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GENETIC STUDIES ON SOME ECONOMIC CHARACTERS IN DIALLEL CROSSES OF CUCUMBER (*Cucumis sativus*, L.).

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ABSTRACT

Four cucumber strains and their six possible F_1' hybrids were used to study the GCA, and SCA and to illustrate their relations to the type of gene action for six traits (Total yield/ plant, early yield / plant, Number of fruits/ plant, average fruit weight, fruit shape and powdery mildew resistance).

The results showed that GCA and SCA contribute significant role for controlling total yield/plant, number of fruits/plant, average fruit weight and shape index Meanwhile, for early yield trait, SCA appeared to have no significant role on controlling this character.

Results of resistance to powdery mildew for the 10 studied genotypes did not differ significantly.

The strain 106 could be used as a good combinor for the studied characters except for the average fruit weight, where the strain 104 showed superiority for GCA.

INTRODUCTION

Cucumber (*cucumis sativus*, L.) is one of the important vegetable crops grown in Egypt. The cultivated area reached 41433 feddan with average of 6.56 tons total yield / feddan. All the mentioned area is cultivated with imported seeds and this cost a lot of money. Introducing of local cucumber hybrids with good fruit quality and resistant to some diseases is of great importance. Selecting inbred lines with high GCA and high SCA for the economic characters is the first step to produce new hybrids suitable for the local environmental conditions.

1- GCA and SCA for yield components:

GCA is a measure of the relative performance of a line in a series of crosses, whereas SCA represents the deviations of particular cross from the average of GCA's of its parents.

Sprague and Tatum (1942) used the term "general combining ability" to designate the average performance of line hybrid combinations. The term "Specific combining ability" was used to designate those cases in which a certain combination do relatively better or more than would be expected in the basis of the average performance of the line involved.

Griffing (1956) restricted his analyses of the F_1families and suggested that their genetic variation could be expressed in terms of two statistical parameters refering to the variances of general and specific combining abilities. He demonstrated that diallel crossing techniques might vary, depending upon whether or not the parental inbreds or the reciprocal F_1 hybrids were included or both. With this as a basis for classification there were four possible experimental methods:

1- Parents and set of F_1,s were included, (all p2 combinations).

2- Parents and one set of F_1,s were included but reciprocal F1,s were not (½P (P+1) combinations).
3- One set of F_1,s and reciprocals were included, but not the parents (P (P-1) combinations).
4- One set of F_1,s but nither parents nor reciprocal F_1,s were included (½P (P-1) combinations). Each of these methods necessitated a different way of analysis.

Matzinger (1961) clarified that the subdivision of the analysis of diallel crosses into variances of GCA (6^2_g) and SCA (6^2_s) requires no genetic assumptions, as the subdivision is purely statistical. The use of the estimates and their interpretation require some genetic assumptions.

Mikhov and Petkova (1971) found that in cucumber wisconsin SMR 18, Pixie and Medel had the best GCA among ten varieties for yield components traits. On the other hand, Wang and Wang (1980) observed in cucumber that GCA and SCA effects were significant for yield. Additive variance was of importance in phenotypic variation. Similarly, Prudek (1986) mentioned that both GCA and SCA were of significant in determining both weight and number of fruits per plant in cucumber. Gharib (1991) revealed that the mean squares of GCA and SCA were significant or highly significant for total yield and number of fruits per plant in cucumber. Moreover, variance of SCA for F_1 crosses was greater than GCA. Darwish (1992) found that GCA and SCA were significant for number of fruits per plant in cucumber.

ELMhdy *et al.* (1992) found that both GCA and SCA were significant for total yield as number and weight of fruits. Therefore, both additive and non-additive gene effects were important in the inheritance of this traits. Although, the non-additive gene effects were more important than the non-additive ones. Awad (1996) mentioned that GCA and SCA effects were highly significant for total number and weight of cucumber hybrids.

