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BREEDING AND PRODUCING NEW INBRED LINES AND F_1 HYBRIDS OF PICKLING CUCUMBERS.

A.M. Abd Rabou and Nahla A. EL-Magawry
Vegetables Breeding Dept. Hort. Res. Inst, ARC, Giza, Egypt.

ABSTRACT

Pickling cucumber is considered one of the important types of vegetables in Egypt, but there is less interest in it; this due to the lack of hybrids charactercterized with high productivity and good commercial traits. Production can be increased through increasing genetic diversity and thus productivity via plant breeding. The present experiment was conducted at Kaha Vegetable Research Farm, Wady El- Natroon and Ismailia during 2016-2020. Six cucumber genotypes from Netherland and Sweden Gene Banks (18-CGN, 8-CGN, 16-CGN, 11-NGB, 15-CGN and 21-NGB) were selfed pollinated for 6 generations to have pure inbred lines. They crossed by half diallel method to produce 15 F_1 hybrids. Evaluation of the 6 parents, 15 produced hybrids and two commercially hybrids (Livina F_1 and Magdalina) was carried out for fruit length, fruit diameter, fruit weight, number of female flowers per node, node of the first female flower, number of fruits/plant and total yield/plant was done. Heterosis, heritability, inbreeding depression and number of genes controlling studied traits were estimated. The results in the cross P_1 x P_5 showed that highest mid-parent heterosis values for studied characters that were positive by contrast. Most high-parent heterosis values for studied characters were negative. High inbreeding depression was observed. The inbreeding depression was positively and negatively lower significant indicating the presence of vigor in F_2. High estimates of narrow and broad sense heritability were observed in the cross P_1 x P_5, but were moderate for number of female flowers per node and node of the first female flower. Concerning number of effective genes controlling most characters were found to be 1-2 pairs of genes (or group of genes); only fruit weight and node of the first female flower traits controlled by (4) and (9) additive genes respectively.

Key words: ***Pickling cucumber, Cucumis sativus L., Heterosis, Heritability, Genetic Advance, Inbreeding depression, Number of genes***

INTRODUCTION

Cucumbers are one of the most important crops in the field of horticulture (Mihov and Alexandrova 1975). Cucumber belongs to family Cucurbitaceae which is an important summer vegetable, grown for its immature fruits, used as fresh for salad, making pickles and even brined on commercial scale in almost every part of the world (Kumar *et al* 2016). Cucumber is eaten fresh, or as a processed product (processing or pickling types) (Staub *et al* 2008).

In Egypt, there are favorable conditions for growing a long fruited type cucumber as well as pickling type. Pickling cucumber production is meant mainly for the canning industry. The heterosis method on the base of gynoecious lines crossed with father lines is important to produce good pickling hybrids (Hanchinamani, and Patil, 2009).

Three new pickling cucumber hybrids that could be of great importance for the canning industry were studied by Velkov and Alexandrova (2010). They were distinguished from the control hybrid Tony

F_1 in yield structure. These hybrids are produced from 1 to 8 percent (in relative values) taller 3-6 cm and 6-9 cm in comparison with the control.

Wilde and Duyfjes, 2010 showed that it was important to study fruit quality traits of cucumber including fruit colour, spine colour, stripes, fruit size and firmness to cucumber pickling fruits. The fruits can be harvested as gherkins (3 to 6 cm in length), for pickling (6 to 10 cm), and for brining (8 to 15 cm) (Velkov and Alexandrova 2010). Also, De Ponti (1976) showed that parthenocarpic pickling cucumbers have been selected after crossing pickling and slicing cucumbers and on the best lines found that 90 ~ of the female flowers set fruit up to 75 fruits per plant within six weeks.

Ranjan *et al* (2008) reported that pickling cucumber as an immature cucumber used for processing (brining or pasteurizing). Unless mechanized, harvest is labor intensive due to small fruit size, which is generally <15 cm long. Veena *et al* (2012) evaluated thirty-eight advanced lines of cucumber for variability, heritability and genetic advance for yield and contributing traits. They found that genotypic coefficient of variation and phenotypic coefficient of variation were highest for node at first female flower appearance followed by yield per plant, average fruit weight and number of fruits per plant. High heritability and high estimated genetic advance over mean were observed for node at first female flower appearance (82.17%), number of fruits per plant (85.78%), fruit length (88.92%) and fruit breadth (86.91%), indicating that these characters had additive gene effects and therefore, they are more reliable for effective selection.

The exploitation of heterosis has become a potential tool to improve the ridge guard yield. Information on the magnitude of heterosis in different cross combinations is a basic requisite for identifying crosses that exhibit high degree of exploitable heterosis hence heterosis breeding is one of the ways to improve the production and productivity in order to harness the potential (Dhumal *et al* 2019).

The present investigation was carried out with an objective of extending the magnitude of heterosis in different crosses and its confirmation through inbreeding depression in F_2 generation and then utilization in future crop improvement progammes.

The main objectives of this study were 1) to evaluate some inbred lines and their hybrids for yield and yield components to continue hybrids production breeding program, and 2) to examine the amount of mid-parent and high-parent heterosis, heritability, number of genes controlling the traits and inbreeding depression for fruit yield and yield components in pickling cucumber.

