J. of Agricultural Chemistry and Biotechnology, Mansoura Univ., Vol. 10 (12):249-255, 2019

Journal of Agricultural Chemistry and Biotechnology

Journal homepage: www.jacb.mans.edu.eg
Available online at: www. jacb.journals.ekb.eg

Estimation of Genetic Parameters Controlling Inheritance of Quantitative Traits in Cucumber (*Cucumis sativus*, L.).

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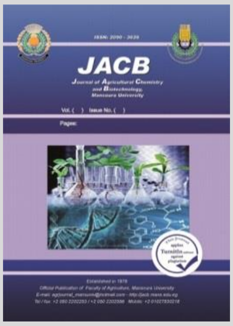

ABSTRACT

The purpose of this investigation was to examination the genetic potential of a set of five genotypes and their 10 F_1 hybrids combinations through estimation their genetic parameters controlling inheritance of important economical characters in cucumber. A half diallel mating design was applied using five lines of cucumber. The parental lines demonstrated wide range of diversity regarding studied traits which appeared from the significant differences that found for the studied traits. Analysis for combining ability indicated that GCA and SCA variances were largely significant, indicating that both additive and dominance gene action included in the manifestation of all studied traits. The results reported that the good general combiner parent that showed to have the significant positive magnitudes of GCA effects was reported to be parental line "99-340"(P_3) and parental line "99 -357" (P_4) for ennobled studied traits. Furthermore, the highest SCA magnitudes were obtained by the following combinations; P_2 x P_3; P_2 x P_4 and P_3 x P_4 for early yield / fed., average fruit weight (g), number of fruits / plant and total yield / fed (ton) traits, which are the best and promising F_1 hybrids. The large heritability indicates few effect of the environment of the studied traits. Broad sense heritability percentage ranged from 88.24 to 99.84 % for fruit diameter and average fruit weight, while narrow sense heritability percentage ranged from 8.73 to 92.56 % for number of fruits / plant and plant length. According to current results, it's could recommended that the integration of these parental lines in genetic enhancement cucumber programs directing to increase yield and improve other interested traits.

Keywords: Cucumber – combining ability – additive - dominance – heritability – yield.

INTRODUCTION

Cucumber (*Cucumis sativus,* L.) is a remarkable member of the *Cucurbitaceae* Family, with a chromosome number 2n = 14. Lower *et al.* (1982) elucidate that cucumber is well celebrated for its frugal sizable as food vegetable, mainly grown to its edible bestowal fruits used as salad, pickles, it is a great vegetable for the peoples. So, it has became assimilate to screen crop germplasm to segregate possibility combining lines and suitable crosses either to utilize hybrid vigour or to obtain new combinations. In order to answer this higher demand for food by the expanding population, high yield important to vegetable breeders can be achieved by improving cultural practices and by developing genetically improved lines (Achu *et al.,* 2006).

Expression of several plant traits are controlled by environmental and genetic factors. Hence, the study of genetic measurements is essential for a successful breeding programme which will provide worthy data on the mode of inheritance of many traits which would be helpful in selecting plants having suitable traits to develop new hybrids. In a breeding programme, knowing of association among yield and its component is necessary. So, estimation of correlation among traits is a matter of considerable importance in selection program.

The breeding protocol and electing of high yielding lines are the basic of any breeding program for development of superior parents or hybrids. Ene *et al.* (2019) illustrated that the true choice of superior lines for crosses and the nature of gene effect included in expression of quantitative traits is important and crucial for effective expansion of vegetable varieties. Hayman, (1954) and Griffing's (1956) elucidate a superior mean of obtaining results on magnitude and direction of dominance, over-dominance and gene action.

Comprehension of the different gene actions that controls the inheritance of some important quantitative traits can help vegetable breeders to select desirable lines and devise an appropriate breeding starting. (Hayman, 1958; Griffing's, 1956 illustrated that the diallel analysis of cross pollinated plants is used to investigate the genetic govern of quantitative characters and to estimate general combining ability and specific combining. The superiorities of a breeding programme of cucumber depend on the available genetic diversity in most of the horticultural traits in its germplasm (Ene *et al.,* 2016_b).

Knowledge on the related importance of general and specific combing abilities is of the major magnitudes in the breeding programme for the species which are modifiable to the development of hybrids, as cucumber. However, when a particular parental line commutates a large evaluate of general combing ability, it means that it's a best combiner parent. While, a large specific combining ability of a particular recombination, it means that the lines of the hybrid can be combine well to introduce a cross with an excellent common performance. Analysis of combining ability effects in cucumber has been measured by several authors; in cucumber, Madhu, 2010; Mule *et al.,* 2011; Sarker and Sirohi 2011; Golabadi *et al.,* 2015; Jat *et al.,* 2016; Ene *et al.,* 2019 and Laxuman *et al.* (2012) in bitter gourd. On cucumber (Pal *et al.,* 2016; Jat *et al.,* 2017), on

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DOI: 10.21608/jacb.2019.71147

snake cucumber, Abd El-Salam *et al.* (2010); Abo Kamar *et al.* (2015) on melon; Koffi *et al.* (2016) on watermelon, they found that the heritability, magnitude of genotypic and phenotypic variation and combining abilities of genotypes are important for success of breeding programs, indicate the value of improvement transacts through selection and give the data helps improvement and developing productive hybrids. Generally, the additive gene action represents the great component of the all genetic variance; general combining ability parameter would be expected in a selection programme, while, F_1 hybrid breeding programme may be the agreeing choice if the dominance genetic variance is the major component.