2- Fruit characteristics:

Ragab (1984) Reported that the average fruit weight of cucumber was controlled by 2-3 genes and this number of genes was highly affected by environmental conditions. Owens *et al.* (1985) found that GCA and SCA estimates for fruit length and weight were significant among lines of cucumber. Prudek (1986) studied some hybrids of cucumber. He found that GCA was more important but SCA was of no importance with the regard to mean single fruit weight.Gharib (1991) Showed that mean squares for GCA and SCA were significant for fruit weight and fruit shape index. Variances of SCA for F_1 crosses was greater than those GCA in fruit weight and was similar for fruit shape index. Awad (1996) Mentioned that highly significant positive GCA effects were noticed for heavy fruit weight by the line p_4, where the parents, p_2 , p_3 and p_5 showed highly significant negative values for the trait. He added that three F_1 hybrids showed highly significant positive SCA effect values. High GCA effects were related to effective genetic effects or additive x additive interaction effects, while SCA was a result of dominance effects and epistasis (intra - and inter - allelic interaction, Griffing, 1956 and Sprague and Tatum, 1942).

3-Powdery Mildew Resistance :

Imam *et al.* (1975) used Poinsett and Yomaki cvs as sources of resistance. They found that two recessive genes controlled this character.

EL-Doweny *et al.* (1995) found that the three inbred lines namely i.e. 104, 105 and 106 were highly resistant to powdery mildew with a good fruit characters.

The aim of this investigation was to study the GCA and SCA of some cucumber strains for some characteristics related to yield, fruit quality and resistance to powdery mildew, in order to determine which strains could be used as parents for new hybrids suitable for our local conditions.

MATERIALS AND METHODS

Four inbred lines of cucumber (*cucumis sativus*, L.), were used as parental lines in a diallel crosses mating design. These lines namely i.e., 104 105, 106 and 159. All the mentioned lines were highly resistant to powdery mildew with good fruit quality (EL **-**Deweny *et al.* 1995) Seeds from each line were sown in pots (5 cm.) under greenhouse conditions in Vegetable Research Department at Dokki, Giza in summer season of 1996. At the four leaf stage, seedlings were crossed took place using all possible combinations of diallel, giving a total of six crosses as follows:

1-	F_1 104 x 105	2-	F_1 104 x 106
3-	F_1 104 x 159	4-	F_1 105 x 106
5-	F_1 105 x 159	6-	F_1 106 x 159

Crossing technique was done as follows:

Special clips as recommended by Andeweg (1956) were applied in the afternoon to the tips of the floral buds that are expected to open in the following morning: The clipping was done to both staminate and postulate flowers. Hybridization was usually made between 8.0 - 10.0 am. The pollinated flowers were retied with a cotton filament and taged. Fruits reached maturity stage within30-40 days after pollination. Seeds were extracted from fruits cleaned and spread for drying.

Seeds of parents and F_1 hybrids were sown as mentioned in the greenhouse at Dokki in 15th of January, 1997. A complete randomized blocks design with four replication were used. Each experimental plot contained 25 plants. Fruits were harvested three times a week. Data were recorded as follows:

1- Early yield (kg)/ plant.
2- Total yield (kg)/ plant .
3- Number of fruits/ plant.
4- Average fruit weight (gm).
5- Fruit shape index (L/D).

As for powdery mildew resistance, plants were artificially inoculated twice when the first and second leaves have been expanded. Inoculation was prepared by collecting a mixture of infected cucumber leaves obtained from different areas. Suspension of the powdery mildew spores to a concentration of 500.000 spore / ml. was prepared. Preparation was carried out not more than one hour before inoculation. Within 16 days after inoculation reading of reasonable degree of accuracy have been made on powdery mildew resistance. Infected plants were counted and percentage of infection was recorded.

Statistical analysis :

The statistical analyses of recorded data were carried out following the procedure of the used experimental design, complete randomized block design, as illustrated by Snedecor and chochran (1972). The multiple comparisons among the populations means were also followed, using Duncan's Multiple Range Test.

The data of the parental strains and F_1 hybrids were used to study the general and specific combining abilities and to illustrate their relations to the type of gene action involved (Griffing, 1956).

The analysis of variance used for these data in estimating the components of genotype variance are illustrated in Table (1), along with the expected mean squares. The components of the genotypic variances were estimated in the usual fusion.