MATERIALS AND METHODS

The present experiment was conducted during 2016-2020. The breeding materials used included six different genotypes of cucumber, they were collected from Netherland and Sweden Gene Banks (18-CGN, 8-CGN, 16-CGN, 11-NGB, 15-CGN and 21-NGB), they selfed pollinated for 6 generations to have pure inbred lines. These inbred lines were cultivated at Kaha Vegetable Research Farm (K.V.R.F), Qalubia, Egypt in February 2016 to increase seeds by self pollination and produce crosses by half diallel method among the six cucumber inbred lines in all possible combinations and obtain 15 F_1 hybrids. One cross (P_1 x P_5) out of 15 was chosen for genetic studies. Some plants of $F_{1's}$ for this hybrid were selfed to produce F_2 generation; some other plants were crossed with either P_1 or P5 to produce Bc_1 and Bc_2, respectively under greenhouse conditions at K.V.R.F in July 2016. Genetic studies on P_1×P5 hybrid were carried out at K.V.R.F in February 2017. Evaluation of 6 parents, 15 produced hybrids and two commercial hybrids (Livina F_1 and Magdalina) as control was carried out in open field at Wady El- Natroon and Ismailia during the spring season of 2020. Recommended cultural practices were adopted for proper growth and stand of the crop. The observations were recorded on seven economic traits from five randomly selected guarded plants from each genotype in each replication. Data obtained were statistically analyzed according to the analysis of variance and L.S.D tests (Steel and torrie 1960). Heterosis was calculated according to the formula given by Sinha and Khanna (1975), heritability by Allard (1999), number of genes controlling Castle and Wright (1921) and Inbreeding depression by Cramer and Wehner (1998).

RESULTS AND DISCUSSION

A. Evaluation of cucumber genotypes for horticultural characters

Twenty three available cucumber genotypes (6 parents, 15 hybrids and 2 commercial hybrids (Livina F_1 and Magdalina) cultivated on open field at two locations at (Wady El- Natroon and Ismailia) in 2020 to evaluate their performance. The results are presented in Table (1).

1- Fruit length (cm)

Data obtained on fruit length for 23 cucumber genotypes are presented in Table (1) and Fig (1). The results obtained showed that line 5 gave the highest significant fruit length (15.2 and 15.6 cm) at Wady El-Natroon and Ismailia, respectively, compared with the other tested inbred lines at Wady El- Natroon and Ismailia locations. On the other hand, line 2 had the shortest fruits in both locations of study (5.9 and 6.3 cm), respectively. In addition P_1XP_2, P_1XP_5, P_2XP_5 and P_4XP5 (14.1, 14.4, 14.2 and 15.0 cm) respectively at Wady EL- Natroon, and P_1XP5, P_2XP5 and P_4XP5 (16.3, 16.6 and 15.6 cm, respectively) at Ismailia, gave the highest significant fruit length compared with the other tested hybrids in both locations. These results are in agreement with Ranjan *et al* (2008) who recommended the pickling cucumber is an immature cucumber of small fruit size, which is generally <15 cm long.

2- Fruit diameter (cm)

Data obtained on fruit diameter of 23 cucumber genotypes in the two locations are presented in Table (1) and Fig (**1)**. The results obtained exhibited significantly greater fruit diameter for parents P_3 and P5 in both locations of study. The results showed also that the hybrids $P_3X\ P_4$ and P_3XP_5 were the highest and significant fruit diameter (3.4, 3.3, 3.5 and 3.3 cm, respectively), as compared with the other hybrids in both locations of the study.

3- Fruit weight (g)

Data obtained on the fruit weight of 23 cucumber genotypes i.e., 6 parents, 15 produced hybrids and 2 commercial hybrids (Livina F_1 and Magdalina) in the two locations in 2020 are presented in Table (1). The results obtained cleared that the parent P_5 gave the heaviest fruit weight as compared with the other used parents in both locations (129.7 and 124.3, g respectively).

Table 1. Average of Fruit length(cm), fruit diameter(cm), fruit weight (g) and number of female flowers per node of cucumber genotypes evaluated in two location at 2020.

Genotypes	FL		FD		FW		FLNO	
	Ism.	Wad.	Ism.	Wad.	Ism.	Wad.	Ism.	Wad.
P1	8.9	8.1	1.8	1.9	52.5	49.2	4.8	5.3
P2	5.9	6.3	2.5	2.6	47.0	48.7	1.0	0.7
P3	11.3	12.3	3.1	3.2	93.5	89.3	1.0	1.0
P4	7.2	8.1	2.9	3.0	65.3	61.7	2.0	1.3
P5	15.6	15.2	3.1	3.0	129.7	124.3	1.7	1.3
P6	4.6	4.9	1.5	1.6	31.3	33.0	1.0	1.0
P_1 x P_2	14.1	12.2	2.1	2.2	117.3	109.7	4.0	4.3
P_1 x P_3	11.5	11.7	2.4	2.5	73.2	70.1	3.0	2.3
P_1 x P_4	9.6	9.8	2.9	2.9	59.0	55.6	2.7	3.0
P_1 x P_5	14.4	15.6	2.4	2.5	114.3	119.3	3.0	2.0
P_1 x P_6	5.7	6.7	1.8	1.9	34.2	36.2	3.7	3.0
P_2 x P_3	9.9	11.1	3.2	3.3	74.3	70.0	1.0	1.0
P_2 x P_4	8.7	7.7	2.6	2.7	69.8	67.0	2.0	2.0
P_2 x P_5	14.2	16.6	2.9	2.9	117.0	120.7	2.0	1.7
P_2 x P_6	5.0	5.5	1.8	1.9	41.9	44.2	1.0	0.7
P_3 x P_4	11.0	12.1	3.4	3.3	73.3	70.3	2.0	1.7
P_3 x P_5	12.8	11.0	3.5	3.3	127.0	118.7	1.7	1.3
P_3 x P_6	7.2	7.4	2.4	2.5	42.2	37.4	1.0	0.7
P_4 x P_5	15.0	16.3	3.0	2.9	94.0	95.7	2.0	2.0
P_4 x P_6	8.9	10.1	1.8	1.9	50.3	54.3	2.0	1.7
P_5 x P_6	12.3	13.5	2.0	1.9	66.2	69.2	2.0	1.7
Livina F1	10.6	11.7	2.2	2.1	71.0	67.3	3.0	3.7
Magdalina	4.2	5.4	1.1	1.2	12.0	13.7	4.7	4.8
LSD	1.0	0.9	0.12	0.3	7.3	6.0	0.5	0.6

