General Performance, Heterosis and Potence Ratio for Some Important Characters Using Complete Diallel Cross among Five Inbred Lines of Cucumber (*Cucumis sativus*, L.) under Greenhouse Conditions

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ABSTRACT: Self-pollination for five selected cucumber indeterminate inbred lines was carried out for two generations, during summer and autumn season of 2016, to confirm their purity as parents in a hybrid breeding program. Complete diallel cross among the five inbred lines were conducted during summer season of 2017 to produce all possible hybrids combinations. The twenty-five genotypes (Five parents, their 10 F_1 hybrids and 10 F_1 reciprocals**)** were grown and evaluated under greenhouse conditions in three sowing dates (mid of each months February, March and May respectively) for two successive years (2018 and 2019) in a randomized complete block design with three replicates. Mean performance, heterosis % and Potence ratio were estimated, for characteristics of vegetative, flowering and fruit quality, yield and its components. The results clarified that there were significant and high significant differences between genotypes of the study in all studied traits. The best parents for vegetative growth, yield components and fruit quality traits were P_4 followed by P_5 and P_2. Therefore, the three parental inbred liens $P_{4,}$ P_5andP_2 can be selected as tester parents, and for the sharing in hybrid combinations to predict the best hybrids. The best hybrid combinations for most traits were found to be F_1hybrids of P_2XP_4 and P_1XP_5, and their reciprocals which recorded the highest productivity for total yield, number of fruits/plant and high average fruit weight and other fruit quality traits. Therefore, F_1hybrids P_2XP_4 and P_1XP_5 and their reciprocals could be generally, considered the most important ones and promising new produced cucumber hybrids of this study. The results proved the existence of marked potence ratios and heterosis, either over the mid-parental value or that of the better parent for all studied traits. Heterosis values for vegetative measurements, early yield, total yield, number of fruits, average fruit weight and fruit length traits were positive and significant in the most crosses, while potence ratio estimates were positive and greater than one. Therefore, the inheritance of these traits involved complete to over dominance for high over low values. However, heterosis values for flowering and fruiting measurements were negative and significant in most crosses, also potence ratio estimates were negative and greater than one. Therefore, the inheritance of these traits seemed to have dominance to overdominance nature for early over late flowering and fruiting.
Key words: Cucumber (*Cucumis Sativus*., L.), heterosis, hybrid vigor, potence ratio, diallel cross.

INTRODUCTION

Cucumber (*Cucumis sativus*, L., 2n = 2x = 14), belong to the family Cucurbitaceae which includes 117 genera and 825 species (Gopalakrishnan *et al.,* 2007). Cucumber is grown throughout the world and represents the fourth most important cross pollinated vegetable crop after tomato, cabbage, and onion (Tatlioglu 1993). Cucumber cultivation goes back to at least 3000 years in India and 2000 years in China (Robinson and Decker-Walters 1997). The fruits of cucumber are eaten fresh at botanical immature stage. It is a good source of water, minerals, carbohydrates, protein, lipid, ion and vitamin in human diet (Abbey *et al.,* 2017). Global productivity for cucumber in 2018 reached 75219440 tons, with an average harvested area 4903744 fed (1984518 ha) with an average productivity15.3 tons/fed. Regarding productivity in Egypt, in 2018 reached 457795 tons, with an average harvested area 50796.35 fed with average productivity 9 tons / fed (FAO, 2020).

Cucumber production can be increased by providing additional area for cultivation or by adopting superior varieties and good agricultural practices, but it is very difficult to increase the area due to the negative impact on other vegetable crops. The most desirable way to increase the yield of cucumber is to choose high-yielding genotypes according to the available agricultural conditions under the specific cultivated area (Al-Rawahi*et al.,* 2011). As in other crops the selections of suitable parents and cross combinations are necessary for genetic improvement (Singh *et al.,* 2012). Cucumber genotypes had high degree of cross-pollination, wide range of genetic variability in vegetative growth and fruit characteristics. It being monoecious in nature which considered very well suited for hybrid seed production, hence heterosis in breeding program is one of the most efficient tools to exploit the genetic diversity in cucumber (Hemant and Tiwari 2018).

Selective mating designs such as diallel, which may allow inter-mating of the selects in different cycles, and exploit both additive and non-additive gene effects, could be useful for the genetic improvement of yield components and nutritional values (Singh and Pawar,2005). Diallel analysis provides information regarding the components of genetic variation, and helps the breeder in the selection of desirable parents for hybridization. deciding a suitable breeding moreover, it shares in procedure for the genetic improvement of various quantitative traits. (Singh *et al.,* 2012). Genetic information is very useful in improving plant's characteristic through selection or other breeding strategies.

The main objectives of the present investigation were: a) study and evaluate some important traits of five selected cucumber inbred lines and their all-possible hybrid combinations using complete diallel cross system to select and determine the best hybrids for yield and yield components traits under greenhouse conditions. b) Heterosis percentage values and potence ratios for the studied traits were also estimated in order to understand gene effects contributing to the genetic variations.

MATERIAL AND METHODS

This study was conducted during four years 2016 to 2019 at the low technology greenhouses of the experimental frame of both of the Faculty of Agriculture, Alexandria University and Sabahya Horticulture Research Station, Alexandria, Egypt.

Development of Genetic Materials:

The genetic materials of the present investigation started with seeds of five selected cucumber indeterminate inbred lines (coded symbol P_1, P_2, P_3, P_4 and $P_{5)}$ produced through cucumber breeding program of the Vegetable Cross Pollination Researches Department, Sabahya Research Station, Alexandria, Horticulture research institute, Agriculture Research Center. In the first and second seasons, self-pollination for five selected cucumber indeterminate inbred lines were executed for two generation, during summer and autumn seasons of 2016, to confirm their purity as parents in a hybrid breeding program. In the third season, hybridization and selfing among the five parental inbred lines in a complete diallel crossing system were conducted during the summer season of 2017 in low technology greenhouse, to produce all possible hybrids combinations (10 F_1 hybrids and 10 F_1reciprocals).

Evaluation of Genetic Materials:

The twenty-five genotypes (Five parents, their 10 F_1 hybrids and 10 F_1 reciprocals**)** were grown and evaluated under greenhouse conditions in three sowing dates (mid of each month February, March and May, respectively) for two successive years of 2018 and 2019 in Agricultural Research and Experimental Station Farm at Abies region, Faculty of Agriculture, Alexandria University, Alexandria. The experimental design was randomized complete block design with three replicates, each experimental unit contains 15 plants arranged in two rows, with 40 cm a part between plants. common agricultural practices used for cucumber production were done as normal in the area and situated to greenhouses and drip irrigation conditions, from irrigation, fertilization and blight management.

Recorded Measurements:

Vegetative growth, flowering and fruiting set:

The following characters were recorded on samples of 5 plants from each plot at the end of the season after the final harvest as follows: Plant length (m) from the crown to the root, total number of nodes/plants on the main stem, number of days for the first female flower appears, number of nodes from the cotyledonary leaves at which the first female flower appeared, number of days for first picked fruit, number of nodes for the first fruit from the cotyledonary leaves.

Yield and its components characters:

The following characters were recorded on all growing plants in each plot during each harvest in the season as follows: Early yield and total yield were recorded as the total weight of all harvested fruits (kg) in the first two week and whole harvesting season, respectively, from all plants in each plot divided by the number of plants. Total fruits number per plant was also recorded as the total number of all harvested fruits divided by the number of plants

Fruit characteristics:

Samples of ten random fruits at the edible stage of each plot were taken to determine the following fruit characteristics: average fruit weight (gm), fruit length(cm), fruit diameter (cm), flesh thickness(cm), dry matter %. Dry matter calculating using the same previous fruits, were chopped into small pieces to facilitate drying. One hundred gram of cut pieces were oven dried at 75°C±1 until constant weight and the fruit dry weight was recorded as g per 100 g fresh weight.