(Pragya *et al.*, 2015; Soliman, 2015 and Ratnakar *et al.*, 2018) reported that the heritability in narrow sense was low to productivity traits and lower than their corresponding magnitudes in broad sense heritability for the same studied traits. Determination of general and specific combining abilities effects; the efficiency of genotype to produce excellent progeny upon heterosis with other genotypes, is important for selection of lines for breeding programme. Hence, the study involving 5× 5 diallel analysis aimed to study the combining abilities effects, gene action and heritability percentage in narrow and broad senses for different quantitative studied traits in cucumber (*Cucumis sativus*, L.).

MATERIALS AND METHODS

The study was carried out during three seasons of 2015, 2016 and 2017, respectively at Kaha Research Farm, Horticultural Research Institute, (HRI), Agriculture Research Center (ARC) in the Kalyobiya Governorate, Egypt. This study aimed to evaluation of genetic parameters controlling inheritance of quantitative traits in cucumber (*Cucumis sativus*, L.).

The genotypes used in this investigation were five parental lines of cucumber (*Cucumis sativus*, L.), named, Line 1380-1 (P_1); Line 87- 674-1(P_2); Line 99-340 (P_3); Line 99-357 (P_4) and (Line 99-347) (P_5), obtained from Cornell University. The five parental lines were sown at the first of February 2015 and self-pollinated in the green house to obtain sufficient quantity seeds from every parental line. In the season of 2016, the parental lines crossed according to 5 x 5 half diallel mating design (excluding reciprocals) to obtain 10 F_1 combinations. In the growing season of 2017, all genotypes (the five parental lines and their F_1 hybrids) under this study were grown and evaluated in a randomized complete blocks design (RCBD) with three replicates under field condition. Every plot included one ridge of 5 meter length and 2 meter width with experimental plot unity of 10 meter. The distances among plants were 0.50 meter. Recommended cultural operations, fertilization, irrigation and plant protection measured were followed to obtained healthy crop.

Data recorded:

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

Genetically analysis:

Combining abilities variances and their effects were evaluated by Griffing (1956) Method 2 (Model 1). The significance for GCA effect (g_i) and SCA effect (s_{ij}) were tested by Cochran and Cox (1950).

The GCA effect (g_i) and SCA effect (s_{ij}) are defined:-

$$\text{GCA effect } (g_i) = 1/ n+2 \{\Sigma (Y_{i.} + Y_{ii}) -2 / n\, Y_{..}\}.$$

$$\text{SCA effect } (s_{ij}) = Y_{ij} - 1 / n+2 \{Y_{i.} + Y_{ii} + Y_{.j} + Y_{jj}\} + 2 / (n+1)(n+2)\, Y_{..}$$

$$\text{SE GCA } (g_i - g_j) = \sqrt{(2 / (n+2)}$$

$$\text{SE SCA } (s_{ij}) = \sqrt{n (n - 1) / (n + 1) (n + 2)}$$

Additive ($\sigma^2 A$) and non-additive ($\sigma^2 D$) calculated by Matzinger and Kempthorne (1956) as follows: $\sigma^2 A = 2\sigma^2 g$ $\sigma^2 D = \sigma^2 s$.

Narrow sense ($h^2_{n.s}$ %) and broad sense ($h^2_{b.s}$ %) heritability for whole the genotypes used for the present investigation were estimated from the genetic components according to the following equations proposed by Mather and Jinks (1971).

$$h^2_{b.s}\% = \{2\sigma^2 g + \sigma^2 s / 2\sigma^2 g + \sigma^2 s + \sigma^2 e\} \times 100$$

$$h^2_{n.s}\% = \{2\sigma^2 g / 2\sigma^2 g + \sigma^2 s + \sigma^2 e\} \times 100$$

Where: $\sigma^2 gca = \{Mg - Ms\}$ $\sigma^2 sca = Ms - Me$ $\sigma^2 e = Me.$

RESULTS AND DISCUSSION

The analysis of variance:-

Mean squares of all genotypes for studied traits plant length (cm), number of leaves / plant, days to anthesis first female flower (days), fruit length(cm), fruit diameter (cm), fruit shape index (cm), early yield / feddan (ton), average fruit weight (g), number of fruits / plant and total yield / feddan (ton) are listed in Table 1 and were appeared highly significant. These results are reflected the presence of true differences between all genotypes (parents and 10 F_1 hybrids). The significance of mean squares of parental lines and their F_1 hybrids proposed that the planned comparators to discernment the kind of diversity and determinate the values of genetic parameters for all studied characters of the present study.