Ism.: Ismailia station, Wad.: Wady El-natroon, FL: fruit length, FD: fruit diameter, FW: fruit weight and NOFL: number of female flowers per node.

The results revealed that the hybrids P_1X P_2, P_1X P_5, P_2X P_5 and P_3X P_5 were significantly greater in fruit weight as compared with the other

hybrids in both locations of study. On the other hand, P_6 had significantly the lightest fruit weight in both locations from significant differences from the other parents. Besides, the check hybrid Magdalina gave the lightest fruit weight in both locations. These results are in agreement with those reported by Mousavizadeh *et al* (2010), who evaluated three varieties of cucumber pickling (Green Gold, Dharwad, and Super Dominus). His results showed that Green Gold had the highest

4- Number of female flowers per node

Data obtained on number of female flowers per node of parents, F_1 hybrids and 2 commercial hybrids in the two locations are presented in Table (1) and Fig (2). The results obtained indicated that parent P_1 had the highest number of female flowers per node compared with other parents used at both locations (4.8 and 5.3, respectively). Besides, results showed that the check hybrid Magdalina was significantly the highest in the number of female flowers compared with all hybrids (4.7 and 4.8), and (P_1) X (P_2) was significantly the highest in number of female flowers produced per node compared with the other produced hybrids in the two locations of study.

It is worth here to mention that hybrid (P_1) X (P_2) could be considered promising for high yielding ability due to multi female flowers which are produced on a single node, and consequently multi number of fruits produced on each node of the plant. Wenjing *et al* (2019) studied 16 parthenocarpic cucumber cultivars from the four major types. They were cultivated in high tunnels at three locations in Indiana. They found that all cultivars had one female flower at each node, only one cv. had 1-5 female flowers at each node.

5- Node of the first female flower

Data obtained on node of the first female flower of 23 cucumber genotypes in the two locations are presented in Table (2). The results obtained indicated that parent P_1 showed the lowest node of the first female flower compared with other parents used in both locations (1.3 and 1, respectively). Besides, results showed that the hybrid $P_1X\ P_2$ was significantly the lowest in the node of the first female flower compared with all hybrids (1.3 and 1.7), in the two locations of study, respectively. In that

respect, Maleknia *et al* (2016) reported that the two locations of the first female flower is important because it is important to have early yield. For cucumbers, it also provides an indication of whether the first flower should be allowed to produce fruit; if the node is too close to ground. Wenjing *et al* (2019) found that the first female flower was developed on the 2nd or 3rd node of two cvs. Of 16, and on the third to fifth node of Dutch greenhouse types.

Table 2. Average of node of the first female flower (NFFF), number of fruits/plant (NF) and total yield/plant (TY) (kg) of cucumber genotypes evaluated at two location in 2020

Genotype	NFFF		NF		TY (kg)	
	Ism.	Wad.	Ism.	Wad.	Ism.	Wad.
P_1	1.3	1.0	54.0	62.0	3.0	2.6
P_2	4.3	5.7	31.7	29.0	1.4	1.2
P_3	5.3	5.0	15.3	16.7	1.6	1.3
P_4	3.7	4.7	33.3	29.3	2.0	2.1
P_5	3.3	4.3	16.3	19.3	2.3	2.1
P_6	4.0	2.7	34.3	37.3	1.1	1.0
$P_1 \times P_2$	1.3	1.7	33.7	37.7	4.0	4.1
$P_1 \times P_3$	3.7	4.3	45.7	41.7	3.2	3.0
$P_1 \times P_4$	3.0	3.7	49.7	50.7	3.0	3.1
$P_1 \times P_5$	4.3	3.3	36.7	39.3	4.2	4.7
$P_1 \times P_6$	3.7	4.0	72.3	67.0	2.7	2.4
$P_2 \times P_3$	6.7	7.7	32.7	35.0	2.5	2.1
$P_2 \times P_4$	5.0	5.7	38.7	42.3	2.9	3.3
$P_2 \times P_5$	4.0	3.3	34.3	31.3	3.9	3.6
$P_2 \times P_6$	5.3	4.7	39.9	43.0	1.7	1.4
$P_3 \times P_4$	8.7	8.0	27.0	30.0	2.2	2.3
$P_3 \times P_5$	6.3	5.3	24.3	19.7	3.1	2.8
$P_3 \times P_6$	6.7	5.7	37.3	39.7	1.7	1.5
$P_4 \times P_5$	3.7	3.3	24.7	29.0	2.4	2.6
$P_4 \times P_6$	3.7	4.0	41.7	43.0	2.0	2.6
$P_5 \times P_6$	3.3	4.0	46.2	54.3	3.1	3.8
Livina F_1	3.7	3.0	68.3	72.0	4.8	4.4
Magdalina	3.3	3.7	138.7	128.3	1.7	1.9
LSD $_{0.05}$	0.4	0.5	7.0	5.8	0.5	0.4

Ism.: Ismailia station, Wad.: Wady El- Natroon, NFFF: node of the first female flower, NF: number of fruits/plant and TY: total yield/plant. Values in

fruit diameter, volume, weight, flesh thickness, geometric mean diameter and sphericity.