Statistical proceduresand Estimation of Genetic Parameters:

The statistical analyses of the recorded data were carried out using the standard method of the combined analysis of variance for a series of similar experiments in several years as suggested by Snedecor and Cochran (1980). Heterosis for each cross was calculated according to Bhatt (1971) as follow:

1- Heterosis over mid parents (MP): The heterosis expressed as percentage increase or decrease in the mean value of hybrids over its parental value.

$$\text{Per cent heterosis over mid parent (MP)} = \frac{\overline{\text{F1}} - \overline{\text{Mp}}}{\overline{\text{Mp}}} \times 100$$

Where,

$\overline{\text{F1}}$ = Mean of the F1 hybrid, $\overline{\text{MP}}$ = Mean of the parents of that particular F1cross

2- Heterosis over better parent (BP): The heterosis expressed as percentage increase or decrease in the mean of F1 hybrids over its better parent.

$$\text{Percent heterosis over better parent (BP)} = \frac{\overline{\text{F1}} - \overline{\text{Bp}}}{\overline{\text{Bp}}} \times 100$$

Where,

$\overline{\text{F1}}$ = Mean of the F1 hybrid, $\overline{\text{BP}}$ = Mean of the better parent of that particular F1cross

3- Significance of the heterosis H% values was tested using " t " test at error degrees of freedom as shown by Chaudhary*et al.*, (1978).

$$\text{Heterosis over mid parent value} = \frac{\text{F1} - \text{MP}}{\sqrt{\frac{\text{Me}}{\text{r}} \times {}^{3}/_{2}}} \times 100$$

$$\text{Heterosis over better parent value} = \frac{\text{F1} - \text{BP}}{\sqrt{\frac{\text{Me}}{\text{r}} \times 2}} \times 100$$

Where,

Me = error variance, r = number of replicates

4- Potence ratio % it was calculated by equation of Peter and Frey (1966):as follow

$$\text{Potence ratio \% (PC)} = \frac{\overline{\text{F1}} - \overline{\text{Mp}}}{\overline{0.5(\overline{\text{Bp}} - \overline{\text{MP}})}}$$

Where,

$\overline{\text{F1}}$ = Mean of the F1 hybrid, $\overline{\text{MP}}$ = Mean of the parents of that particular F1 crosses

$\overline{\text{BP}}$ = Mean of the better parent of that particular F1 cross

RESULTS AND DISCUSSION

Analysis of variance.

The combined analyses of variance for the data of the all studied character; vegetative growth, yield and its components traits are presented in Tables1 and 2. The different sources of variance, generally, reflected highly significant estimated values for variances in all studied characters, with few exceptions.

High significant values were detected for years (Y) in the case of the six characters; number of nodes to first female flower, number of nodes for first picked fruit (table 1), total yield/plant, number of fruits/plants, average fruit weight and fruit length (table 2). However, High significant values were detected for both sowing date(S)and genotypes (G) in all studied characters, except fruit diameter and flesh thickness for sowing date variance (Table 2). These results may be due wide range of variability among the inbred lines and high effect of genotype× environmental interaction. Similar results were found by Dhillon and Ishiki (1998) when evaluated four cucumber genotypes in six years condition and reported that there were climatic changes occur every year that affect the productivity of vegetable crops, even though they are grown on the same dates.

Concerning the first-degree interaction between years and sowing dates (Y×S), the differences were highly significant and significant in traits; plant length, total nodes/plant, number of nodes for first female flower, number of fruits, average fruit weight, flesh thickness and dry matter (table 2). Regarding interaction between years and genotypes (Y×G), the differences were highly significant and significant in all traits, except for plant length, number of nodes/plant(table1), fruit length and dry matter(table2). Also, the interaction between sowing dates and genotypes (S×G), were highly significant in all traits, except for fruit diameter, flesh thickness and dry matter(table2). Regarding the second-degree interaction among years and sowing dates and genotypes (Y×S×G), the differences were highly significant in all traits, except for plant length, total nodes/plant (table1) and fruit diameter traits (table2). These results indicated that the most traits exhibited high and significant differences, It also, suggesting that these traits were affected by changing environmental from year to year and sowing date to another sowing date. These results were in agreement with those found by Saglam and Yazgan, (1999), Mrinalini and Devi, (2017), and Dia *et al.,* (2018).

The comparisons among the different sources of variance clarified that the estimated values of the variance due to the genotypes (G) appeared much higher in magnitude, in all characters except for average fruit weight, than those of the two interactions years x genotypes (Y×G) and sowing date x genotypes (S × G), respectively. Such a result means that the noticed differences due to genotypes were so pronounced compared with sowing date and years, suggesting that the superior genotypes can be selected and recommended for growers under different environment.

General performance of the genetic populations.

The results concerning vegetative growth, female flowering, fruiting and early yield traits for the five parental inbred lines of cucumber, their F_1 hybrids and reciprocals averaged over the three sowing dates during the two summer seasons of 2018 and 2019 are illustrated in Table 3. Means of the parental inbred lines showed a wide range of variability in all mentioned traits in Table 3. The comparisons among the means of the parental inbred lines indicated that all differences detected among them appeared significant, and P_5 had the best desirable values for all studied traits. Where, P_5 inbred lines had the highest values for plant length (3.372 m) and number of nodes/plant (52.167) followed by P_2 (3.311 m and 51.813 for the both traits, respectively). While P_5 had the lowest values (desirable)for the earliness traits number of days to first female flower (38.88 day), number of nodes to first female flower (2.25 nodes), number of days to first picked fruit (47.89 day) and number of nodes to first picked fruit (2.81 nodes), followed by P_2 for the four previous traits (40.34 day, 2.81 nodes, 49.86 day and 3.33 nodes, respectively). Also, P_5hadthe highest value for early yield (0.703 kg/plant), followed by P_4 (0.651 kg/plant) (table3).

Concerning the performances of F_1 hybrids and reciprocals for the above-mentioned traits (Table 3), the result indicated that: the reciprocal hybrid $P_2 \times P_1$ gave the heist value (5.074 m) for plant length, followed by those of $P_1 \times P_2$ (4.903 m), $P_5 \times P_1$ (4.518 m*),* $P_1 \times P_5$(4.511m), respectively. Hybrid $P_1 \times P_5$ and its *reciprocal have highest* number. of nodes/plant (66.664 and 66.947 nodes, for hybrid and reciprocal respectively) followed by hybrid $P_2 \times P_5$ (65.193 nodes). For number of days to first female flower trait, the lowest value (earliest) was obtained by the hybrids $P_5 \times P_2$ (39.015), $P_5 \times P_3$ (39.386), $P_1 \times P_5$ (39.39) and $P_4 \times P_5$ (39.557), respectively without significant differences among each other(table3). The hybrids which have the lowest number of nodes for first female flower was $P_2 \times P_5$ and its reciprocals (2.271 and 2.392 nodes) followed by $P_1 \times P_5$ and its reciprocals (2.341 and 2.372, respectively). The earliest hybrids that reflected the lowest days to first picked fruit and lowest number of nodes to first picked fruit were $P_1 \times P_5$, $P_2 \times P_5$ and their reciprocals. Regarding early yield traits, the F_1 hybrid which scored the highest early yield was P1×P_5 followed by $P_2 \times P_4$ (0.807 and 731 kg respectively), while the F_1 reciprocal which recorded the highest early yield was $P_5 \times P_1$ followed by $P_5 \times P_4$(table3).

The data of the first-generation hybrids for the three traits plant length, number. of nodes/plant and early yield (Table 3) clarified that all F_1 hybrids and reciprocals showed significant higher values than those of their respective higher parents. This general trend of the obtained results, apparently, indicated that the inheritance of these three characters involved complete- to over -dominance for taller over short plant, high over low number of nodes per plant and early over late productivity. However, for the earliness traits number of days to first female flower, number. of nodes to first female flower, number of days to first picked fruit and number of nodes to first picked fruit, the data showed that most of the F_1 hybrids and reciprocals reflected some improvements for earliness characters. In sixteen F_1 hybrids produced average values that tended to be very closer to their respective lower parent value (without significant different) for the four characters. The other four F_1 hybrids reflected average values that tended to be around their respective mid-parental values or deviated towards the lower parent. These results indicate that the four earliness traits seemed to have dominance or over-dominance nature for early over late flowering and fruiting. These results confirmed the findings of Simi et al., (2017), Kumar *et al.,* (2018) and Preethi *et al.,* (2019)

Regarding the comparisons between the F_1 hybrids and their F_1 reciprocals for all traits, the results showed that there were insignificant differences between the means of the F_1 hybrids and their F_1 reciprocals hybrids for all studied traits, except in three cases of plant length ($P_1 \times P_2$, $P_2 \times P_4$ and $P_3 \times P_4$) and two cases for number of nodes/plant ($P_3 \times P_4$ and $P_4 \times P_5$)(table3).