Table 1. The analysis of variance and mean squares for all studied traits of cucumber.

Traits Para.	df	P. L. (cm)	No. L. /P.	D. F. F. F.	F. L. (cm)	F. D. (cm)	F. Sh. I. (cm)	E.Y. /fed. (ton)	A. F. W. (g)	No. F./ P	T.Y. /fed. (ton)
Replicates	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

P.L.: plant length, No. L. / P.: number of leaves / plant, D.F.F.F.: days to anthesis first female flower, F.L.: fruit length, F.D.: fruit diameter, F. Sh. I.: fruit shape index, E.Y/fed.: early yield / feddan, A.F.W.: average fruit weight, No. F. /P.: number of fruits / plant and T.Y. /fed.: total yield / feddan. **: significant at 0.01 level of probability.

Analysis of combining ability:-

Combining ability is useful in prediction of genetic capableness of parents and F_1 hybrids. Analysis of variance for combining abilities listed in Table 2. Analysis of variance for general and specific combining ability of traits for all genotypes revealed highly significant for GCA variance in all studied traits under this study. Also, the results showed highly significant for specific combining ability variance was noticed in all studied traits. Highly significant for mean squares of general and specific combining ability reported in all the studied traits, propose the great role of additive ($\sigma^2 A$) and dominance genetic variances ($\sigma^2 D$) of heritable variance and which are accountable for diversity noticed in the studied traits.

However, the results revealed that the general combining ability variance was larger in value than the specific combining ability variance for all studied traits excluding number of fruits / plant trait. These means play the major part of additive and additive by additive types of gene effect are involving in governing these traits. Evaluation of ratio GCA ÷ SCA is greater than unity for all studied traits under this study excluding number of fruits per plant, revealing the predominance of non additive gene effect in the inheritance of this trait. The result was in accordance to the record of Ene *et al.* (2019) that estimated varying ratios, larger and lesser than unity in F. L.(cm); F. D. (cm); F. Sh. I (cm); A. F. W. (g); No. F. /feddan and T. / Y. / feddan (ton).

The specific combining ability (SCA) reveals the good F_1 hybrid between all genotypes which can be beneficial for developing crosses with great heterosis for the studied traits. The GCA variance (σ^2g) was lesser than the SCA variance (σ^2s) for all studied traits. These results were found to agree with those reported by Golabadi *et al.* (2015); Ene *et al.* (2016$_b$); Jat *et al.* (2016) and Ene *et al.* (2019) on cucumber. However, Ene *et al.* (2019) reported that a great role for (σ^2g) in F. L. (cm) and F. D. (cm) between all studied characters, adverting that additive genes had higher influence on the genetic control of these traits. The low magnitude of ratio σ^2g / σ^2s was reported for all studied traits other than days to (D. F. F. F. day) trait. Many researchers suggested that improvement of these traits could be exploited to explore heterosis with recurrent selection. Furthermore, in cucumber, Lopez-Sese and Staub (2002) and Anuradha (2014) reported that association of additive and dominance variances of heritable variance for fruit length(cm), fruit diameter(cm), early yield / feddan(ton), number of fruits / plant and total yield / feddan(ton). These traits showed significant variances for specific combining ability had been proposed to be improved over heterosis which indicates the predominance of dominance gene effects, nevertheless general combining ability has been inspirer of selection as the good improvement planning. These results agreed with Singh *et al.* (2013).

Table 2. The analysis of general and specific combining ability and mean squares of F_1 hybrids for studied traits of cucumber.

Traits Parameters	df	P.L (cm)	No. L/P	D.F.F.F	F.L (cm)	F.D (cm)	F.Sh. I (cm)	E.Y./F (ton)	A.F.W (g)	No. F./ P	T.Y./F. (ton)
GCA	4	48.84**	15.10**	7.88**	4.78**	0.07**	0.72**	1.21**	157.36**	177.71**	5.74**
SCA	10	41.86**	2.02**	1.02**	0.88**	0.04**	0.39**	0.79**	91.21**	249.62**	3.40**
GCA/SCA		1.17	7.48	7.73	5.43	1.75	1.85	1.53	1.73	0.71	1.69
Error	28	0.29	0.15	0.10	0.01	0.01	0.02	0.01	0.18	1.72	0.01
components											
σ^2g		1.00	1.87	0.98	0.56	0.01	0.05	0.06	9.45	10.028	0.26
σ^2s		41.58	1.88	0.92	0.87	0.04	0.38	0.79	90.04	247.90	3.93
σ^2g / σ^2s		0.02	0.99	1.07	0.64	0.25	0.13	0.08	0.10	0.05	0.07

P. L.: plant length, No. L. / P.: number of leaves / plant, D. F. F. F.: days to anthesis first female flower, F. L.: fruit length, F. D.: fruit diameter, F. Sh. I.: fruit shape index, E.Y/fed.: early yield / feddan, A. F. W.: average fruit weight, No. F. /P.: number of fruits / plant and T.Y. /fed.: total yield / feddan. **: significant at 0.01 level of probability.