6- Number of fruits/plant

Data obtained on number of fruits/plant of 23 cucumber genotypes tested in two locations in 2020 are presented in Table (2). The results obtained indicated that parent P_1 revealed the highest number of number of fruits/plant compared with other parents used in both locations (54 and 62), respectively. Besides, results showed that the check hybrid Magdalina was significantly the highest in number of fruits/plant compared with all hybrids (138.7 and 128.3), and $P_1X\ P_6$ was significantly the highest in number of fruits/plant (72.3 and 67.0) compared with the other produced hybrids of study and equal with the check hybrid Livina F_1 (68.3 and 72) in the two locations, respectively.

Wenjing *et al* (2019) reported that in general, cucumber cultivars with small fruits produced greater number. By contrast, and cultivars with larger cucumbers produced fewer. For example, cultivar Picolino, harvested at the shortest fruit length, consistently produced the highest number fruits per plant. In contrast, Dutch cultivar greenhouse-type cucumbers, Japanese cucumbers, and 'Sweet Success', all harvested at longer length, produced the least number of fruits.

7- Total yield/plant (kg)

Data obtained on total yield/plant of 23 cucumber genotypes at the two locations in 2020 are presented in Table (2). The results obtained indicated that parent P_1 had the highest total yield/plant compared with other parents used in both locations (3 and 2.6 kg), respectively. Besides, results showed that the hybrid Livina F_1 was significantly the highest in total yield/plant (4.8 and 4.4 kg) beside $P_1X\ P_5$ (4.2 and 4.7 kg), compared with all hybrids in the two locations of study. These results are similar to those of Melisa and Wehner (2006) who found in their study on fourteen cultigens (cultivars and breeding lines) in spring location that 'Dasher II' (tall, gynoecious, slicing type) had high total yield, and a high percentage of marketable fruit.

Fig(1): Fruit of P_1 (18-CGN)

Fig(2): Number of female flowers/node of P_1 (18-CGN)

Genetic studies

Genetic information of parents, F_1, F_2, Bc_1 and Bc_2 populations of one chosen cross (P_1X P_5) are presented in Tables (3 to 9). Parents were distinctively different in their characters, as expressed by range between the lowest value and the highest one. Data showed wide variance between the two parents for the seven traits studied (as shown in the frequency distributions in the seven tables).

Table 3. Frequency distribution of fruit length (cm) of P_1, P_5, F_1, F_2, Bc_1 and Bc_2 population of the cross $P_1 \times P_5$.

Genotypes	8	9.5	11	12.5	14	15.5	16	17.5	Total	Mean
P_1 (1)	31	15							46	8.5
P_2 (5)						41	7		48	14.7
F_1				4	33	2			39	13.9
F_2	2	18	11	11	45	24	3	1	115	12.9
Bc_1					17	32	34	22	105	15.5
Bc_2	27	25	43	13	9				117	10.4

Table 4. Frequency distribution of fruit diameter (cm) of P_1, P_5, F_1, F_2, Bc_1 and Bc_2 population of the cross $P_1 \times P_5$.

Genotypes	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	Total	Mean
P_1 (1)	5	46								51	1.5
P_2 (5)							15	35		50	3.2
F_1					46	1				47	2.4
F_2	2	2	7	14	35	24	12	12	7	115	2.6
Bc_1	2	16	38	12	26	5	5	1		105	2.0
Bc_2					14	34	51	17	1	117	2.9

Table 5. Frequency distribution of fruit weight (g) of P_1, P_5, F1, F_2, Bc_1 and Bc_2 population of the cross $P_1 \times P_5$.

Genotypes	39.5	52.5	65.5	78.5	91.5	104.5	117.5	130.5	143.5	Total	Mean
P_1 (1)	16	35	0							51	48.4
P_2 (5)					0	0	9	41		50	128.2
F_1				0	0	44	3			47	105.3
F_2	0	0	0	7	17	39	2	15	0	80	104.6
Bc_1					14	14	41	36		105	116.7
Bc_2	26	55	28	8						117	54.5

Table 6. Frequency distribution of number of female flowers per node of P_1, P_5, F_1, F_2, Bc_1 and Bc_2 population of the cross $P_1 \times P_5$.

Genotypes	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	Total	Mean
P_1 (1)						42	7	0		49	5.5
P_2 (5)	1	47								48	1.6
F_1					8	43				51	3.1
F_2	1	9	1	4	13	39	39	22	12	140	5.1
Bc_1						19	29	45	0	93	5.8
Bc_2	11	23	27	36	1					98	2.3

Table 7. Frequency distribution of node of the first female flower of P_1, P_5, F1, F_2, Bc_1 and Bc_2 population of the cross $P_1 \times P_5$.

Genotypes	1	2	3	4	5	6	7	Total	Mean
P_1 (1)	48	3						51	1.1
P_2 (5)				42	8			50	4.2
F_1	41	6						47	5.2
F_2	7	3	12	21	49	23	0	115	4.8
Bc_1	77	4	15	9				105	1.4
Bc_2	22	26	23	38	8			117	3.0

Table 8. Frequency distribution of number of fruits/plant of P_1, P_5, F1, F_2, Bc_1 and Bc_2 population of the cross $P_1 \times P_5$.