The results of mean performance for the five parental inbred lines of cucumber, their 10 F_1 hybrids and 10 F_1 reciprocals, for yield components and fruit quality traits are listed in Table 4. Significant differences were, generally, detected among the parental inbred lines. The best parent in both total yield and number of fruits/plants was P_4 (2.138 kg/plant and 22.76 fruit/plant) followed by P_5 (2.131 kg/plant and 21.33 fruit/plant). The parent $P_3$and P_5recorded the highest value of average fruit weight (98.945 g), (98.885 g) respectively. Regarding the fruit length trait, it was noticed that, parent which recorded the highest fruit length was P1 followed by P_3 (16.70 and 15.25 cm, respectively), however, the lowest value (desirable) was reflected by P_4 (13.09 cm). Fruit diameter estimates showed that the widest parent was P_4 followed by P_5 (4.263 and 4.217 cm, respectively). For flesh thickness and dry matter traits, the inbred line which recorded the highest value was P_4 followed by P_2(table 4).

About the general performances of F_1 hybrids and reciprocals for yield components traits, the results in Table 4 indicated that two F_1hybrids P_2XP_4 and P_1XP_5, and their reciprocals recorded the highest productivity for total yield and total number of fruits/plant. Also, F1 hybrid $P_2 \times P_4$ and their reciprocals had the highest value for both flesh thickness and dry matter traits. On the other hand, the hybrids $P_2 \times P_4$ and their reciprocal recorded the lowest values (desirable) for fruit length, while the highest value for fruit diameter was recorded in $P_4 \times P_5$ followed by $P_1 \times P_4$(table 4).

The data in Table 4 clarified also that pronounced improvement was reflected on the general performances of the single crosses for the two traits total yield and number. of fruits/plant, since all F_1 hybrid populations showed significant superiority in total productivity over their respective high yielding parents. This general trend of the obtained results, indicated that the inheritance of these traits involved over -dominance for high over low number of fruits/plant. However, for the two traits average fruit weight and fruit length, twelve F_1 hybrids showed significant higher values than those of their respective higher parents, and eight F_1 hybrids reflected average that tended towards the higher parents. These results also suggested that pronounced degrees of dominance and over dominance were involved in the inheritance of these traits. For fruit diameter characters, 18 F_1 hybrids produced an average tended to be relatively higher than their respective mid-parental value or deviated towards their higher parent, the other two F_1 hybrids produced an average more than their respective higher parent. These results may indicate that fruit diameter trait seemed to have partial and complete dominance nature for high value of fruit diameter. On the other hand, for flesh thickness and dry matter traits most of the first-generation hybrid produced an average value that tended to deviate towards the lower parent, reflecting partial dominance for low over high value for these traits(table4). These results were in agreement with those found by Singh *et al.,* (2016), Manisha*et al.,* (2017), Hassan and Bader (2018), Chikezie *et al.,* (2019) and Gehan (2020)

Concerning the comparisons between the F_1 hybrids and their F_1 reciprocals for yield components traits (Table 4), the results showed that there were insignificant differences between the means of the F1 hybrids and their F_1 reciprocals hybrids for all studied traits, with few exceptions. Significant differences were detected between the means of the F_1 hybrids and their F_1 reciprocals in the case of $F_1P_1 \times P_5$ for total yield, $P_2 \times P_5$ for fruit length, $P_4 \times P_5$ for flesh thickness and five of the ten hybrids for fruit diameter traits.

Table 1. Combined analyses of variance of the six experiments (three sowing dates during two summer seasons of 2018 and 2019) for vegetative growth, female flowering, fruiting traits and early yield of the 25 genetic populations of cucumber (five parental inbred lines, their 10 F_1 hybrids and their 10 F_1 reciprocals)

Sources of variance	D.F.	Vegetative growth traits		Female flowering traits		Fruiting traits		Early yield (kg/plant)
		Plant Length (m)	No. of nodes/plant	Days to first female flower	No. of nodes to first female flower	Days to first picked fruit	No. of nodes to first picked fruit	
Blocks	2	0.050^{NS}	0.380^{NS}	0.069^{NS}	0.267^{NS}	1.006^{NS}	0.037^{NS}	0.002^{NS}
Years (Y)	1	0.007^{NS}	4.873^{NS}	0.580^{NS}	6.468**	0.116^{NS}	1.678**	6.092^{NS}
Sowing date (S)	2	57.947**	5501.965**	327.798**	25.587**	396.301**	11.574**	0.852**
Genotypes (G)	24	8.309**	854.679**	34.835**	6.002**	92.190**	5.073**	0.065**
Y x S	2	0.184**	21.877**	2.313^{NS}	0.982**	0.830^{NS}	0.303^{NS}	0.001^{NS}
Y×G	24	0.024^{NS}	3.448^{ns}	4.890**	0.691**	6.474**	0.800**	0.011**
S×G	48	2.520**	286.884**	20.565**	2.540**	33.088**	2.211**	0.030**
Y×S×G	48	0.037^{NS}	4.103^{NS}	5.890**	1.072**	7.104**	0.642**	0.010**
Error	298	0.029	3.426	1.450	0.171	2.481	0.129	0.002

** Significant at 1% levels of probability, NS = Not significant

Table 2. Combined analyses of variance of the six experiments (three sowing dates during two summer seasons of 2018 and 2019) for yield components and fruit traits of the 25 genetic populations of cucumber (five parental inbred lines, their 10 F_1 hybrids and their 10 F_1 reciprocals)

Sources of variance	D.F.	Yield components traits			Fruit traits			
		Total yield (kg/plant)	No. of fruits/plant	Average fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Flesh thickness (cm)	Dry matter (%)
Blocks	2	2.059^{NS}	7.956^{NS}	87.913^{NS}	0.030^{NS}	1.676^{NS}	0.010^{NS}	0.107^{NS}
Years (Y)	1	0.025^{**}	178.195^{**}	926.428^{**}	5.260^{**}	0.015^{NS}	0.037^{NS}	$8e\text{-}6^{NS}$
Sowing date (S)	2	8.645^{**}	2369.179^{**}	4986.572^{**}	5.596^{**}	0.001^{NS}	0.016^{NS}	0.313^{**}
Genotypes (G)	24	1.313^{**}	126.518^{**}	185.034^{**}	32.117^{**}	1.250^{**}	0.388^{**}	1.555^{**}
Y x S	2	7.975^{NS}	140.173^{**}	1056.917^{**}	0.361^{NS}	0.004^{NS}	0.035^{*}	0.225^{**}
Y×G	24	0.006^{**}	8.950^{**}	135.587^{**}	0.359^{NS}	0.007^{*}	0.020^{**}	0.049^{NS}
S×G	48	0.384^{**}	63.686^{**}	282.437^{**}	0.586^{**}	0.004^{ns}	0.013^{NS}	0.040^{NS}
Y×S×G	48	0.002^{*}	21.252^{**}	240.011^{**}	0.556^{**}	0.005^{ns}	0.016^{**}	0.132^{**}
Error	298	0.002	3.130	29.367	0.251	0.004	0.010	0.045

** Significant at 1% levels of probability, NS = Not significant

Table (3). Mean performance for the five parental inbred lines of cucumber, their 10 F_1 hybrids and 10 F_1 reciprocals, averaged over the six experiments (three sowing dates during two summer seasons of 2018 and 2019) for vegetative growth, female flowering, fruiting and early yield traits.