General combining ability (GCA) effects (g_i):-

Estimated of general combining ability (GCA) effects (g_i) of five lines for all traits are listed in Table 3. revealed that there were a good general combiner parent that express to have the positive and negative significant of general combining ability effects on different traits of cucumber. As for as GCA effects (g_i) for plant length the parental line "99- 347" (P_5) exhibited significant negative (-2.79 ± 0.39) followed by parental line "87- 674 - 1" (P_2) (-0.79 ± 0.39), the results showed that the parental line "99-340" (P_3) and parental line "99 – 357 "(P_4) had the greatest values of GCA effects (3.54 ± 0.39 and 1.71 ± 0.39, respectively). Number of leaves / plant, the line "99-357" (P_4) expressed its superiority with GCA value of (0.86 ± 0.15) followed by parental line "99-340" (P_3) (0.81 ± 0.15). As regarded days to anthesis first female flower, the line "99 - 347" (P_5) recorded higher magnitude of GCA (4.34 ± 0.11) followed by parental line "99-340" (P_3) (4.43 ± 0.11).

In the same time, parental line "99-340" (P_3) gave the higher magnitude of GCA (1.05 ± 0.03) followed by parental line "87 - 674 - 1" (P_2) (0.56 ± 0.03) for fruit length (cm) trait. While, parental line "99 - 357"(P_4) exhibited higher magnitude of GCA for fruit diameter (cm) trait (0.45 ± 0.02). Parental line "99-340" (P_3) was the good general combiner line that express to have the significant largest positive magnitude of GCA effects (0.51 ± 0.05), (0.48 ± 0.04), (6.64 ± 0.14) and (1.10 ± 0.04) for the fruit shape index (cm), early yield / feddan (ton), average fruit weight(g) and total yield / feddan(ton) traits, respectively. Parental line "99 – 357 " (P_4) was the top with (60.14 ±0.44) general combining ability (GCA) effects (g_i) value among the five parental lines for number of fruits / plant trait followed by line "99-340" (P_3) were exhibited high and significant positive value (59.74 ± 0.44), parental line "87 - 674 -1" (P_2) (56.16 ± 0.44) and parental line " 86 - 1380 -1" (P_1) (54.69 ± 0.44) for the same trait, while the parental line "99 - 347" (P_5) was the lowest GCA effect (47.62 ± 0.44). Since the parental lines "99-340" (P_3) and "99 – 357" (P_4) had large of general combining ability effects (g_i) and yield components traits; they could be utilized to breeding large of total yield in cucumber.

On melon, Shamel, (2013) reported that non the parent was the best general combiner for all studied traits, the great of GCA effects (g_i) were attributed to additive gene effects or additive by additive interaction. The results reported that combining ability evaluates can be utilized to chosen the lines to be included in F_1 hybrid to foretelling the good hybrids. In general, the results reported that the parents with best general combining ability don't needs introduce excellent hybrid with good specific combining ability in all F_1 hybrids. Results are in accordance to Golabadi *et al.*, 2015; Soliman, 2015; Ene *et al.*, 2019) on cucumber and Laxuman *et al.* (2012) on bitter gourd.

Table 3. General combining ability (GCA) effects (g_i) on the all studied traits of five parental lines of cucumber.

Traits / Parents	P. L. (cm)	No. L. / P.	D.F.F.F.	F. L. (cm)	F. D. (cm)	F. Sh. I. (cm)	E.Y. /fed. (ton)	A. F.W. (g)	No. F. / P.	T.Y. /fed. (ton)
P_1	- 0.29	-0.09	5.05^{**}	$- 0.08^{*}$	0.06^{*}	$- 0.15^{**}$	- 0.03	1.71^{**}	54.69^{**}	0.25^{**}
P_2	- 0.74	-0.43^{**}	5.72^{**}	0.56^{**}	0.06^{*}	0.12^{*}	$- 0.12^{**}$	-1.85^{**}	56.16^{**}	-0.57^{**}
P_3	3.54^{**}	0.81^{**}	4.43^{**}	1.05^{**}	$- 0.54^{**}$	0.51^{**}	0.48^{**}	6.64^{**}	59.74^{**}	1.10^{**}
P_4	1.71^{**}	0.86^{**}	6.20^{**}	$- 0.47^{**}$	0.45^{**}	$- 0.23^{**}$	0.28^{**}	-0.20	60.14^{**}	0.47^{**}
P_5	$- 2.79^{**}$	-1.15^{**}	4.34^{**}	$- 1.06^{**}$	$- 0.10^{**}$	$- 0.26^{**}$	$- 0.62^{**}$	-6.30^{**}	47.62^{**}	-1.23^{**}
SE(gi)	0.39	0.15	0.11	0.03	0.02	0.05	0.04	0.14	0.44	0.04
SE(gi – gj)	0.62	0.21	0.17	0.05	0.03	0.07	0.06	0.22	0.70	0.06

P. L.: plant length, No. L. / P.: number of leaves / plant, D. F. F. F.: days to anthesis first female flower, F. L.: fruit length, F. D.: fruit diameter, F. Sh. I.: fruit shape index, E.Y/fed.: early yield / feddan, A. F.W.: average fruit weight, No. F. / P.: number of fruits / plant and T. Y. / fed.: total yield / feddan. *, **: significant at 0.05 and 0.01 levels of probability, respectively.