RESULTS AND DISCUSSION

1- Yield components:

1.1 Total yield

The analysis of variances of total yield per plant (kg.) of the four parental strains and their six possible F_1 hybrids is shown in Table (1). These different 10 genetic populations reflected a highly significant difference due to the significant differences among the parental strains and F_1 crosses. The significant variation of general and specific combining abilities were also found, assuring their importance as contributors to the genetic difference noticed among the compared crosses. This was in agreement with the findings of Wang and Wang (1980) and Prudek (1986) they found that GCA and SCA contribute to determining weight of fruits/ plant.

Gharib (1991) illustrated that variance of SCA for F_1 crosses was greater than GCA variations. EL Mahdy *et al.* (1992) also showed also that both additive and non-additive effects were important in the inheritance of this trait, although the additive gene effects more important than the non-additive ones.

The mean values of the total yield (kg)/ plant for different populations are arranged in Table (2) with the selfed parental progenies shown underlined values in diagonal. The last column of this table showed the means of parental strains in all crosses to constract a basis for comparing the GCA of the strains. The highest total yield was produced by 106 of all the tested parents. The other three parents did not differed significantly from each other.

Concerning the GCA, the line 106 reflected superiority over the three other parents. On the other hand, 105 reflected significant inferiority to all parents. An intermediate GCA was reflected by 104 and 159.

The highest SCA for total yield / plant was reflected by the combination 104 x 106 followed by 106 x 159 without any significant differences. The lowest cross was 104 x 159 followed by 105 x 159 and 104 x 105 without significant differences. In the same time, all the crosses were higher in yield than the highest parent showing the presence of over dominance or heterosis controlling this trait.

1.2 Early yield

The highly significant differences noticed among the genetic populations for early yield / plant (kg) Table (1), appeared to be the results of the differences among crosses. The variances among parents were in significant. It was also noticed that the GCA and the orthogonal components between parents and F_1 hybrids contributed a significant differences to the variances among crosses, whereas the variance of SCA appeared to be insignificant.

Concerning GCA, Table (3) showed that the line 106 reflected superiority mean, while 104 and 159 were intermediate, whereas, 105 showed the lowest GCA significantly.

The highest SCA for early yield / plant was reflected by the cross 104 x 106 and 106 x 159 without any significant differences from the other crosses, but differed significantly from three of the four parents.

1.3 Number of fruits / plant

Concerning number of fruits per plant, the ten different genetic populations reflected significant variance arising from the significant differences among crosses and the orthogonal comparison between crosses and parents, (Table 1). The parents used showed insignificant differences. Meanwhile the GCA and SCA showed highly significant differences. These finding are in agreement with those obtained by Prudek (1986), Gharib (1991) and Darwich (1992). They showed that both "GCA and SCA were of significant in determining number of fruits / plant in cucumber, and that variance of SCA for F_1 crosses was greater than GCA. On the other hand, EL Mahdy *et al.* (1992) found that both additive and non additive gene effects were important in the inheritance of these traits, but the additive gene effects were more important that the non additive ones.

The mean values of the number of fruits / plant for the different evaluated populations were arranged in Table (4) the results indicated that strain 106 showed the highest GCA of all tested varieties significantly. ON the contrary, strain 104 was the lowest in this respect.

The highest SCA was reflected by the cross 105 X 106 significantly, which showed also higher value than its higher parent, followed significantly by the cross 106 x 159. The other four crosses did not differ significantly from their parents. The lowest values of the number of fruits/ plant were detected from the crosses 104 x 106 and 104 x 159 without any significant differences.

2- Fruit characteristics: -

Analysis of variance of average fruit weight in (gm) of the four cucumber varieties and their possible F_1 hybrids are presented in Table (1).

The highly significant difference among genetic populations appeared to be the result of the differences among parents, crosses and the orthogonal comparison between parents and F_1's. It was noticed also that GCA and SCA contributed highly significant differences to the variance among crosses. These findings are in agreement with those obtained by Owens *et al*. (1985) they reported that GCA and SCA estimated for fruit weight were significant among strains of cucumber. Awad (1996) found also that highly significant GCA for fruit weight of cucumber, and highly significant SCA effect values for three F_1 hybrids. On the contrary,
Prudek (1986) indicated that in cucumber, hybrids GCA was the most important and the SCA was of no importance. Gharib (1991) showed that variance of SCA for F1 crosses was greater than GCA in fruit weight.

Table (5) showed that 104 reflected superiority for the GA significantly, followed by 159, while 105 and 106 gave the lowest GCA significantly.