Genotypes	13.5	20.5	27.5	34.5	41.5	48.5	55.5	62.5	69.5	Total	Mean
P_1 (1)							34	17		51	57.8
P_2 (5)	36	7								43	14.6
F_1	0	0	0	33	7	3	0	0	0	43	36.6
F_2	4	4	2	4	17	49	5	12	16	113	47.1
Bc_1	58	5	12	3	2				0	80	1.4
Bc_2				4	4	1	58	23	0	90	18.1

Table 9. Frequency distribution of total yield/plant (kg) of P_1, P_5, F1, F_2, Bc_1 and Bc_2 population of the cross $P_1 \times P_5$.

Genotypes	1.1	1.65	2.2	2.75	3.3	3.85	4.44	4.95	5.5	Total	Mean
P_1 (1)				54	9					63	2.8
P_2 (5)		4	43							47	2.2
F_1						7	33			40	4.3
F_2	2	0	5	7	1	39	45	13	1	113	4.0
Bc_1						25	23	51		99	4.6
Bc_2	10	23	24	18	14					89	2.2

The obtained quantitative genetic parameters (mid and high-parent heterosis, inbreeding depression, narrow and broad sense heritability and number of genes controlling a traits) for yield components of the cucumber hybrids studied, are presented in Table (10).

1- Mid and high parent heterosis

Heterosis for studied characters (Table 10 and Fig. 3) varied from -125% to 87% when two types of heterosis are considered. Most of mid parent heterosis values for studied characters were positive. This is desirable for fruit length, fruit weight, number of fruits/plant and total yield/plant only desirable negative MP heterosis who observed was observed in fruit diameter and undesirable negative MP heterosis in number of female flowers per node. On the contrary, most of high parent heterosis values for studied characters were negative, only fruit length and fruit weight showed desirable positive HP heterosis.

Table 10. Quantitative genetic parameters of 7 characters in the cross $P_1 \times P_5$.

Trait	H.M.P%	H.H.P%	ID%	N	NSH%	BSH%
Fruit length	**18**	**8**	**2.6**	**0.10**	**88**	**94**
Fruit diameter	**-2**	**-23**	**0.2**	**1.42**	**91**	**96**
Fruit weight	**25**	**12**	**-0.7**	**3.64**	**72**	**91**
Number of female flowers per node	**-8**	**-76**	**2**	**1.03**	**27**	**98**
Node of the first female flower	**87**	**-30**	**-0.4**	**8.29**	**39**	**76**
Number of fruits/plant,	**4**	**-125**	**10.5**	**0.37**	**89**	**97**
Total yield/plant	**58**	**-83**	**-0.3**	**0.10**	**88**	**94**

H.M.P: heterosis of mid parent, H.H.P: heterosis of high parent, ID: Inbreeding depression, N: Number of gene, NSH: Narrow sense heritability and BSH: Broad sense heritability.

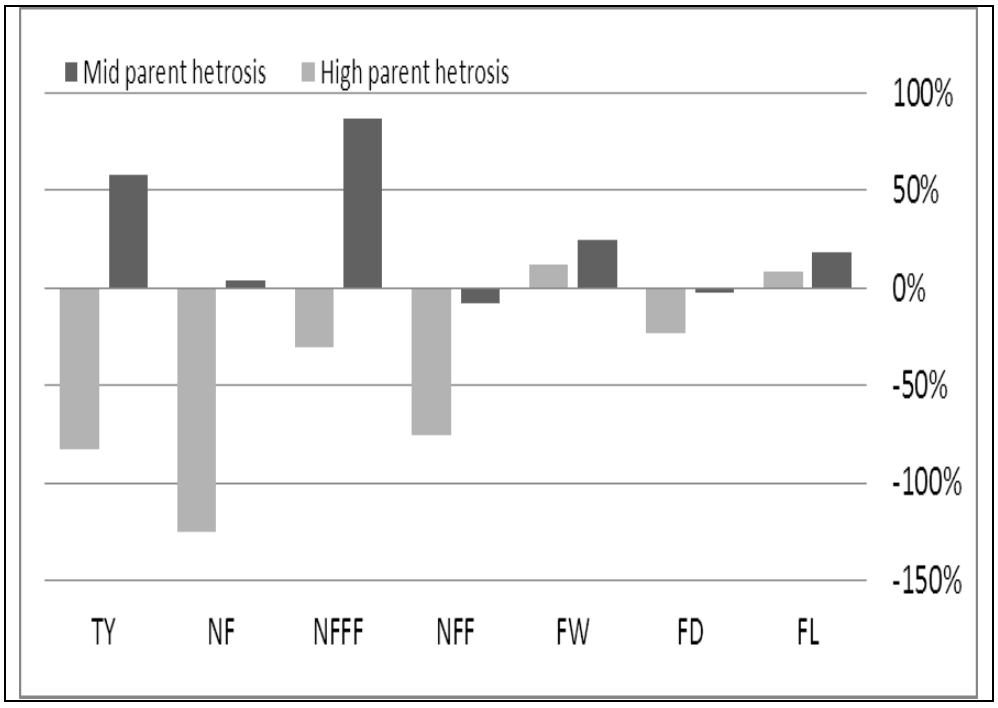

Fig. 3. Mid and high parent heterosis in each cucumber generation and hybrids.

FL: fruit length, FD: fruit diameter, FW: fruit weight, NFF: number of female flowers per node, NFFF: node of the first female flower, NF: number of fruits/plant and TY: total yield/plant.