Parents	Vegetative measurements		Female flowering measurements		Fruiting measurements		
	Plant Length (m)	Total No. of nodes / plant	No. of days for First female flower	No. of nodes for First female flower	No. of days to first fruit was picked	No. of nodes for first fruit was picked	Early yield(kg)
P1	2.879_{l}	49.852_{l}	42.926_{b}	3.986_{a}	54.226_{a}	4.378_{a}	0.560_{i}
P2	3.112_{k}	51.183_{k}	41.383_{cde}	3.189_{cdef}	51.22_{cd}	3.680_{cd}	0.605_{h}
P3	2.814_{l}	44.989_{m}	43.800_{a}	3.189_{cdef}	54.841_{a}	4.471_{a}	0.574_{i}
P4	2.401m	38.427_{n}	40.347_{fgh}	2.810_{g}	49.867_{e}	3.337_{g}	0.651_{fg}
P5	3.372_{i}	52.167_{jk}	38.886_{j}	2.254_{h}	47.898_{f}	2.817_{h}	0.703_{bcd}
Hybrids							
$P_1 \times P_2$	4.903_{b}	60.383_{e}	41.539_{cd}	3.319_{bcd}	51.396_{c}	3.725_{cd}	0.665_{efg}
$P_1 \times P_3$	4.278_{d}	62.909_{cd}	43.156_{ab}	3.991_{a}	54.298_{a}	4.421_{a}	0.683_{def}
$P_1 \times P_4$	3.145_{jk}	54.407_{hi}	40.385_{fgh}	2.854_{g}	50.232_{de}	3.368_{fg}	0.730_{b}
$P_1 \times P_5$	4.511_{c}	66.664_{a}	39.392_{ij}	2.341_{h}	48.139_{f}	2.974_{h}	0.807_{a}
$P_2 \times P_3$	3.640_{g}	58.561_{fg}	41.391_{cde}	3.572_{b}	52.749_{b}	3.982_{b}	0.644_{g}
$P_2 \times P_4$	3.506_{g}	53.127_{ij}	40.377_{fgh}	2.868_{g}	50.337_{cde}	3.413_{efg}	0.731_{b}
$P_2 \times P_5$	4.340_{d}	65.139_{b}	39.584_{hij}	2.271_{h}	48.314_{f}	2.846_{h}	0.730_{b}
$P_3 \times P_4$	3.257_{j}	53.620_{i}	41.100_{def}	3.028_{defg}	50.072_{e}	3.523_{defg}	0.688_{cde}
$P_3 \times P_5$	4.162_{e}	63.104_{cd}	39.871_{ghi}	2.975_{efg}	48.232_{f}	3.616_{def}	0.714_{bcd}
$P_4 \times P_5$	3.818_{f}	59.704_{ef}	39.557_{hij}	2.376_{h}	48.296_{f}	2.833_{h}	0.730_{b}
					Reciprocals		
$P_2 \times P_1$	5.074_{a}	59.483_{ef}	41.667_{cd}	3.250_{cde}	51.444_{c}	3.697_{cd}	0.664_{efg}
$P_3 \times P_1$	4.374_{d}	64.072_{bc}	43.081_{ab}	3.997_{a}	54.387_{a}	4.393_{a}	0.682_{def}
$P_4 \times P_1$	3.242_{j}	54.252_{hi}	40.633_{efg}	2.889_{fg}	50.113_{de}	3.378_{fg}	0.730_{b}
$P_5 \times P_1$	4.518_{c}	66.947_{a}	39.628_{hij}	2.372_{h}	48.419_{f}	2.826_{h}	0.811_{a}
$P_3 \times P_2$	3.707_{fg}	58.874_{f}	41.998_{c}	3.491_{bc}	52.909_{b}	3.904_{bc}	0.634_{g}
$P_4 \times P_2$	3.465_{hi}	53.393_{ij}	40.568_{efg}	2.863_{g}	50.357_{cde}	3.370_{fg}	0.723_{b}
$P_5 \times P_2$	4.374_{d}	63.650_{cd}	39.017_{ij}	2.392_{h}	48.253_{f}	3.016_{h}	0.712_{bcd}
$P_4 \times P_3$	3.385_{i}	55.006_{h}	40.808_{def}	3.233_{cde}	50.141_{de}	3.652_{cd}e	0.683_{def}
$P_5 \times P_3$	4.056_{e}	62.400_{d}	39.386_{ij}	2.922_{fg}	48.297_{f}	3.388_{fg}	0.718_{bc}
$P_5 \times P_4$	3.744_{fg}	57.563_{g}	39.408_{ij}	2.413_{h}	48.208_{f}	2.827_{h}	0.735_{b}

Values followed by the same alphabetical letter in each column do not differ significantly from each other using revised LSD Test at 0.05.level..

Table (4). Mean performance for the five parental inbred lines of cucumber, their 10 F_1 hybrids and 10 F_1 reciprocals, averaged over the six experiments (three sowing dates during two summer seasons of 2018 and 2019) for yield components, and fruit quality traits.

Parents	**yield components traits**		**Fruit measurements**				
	Total yield (kg) / plant	**Total yield (Fruits number) / plant**	**Average fruit weight (g)**	**Average fruit length (cm)**	**Fruit diameter (cm)**	**Flesh thickness (cm)**	**Dry matter %**
P1	1.784$_{o}$	19.386$_{h}$	95.419$_{d}$	16.702$_{d}$	3.525$_{m}$	2.286$_{fghi}$	5.077$_{gh}$
P2	1.954$_{m}$	20.694$_{g}$	95.665$_{d}$	14.743$_{h}$	3.432$_{n}$	2.536$_{bc}$	5.524$_{cd}$
P3	1.860$_{n}$	19.034$_{h}$	98.945$_{cd}$	15.253$_{fg}$	3.791$_{i}$	2.483$_{cd}$	5.383$_{de}$
P4	2.138$_{l}$	22.759$_{de}$	90.670$_{e}$	13.091$_{i}$	4.263$_{b}$	2.756$_{a}$	6.161$_{a}$
P5	2.131$_{l}$	21.327$_{fg}$	98.885$_{cd}$	13.200$_{i}$	4.217$_{c}$	2.179$_{l}$	4.948$_{h}$
Hybrids							
$P_1 \times P_2$	2.183$_{k}$	22.114$_{def}$	100.685$_{bc}$	17.007$_{cd}$	3.494$_{m}$	2.316$_{efgh}$	5.250$_{ef}$
$P_1 \times P_3$	2.587$_{c}$	26.175$_{bc}$	101.552$_{abc}$	17.952$_{a}$	3.706$_{ik}$	2.334$_{efg}$	5.168$_{fg}$
$P_1 \times P_4$	2.247$_{gh}$	23.141$_{de}$	102.267$_{abc}$	16.861$_{cd}$	4.101$_{d}$	2.372$_{e}$	5.287$_{ef}$
$P_1 \times P_5$	2.597$_{c}$	26.939$_{ab}$	101.247$_{abc}$	16.971$_{cd}$	3.982$_{g}$	2.37$_{kl}$	4.983$_{h}$
$P_2 \times P_3$	2.226$_{hi}$	22.366$_{def}$	102.879$_{abc}$	15.371$_{fg}$	3.728$_{i}$	2.496$_{bcd}$	5.407$_{cde}$
$P_2 \times P_4$	2.859$_{a}$	27.999$_{a}$	102.813$_{abc}$	15.372$_{f}$	3.891$_{h}$	2.552$_{bc}$	5.756$_{b}$
$P_2 \times P_5$	2.477$_{d}$	25.207$_{c}$	104.330$_{ab}$	15.404$_{f}$	3.892$_{h}$	2.238$_{iikl}$	5.056$_{gh}$
$P_3 \times P_4$	2.202$_{iik}$	27.321$_{ab}$	100.344$_{bc}$	16.054$_{e}$	4.053$_{ef}$	2.544$_{bc}$	5.527$_{cd}$
$P_3 \times P_5$	2.416$_{e}$	25.269$_{c}$	101.273$_{abc}$	15.958$_{e}$	4.054$_{ef}$	2.256$_{hiik}$	5.027$_{gh}$
$P_4 \times P_5$	2.298$_{f}$	25.211$_{c}$	102.231$_{abc}$	13.600$_{i}$	4.327$_{a}$	2.266$_{ghii}$	5.047$_{gh}$
					Reciprocals		
$P_2 \times P_1$	2.192$_{k}$	21.949$_{defg}$	103.038$_{abc}$	16.832$_{cd}$	3.501$_{m}$	2.348$_{ef}$	5.274$_{ef}$
$P_3 \times P_1$	2.607$_{bc}$	26.111$_{ab}$	100.232$_{bc}$	17.550$_{a}$	3.665$_{kl}$	2.335$_{efg}$	5.152$_{fg}$
$P_4 \times P_1$	2.256$_{g}$	23.237$_{d}$	104.180$_{ab}$	16.890$_{cd}$	3.985$_{g}$	2.379$_{e}$	5.298$_{ef}$
$P_5 \times P_1$	2.627$_{b}$	27.121$_{ab}$	101.335$_{abc}$	17.200$_{c}$	4.114$_{d}$	2.206$_{ikl}$	4.981$_{h}$
$P_3 \times P_2$	2.215$_{ii}$	21.848$_{efg}$	104.267$_{ab}$	15.496$_{f}$	3.634$_{l}$	2.496$_{bcd}$	5.399$_{cde}$
$P_4 \times P_2$	2.836$_{a}$	28.074$_{a}$	101.646$_{abc}$	15.443$_{f}$	3.8583$_{h}$	2.566$_{b}$	5.744$_{b}$
$P_5 \times P_2$	2.475$_{d}$	25.0673$_{c}$	105.224$_{a}$	14.925$_{gh}$	4.042$_{f}$	2.285$_{fghi}$	5.044$_{gh}$
$P_4 \times P_3$	2.185$_{k}$	27.000$_{ab}$	99.791$_{cd}$	16.026$_{e}$	4.082$_{def}$	2.539$_{bc}$	5.546$_{c}$
$P_5 \times P_3$	2.433$_{e}$	24.905$_{c}$	102.227$_{abc}$	16.227$_{e}$	4.096$_{de}$	2.278$_{fghii}$	5.065$_{gh}$
$P_5 \times P_4$	2.311$_{f}$	25.095$_{c}$	102.696$_{abc}$	13.798$_{i}$	4.252$_{bc}$	2.453$_{d}$	5.306$_{ef}$

Values followed by the same alphabetical letter in each column do not differ significantly from each other using revised LSD Test at 0.05.level...

