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STUDIES ON GENERAL AND SPECIFIC COMBINING ABILITIES OF SOME CHARACTERS IN SQUASH (*Cucurbita pepo*, L.).

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ABSTRACT

Five squash (*Cucurbita pepo*, L.) parental inbred lines were used in this investigation in a diallel crosses to determine the general and specific combining abilities as an attempt to establish one inbred line or more as a tester for some economical characters studied.

The crossing procedure was carried out in Dokki, under plastic house conditions, in the growing season of 1997. The studied traits were: number of internodes to the first female flower, early yield, total yield and resistant to powdery mildew. The obtained results could be summarized as follows:-

1. General combining ability (GCA) effects were highly significant for all studied traits. Moreover, highly significant specific combining ability (SCA) was noted in all studied characters.
2. Based on the estimates of GCA and SCA of each parent, potentiality of each parent in each individual. characters was identified. Inbred line P_3 could be relatively considered as a good combinor for the five studied characters. Inbred line P_3 had high desirable states GCA effects for all studied characters and are recommended for breeding with lines that showed crosses with high SCA.

INTRODUCTION

Squash (*Cucurbita pepo*, L.) is an important vegetable crop in Egypt. Great variability regarding yielding ability is found among the local Eskandarani cultivar. Assessment of nature and magnitude of the genetic effects in quantitative traits were essentially important in designing the appreciate breeding programme. A group of parental Eskandarani cultivar differing in some economical characters, i.e., number of internodes to the first female flower, early yield, total yield and resistant to powdery mildew. The diallel analyses were available method to evaluate parents and hybrid combinations.

Number of internodes to the first female flower:

Sachan and Nath (1976) studied the combining abilities in a complete set of diallel crosses involving 10 varieties of watermelon. The results showed that GCA and SCA effects were significant for number of days to the first female flower anthesis. Fridrick and Staub (1989) found that both GCA and SCA mean squares were significant for days to anthesis in cucumber. Gharib (1991) showed that the mean squares for GCA and SCA showed highly significant for days to anthesis of the first female flower in cucumber. Moreover, variance of SCA for F_1 crosses was greater than the GCA. El-Mahdy *et al.* (1992) reported that both GCA and SCA were significant for time needed to female flowering in cucumber. Therefore, the additive and non-additive gene effects were important in the inheritance of this trait. Wadid (1996) found that GCA and SCA were highly significant for days to the first female flower in cucumber.

Early yield (Kg/plant):

Tulupov (1970) reported that the F_1 hybrids of cucumber approached the early material parent in date of flowering and fruit setting. Investigation on yield in the F_1 crosses of bitter gourd investigated partial dominance for the few number of days to the first harvest (Sirohi and Choudhury, 1977). Abd El-Mageed (1989) found significant effects for general and specific combining abilities for early yield trait in squash, indicating that both additive and non-additive gene actions were involved in the inheritance of this trait. He also mentioned that the same results were obtained in cucumber. Wadid (1996) showed that GCA effects showed highly significant in this trait in cucumber. Moreover, highly significant SCA was noted. Kamooh *et al.* (2000) found significant effect for general combining ability for early yield in cucumber.

Total yield (kg/plant):

Prudek (1986) reported that general and specific combining abilities were significant for total yield in cucumber, although the GCA was more important. Abd El-Mageed (1989) found significant effect for both general and specific combining abilities for total yield per plant in squash. Arora *et al.* (1996) observed significant general and specific combining abilities effect for total yield per plant in summer squash. Wadid (1996) observed highly significant effect for both GCA and SCA for total yield in cucumber. Kamooh *et al.* (2000) showed highly significant variation of GCA and SCA for total yield per plant in cucumber.

Powdery mildew resistance:

Imam *et al.* (1977) used Poinset and Yomaki cultivars as sources of resistance to powdery mildew. They found that two recessive genes controlled the resistant character. El-Doweny *et al.* (1995) found that the three inbred lines; 104, 105 and 106 showed highly resistant to powdery mildew with a good fruit characters. Kamooh *et al.* (2000) used the mentioned cucumber lines of cucumber in diallel crosses studies. The results indicated that the parents and their F_1 crosses were highly resistant to powdery mildew and showed no significant differences among them.