Specific combining ability (SCA) effects (*Sij*):-

Estimation of SCA effects (*Sij*) on the crosses in ten F_1 hybrids revealed that there were a best number of hybrids exhibited significant negative and positive of specific combining ability effects (*Sij*) on different characters in cucumber. Data in Table 4 exhibited that the desirable F_1 hybrids and specific combining ability (SCA) effects for studied traits. For plant length F_1 hybrid P_1 x P_2 exhibited significant negative specific combing ability effects (*Sij*) (- 4.42 ± 0.80) followed by the cross P_1 x P_4 (- 3.29 ± 0.80). F_1 hybrid P_3 x P_4 showed maximum SCA effects (*Sij*) (9.38 ± 0.80) followed by F_1 hybrid P_2 x P_5 (6.37 ± 0.80), P_1 x P_3 (4.87 ± 0.80) and P_3 x P_4 (4.38 ± 0.80). The crosses P_3 x P_4, P_2 x P_5, P_1 X P_4 and F_1 hybrid P_1 x P_3 displayed highly significant effects (5.11 ± 0.27), (2.35 ± 0.27), (2.01 ± 0.27) and (1.73 ± 0.27) respectively for number of leaves / plant. Cross P_3 x P_4 recorded the largest desirable negative significant (- 1.30 ± 0.21) followed by F_1 hybrid P_2 x P_4 (- 0.92 ± 0.21) while, F_1 hybrid P_1 x P_4 and P_2 x P_5 recorded (0.59 ± 0.07) for days to anthesis first female flower trait. The crosses exhibited large SCA effects (*Sij*) can be good used in heterosis breeding (Jat *et al.*, 2017). The F_1 hybrid P_2 x P_4 exhibited significant positive for specific combining ability (SCA) effects (*Sij*) for fruit characteristics such as fruit length, fruit diameter and fruit shape index traits (2.01 ± 0.07, 0.24 ± 0.04 and 1.03 ± 0.09), respectively in F_1 generation. For early yield per feddan, the SCA effects of cross P_3 x P_4 was the largest (1.27 ± 0.07) followed by the cross P_1 x P_4 (1.01 ± 0.07), F_1 hybrid P_2 x P_4 (0.93 ± 0.07) and F_1 hybrid P_3 x P_5 (0.64 ± 0.07). The cross P_3 x P_4 exhibited significant positive SCA effects (10.80 ± 0.29) followed by F_1 hybrid P_2 x P_5 (10.01 ± 0.29), P_1 x P_3 (9.55 ± 0.29) and F_1 hybrid P_1 x P_4 (8.65 ± 0.29) for average fruit weight trait. Five crosses displayed high values and had largely significant SCA magnitudes for number of fruits / plant, the cross P_2 x P_3 (20.94 ± 0.90) had the highest SCA value followed by F_1 hybrid P_1 x P_4 (13.25 ± 0.90), P_3 x P_4 (10.86 ± 0.90), P_2 x P_4 (10.54 ± 0.90) and F_1 hybrid P_3 x P_5 (10.04 ± 0.90). For total yield per feddan, the SCA effect of F_1 hybrid P_3 x P_4 (2.40 ± 0.07) had the most highest as concerned F_1 hybrid P_1 x P_4 (2.14 ± 0.07), P_2 x P_4 (10.04 ± 0.90) and F_1 hybrid P_2 X P_5 (1.55 ± 0.07). In all crosses, the F_1 hybrids P_2 x P_3, P_2 x P_4 and P_3 X P_4 gave great SCA effects (*Sij*) for most of the traits involving total yield / feddan and may be used in utilization of heterosis with relationship to earliness, yield and its component traits.

Therefore, from this study it was found that the best specific combiners for several traits included parents with low X low, high X low and high X high of general combing ability (GCA). Occurrence of low by low combinations hybrids with opportune specific combining ability (SCA) effects (*Sij*) revealed that the lines in such hybrids lack additive genetic variances as comparative to large GCA parents. Results also indicated that, negative and positive SCA effects (*Sij*) showed that parental lines were in the same and opposite heterotic sets, respectively. Such results elucidated generally that both general combining ability (GCA) and specific combining ability (SCA) effects were exhibited to be great contribution factors in cucumber, indicating the major role of additive and dominance genetic variances in the inheritance of these studied traits (Soliman, 2015). Similar findings have been reported by many authors subsequently (Ene *et al.*, 2016a; Jat *et al.*, 2017 on cucumber), Karipcin and Inal (2017) on squash, Moharana *et al.* (2017) on bitter gourd.