Heterosis Percentages and Potence ratio Parameters:

Heterosis percentages relative to mid and better parental (MP and BP) values and potence ratio estimates for vegetative measurements are listed in Table 5. The results showed that heterosis values were positive and high significant in all crosses for both plant length and number. of nodes/plant traits. These results indicate that the hybrid vigor tends towards taller and more nodes traits in cucumber genotypes. Highest heterosis values recorded by genotype $P_2 \times P_1$ (69.37 and 63.03 % relative to mid and better parent respectively for plant length and genotype $P_3 \times P_1$recorded 35.12 and 28.52 % relative to mid and better parental values, respectively for total nodes/plant). Potence ratio (PR) estimates for vegetative measurements were positive and greater than one (>1) for all crosses. It ranged from 1.77 % to 43.68 % for plant length and from1.31 to 27.37 % for total nodes / plant, indicating that over dominance gene action was existing in the inheritance of these traits. Similar findings were recorded by El-Tahawey*et al.,* (2015) on pumpkin, and Abeer et *al.,* (2018) on cucumber. They stated that the increase in vegetative measurements considered a natural result of crossbreeding between parents which have a genetic divergence between them.

Heterosis estimates and potence ratio for female flowering and fruiting measurements are represented in Table 6. Heterosis percentages relative to mid and better parental values for both number of days to first female flower and number of nodes to first female flower traits were negative in all crosses. The significant or highly significant differences were recorded in most crosses relative to both mid and better parental. The highest heterosis values for days to first female flower were recorded by genotype$P_5 \times P_3$ (-4.74and -10.08% relative to mid and better parental values, respectively), while for number of nodes to first female flower it reflected by genotype$P_1 \times P_5$ (-24.98and -41.27 % relative to mid and better parental values, respectively). Potence ratio estimates were negative and less than one (<1) in all crosses for both traits. It ranged from -0.08 to -0.99for days to first female flower and from -0.12 to -0.97 for number of nodes to first female flower(table6). This result indicated the importance of both additive and non-additive gene action in inheritance of these traits, and existence of partial dominant for early flowering and the hybrid vigor tends towards fewer days and nodes number until appearance the first female flower.

Regarding heterosis estimates and potence ratio for fruiting measurement (Table 6), the heterosis values for both number of days to first picked fruit and number of nodes to first fruit were negative in all crosses and high significant in most crosses. The highest heterosis values were recorded by genotype $P_3 \times P_5$ (-6.108and -12.05% over mid parent and better parent, respectively) for the first trait, and genotype $P_5 \times P_1$(-21.46and -35.47% relative to mid and better parental values, respectively) for the second trait. Potence ratio estimates were negative and less than one (<1) in all crosses for both traits. It ranged from -0.1٦ to -0.924 and -0.03 to -0.99 for number of days and nodes for first picked fruit respectively. These results, also, indicated that there was partial dominant for early flowering and fruiting and the hybrid vigor tends towards fewer days and nodes number until first flower appears and first fruit was picked. Previous results are partly in agreement with Simi *et al.,* (2017)and Kumar *et al.,* (2018) who found negative heterosis values with over dominance in some genotypes and partial dominance in others for early flowering and fruiting, and they reported that early flowering was responsible for the preservation of the species and that the earlier the flowering occurs, the greater the chance of preserving the offspring and passing on the genes to the next generation, Thus exposing the plants to unfavorable conditions makes them tend to flower faster. Similar results were found by Preethi*et al.,* (2019) which reported that heterosis in negative direction is preferred for days to female flower anthesis and for days to first harvest because is a well-recognized and prime objective of any breeding program as it helps the grower to a good early market price.

Heterosis estimates and potence ratio for yield component traits (early yield, total yield and number of fruits/plant) are illustrated in Table (7). For early yield trait, heterosis values were positive and significant or highly significant in all crosses except genotypes $P_2 \times P_5$, $P_3 \times P_5$, $P_4 \times P_5$, $P_3 \times P_2$, $P_5 \times P_2$, $P_4 \times P_3$, $P_5 \times P_3$ and $P_5 \times P_4$when estimates were relative to better parent. The highest heterosis values for early yield were recorded by genotype $P_5 \times P_1$ (28.32 and 15.2٦ % relative to mid and better parental values, respectively). Potence ratio estimates were positive and greater than one (>1), and ranged from 1.1٦ % to 16.7٧ %, therefore this trait seemed to involved over dominance gene action in its inheritance toward high early yield. Heterosis values for total yield and number of fruits traits were positive and high significant in all crosses relative to both mid and better parental values. The highest heterosis values were recorded by genotype $P_3 \times P_1$ for total yield (kg/ plant) (43.07٨ and 40.1٦ % relative to mid and better parental values, respectively), and genotype $P_1 \times P_3$ for number of fruits/plant (36.2٦and 35.02 % relative to mid and better parental values, respectively. Potence ratio estimates for yield components traits were positive and grated than one (>1), and ranged from 1.3٤ % to 51.73 % and 1.2٣ % to 39.5٧ % for total yield (kg/ plant) and number of fruits/plants, respectively. These results indicated that dominance and over dominance were existing in the inheritance of these traits and the hybrid vigor tends towards high total yield. These results were in accordance with those found by Singh *et al.,* (2016), Manisha*et al.,* (2017), Hassan and Bader (2018), Chikezie *et al.,* (2019) and Gehan (2020). These authors reported that the yield and its components controlled by dominance gene action and hybrid vigor appear clearly in these attributes, especially when there is a difference between the genotypes used in the crossbreeding program in the degree of genetic affinity.

Heterosis estimates and potence ratio for fruit measurements represented in Table (8). The heterosis values for average fruit weight were positive for all crosses and the differences were significant or high significant in all crosses except genotypes $P_3 \times P_5$when estimates were relative to mid parental, and $P_1 \times P_3$, $P_1 \times$P5, $P_3 \times$P4, $P_3 \times$P5, $P_3 \times$P1, $P_4 \times P_3$ and $P_5 \times P_3$ when estimates were relative to better parent. The highest heterosis values for average fruit weight were recorded by genotype $P_4 \times P_1$ (11.9٧% and 9.18% relative to mid and better parental values, respectively). Concerning fruit length, heterosis values were positive and significant or high significant in all crosses except genotypes $P_1 \times P_4$, $P_1 \times P_5$, $P_2 \times P_3$, $P_2 \times P_1$, $P_3 \times P_2$, $P_4 \times P_2$, and $P_5 \times P_2$when estimates were relative to better parent. The highest heterosis values recorded by genotype $P_5 \times P_3$ (14.062% and 6.385% relative to mid and better parental values, respectively). Potence ratio estimates were positive and greater than one (>1), and ranged from 1.20 to 109.58

and 1.0٩ to 11.93 for fruit weight and length respectively. So, it can be indicated that there were complete or over dominance for high fruit weight and length and the hybrid vigor tends towards high total yield. Same trend of these results was detected by Dogra and kanwar (2011), Arya and Singh (2014), Jat*et al.,* (2015) and Preethi*et al.,* (2019) reported that averagefruit weight and length is an important component which ultimately results in higher fruit yield, and it is related to the strength of growth that the plant acquires through hybridization. But these results not in agreement with Uddin (2008) and Simi (2017) who found that the hybrid vigor tends towards low fruit length.

