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TYPE OF GENE ACTION, COMBINING ABILITY AND RECIPROCAL DIFFERENCES FOR SOME IMPORTANT CHARACTERS IN SUMMER SQUASH (*Cucurbita pepo* L.)

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ABSTRACT

A diallel set of crosses including reciprocals among four inbred lines of summer squash were used to study the nature of gene action, and combing ability for sex ratio, setting ratio, number of nodes to the first female flower, number of days to the first female flower, early yield per plant, number of fruits / plant, total yield/plant, fruit weight and weight 100 seed.

The results revealed that additive and non-additive components made up the genetic variation for studied traits. The dominance component was larger in magnitude than additive one resulting for setting ratio, number nodes to the first female flower, early yield / plant, number of fruits per plant, total yield per plant and fruit weight. The value $(H_1/D)^{0.5}$ ***was more than unity, indicating the role of over dominance gene effect in the inheritance of these traits. High heritability (narrow sense) was observed for all studied traits except setting ratio.***

The most desirable general combining ability effects were shown by the parental lines derived from Shamamee for early yield / plant and weight of 100 seed and from Eskandrani for the rest traits. The greatest specific combining ability effects were in the cross combination

Eskandrani x Matrouhee for sex ratio, number of nodes to the first female flower, number of fruits / plant, total yield / plant and weight of 100 seed, Eskandrani x Shamamee and Eskandrani x Cobee for setting ration and fruit weight, respectively.

Key Words: ***Squash, Cucurbita, Diallel, Gene action , Combining ability , Heritability, Reciprocal differences.***

INTRODUCTION

The development of summer squash improved local genotypes adapted to local conditions may be achieved through a successful hybridization program. The economic value for this crop is limited by yielding ability and earliness such as total yield, No. of fruits/plant, early yield and No. of days to the first female flower. The genetic analysis of these traits is difficult because they are usually controlled by quantitative genes (polygenes). The situation is further complicated by the fact that phenotypic expression is influencing by environmental factors. It is of great interest to plant breeders to study hereditary behaviour for yield and its components of this crop to improve its genetic constitution. The types of gene action for various traits in this crop were described by some investigators (El-Mighawry 1998, Ghai *et al* 1998, El-Gendy 1999, El-Lithy 2002 and Abd El-Hadi and El-Gendy 2004).

The present investigation represent an attempt to study the genetic behaviour, and combining ability effects in a set of diallel crosses among four parents of summer squash.

MATERIALS AND METHODS

The genetic materials used in the present investigation included four different local races of summer squash, viz, Eskandrani, Matrouhee, Shamamee and Cobee. These genotypes were chosen because they have sufficient genetic diversity in their yield and its components. Individual plants from each genotype were selfed for four successive generations during summer and fall seasons of 2003 and 2004 to obtain inbred lines. The uniform inbreds were selected at the end of the fourth selfing generation, as parents for this study. These four uniform inbred lines were crossed, according to a diallel mating system, including reciprocals, to obtain 12 F_1 hybrids in the summer season of 2005. The 16 entries, i.e. 4 parental lines and 12 single crosses, were evaluated in a field trail at the El-Kassassen experimental farm. A randomized complete block design with three replicates was used in this study. Treatments in each replicate (4 parents + 6 F_1's + 6 reciprocals) were randomly assigned to plots, the plot dimensions were 15m long and 70 cm width, plants were spaced 50 cm apart. The observations were recorded on individual plant basis for sex ratio, setting ratio, No. of nodes to first female flower, No. of days to first female flower, Early yield plant (g). No. of fruits / plant, total yield / plant (kg), fruit weight (g) and weight of 100 seed (g). The obtained data were subjected to the analysis of variance according to Snedecor and Cochran 1967. The data were also, subjected to Hayman approach of a complete diallel (Hayman 1954 a and b) as described by Mather and Jinkes 1971 to calculate and test the genetic components and heritability. General and specific combining ability were estimated according to method II, model I, as described by Griffing 1956.

RESULTS AND DISCUSSION

Type of gene action

The analysis of variance in Table (1) showed highly significant differences among the 16 genotypes of summer squash for the flowering stage and yield and its components traits. The insignificant of t^2 and the regression coefficient (b), indicating the fulfillment of assumption underlying diallel analysis and the absence of epistatic gene action.

The average of different traits for the four parental lines and their 6 single crosses and 6 reciprocals are presented in Table (2). It is clear that the parental lines and their crosses exhibited a wide range of differences for all studied traits.

Table 1. Analysis of variance for some local summer squash genotypes traits

S.O.V	d.f	M.S of flowering traits				M.S of Yield traits				
		Sex ratio	Setting ratio	No.of nodes to first female flower	No.of days to first femal flower	Early yield/ plant (g)	No.of fruits/ plant	Total yield/ plant (kg)	Fruit weight (g)	Weight of 100 seeds (g)
Rep.	2	0.032	3.858	4.946	11.928	1971.075	3.598	0.001	64.985	0.173
Genotypes	15	0.366**	255.54**	7.745**	42.733**	55470.271**	21.91**	0.171**	176.589**	3.669**
Error	30	0.014	13.438	0.652	3.015	478.826	2.059	0.001	15.808	0.061
t^2		0.263	-26276.77	0.777	-3416.429	-1.774	0.335	0.030	-38182.96	1.263
±S.E.(b)		0.787± 0.143	0.719± 0.070	1.382± 0.433	0.863± 0.257	0.657± 0.435	0.273± 0.893	0.61 1± 0.498	1.171± 0.176	1.571 ± 0.241
Ho:-.b.0		5.512	10.243	3.189	3.352	1.512	0.306	1.228	6.638	6.508
1 Ho:.b.1		1.492	4.012	-0.881	0.532	0.788	0.814	0,782	-0.968	2.365

*, ** Significant at 0.05 and 0.01 probability levels respectively.