Table 4. Specific combining ability effects (SCA) (*Sij*) on the studied traits of ten F_1 hybrids of cucumber.

Traits / Hybrids	P. L. (cm)	No. L. /P.	D. F. F. F.	F. L. (cm)	F. D. (cm)	F. Sh. I. (cm)	E.Y. /fed. (ton)	A. F. W. (g)	No. F. / P.	T.Y. /fed. (ton)
P_1X P_2	$- 4.42^{**}$	$- 1.36^{**}$	1.23^{**}	-0.25^{**}	- 0.08	0.03	-0.92^{**}	3.97^{**}	-24.75^{**}	-2.59^{**}
P_1X P_3	4.78^{**}	1.73^{**}	1.17^{**}	0.52^{**}	- 0.05	0.27^{**}	-0.55^{**}	9.55^{**}	-16.93^{**}	1.17^{**}
P_1X P_4	$- 3.29^{**}$	2.01^{**}	-0.59^{*}	-0.33^{**}	$- 0.19^{**}$	0.14	1.01^{**}	8.65^{**}	13.25^{**}	2.14^{**}
P_1X P_5	$- 1.90^{*}$	-0.99^{**}	-0.25	-1.01^{**}	0.04	-0.40^{**}	-0.15	-3.47^{**}	2.50^{**}	-0.02
P_2X P_3	0.35	0.61^{*}	0.51^{*}	-0.94^{**}	0.11^{*}	-0.61^{**}	0.04	-12.63^{**}	20.94^{**}	0.01
P_2X P_4	4.38^{**}	-0.31	-0.92^{**}	2.01^{**}	0.24^{**}	1.03^{**}	0.93^{**}	7.68^{**}	10.54^{**}	1.84^{**}
P_2X P_5	6.37^{**}	2.35^{**}	-0.59^{*}	-0.27^{**}	$- 0.34^{**}$	0.51^{**}	0.44^{**}	10.01^{**}	1.02	1.55^{**}
P_3X P_4	9.38^{**}	5.11^{**}	-1.30^{**}	0.39^{**}	$- 0.41^{**}$	0.92^{**}	1.27^{**}	10.80^{**}	10.86^{**}	2.40^{**}
P_3X P_5	- 0.43	-0.55^{*}	0.03	0.74^{**}	0.09	0.08	0.64^{**}	-1.61^{**}	10.04^{**}	0.48^{**}
P_4X P_5	1.26	-0.94^{**}	-0.40	0.01	0.25^{**}	-0.43^{**}	-0.54^{**}	-2.00^{**}	-2.46^{**}	-0.11
SE(Sij)	0.80	0.27	0.21	0.07	0.04	0.09	0.07	0.29	0.90	0.07
SE(Sii-Sij)	1.08	0.36	0.29	0.09	0.06	0.12	0.10	0.39	1.00	0.10

P. L.: plant length, No. L. / P.: number of leaves / plant, D. F. F. F.: days to anthesis first female flower, F. L.: fruit length, F. D.: fruit diameter, F. Sh. I.: fruit shape index, E.Y/fed.: early yield / feddan, A. F.W.: average fruit weight, No. F. / P.: number of fruits / plant and T. Y. / fed.: total yield / feddan. *, **: significant at 0.05 and 0.01 levels of probability, respectively.

Types of gene action and heritability percentage:-

The relative values of heritability and genetic parameters for aforementioned traits were recorded and the obtained results are listed in Table 5. Largely significant magnitudes of additive ($\sigma^2 A$) and dominance genetic variance ($\sigma^2 D$) showed the importance of additive and dominance genetic variance for the inheritance of all traits under this study. The results elucidated that, both $\sigma^2 A$ and $\sigma^2 D$ involving dominance genetic variance was participated in the inheritance of these traits. The dominance genetic variance were highly significant and much greater than their corresponding magnitudes of $\sigma^2 A$ for all studied traits expect for number of leaves / plant, days to anthesis first female flower and fruit length. This proposed that non - additive genetic variance ($\sigma^2 D$) played important part in the inheritance of the aforementioned traits and selection would be effective for development of these traits. The environmental variance ($\sigma^2 E$) exhibited significant positive for all the traits indicated sufficient variation due to environment in the expressiveness of these traits.

Kumar *et al.* (2010) reported the overall dominance effects of heterozygous loci were largely significant and governed all traits under the study. The phenotypic variance of a trait is combined of heritable (genotypic variance) and non-heritable (environmental variance) magnitudes, which are correlated as:

Phenotypic variance = (environmental + genotypic) variance.