MATERIALS AND METHODS

Five inbred lines of squash (*C. pepo*, L.) were used as parental lines in a diallel crosses mating design. The lines named; P_1, P_2, P_3, P_4 and P_5. The lines P_3 and P_4 were resistant to powdery mildew. Seeds from each line were sown in pots (5 cm) under greenhouse conditions in Vegetable Research Department at Dokki, Giza in 6th of January 1997. At the three leaf stage, seedlings were transplanted to the greenhouse. Crossing took place using all possible combinations of diallel, giving a total of 10 crosses as follows:-

1- $P_1 \times P_2$ 5. $P_2 \times P_3$ 8. $P_3 \times P_4$
2. $P_1 \times P_3$ 6. $P_2 \times P_4$ 9. $P_3 \times P_5$
3. $P_1 \times P_4$ 7. $P_2 \times P_5$ 10. $P_4 \times P_5$
4. $P_1 \times P_5$

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 filement and taged. Fruits reached maturing stage within 35-45 days after pollination. Seeds were extracted from fruits cleaned and spread for drying.

Seeds of the parents and the F_1 hybrids were sown as mentioned in the greenhouse at Dokki in January, 1998. A complete randomized blocks design with three replicates was used. Each experimental plot contained 20 plants. Fruits were harvested three times a week. Data was recorded as follows:-

1. Number of internodes to the first female flower.
2. Early yield kg/plant.
3. Total yield kg/plant.

As for powdery mildew resistance, plants were artificially inoculated when the first leaves have been expanded. Inoculation was prepared by collecting a mixture of infected squash leaves. Suspension of the powdery mildew spores to concentration of 500.000 spore / ml. was prepared. Preparation was carried out not more than one hour before inoculation. Within 20 days after inoculation reading of reasonable degree of accuracy have been made on powdery mildew resistance. Infected plants were counted and percentage on infection was recorded.

Statistical analyses:

The statistical analyses of recorded data were carried out following the procedures of the used experimental design randomized complete blocks design as illustrated by Snedecor and Cochran (1967). The multiple comparisons among the population means were also followed using Duncan's Multiple Range Test.

The data of the parental lines and their 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 variances 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. Number of internodes to the first female flower:

The results of Table 1 showed the analysis of variance for the number of internodes to the first female flower for the five parental lines and their ten possible crosses. These different 15 populations reflected a highly significant variance, arising from the significant differences among parental lines and among crosses. The general and specific combining ability contributed also highly significant differences and seemed to be responsible for the differences noticed among the single crosses.

Table 1. The analysis of variances and the expectation of themean squares for all studied traits.

Source of variance	df	Mean squares				
		No. of internodes	Early yield per plant (kg)	Total yield per plant (kg)	Resistance to PM	Expected mean squares
Replication	2					
Population	14	12.6663**	0.411096**	0.25511**	3394.660**	
Among parents	4	19.850**	0.31348**	0.27729**	5954.890**	$\sigma^2e + r\sigma^2p$
Among crosses	9	9.890**	0.49796**	0.27200**	1909.636**	$\sigma^2e + r\sigma^2c$
GCA	4	14.429**	0.2633**	0.29435**	2720.10**	$\sigma^2e + r\sigma^2s + c\sigma^2g$
SCA	5	6.261**	0.68567**	0.25435**	1261.28**	
Parents vs crosses	1	8.909**	0.28994**	0.13716	6519.00**	$\sigma^2e + rc\sigma^2s$
Error	42	0.3079	0.00583	0.01461	4.9057	σ^2e
σ^2p		4.8855	0.76913	0.06567	11.26446	
σ^2g		0.6806	0.10559	0.00333	4.1472	
σ^2s		1.4885	0.16996	0.059934	17.4997	

** Significant at 0.01 level.

The mean values of number of internodes to the first female flower for different populations are arranged in Table 2. The two parental lines P_1 and P_2 appeared to be the latest to produce female flowers. Meanwhile, P_4, P_5 and P_3 were the earlier in that aspect significantly. The lowest values for GCA were showed for P_3, P_5 and P_4 lines, respectively without any significant differences. Concerning the GCA, the line P_2 reflected the highest GCA (Table 2). The results are in agreement with that of Sachan and Nath (1976), Fridrick and Staub (1989), Gharib (1991), El-Mahdy (1992) and Wadid (1996) in watermelon and cucumber, respectively.

