypic association may occur by chance. Without significant genetic correlation, there is no use of significant phenotypic correlation. Non-significant phenotypic correlation along with significant genotypic correlation showed the existing real correlation which is masqueraded by the environmental effect. Results illustrated that plant length and number of leaves per plant showed positive and significant genotypic and phenotypic correlation with fruit length, fruit shape index, early yield per feddan, average fruit weight, number of fruits per plant and total yield per feddan. Negative and significant association was recorded with days to anthesis first female flower and fruit diameter.

This finding was in confirmation with (Chaudhary *et al*., 2004; Ullah *et al*., 2012; Ene *et al*., 2016$_a$). Among other attributes, days to anthesis first female flower exhibited negative and significantly associated with all aforementioned traits. Kumar *et al*. (2010), Babu *et al*. (2013) and Kumari *et al*. (2018) found similar results.

For both phenotypic and genotypic level, fruit length had significant positive relationship with all traits excluding fruit diameter. With respect to fruit diameter had negatively correlated with fruit shape index, early yield per feddan, average fruit weight and total yield per feddan (Ullah *et al*., 2012). Also, fruit shape index exhibited positive significant interrelation with early yield per feddan, average fruit weight and total yield per feddan. These finding is in consonance with results of Singh and Singh (2015) on bitter gourd and Kumari *et al*. (2018) on cucumber. As for early yield per feddan. Opening had largely significant and positive correlation with average fruit weight, number of fruits per plant and total yield per feddan, similar results reported by Khan *et al*. (2016) in snake gourd. Average fruit weight constantly was positive and significantly associated with total yield per feddan. Golabadi *et al*. (2013) in their studies on determining relationships between different traits in cucumber genotypes found that number of fruits per plant had highly significant positive correlation with total yield per feddan. These results are in agreement with those of Mehta *et al*. (2009) on musk melon, Pal *et al*. (2016); Ene *et al*. (2016b) and Deepa *et al*. (2018) on cucumber. This study reveals that values of genotypic associations were larger than those of their respective phenotypic associations in majority of the cases proposing that genotypic associations were stronger reliable and free from the environmental factors.

The results of present study concluded that most important positive characters contributing towards total yield per plant at genotypic level were all aforementioned traits, suggesting that selection procedure applied for increasing these traits will help in eventually increasing the yield.

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انتاج هجن جديدة من الخيار للحقل المفتوح

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أجري هذا البحث بمزرعة قها – معهد بحوث البساتين – مركز البحوث الزراعية – مصر. خلال عامى ٢٠١٥ و ٢٠١٦ لتقدير قوة الهجين عن طريق متوسط الأباء وأحسن الآباء، ودرجة السيادة ومعامل الارتباط لبعض الصفات الأقتصادية الهامة فى الخيار وهى طول النبات بالسنتيمتر و عدد الأوراق للنبات و عدد الأيام حتى تفتح أول زهرة مؤنثة و طول الثمرة بالسنتيمتر و قطر الثمرة بالسنتيمترو دليل شكل الثمرة بالسنتيمتر و المحصول المبكر للفدان بالطن و متوسط وزن الثمرة بالجرام وعدد الثمار للنبات و المحصول الكلى للفدان بالطن. وقد أستخدم فى هذ البحث خمسة سلالات من الخيار وهى P_1 (Line 86-1380-1), P_2 (Line 87- 674-1), P_3 (Line 99 - 340), P_4 (Line 99 - 357) و P_5 (Line 99 - 347) وقد أجرى التهجين بين هذة السلالات بنظام التهجين فى أتجاه واحد وذلك باستخدام تصميم قطاعات كاملة العشوائية فى ثلاث مكررات.وقد أوضحت النتائج وجود أختلافات (تباينات) بين السلالات المستخدمة لكل الصفات المدروسة.وجود قوة هجين فى بعض الهجن بالمقارنة بمتوسط الأبوين حيث سجلت أعلى قوة هجين (٤٧,٣٠ %) لصفة المحصول المبكر / فدان تلاها صفتى المحصول الكلى / فدان حيث سجلت (٤٥,٨١ %) ودليل شكل الثمرة (٤٠,٧٨ %) بينما سجلت أعلى قيمة لتقدير قوة الهجين بالمقارنة بأفضل الأباء (٣٣,٩٧ % و ٣٢,٨٦ %) و (٣١,٥٣ % و ٣١,٥٠ %) لصفتى المحصول المبكر / فدان والمحصول الكلى / فدان على التوالى.أن صفتى طول النبات وعدد الأوراق / النبات أظهرتا ارتباط وراثياً ومظهرياً موجبا وعالى المعنوية مع طول الثمرة ، دليل شكل الثمرة ، المحصول المبكر للفدان ، متوسط وزن الثمرة ، عدد الثمار للنبات والمحصول الكلى للفدان. أشارت هذه الارتباطات الإيجابية إلى أن اختيار البرنامج مبنى على ان الانتخاب لأي من هذه الصفات سوف يؤدي إلى زيادة الانتاج فى الخيار. تم تقدير ارتباط سلبي وهام لصفتى عدد الأيام حتى تفتح أول زهرة مؤنثة وقطر الثمرة.التوصية: أنه يمكن استخدام هذه السلالات كآباء في برامج التحسين الوراثي لصفات المحصول والأستفادة من قوة الهجين سواء عن طريق متوسط الآباء أو أفضل الآباء وكذلك عن طريق الأنتخاب فى الأجيال الأنعزالية و التي تهدف الى تحسين الأنتاج فى الخيار.