All the crosses gave average fruit weight values close to the higher parent or exceeds its value showing dominance of over dominance controlling this trait.

The highest SCA for fruit weight values was reflected by the cross 104 x 106 followed by 104 x 159, 105 x 159 and 104 x 105 without any significant differences, showing that 104 combined well with the other three varieties for fruit weight character.

2.1 Fruit shape Index :

The results of analyses of variance for fruit shape index (L/D) for the four cucumber strains and their possible F_1 hybrids are presented in Table (1). The results showed highly significant differences among populations, parents, crosses and orthogonal comparison between parents and crosses. The data showed also highly significant difference for GCA and SCA. The variance of SCA was greater than those GCA variance for F_1 crosses. These results agreed with that of Gharib (1991) who found that GCA and SCA were highly significant for fruit shape index in cucumber. The SCA variance for F1 crosses was greater than GCA in fruit shape.

The mean values of fruit shape index for the different genotypes are tabulated in Table (6). The highest GCA was reflected by strain 106. Meanwhile, The lowest was 159, followed by 105 without any significantly differences. The highest SCA was detected from the cross 104 X106 significantly. The lowest ones were the crosses 104 x 159, 105 X 106 and 104 x 105 without any significant differences.

3- Powdery Mildew Resistance:-

Data presented in Table (1) showed that the parents and their crosses tested for the powdery mildew resistance did not significantly differ from each other. This findings due to insignificant differences among the parental strains which were used. This was also clear from the data tabulated in Table (7).

The results were in agreement with those of EL-Doweny *et al* (1995) who found that the strains 104, 105 and 106 were highly resistant to powdery mildew.

Table (2): Average total yield/plant (kg) of the four parental verities and theire six possible crosses. The under lined values are those of the parental.

	Strain 104	Strain 105	Strain 106	Strain 156	Mean of crosses and significance
SVR 104	0.656 e	0.899 be	0.956 a	0.887 c	0.914 + 0.00196 B
SVR 105		0.689 e	0.908 bc	0.896 bc	0.901 + 0.00196 D
SVR 106			0.824 d	0.927 ab	0.930 + 0.00196 A
SVR 109				0.672 e	0.903 + 0.00196 C

Values with an alphabetical letter in common do not significantly differ from one another, using Duncan's Multiple Range test at 0.05 level .

Table (3): Average early yield/plant (kg) of the four parental strains and their six possible crosses. The under lined values are those of the parental progenies.

	Strain 104	Strain 105	Strain 106	Strain 156	Mean of crosses significance
SVR 104	0.209 e	0.285 ab	0.445 a	0.276 ab	.3353 + 0.0189 B
SVR 105		0.180 b	0.338 ab	0.307 ab	.3100 + 0.0189 C
SVR 106			0.295 ab	0.442 a	.408 + 0.0189 A
SVR 109				0.169 b	.3416 + 0.0189 B

Values with an alphabetical letter in common do not significantly differ from one another, using Duncan's Multiple Range test at 0.05 level.

Table (4): Average number of fruits / plant of the four parental strains and their six possible crosses. The under lined values are those of the parental progenies.

	Strain 104	Strain 105	Strain 106	Strain 156	Mean of crosses and significance
SVR104	6.4 bc	6.2 c	6.0 c	6.0 c	6.0666 + 0.0971 D
SVR105		6.7 bc	7.6 a	6.1 c	6.633 + 0.0971 B
SVR106			6.1 c	6.9 b	6.833 + 0.0971 A
SVR109				6.2 c	6.3333 + 0.0971 C

Values with an alphabetical letter in common do not significantly differ from one another, using Duncan's Multiple Range test at 0.05 level .

Table (5): Average fruit weight (gm.) of the four parental strains and their six possible crosses. The under lined values are those of the parental progenies.

	Strain 104	Strain 105	Strain 106	Strain 156	Mean of crosses and significance
SVR 104	.103 e	.145 ab	.159 a	.148 ab	.15066 + 0.005 D
SVR 105		.103 e	.120 cd	.148 ab	.13766 + 0.005 C
SVR 106			.134 bc	.136 b	.1383 + 0.005 C
SVR 109				.108 ed	.14400 + 0.005 B

Values with an alphabetical letter in common do not significantly differ from one another, using Duncan's Multiple Range test at 0.05 level .