The heterosis values for fruit diameter were positive, when estimates were relative to mid parental values, and were negative when estimates were relative to better parent. The differences were significant or high significant in most crosses. The highest heterosis values were recorded by genotype P_5×P_1 (6.269% and -2.45% relative to mid and better parental values, respectively). Potence ratio estimates were positive and less than one (<1), and ranged from 0.0٣ to 0.70, reflecting partial dominance nature for high fruit diameter. These results Partially compatible with those found by Arya and Singh, 2014 and Simi *et al.,* (2017) Who found that all the crosses except one, exhibited significant negative for heterosis over mid and better parent for this trait, and showed that for fresh consumption less fruit diameter is preferred therefore, negative heterosis consider to be desirable. Concerning flesh thickness trait, heterosis values were negative for all crosses and significant or high significant in all crosses, except genotypes P_1×P_4, P_2×P_3, P_3×P_2, P_5×P_1, P_3×P_2 and P_5×P_4, when estimates were relative to mid parental values, and genotypes P_2×P_3 and P_3×P_2 when estimates were relative to better parent. Highest heterosis values recorded by genotype P_4×P_5 (-8.18% and -17.7٩% relative to mid and better parental values, respectively). Also, heterosis values for dry matter content were negative for all crosses and high significant in most crosses. The highest heterosis values were recorded by genotype P_1×P_4 (-5.91% and -14.1٩% relative to mid and better parental values, respectively). Potence ratio estimates were negative and smaller than one (<1), and ranged from -0.050to -0.859 and from -0.1٢ to -0.8٤ for flesh thickness and dry matter traits respectively. So, there is a partial dominance for both characteristics for lower flesh thickness or lower dry matter. These findings were in line with those found by Airina*et al.,* (2013) and Simi*et al.,* (2017) these authors concluded that there was dominance for high placenta diameter hence, that affects negatively on flesh thickness of fruit.

CONCLUSION:

The general performance of the genetic populations and the estimations of heterosis (H%) percentages and potence ratios (PR) of the F_1 hybrids and reciprocals illustrated that the inheritance of vegetative growth, yield components and fruit length traits involved complete to over dominance for high over low values. (H% positive & BH positive and >1). However, the earliness characters seemed to have dominance or over-dominance nature for low over high values (early over late flowering and fruiting, H% negative & BH negative and >1). While, fruit diameter trait reflected partial dominance nature for high value (H% positive & BH positive and <1). On the other hand, flesh thickness and dry matter traits showed partial dominance for low value (H% negative & BH negative and <1).

This study concluded that the F_1 Hybrids $P_1 \times P_5$ and $P_2 \times P_5$ and their reciprocals had the best performances for vegetative growth, female flowering and fruiting traits, while the F_1 Hybrids $P_1 \times P_5$ and $P_2 \times P_4$ reflected the highest early yield traits. F_1hybrids P_2XP_4 and P_1XP_5 and their reciprocals recorded the highest productivity for total yield, number of fruits/plant and highest average fruit weight and other fruit quality traits. Therefore, F_1hybrids P_2XP_4 and P_1XP_5 and their reciprocals could be generally, considered the most important ones and promising new produced cucumber hybrids from this study. Also, P_5 inbred lines followed by P_2reflected the best desirable values for vegetative growth, female flowering, fruiting and early yield traits. The best parent for yield components and fruit quality traits was P_4 followed by P_5. Therefore, the three parental inbred liens $P_{2,}$ P_4 andP_5 can be selected as tester parents and for the involvement in hybrid combinations to predict the best hybrids.

Table (5). Heterosis percentages relative to mid and better parental (MP and BP) values and potence ratio (PR) of the 10 cucumber F_1 hybrids and their reciprocals for vegetative growth traits, averaged over the six experiments (three sowing dates during two summer seasons of 2018 and 2019).

Hybrids	Vegetative measurements					
	Plant length (m)			Total number of nodes / plants		
	MP	BP	PR	MP	BP	PR
$P_1 \times P_2$	63.65**	57.53**	16.38	19.53**	17.98**	14.82
$P_1 \times P_3$	50.29**	48.58**	43.68	32.66**	26.19**	6.37
$P_1 \times P_4$	19.12**	9.22**	2.11	23.26**	9.14**	1.80
$P_1 \times P_5$	44.32**	33.77**	5.62	30.69**	27.79**	13.52
$P_2 \times P_3$	22.85**	16.96**	4.54	21.78**	14.41**	3.38
$P_2 \times P_4$	27.17**	12.64**	2.11	18.57**	3.80**	1.31
$P_2 \times P_5$	33.84**	28.68**	8.44	26.05**	24.87**	27.37
$P_3 \times P_4$	24.90**	15.74**	3.15	28.56**	19.19**	3.63
$P_3 \times P_5$	34.57**	23.43**	3.83	29.90**	20.97**	4.05
$P_4 \times P_5$	32.28**	13.23**	1.92	31.81**	14.45**	2.10
Reciprocals						
$P_2 \times P_1$	69.37**	63.03**	17.85	17.75**	16.22**	13.47
$P_3 \times P_1$	53.67**	51.92**	46.61	35.12**	28.52**	6.85
$P_4 \times P_1$	22.80**	12.60**	2.52	22.91**	8.83**	1.77
$P_5 \times P_1$	44.53**	33.97**	5.65	31.24**	28.33**	13.77
$P_3 \times P_2$	25.10**	19.10**	4.99	22.43**	15.03**	3.48
$P_4 \times P_2$	25.70**	11.34**	1.99	19.17**	4.32**	1.35
$P_5 \times P_2$	34.90**	29.70**	8.71	23.17**	22.01**	1.35
$P_4 \times P_3$	29.82**	20.30**	3.77	31.88**	22.27**	4.05
$P_5 \times P_3$	31.14**	20.28**	3.45	31.81**	19.62**	3.85
$P_5 \times P_4$	29.72**	11.04**	1.77	27.08**	10.34**	1.78

*, ** Significant and highly significant at the 0.05 and 0.01 level of probability, respectively.

Table (6). Heterosis percentages relative to mid and better parental (MP and BP) values and potence ratio (PR) of the 10 cucumberF_1 hybrids and their reciprocals for female flowering, fruiting and early yield traits, averaged over the six experiments (three sowing dates during two summer seasons of 2018 and 2019).