The lowest hybrid in the No. of days needed to first female flower were P_3 x P_4, P_3 x P_5 and P_4 x P_5. The highest SCA for the number of internodes to the first flower were P_1 x P_2 followed by P_1 x P_3, P_1 x P_4 and P_1 x P_5 without any significant differences. Generally, the results showed that the parental lines P_3, P_4 and P_5 could combine well with each other to produce their best earlier single crosses.

Table 2. Average number of internodes of the five parents and their ten possible crosses. The underlined values are those of the parental lines.

	P_1	P_2	P_3	P_4	P_5	Mean of crosses and significance
P_1	10.5 a	10.25 ab	9.50 bc	9.50 bc	9.50 bc	9.680±1.3964 A
P_2		10.75 a	9.25 c	9.50 bc	9.25 c	9.563±1.3964 A
P_3			6.50 d	6.25 d	6.25 d	7.813±1.3964 B
P_4				6.25 d	6.50 d	7.930±1.3964 B
P_5					6.50 d	7.875±1.3964 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.

2- Early yield (kg/plant):

The analysis of variance for early yield data of 15 populations tested showed highly significant variance that reflected by the comparison among the parental lines and among the F_1 crosses as well as the comparison between the overall means of the two groups. The variation due to both general and specific combining abilities were also showed highly significant, assuring their contribution to the differences noticed among the compared crosses.

The mean values of early yield in kg/plant for different genetic populations are presented in the form of two-way table (Table 3), with the selfed parental progenies shown as underlined values in the diagonal. The last column of this table shows the means of the parental lines in all crosses to furnish a basis for comparing the general combining ability of these lines.

Table 3. Average early yield / plant (kg) of the five parents and their ten possible crosses. The underlined values are those of the parental lines.

	P_1	P_2	P_3	P_4	P_5	Mean of crosses and significance
P_1	0.7580 f	0.8330 ef	0.7800 ef	0.7980 ef	0.7800 ef	0.798 ± 0.1748 B
P_2		0.7430 f	0.8730 e	0.8100 ef	0.7250 f	0.810 ± 0.1748 B
P_3			1.3000 b	1.578 a	1.588 a	1.205 ± 0.1748 A
P_4				1.275 cd	1.388 b	1.144 ± 0.1748 A
P_5					1.192 d	1.120 ± 0.1748 A

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

The highest GCA was that reflected by lines P_3 followed by P_4 and P_5 without any significant differences. Abd El-Megeed (1989) found that GCA and SCA were significant for early yield in cucumber. Kamooh (2000) showed significant effect for GCA in cucumber.

The highest specific combining ability was reflected by the two crosses $P_3 \times P_5$ and $P_3 \times P_4$ which produced the highest early yield of all crosses. The superiority of these two F_1 hybrids to all other F_1's was found to significant, and also higher over all lines.

4. Total yield (kg/plant):

Table 4 showed the analysis of variance for total yield data recorded for the five parental lines and their ten possible crosses. These 15 different populations reflected a highly significant variance. The combining ability, general or specific, contributed highly significant differences and seemed to be responsible for the differences noticed among the single crosses.

The mean values of total yield in kg/plant for the different populations (Table 4) showed that the parental line P_3 appeared to be the highest total yield productivity, but did not differ significantly from the P_5 and P_4 lines. Line P_1 reflected the poorest average of all, though, it did not differ significantly from the P_2 line.

Concerning the GCA, the P_3 showed the highest GCA of all as appeared in Table 4 followed by P_5 and P_4 without any significant differences.