Table (6) Fruit shape Index (L/D) of the four parental strains and their six possible crosses. The under lined values are those of the parental progenies.

	Strain 104	Strain 105	Strain 106	Strain 156	Mean of crosses and significance
SVR104	12.00 d	12.50 d	15.21 a	11.91 d	13.206 + 0.485 B
SVR105		11.81 d	14.62 b	11.91 d	13.010 + 0.485 BC
SVR106			15.22 a	14.17 c	14.666 + 0.485 A
SVR109				12.01 d	12.663 + 0.485C

Values with an alphabetical letter in common do not significantly differ from one another, using Duncan's Multiple Range test at 0.05 level .

Table (7): Percent of infection with P.M. of the four parental strains and their six possible crosses. The under lined values are those of the parental progenies.

	Strain 104	Strain 105	Strain 106	Strain 156	Mean of crosses and significance
SVR104	94.23	92.33	85.93	93.33	90.59 N.S.
SVR105		92.37	86.13	92.23	90.23 N.S.
SVR106			86.07	84.43	88.09 N.S.
SVR109				92.77	90.06 N.S.

N. S. not significant .

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دراسات وراثية لبعض الصفات الأقتصادية بإستخدام الداى أليل فى الخيار

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أستخدم فى هذا البحث أربع سلالات من الخيار مرباه تربية ذاتية، وتم التهجين بينهما والحصول على ٦ هجن. زرعت الهجن وقدرت القدرة العامه والخاصة على التوافق لتوضيح علاقتها بتأثير الجين على ست من الصفات الإقتصادية (المحصول الكلى للنبات - المجصول المبكر للنبات - عدد الثمار على النبات - متوسط وزن الثمرة - معامل شكل الثمرة - المقاومة للبياض الدقيقى) .

وقد أوضحت النتائج التأثير المعنوى للقدرة العامة والخاصة للتوافق على صفات المحصول الكلى للنبات وعدد الثمار على النبات ومتوسط وزن الثمرة ومعامل شكل الثمرة ولم يكن هناك أى تأثير معنوى للقدرة الخاصة على التالف على صفة المحصول المبكر.

أظهرت الدراسة أن كل السلالات والهجن المستخدمة كانت عالية المقاومة للبياض الدقيقى بدون فروق معنوية. السلاله ١٠٦ قدرتها على التوافق عالية لكل الصفات المدروسة فيما عدا صفه متوسط وزن الثمرة وكانت السلاله ١٠٤ متفوقة فى القدرة الخاصة على التآلف .

Table (1) The analysis of variances and expected mean squares for all studied traits.

Source of Variation	d.f.	Mean squares						Expected Mean squares
		Total yield / plant (kg)	Early yield / plant (kg)	Number of fruits/ plant	Fruit weight (kg)	Fruit shape Index (L/D)	Rest. To PMR	
Replication	2							
Population	(9)	.039566 **	.03670 **	.78077 **	.0012627	.727527 **	205.0428	
Among Parents	3	.017710 **	.0097325	.16111	.0006706	.896888 **		⇔^{2} +r⇔$^2{}_p$
Among crosses	(5)	.001944 **	.01751 *	1.28722 **	.000459	.70712 **		⇔^{2} +r⇔^{2}c
G. C. A.	3	.00243 **	.0237685 *	1.538 **	.000495	.83285 **		⇔^{2} +r⇔^{2}s +⇔^{2}
S. C. A.	2	.0012219 *	.008109	.874950 **	.0004105	.519024 **		⇔^{2} +r⇔^{2}s
Parents Vs. crosses	1	.293244 **	.2135687 *	.107567	.007053	.31348 **		
Error	18	.00034557	.0062549	.14211	.0000598	.0180629	264.6763	⇔^{2}
Total	29							

⇔2 p	**.0057848**	**.000106116**	**.00633**	**.000203**	**.292961**
⇔29	**.0004027**	**.0052198**	**.221016**	**.00002816**	**.104**
⇔2s	**.0000292 .**	**000618**	**.24428**	**.0001169**	**.1670**

*** Significance at 0.05 at level.**

**** Significance at 0.01 at level .**