Hybrids	Female flowering measurements						Fruiting measurements					
	Number of days for the first female flower appears			Number of nodes for the first female flower appears			Number of days for the first fruit picked			Number of nodes for the first fruit picked		
	MP	BP	PR	MP	BP	PR	MP	BP	PR	MP	BP	PR
$P_1 \times P_2$	-1.46^{NS}	-3.23^{**}	-0.80	-7.47^{**}	-16.71^{**}	-0.67	-2.52^{**}	-5.22^{**}	-0.88	-7.55^{**}	-14.92^{**}	-0.87
$P_1 \times P_3$	-0.48^{NS}	-1.47^{NS}	-0.47	-0.75^{NS}	-1.63^{NS}	-0.85	-0.43^{NS}	-0.99^{NS}	-0.76	-0.08^{NS}	-1.11^{NS}	-0.07
$P_1 \times P_4$	-3.01^{**}	-5.92^{**}	-0.97	-15.99^{**}	-28.38^{**}	-0.92	-3.49^{**}	-7.36^{**}	-0.83	-12.70^{**}	-23.08^{**}	-0.94
$P_1 \times P_5$	-3.70^{**}	-8.23^{**}	-0.75	-24.98^{**}	-41.27^{**}	-0.90	-5.73^{**}	-11.23^{**}	-0.92	-17.34^{**}	-32.08^{**}	-0.80
$P_2 \times P_3$	-2.82^{**}	-5.50^{**}	-0.99	-1.41^{NS}	-11.95^{**}	-0.12	-0.53^{NS}	-3.81^{**}	-0.16	-2.30^{NS}	-10.94^{**}	-0.24
$P_2 \times P_4$	-1.19^{NS}	-2.43^{**}	-0.94	-4.40^{NS}	-10.09^{*}	-0.70	-0.41^{NS}	-1.72^{**}	-0.31	-2.73^{NS}	-7.26^{**}	-0.56
$P_2 \times P_5$	-1.37^{NS}	-4.35^{**}	-0.44	-16.58^{**}	-28.81^{**}	-0.97	-2.52^{**}	-5.67^{**}	-0.75	-12.41^{**}	-22.68^{**}	-0.93
$P_3 \times P_4$	-2.33^{**}	-6.18^{**}	-0.57	-11.82^{**}	-25.37^{**}	-0.65	-4.36^{**}	-8.70^{**}	-0.92	-9.75^{**}	-21.19^{**}	-0.67
$P_3 \times P_5$	-3.56^{**}	-8.97^{**}	-0.60	-5.73^{NS}	-26.67^{**}	-0.20	-6.11^{**}	-12.05^{**}	-0.91	-0.76^{**}	-19.11^{**}	-0.03
$P_4 \times P_5$	-0.15^{NS}	-1.96^{**}	-0.08	-6.19^{NS}	-15.46^{**}	-0.56	-1.20^{NS}	-3.15^{**}	-0.60	-7.94^{**}	-15.12^{**}	-0.94
<u>Reciprocals</u>												
$P_2 \times P_1$	-1.16^{NS}	-2.93^{**}	-0.63	-9.41^{**}	-18.46^{**}	-0.85	-2.43^{**}	-5.123^{**}	-0.85	-8.24^{**}	-15.56^{**}	-0.95
$P_3 \times P_1$	-0.65^{NS}	-1.64^{NS}	-0.65	-0.60^{NS}	-1.48^{**}	-0.67	-0.27^{NS}	-0.83^{ns}	-0.48	-0.72^{ns}	-1.74^{NS}	-0.69
$P_4 \times P_1$	-2.41^{**}	-5.34^{**}	-0.78	-14.98^{**}	$-27,52^{**}$	-0.87	-3.72^{**}	-7.59^{**}	-0.89	-12.44^{**}	-22.85^{**}	-0.92
$P_5 \times P_1$	$-.3.13^{**}$	-7.68^{**}	-0.63	-23.97^{**}	-40.48^{**}	-0.86	-5.18^{**}	-10.71^{**}	-0.84	-21.46^{**}	-35.47^{**}	-0.99
$P_3 \times P_2$	-1.39^{NS}	-4.12^{**}	-0.49	-3.67^{NS}	-13.97^{**}	-0.31	-0.23^{NS}	-3.52^{**}	-0.07	-4.21^{NS}	-12.68^{**}	-0.43
$P_4 \times P_2$	-0.73^{NS}	-1.97^{*}	-0.57	-4.57^{NS}	-10.24^{**}	-0.72	-0.37^{NS}	-1.68^{NS}	-0.28	-3.97^{NS}	-8.44^{**}	-0.81
$P_5 \times P_2$	-2.80^{**}	-5.72^{**}	-0.90	-12.11^{*}	-25.00^{**}	-0.71	-2.64^{**}	-5.79^{**}	-0.79	-7.16^{**}	-18.04^{**}	-0.54
$P_4 \times P_3$	-3.01^{**}	-6.83^{**}	-0.73	-5.83^{NS}	-20.31^{**}	-0.32	-4.23^{**}	-8.57^{**}	-0.89	-6.45^{**}	-18.31^{**}	-0.44
$P_5 \times P_3$	-4.74^{**}	-10.08^{**}	-0.30	-7.42^{*}	-27.99^{**}	-0.26	-5.98^{**}	-11.93^{**}	-0.89	-7.01^{**}	-24.21^{**}	-0.31
$P_5 \times P_4$	-0.53^{NS}	-2.33^{*}	-0.29	-4.72^{NS}	-14.14^{**}	-0.43	-1.38^{NS}	-3.33^{**}	-0.69	-8.14^{**}	-15.30^{**}	-0.96

*, ** Significant and highly significant at the 0.05 and 0.01 level of probability, respectively, NS = Not significant

Table (7). Heterosis percentages relative to mid and better parental (MP and BP) values and potence ratio (PR) of the 10 cucumberF_1 hybrids and their reciprocals for yield components traits, averaged over the six experiments (three sowing dates during two summer seasons of 2018 and 2019).

	Early yield (kg)			yield components traits					
				Total yield (kg/ plant			Total yield (as number of fruits)		
Hybrids	**MP**	**BP**	**PR**	**MP**	**BP**	**PR**	**MP**	**BP**	**PR**
$P_1 \times P_2$	14.08^{**}	9.84^{**}	3.65	16.81^{**}	11.72^{**}	3.69	10.35^{**}	6.86^{*}	3.17
$P_1 \times P_3$	20.33^{**}	18.89^{**}	16.77	42.00^{**}	39.10^{**}	20.15	36.26^{**}	35.02^{**}	39.57
$P_1 \times P_4$	20.43^{**}	12.02^{**}	2.72	14.61^{**}	5.12^{**}	1.62	9.82^{**}	1.68^{NS}	1.23
$P_1 \times P_5$	27.68^{**}	14.68^{**}	2.44	32.70^{**}	21.89^{**}	3.69	32.34^{**}	26.31^{**}	6.78
$P_2 \times P_3$	9.19^{**}	6.38^{*}	3.48	16.73^{**}	13.92^{**}	6.77	12.60^{**}	8.08^{**}	3.01
$P_2 \times P_4$	16.36^{**}	12.24^{**}	4.46	39.75^{**}	33.75^{**}	8.86	28.87^{**}	23.02^{**}	6.07
$P_2 \times P_5$	11.63^{**}	3.83^{NS}	1.55	21.26^{**}	16.23^{**}	4.91	19.97^{**}	18.19^{**}	13.25
$P_3 \times P_4$	12.34^{**}	5.67^{*}	1.96	10.16^{**}	3.00^{**}	1.46	30.75^{**}	20.05^{**}	3.45
$P_3 \times P_5$	11.72^{*}	1.44^{NS}	1.16	21.08^{**}	13.38^{**}	3.10	25.22^{**}	18.48^{**}	4.44
$P_4 \times P_5$	7.83^{**}	3.83^{NS}	2.03	7.68^{**}	7.51^{**}	47.98	14.37^{**}	10.77^{**}	4.42
Reciprocals									
$P_2 \times P_1$	14.01^{**}	9.78^{**}	3.63	17.26^{**}	12.16^{**}	3.79	9.53^{**}	6.06^{**}	2.92
$P_3 \times P_1$	20.23^{**}	18.79^{**}	16.68	43.08^{**}	40.16^{**}	20.67	35.93^{**}	34.69^{**}	39.21
$P_4 \times P_1$	20.48^{**}	12.06^{**}	2.73	15.07^{**}	5.55^{**}	1.67	10.27^{**}	2.10^{NS}	1.28
$P_5 \times P_1$	28.32^{**}	15.26^{**}	2.50	34.18^{**}	23.25^{**}	3.86	33.23^{**}	27.16^{**}	6.97
$P_3 \times P_2$	7.44^{**}	4.67^{NS}	2.81	16.14^{**}	13.33^{**}	6.53	9.99^{**}	5.58^{NS}	2.39
$P_4 \times P_2$	15.03^{**}	10.96^{**}	4.10	38.59^{**}	32.64^{**}	8.60	29.22^{**}	23.35^{**}	6.15
$P_5 \times P_2$	8.84^{**}	1.24^{NS}	1.18	21.18^{**}	16.16^{**}	4.90	19.31^{**}	17.54^{**}	12.81
$P_4 \times P_3$	11.40^{**}	4.79^{NS}	1.81	9.30^{**}	2.19^{**}	1.34	29.21^{**}	18.63^{**}	3.28
$P_5 \times P_3$	12.33^{**}	3.00^{NS}	1.22	21.93^{**}	14.17^{**}	3.23	23.41^{**}	16.77^{**}	4.12
$P_5 \times P_4$	8.48^{*}	4.46^{NS}	2.20	8.28^{**}	8.11^{**}	51.73	13.85^{**}	10.27^{**}	4.26

*, ** Significant and highly significant at the 0.05 and 0.01 level of probability, respectively.

Table (8). Heterosis percentages relative to mid and better parental (MP and BP) values and potence ratio (PR) of the 10 cucumberF_1 hybrids and their reciprocals for fruit characteristics traits, averaged over the six experiments (three sowing dates during two summer seasons of 2018 and 2019).