These results were in complete agreement with that obtained by Prudek (1986) in cucumber, Abd El-Megeed (1989) in squash, Arora *et al.* (1996) in summer squash and Kamooh *et al.* (2000) in cucumber

Table 4. Average total yield / plant (kg) of the five parents and their ten possible crosses. The underlined values are those of the parental lines.

	P_1	P_2	P_3	P_4	P_5	Mean of crosses and significance
P_1	1.55 f	1.612 ef	1.913 d	1.690 ef	1.590 ef	1.701±0.3200 A
P_2		1.563 ef	1.938 cd	1.637 ef	1.727 e	1.729±0.3200 B
P_3			2.100 bc	2.225 ab	2.288 a	2.091±0.3200 A
P_4				1.978 cd	2.103 bc	1.914±0.3200 A
P_5					2.013 c	1.927±0.3200 A

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

The highest SCA for total yield was reflected by the cross $P_3 \times P_5$ followed by $P_3 \times P_4$ without any significant differences showing that P_3 could combine well with the lines P_4 and P_5 to produce their best single cross.

5. Powdery mildew resistance:

Table 1 showed the analysis of variance for data of the five parental lines and their ten possible crosses. These fifteen different genetic populations reflected a highly significant variance, arising from the significant differences among the parental lines, among crosses and those of the orthogonal comparison between these two groups. General and specific combining abilities showed highly significant also. Kamooh *et al.* (2000) indicated that resistant lines of cucumber to PM showed no significant differences.

Table 5 declared that lines P_3 and P_4 showed highly significant percentage of resistance and P_1 was the lowest percentage. The general combining ability showed a highest significantly percentage. Meanwhile, for the specific combining ability percentage, the cross $P_3 \times P_4$ showed the highly degree of resistance to PM for all the tested crosses. On the other hand, the crosses $P_2 \times P_3$ and $P_1 \times P_4$ were the lowest in these respect.

Table 5. Average percentage of PMR of the five parents and their ten possible crosses. The underlined values are those of the parental lines.

	P_1	P_2	P_3	P_4	P_5	Mean of crosses and significance
P_1	15.43 bc	13.13 b	17.15 b	11.75 cd	18.52 b	16.137±4.464 A
P_2		18.00 b	11.25 d	18.12 b	18.75 b	16.187±4.484 B
P_3			89.08 a	89.15 a	17.75 b	32.712±4.464 A
P_4				85.65 a	15.50 b	32.530±4.464 A
P_5					17.50 b	17.505±4.464 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.

The results generally indicated that P_3 and P_4 can combine will to produce the best single cross in PMR.

The results showed that powdery mildew resistance character was a recessive character. The results were in agreement with findings of Imam *et al.* (1975), who mentioned that the powdery mildew resistance character in cucumber was recessive and two genes controlled this character.

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دراسات على القدرة العامة والخاصة على التوافق لبعض الصفات فى الكوسة

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إستخدم فى هذا البحث خمسة سلالات نقية من الكوسة الإسكندرانى وتم التهجين بينها بنظام الدای أليل والحصول على ١٠ هجن ، وتم تقدير القدرة العامة والخاصة على التوافق وذلك لدراسة بعض الصفات الإقتصادية. وقد أجريت التهجينات تحت ظروف الصوبة فى عام ١٩٩٧ والصفات التى تمت دراستها هى عدد السلاميات حتى ظهور أول زهرة مؤنثة ، المحصول المبكر ، المحصول الكلى ، المقاومة للبياض الدقيقى.

أوضحت النتائج التأثير المعنوى للقدرة العامة والخاصة للتوافق على صفات عدد السلاميات حتى أول زهرة مؤنثة والمحصول المبكر والمحصول الكلى والمقاومة للبياض الدقيقى. كما أوضحت الدراسة أيضا أن السلالة ب٣ كانت ذات قدرة عالية على التوافق لكل الصفات المدروسة ويمكن إستخدامها فى برنامج للتربية وذلك بالتهجين بينها وبين السلالات حيث أظهرت قدرة خاصة عالية على التوافق معها.