2- Inbreeding depression

Estimates of inbreeding depression (%) for all studied characters are presented in Table (10) and Fig. (4). The inbreeding depression observed in the cross P_1 x P_5 was positive for fruit length (2.6%), fruit diameter (0.2%), number of female flowers per node (2%) and number of fruits/plant (10.5%), on the other hand, it is negative for fruit weight (-0.7%), node of the first female flower (-0.4%) and total yield/plant (-0.3%). The negative or low positive inbreeding depression was indicates the presence of vigor in F_2. Similar results were obtained by Singh *et al* (2017), Yadagiri *et al* (2017), Wakle (2017) and Tyagi *et al* (2018).

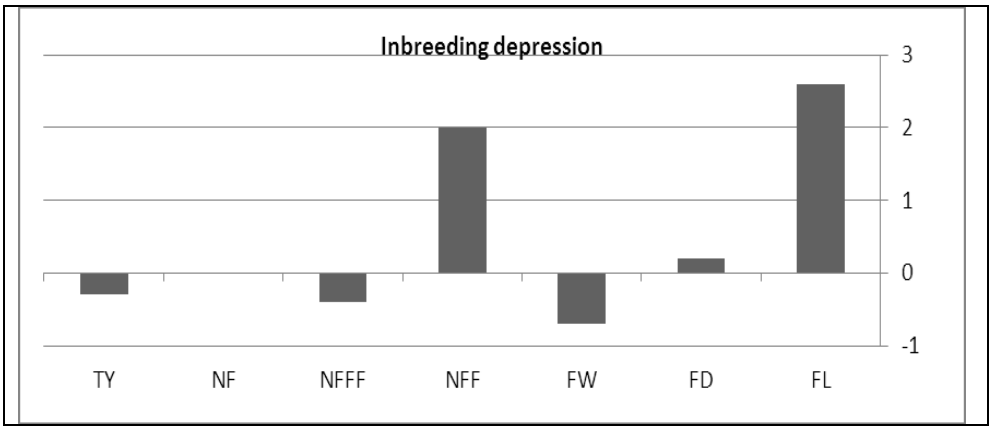

Fig. 4. Inbreeding depression of characters in each cucumber generation and hybrid.

FL: fruit length, FD: fruit diameter, FW: fruit weight, NFF: number of female flowers per node, NFFF: node of the first female flower, NF: number of fruits/plant and TY: total yield/plant.

3- Heritability (Narrow and broad sense heritability)

Estimate of inbreeding depression is presented in. Heritability is a good index of the transmission of characters from parents to their offspring. High estimates of narrow heritability (Table 10 and Fig 5) were observed in the cross P_1 x P_5, it was a high values for fruit length (88%), fruit diameter (91%), fruit weight 72%), number of fruits/plant (89%), and total yield/plant (88%). but it was moderately for number of female flowers per node (27%) and node of the first female flower (39%). On the other hand, High estimates of broad sense heritability were observed for all characters, fruit length (94%), fruit diameter (96%), fruit weight (91%), number of female flowers per node (98%), node of the first female flower (76%) number of fruits/plant (97%), and total yield/plant (94%). The high value of BSH indicates that this character is mainly controlled by genetic constituent additive and non-additive and environment play a minor role, and closer value with NSH enables the breeder to practice a successful selection to this characters. Similar result were reported by Singh *et al*(2017), Yadagiri *et al* (2017), Wakle (2017), Kamer *et al* (2015) and Tyagi *et al* (2018).

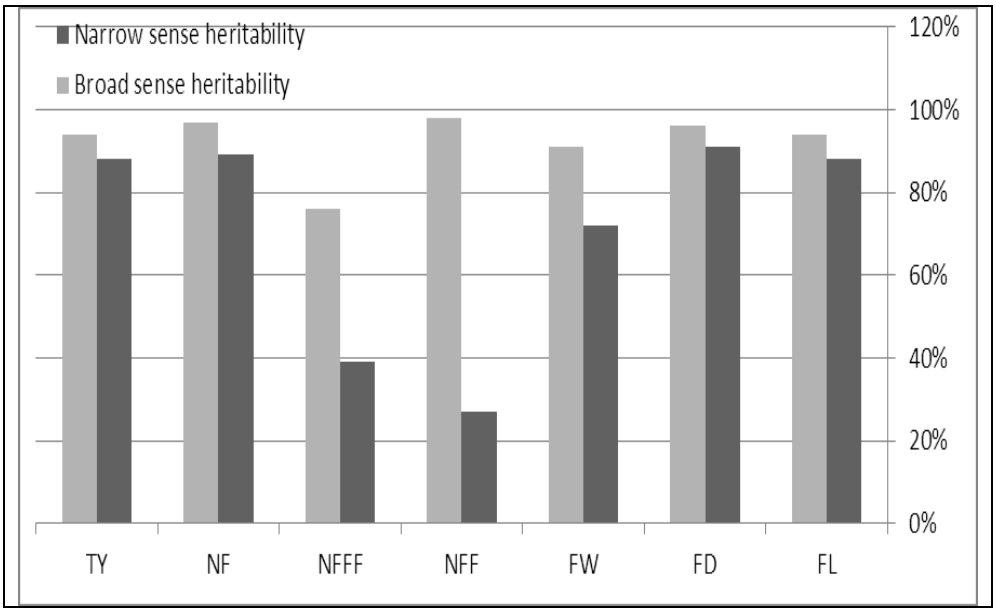

Fig. 5. Narrow and broad sense heritability of characters in each cucumber generation and hybrids.