	Fruit measurements														
	Average fruit weight (g)			Average fruit length (cm)			Fruit diameter (cm)			Flesh thickness (cm)			Dray matter %		
Hybrids	MP	BP	PR	MP	BP	PR	MP	BP	PR	MP	BP	PR	MP	BP	PR
P_1×P_2	5.38**	5.25**	41.88	8.17**	1.82*	1.31	0.46^{NS}	-0.87^{NS}	0.35	-3.96**	-8.70**	-0.76	-0.95^{NS}	-4.96**	-0.23
P_1×P_3	4.50**	2.64^{NS}	2.48	12.35**	7.48**	2.73	1.31**	-2.24**	0.36	-2.13*	-6.02**	-0.52	-1.20^{NS}	-4.00**	-0.41
P_1×P_4	9.91**	7.18**	3.88	13.19**	0.95^{NS}	1.09	5.30**	-3.82**	0.56	-5.93^{NS}	-13.95**	-0.64	-5.91**	-14.19**	-0.61
P_1×P_5	4.22**	2.39^{NS}	2.36	13.51**	1.61^{NS}	1.15	2.86**	-5.59**	0.32	-2.04**	-4.33**	-0.85	-0.59^{NS}	-1.86**	-0.46
P_2×P_3	5.73**	3.98**	3.40	2.48**	0.77^{NS}	1.46	3.24**	-1.66**	0.65	-0.53^{NS}	-1.57^{NS}	-0.51	-0.86^{NS}	-1.57^{NS}	-0.67
P_2×P_4	10.35**	7.47**	3.86	10.46**	4.27**	1.76	1.12*	-8.74**	0.10	-3.57**	-7.42**	-0.86	-1.47^{NS}	-7.42**	-0.27
P_2×P_5	7.25**	5.51**	4.38	10.25**	4.49**	1.86	1.77**	-7.71**	0.17	-5.09**	-11.76**	-0.67	-3.43**	-11.76**	-0.62
P_3×P_4	5.84**	1.41^{NS}	1.34	13.28**	5.25**	1.74	0.65^{NS}	-4.93**	0.11	-2.87**	-7.68**	-0.55	-4.25**	-7.68**	-0.63
P_3×P_5	2.38^{NS}	2.35^{NS}	78.01	12.17**	4.62**	1.69	1.26**	-3.86**	0.24	-3.25**	-9.17**	-0.50	-2.68**	-9.17**	-0.64
P_4×P_5	7.86**	3.38**	1.82	3.46**	3.03**	8.30	0.35**	-0.20**	0.64	-8.18**	-17.79**	-0.70	-9.13**	-17.79**	-0.84
Reciprocals															
P_2×P_1	7.85**	7.71**	61.04	7.06**	0.78^{NS}	1.13	0.64^{NS}	-0.69^{NS}	0.48	-2.60**	-7.40**	-0.50	-0.49^{NS}	-4.52**	-0.12
P_3×P_1	3.14*	1.30^{NS}	1.73	9.84**	5.08**	2.17	0.19^{NS}	-3.33**	0.05	-2.09*	-5.97**	-0.50	-1.50^{NS}	-5.97**	-0.51
P_4×P_1	11.97**	9.18**	4.69	13.38**	1.12**	1.10	2.33**	-6.53**	0.25	-5.62**	-13.67**	-0.60	-5.72**	-13.67**	-0.59
P_5×P_1	4.31**	2.48**	2.41	15.04**	2.98**	1.28	6.27**	2.45**	0.70	-1.19^{NS}	-3.50**	-0.50	-0.64^{NS}	-3.50**	-0.49
P_3×P_2	7.16**	5.38**	4.25	3.32**	1.59^{NS}	1.95	0.64**	-4.14**	0.13	-0.56^{NS}	-1.60^{NS}	-0.54	-1.00^{NS}	-1.60^{NS}	-0.78
P_4×P_2	9.10**	6.25**	3.40	10.97**	4.75^{NS}	1.85	0.28^{NS}	-9.50**	0.03	-3.04**	-6.91**	-0.73	-1.68^{NS}	-6.91**	-0.31
P_5×P_2	8.17**	6.41**	4.94	6.83**	1.24^{NS}	1.24	5.68**	-4.16**	0.55	-3.09**	-9.90**	-0.41	-3.67**	-9.90**	-0.67
P_4×P_3	5.26**	0.85^{NS}	1.20	13.08**	5.07**	1.72	1.36^{NS}	-4.26**	0.23	-3.06**	-7.86**	-0.59	-3.92**	-7.86**	-0.58
P_5×P_3	3.35*	3.32^{NS}	109.58	14.06**	6.39**	1.95	2.30**	-2.87**	0.43	-2.30**	-8.28**	-0.35	-1.95^{NS}	-8.28**	-0.46
P_5×P_4	8.36**	3.85**	1.93	4.97**	4.53**	11.93	0.27^{NS}	-0.27^{NS}	0.49	-0.59^{NS}	-10.99**	-0.05	-4.47**	-10.99**	-0.41

*, ** Significant and highly significant at the 0.05 and 0.01 level of probability, respectively, NS = Not significant.

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الملخص العربى

السلوك العام, وقوة الهجين و درجة السيادة لبعض الصفات الهامة بإستخدام تهجين الداي أليل الكامل بين خمس سلالات مرباة داخليا من الخيار تحت ظروف الزراعة المحمية.

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تم إجراء التلقيح الذاتى لعدد ٥ سلالات مرباة داخليا من أصناف الخيار غير محدودة النمو ولمدة جيلين متتاليين (الصيفى والخريفى لعام ٢٠١٦) ، وذلك للتأكيد على نقاوة هذه السلالات كخطوه تمهيدية لإستخدامها فى برنامج التربية.تم إجراء كل التهجينات الممكنةبين السلالات (داى أليل كامل) خلال الموسم الصيفى لعام ٢٠١٧ لينتج عن ذلك ١٠ هجن و ١٠ هجن عكسيه. فى خلال الموسم الصيفى لعامى ٢٠١٨ و ٢٠١٩ وفى ثلاث مواعيد زراعة مختلفه وهى منتصف شهر فبراير ومارس ومايو, تم تقييم التراكيب الوراثية بزراعه ال٥ آباء المستخدمه فى التهجين بالأضافه لل ١٠ هجن و ١٠ هجن عكسية فى تجربة بإستخدام تصميم القطاعات العشوائية الكاملة بثلاث مكررات. متوسطات القيم وقوة الهجين ودرجة السيادة تم تقديرها للصفات الخضرية وصفات التزهير والإثمار بالاضافه لصفات المحصول ومكوناته. أوضحت النتائجأنه يوجد إختلافات معنوية بل وعالية المعنوية غالبا بين كل التراكيب الوراثيه تحت الدراسه فى كل الصفات. كان أفضل الآباء فى صفات النمو الخضرى والمحصول ومكوناته وصفات الثمره هو P_4 متبوعا بP_5 و P_2 لذلك يمكن إستخدام هذه الثلاث آباء كآباء كشافه او للمشاركه فى التهجينات التى يمكن التنبؤ بتفوقها. أفضل التهجينات فى معظم الصفات التى كانت موجوده فى الجيل الأول F_1 كانت $P_2 \times P_4$ و $P_1 \times P_5$ بالأضافه الى الهجن العكسيه الخاصه بهم حيث كانو مسجلين لأفضل القيم لصفات المحصول الكلى وعدد الثمار الكلى / نبات ومتوسط وزن الثمره بالاضافه الى انها كانت متميزه فى باقى صفات جوده الثمره. لذلك يمكن اعتبار ان الهجن $P_2 \times P_4$ و $P_1 \times P_5$ والهجن العكسيه الخاصه بهم هجن واعده ذات صفات متميزه عن باقى الهجن. بالنسبه لنتائج قوه الهجين سواء على أساس متوسط الأبوين أو الاب الأعلى بالأضافه إلى قيم درجات السياده, كانت هناك قيم معنويه ومعتبره فى كل الصفات تقريبا وقيمه قوه الهجين للصفات الخضريه والمحصول المبكر والمحصول الكلى وعدد الثمار ومتوسط وزن وطول الثمره كانت موجبه ومعنويه فى معظم الهجن, بينما قيم درجه السياده كانت موجبه وأكبر من الواحد الصحيح لذلك توريث هذه الصفات يميل ناحيه السياده الكامله أو السياده الفائقه. بالنسبه لقيم قوه الهجين فى صفات مواعيد التزهير والأثمار كانت سالبه ومعنويه فى معظم الهجن. أيضا قيم درجه السياده كانت سالبه وأكبر من الواحد الصحيح لذلك توريث هذه الصفات يميل إلى السياده أو السياده الفائقه لصفه التبكير فى حمل الأزهار والثمار.