Genotypic variance was the main contributor to the phenotypic variance (total) to the studied traits. (*D.d*) degree of dominance which was larger than the one for plant length (cm) (4.57), fruit diameter (cm) (2.00), fruit shape index(cm) (1.95), early yield / feddan (ton) (2.57), average fruit weight (2.18), number of fruits / plant (3.47) and total yield / feddan (ton) (2.25). These results reflected the over - dominance gene action in the inheritance of aforementioned traits under this study, exhibiting the major role of non - additive in the genetic control of these traits. While, the degree of dominance were lesser than unity for number of leaves / plant (0.71), days to anthesis first female flower (0.69) and fruit length(cm) (0.88) indicate that the partial dominance and the additive genetic variance played the great role in the inheritance of these traits under this study. These results were reported by Golabadi *et al.,* 2015; Jat *et al.,* 2017 and Ene *et al.,* 2019.

Percentage of Heritability assists to determine the grade of environmental effects on the expressiveness of a phenotypic trait. The heritability percentage magnitudes assist the vegetable breeder to knowing the potential and grade to which the development of a trait is imaginable over selection (Robinson *et al.* (1949). The estimations of heritability percentage in narrow sense ($h^2_{n.s}$ %) and heritability in broad sense ($h^2_{b.s}$ %) for aforementioned studied traits given in Table 5. Heritability in broad sense ($h^2_{b.s}$ %) exhibited that high values in all studied traits.

Concerning heritability percentage, it is likely to mention that broad sense heritability ($h^2_{b.s}$ %) was large and surpassed 90 % for all studied traits expect for fruit diameter trait. The heritability in narrow sense ($h^2_{n.s}$ %) was less for fruit diameter(cm), fruit shape index(cm), early yield / feddan(ton), average fruit weight(g), number of fruits / plant and total yield / feddan(ton) traits but intermediate or relatively for number of leaves / plant , days to anthesis first female flower and fruit length(cm) traits whereas, it was high for plant length trait. Genetic analysis illustrated that the broad sense heritability ($h^2_{b.s}$ %) values were large that indicate the studied traits were affected by the genetic factors. Furthermore, the narrow sense heritability ($h^2_{n.s}$%) values indicate the relative importance of additive gene action in the inheritance of the studied traits. Abd-El-Salam *et al.* (2010); Hanchinamani *et al.* (2011) and Ullah *et al.* (2012) they reported the heritability in broad sense indicates alike or not there is enough genetic diversity in a population, that attests alike or not a population will respond to selection stress in cucumber. The results indicated that the broad sense heritability was larger than their indicates in narrow sense heritability (h^2_{ns} %) for studied traits. These results are in line to (Pragya *et al.,* 2015; Soliman, 2015 and Ratnakar *et al.,* 2018) in cucumber. The high heritability in broad sense showed may be due to the appropriate impacts of the environment and genotypes. Ndukauba *et al.* (2015) illustrated high heritability for presented trait indicates that it is controlled by additive gene actions and consequently purveys the most efficient condition for selection. Heritability in broad sense ranged from 88.24 to 99.84 % for fruit diameter and average fruit weight. This finding is in accordance with Mule *et al.* (2011); Golabadi *et al.* (2015); Ene *et al.* (2016$_b$); Jat *et al.* (2016) and Khan *et al.* (2016). On the other side, the heritability in narrow sense (h^2_{ns} %) showed relative high, intermediate and relatively low percentage, the heritability percentage in narrow sense were reported to be relatively large (92.56 %) for plant length, considered moderately high (64.89 and 65.84 %) for (number of leaves / plant and days to anthesis first female flower, respectively). It was considered medium (55.87 %) for fruit length trait and considered medium for fruit diameter (17.65%), fruit shape index (19.26 %), early yield / feddan (12.94 %), average fruit weight (17.32 %), number of fruits / plant (8.73 %) and total yield/ feddan (11.54 %).(Gerrano *et al.,* 2015) reported that heritability magnitudes which were less than 40 % considered low values, the values among 40 and 59% presumed medium while, the values among 60 and 79% considered moderately large and reported that the values larger than 80% considered very large. The predominance of dominance genetic variances and low magnitudes of heritability percentage in narrow sense was estimated for most the important these traits (Jat *et al.,* 2017).

Table 5. Estimation of genetic parameters and heritability for all studied traits of cucumber.

Traits Parameters	P. L. (cm)	No. L. /P.	D. F. F. F.	F. L. (cm)	F. D. (cm)	F. Sh. I. (cm)	E. Y. /fed. (ton)	A. F. W. (g)	No. F. / P.	T. Y. /fed. (ton)
$\sigma^2 A$	1.99	3.74	1.96	1.12	-.0.01	0.10	0.12	18.90	-20.55	0.52
$\sigma^2 D$	41.58	1.88	0.92	0.87	0.04	0.38	0.79	90.04	247.90	3.93
σ^2_E	1.36	0.15	0.10	0.01	0.01	0.02	0.01	0.18	1.73	0.02
D. d	4.57	0.71	0.69	0.88	2.00	1.95	2.57	2.18	3.47	2.75
h^2_{bs} %	96.99	97.39	96.74	99.50	88.24	96.52	98.79	99.84	99.25	99.75
h^2_{ns} %	92.56	64.89	65.84	55.87	17.65	19.26	12.94	17.32	8.73	11.54

P. L.: plant length, No. L. / P.: number of leaves / plant, D. F. F. F.: days to anthesis first female flower, F. L.: fruit length, F. D.: fruit diameter, F. Sh. I.: fruit shape index, E.Y/fed.: early yield / feddan, A. F.W.: average fruit weight, No. F. / P.: number of fruits / plant and T. Y. / fed.: total yield / feddan. *, **: significant at 0.05 and 0.01 levels of probability, respectively.