FL: fruit length, FD: fruit diameter, FW: fruit weight, NFF: number of female flowers per node, NFFF: node of the first female flower, NF: number of fruits/plant and TY: total yield/plant.

4- Number of genes controlling studied traits

Estimate of number of genes controlling studied traits is presented in Table (10) and Fig (6). Concerning number of effective factors, most characters was found to be controlled by 1-2 pairs (or group) of genes namely fruit length (one), fruit diameter (two), number of female flowers per node (two), number of fruits/plant (one) and total yield/plant (one). But, for fruit weight and node of the first female flower traits were found to be controlled by additive genes; (4) and (9), respectively. Gangadhara *et al* (2019) reported that high genetic advance as percent mean was observed for node position of first female flower, fruit weight, number fruits and fruit yield per plant, indicating that these characters are controlled by additive gene action.

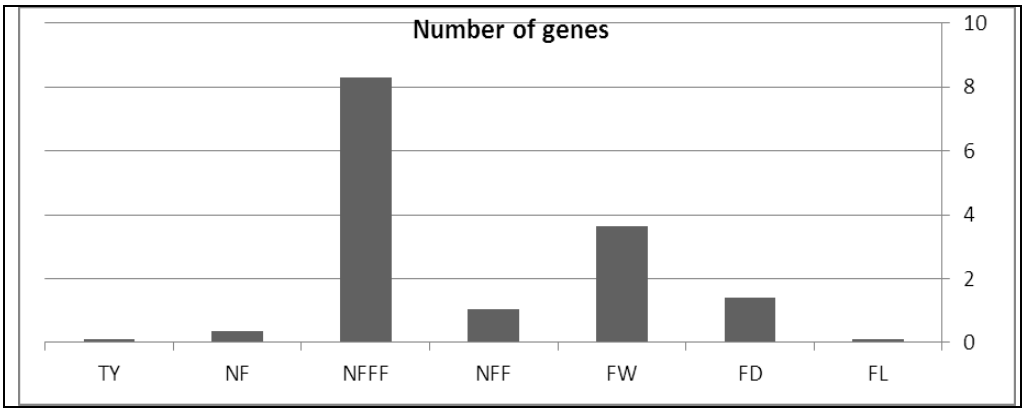

Fig. 6. Number of genes of characters in each cucumber generation and hybrids.

FL: fruit length, FD: fruit diameter, FW: fruit weight, NFF: number of female flowers per node, NFFF: node of the first female flower, NF: number of fruits/plant and TY: total yield/plant.

REFERENCES

Allard, R.W. (1999). Principles of Plant Breeding. John Wiley & Sons, Inc. 473p.

Castle, W.E., S. Wright (1921). An improved method of estimating the number of genetic factors concerned in cases of blending inheritance. Science. 54: 223. Cited by Lobo *et al* 1987.

Cramer, C.S. and T.C. Wehner (1998). Stand correction methods for cucumber fruit yield. Cucurbit Genet Coop 21: 18–20.

De Ponti, O. M. B. (1976). Breeding parthenocarpic pickling Cucumbers (*Cucumis sativus* L.): necessity, genetical possibilities, environmental influences and selection criteria. Euphytica 25, 29-40.

Dhumal, T.L., V.S. Jagtap, T.S. nKale, and V.D. Padekar (2019). Studies on Heterosis, Inbreeding depression and Heritability in Ridge Gourd (*Luffa acutangula* L.). Int. J. Pure App. Biosci. 7(2): 503-508.

Gangadhara, K., Raj Kumar, R. Selvakumar, V.V. Apparao and L.P. Yadav (2019). Evaluation of Cucumber Hybrids/Lines for Yield and Quality under Polyhouse Int.J. Curr. Microbiol. App.Sci (2019) 8(6): 1652-1661

Hanchinamani, CN and M.G. Patil (2009). Heterosis in cuvumber (*Cucumis sativus* L.). Asian Journal of Horticulture, 4(1), 21-24.

Kamer, A., M. E. Mona, M. Yousry and A. M. E. Gamal (2015). Heterosis and Heritability Studies for Fruit Characters and Yield in Melon (*Cucumis melo*, L.). Middle East J. of App. Sci. 5(1): 262-273

Kumar, S, R. Kumar, D. Kumar, N. Gautam, R.K. Dogra and D.K.Mehta (2016). Parthenocarpic gynoecious parental lines of cucumber introduced from Netherlands for developing high-yielding, quality hybrids. J. Crop Improvement. 30: 352-369.

Maleknia, B., Y. Fathipour and M. Soufbaf (2016). How greenhouse cucumber cultivars affect population growth and two-sex life table parameters of *Tetranychus urticae* (Acari: Tetranychidae) Intl. J. Acarol. 42, 70-78.

Mihov, A. and M. Alexandrova (1975). Results of competition in new varsities pickling cucumber. Horticulture No5: 25-28.

Melisa, F. C. and T. C. Wehner (2006). Cucumber Crop Information Choosing a Patio Cucumber. http:// cuke.hort.ncsu.edu /cucurbit /wehner/ 601 / hsposter1. ppt

Mousavizadeh1, K. Mashayekhi1, A. Daraei Garmakhany, A. Ehteshamnia and S. M. Jafari (2010). Evaluation of Some Physical Properties of Cucumber (*Cucumis sativus* L.) S. J. Journal of Agricultural Science and Technology, Volume 4, No.4.

Ranjan, K.N., A.B. Rai and M. Rai (2008). Export of cucumber and gherkin from India: performance, destinations, competitiveness, and determinants. Agric Econ Res Rev. 21:130–8.

Sinha, S.K., and R. Khanna (1975). Physiological, biochemical, and genetic basis of heterosis. Adv. Agron. 27:123–174.

Singh, V., D. K. Rana and K. N. Shah (2017). Genetic variability, heritability and genetic advance in some strains of bitter gourd (*Momordica charantia* L.) under subtropical conditions of Garhwal Himalaya. Plant Archives 17(1): 564-568.

Staub, J. E., M. D. Robbins, T.C. Wehner Cucumber (2008). In: Prohens J, Nuez F, editors. Handbook of plant breeding; Vegetables I: asteraceae, brassicaceae, chenopodiaceae, and cucurbitaceae. New York: Springer; p. 241–82.

Steel, R. G. D., and J. H. Torrie (1960). Principles and Procedures of Statistics with Special Reference to the Biological Sciences. Mc Graw Hill Book Company. Inc. New york.

Tyagi, N., V.B. Singh, and P. K. Maurya (2018). Studies on genetic variability, heritability and genetic advance in Bitter gourd (*Momordica charantia* L.) for yield and yield contributing traits. Int. J. Curr. Microbiol. App. Sci. 7(3): 1788-1794.

Velkov, N. and M. Alexandrova (2010). Study of new F_1 pickling cucumber hybrids, yield and yield components. Genetics, Plant Breeding and Seed Production 45, 5: 519 – 523.

Veena, R., Amrik Singh Sidhu, M. Pitchaimuthu and K. Souravi (2012). Genetic evaluation of Cucumber [*Cucumis sativus* L.] genotypes for some yield and related traits. Electronic Journal of Plant Breeding, 3(3): 945-948.

Wakle, D. G. (2017). Studies on heterosis and combining ability in ridge gourd (*Luffa acutungula* L.). M.Sc. Thesis, submitted to Department of Horticulture, VNMKV Parbhani - 431 402 (M.S.), India

Wenjing, G., T. M. Elizabeth, A. Bronwyn, Z. Julie, S. E. Daniel, and L. I. Laura (2019). Parthenocarpic Cucumber Cultivar Evaluation in High-tunnel Production. American Society of Horticultural Sscience Volume 29: Issue 5, P 634–642.

Wilde, W. J. J. O and B. E. E. Duyfjes (2010). *Cucumis sativus* L. forma hardwickii (Royle). Thai For. Bull. (BOT) 38: 98–107.

Yadagiri, J., N. K. Gupta, D. Tembhire and S. Verma (2017). Genetic variability, heritability and morphological characterization in bitter gourd (*Momordica charantia* L.). Int. J. Pure App. Biosci. 5(4): 1322-1327.

تربية وانتاج سلالات مرباة داخليا وهجن جيل اول جديدة من خيار التخليل

أيمن محمد عبد ربه و نهلة احمد المغاوري

قسم تربية الخضر- معهد بحوث البساتين- مركز البحوث الزراعية- الدقى – جمهورية مصر العربية

يعتبر خيار التخليل من محاصيل الخضر الهامة في مصر و التي تعاني من قلة الاهتمام ، و يرجع ذلك لندرة الهجن ذات الصفات التجارية الجيدة والإنتاجية العالية. ويعتبر زيادة الإنتاجية من الاهداف الهامة لتربية النبات باستخدام مصادر متنوعة. لذلك كانت أهداف هذه الدراسة الحصول على تراكيب وراثية ذات خصائص و قيم عالية لبعض مكونات محصول الخيار. أجريت التجربة الحالية في ثلاث مواقع مختلفة (مزرعة بحوث الخضر بقها ووادي النطرون والإسماعيلية) خلال الفترة 2016-2020 باستخدام 6 سلالات من الخيار تم الحصول عليها من بنكي الجينات بهولندا والسويدي و تربيتهم ذاتيا بغرض تنقيتهم لمدة 6 اجيال متتالية وهي (CGN-18 و CGN-8 و CGN-16 و CGN-11 و NGB-15 و CGN-21 و NGB)، تم التهجين النصف الدائري فيما بينهم لإنتاج 15 هجين. تم تقييم 6 آباء و 15 هجين و 2 هجين تجاري (ليفينا F_1 وماجداللينا) لصفات طول الثمرة وقطر الثمرة ووزن الثمرة وعدد الأزهار المؤنثة في كل عقدة و اول عقدة لظهور اول زهرة مؤنثة وعدد الثمار/ نبات و المحصول الكلي/نبات. تم تقدير قوة الهجين ، كفاءة التوريث وعدد الجينات المتحكمة في الصفات تحت الدراسة. أظهرت النتائج في الهجين P_1 x P_5 أن معظم قيم قوة الهجين لمتوسط الاب للصفات المدروسة كانت موجبة وأن معظم قيم قوة الهجين للاب الاعلي للصفات المدروسة كانت سلبية. لوحظت تقديرات عالية للتوريث بالمعنى الضيق والواسع في الهجين P_1 x P_5 ، لكنها كانت معتدلة بالنسبة لعدد الأزهار المؤنثة لكل عقدة و اول عقدة لظهور اول زهرة مؤنثة. وجد أن معظم الصفات يتحكم فيها 1-2 زوج من الجينات ، وكان وزن الثمرة اول عقدة لظهور اول زهرة مؤنثة يتم التحكم فيهما بواسطة الجينات المضافة (4) (9) على التوالي.

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