CONCLUSION

The results exhibited that sufficient genetic variation was noticed between the parental lines and F_1 hybrids in this study which assists to select the good lines and their desirable hybrids (crosses) for early total yield / feddan contributing traits. The results showed that parental lines "99-340"(P_3) and "99 - 357" (P_4) were best general combiners, in addition, the F_1 hybrids results from hybridization (P_2 x P_3; P_2 x P_4; P_3 x P_4) were the best specific crosses for yield / feddan and related characters and promising crosses. The results illustrated that gene actions is extremely important to cucumber breeder for the selection of lines for crosses. The results exhibited that the importance of additive and non - additive gene action in the inheritance of most traits under this study. High heritability evaluates indicated few effectiveness of the environment of these traits either this just inherited traits controlled by a less great genes or additive gene influence hence, selection of these traits would be more potent in cucumber. However, the heritability in broad sense was larger in magnitudes than their magnitudes the heritability in narrow sense. These parental lines could be utilized as parents in genetic enhancement programme directing to improve vegetative and yield and its component traits on cucumber.

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تقدير الثوابت الوراثية المتحكمة فى وراثة الصفات الكمية فى الخيار.

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أجريت هذة الدراسة لتقدير الثوابت الوراثية والتى تتحكم فى وراثة الصفات الكمية فى الخيار و ذلك عن طريق تقدير القدرة العامة والخاصة على التآلف ، وطبيعة فعل الجين ومعامل التوريث فى المدى الواسع والضيق لبعض الصفات الأقتصادية الهامة فى الخيار وهى طول النبات (سم) و عدد الأوراق / نبات و عدد الأيام حتى تفتح أول زهرة مؤنثة و طول الثمرة (سم) و قطر الثمرة (سم) و دليل شكل الثمرة (سم) و المحصول المبكر / فدان و متوسط وزن الثمرة (جم) وعدد الثمار / نبات و المحصول الكلى / فدان. وقد أستخدمت فى هذة الدراسة خمسة سلالات من الخيار وهى Line 86-1380-1 (P_1); Line 87- 674-1(P_2); Line 99-340 (P_3); Line 99-357 (P_4) and (Line 99-347) (P_5) وقد أجرى التهجين بين هذة السلالات بنظام التهجين النصف دائرى، وذلك باستخدام تصميم قطاعات كاملة العشوائية فى ثلاث مكررات. وقد أشارت النتائج الى :- وجود تباين بين السلالات المستخدمة كآباء لكل الصفات محل الدراسة. وجود أختلافات معنوية عالية لكلاً من تباين القدرة العامة والخاصة على التآلف لكل الصفات محل الدراسة, مما يؤكد على أهمية الفعل الجينى الأضافى والغير أضافى فى وراثة تلك الصفات. أن النسبة المحسوبة بين متوسط مربعات الأنحرافات للقدرة العامة والخاصة على التآلف تؤكد أن الفعل الجينى الأضافى كان يلعب دوراً هاماً عن الفعل الجينى الغير أضافى فى وراثة جميع الصفات ما عدا صفة عدد الثمار / نبات حيث لعب الفعل الجينى الغير أضافى الدور الأكثر أهمية فى وراثة تلك الصفة. أن الأبوين P_3 و P_4 أظهرا تفوقا ايجابياً فى القدرة العامة على التآلف لكثير من الصفات فى حين أظهرت القدرة الخاصة على التآلف تفوق الهجن P_2 X P_3 , P_2 X P_4 , P_3 X P_4 فى معظم الصفات محل الدراسة وهى بذلك تعد هجن مبشرة وواعدة. أن قيم معامل التوريث فى المدى الواسع كانت أكبر من نظيرتها فى المدى الضيق. وارتفاع قيم معامل التوريث فى المدى الواسع تشير إلى التأثيرالقليل من البيئة على هذه الصفات في الخيار. تراوحت قيم معامل التوريث فى المدى الواسع من ٨٨,٢٤٪ إلى ٩٩,٨٤٪ لصفتى قطر الثمرة ومتوسط وزن الثمرة على التوالى ، فى حين تراوحت قيم معامل التوريث فى المدى الضيق من ٨,٧٣ % الى ٩٢,٥٦ % لصفتى عدد الثمار للنبات و وطول النبات. الخلاصة: أنه يمكن استخدام هذه السلالات كآباء في برامج التحسين الوراثي لصفات المحصول وذلك من خلال الأنتخاب فى الأجيال الأنعزالية المتقدمة و التي توجه لتحسين صفات المحصول ومكوناته في الخيار.