The results of the estimates of genetic components of variation are presented in Table (3). The additive component (D) and the dominance effect expressed as the algebraic sum over all loci in heterozygous phase in all crosses (h^2) were highly significant for No. of nodes to first female flower. No. of days to first female flower, No. of fruits per plant and fruit weight, indicating that the additive portion played a considerable role in the inheritance of these traits, as well as, the presence of many positive genes that showed dominance effect.

The dominant components (H_1, H_2) showed significant and highly significant value for all traits except sex ratio. The magnitude of dominance components (H_1 and H_2) were larger than D indicating the importance of non- additive and additive gene action in inheritance of setting ratio, No. of nodes to first female flower, No. of days to first female flower, No. of fruits/plant, fruit weight and weight of 100 seed, but non-additive component was more important than D. The mean estimate of covariance of additive and dominance effect over the arry (F) was insignificant for all

Table 2. Mean performance of 4 parents , 6 F_1's and 6 reciprocals for studied traits of summer squash.

Genotypes	Sex ratio	Setting ratio	No. of nodes to first female flower	No. of days to first femal flower	Early yield/ plant (g)	No. of fruits/ plant	Total yield/ plant (kg)	Fruit weight (g)	Weight of 100 seeds (g)
Parents P_1	1.28	45.04	11.56	50.36	319.42	9.55	0.78	77.42	8.34
P_2	0.61	55.25	9.88	50.03	181.84	10.44	0.63	68.42	11.11
P_3	0.35	48.27	14.44	56.27	177.43	6.09	0.53	71.19	11.97
P_4	0.48	41.08	11.73	58.59	178.21	6.90	0.55	85.06	9.81
Crosses 1x2.	1.31	54.86	8.33	46.22	521.15	14.43	1.26	81.65	10.92
1x3 •	0.75	55.48	10.78	46.77	492.05	11.53	1.09	81.87	11.12
1x4	0.90	66.25	9.00	48.77	417.07	9.83	0.88	85.13	9.06
2x3	0.46	38.50	15.55	51.00	231.54	8.74	0.62	76.19	10.62
2x4	0.41	58.98	12.03	53.22	222.55	9.94	0.76	78.52	9.76
3x4	0.47	34.14	13.11	56.77	116.26	5.61	0.38	73.69	12.71
Reciprocals 2x1	1.27	62.46	9.11	46.44	511.59	15.15	1.22	78.14	10.98
3x1	0.68	66.33	11.00	52.74	242.69	11.17	0.88	86.70	8.78
4x1	1.08	53.14	9.55	46.88	490.56	11.62	1.08	94.85	9.27
3x2	0.44	50.81	11.29	51.82	227.04	9.34	0.70	77.35	10.28
4x2	0.53	56.46	11.20	50.72	297.46	9.76	0.79	83.38	'0.84
4x3	0.44	46.86	12.44	52.33	283.33	6.69	0.66	96.26	10.49
L.S.D 0.05	0.242	5.34	1.14	^2.77	29.36	1,70	0.054	4.69	0.423
L.S.D 0.01	0.333	7.36	1.570	3.80	40.27	2.33	0.074	6.43	0.581

*, ** Significant at 0.05 and 0.01 probability levels respectively.

Table 3. Genetic components, dominance degree and heritability for some local summer squash genotypes traits.

	Flowering stage traits				Yield traits				
Components of variation	Sex ratio	Setting ratio	No.of nodes to first female flower	No.of days to first female flower	Early yield/ plant (g)	No.of fruits/ plant	Total yield/ plant (kg)	Fruit weight (g)	Weight of 100 seeds (g)
D±S.E.	0.191±*	39.042±**	3.336±**	7.253±**	4800.865±	3.967±**	0.013±	42.189±**	2.478±*
	0.013	10.124	0.326	2.287	4025.652	1.015	0.012	2.790	0.251
F±S.E.	-0.068±	-3.477±	0.400±	-1.731±	-10507.875±	-5.670±*	-0.041±	-12.943±	1.145±
	0.033	26.010	0.838	5.875	10342.086	2.608	0.031	7.167	0.645
H_1±S.E.	0.058±	185.889±**	4.971±**	17.199±*	37572.29±**	12.524±**	0.155±*	63.597±**	0.965±*
	0.038	29.431	0.948	6.648	11702.12	2.951	0.036	7.486	0.730
H2±S.E.	0.055±	150,932±**	4.020±**	15.52±*	30543.552±*	9.788±*	0.123±**	63.793±**	1.838±*
	0.035	27.167	0.875	6.137	10801.957	2.724	0.033	7.486	0.674
h^2 ± S.E.	-0.003±	34.332±	3.081±**	26.800±**	34254.418±**	9.368±**	0.127±**	147.832±**	0.002±
	0.024	18.427	0.594	4.162	7326.797	1.845	0.022	5.078	0.457
E±S.E.	0.007±	2.533±	0.226±	1.127±	121.045±	0.360±	0.0005±	3.287±*	0.024±
	0.006	4.528	0.146	1.023	1800.326	0.454	0.005	1.248	0.112
$(H/D)^{0.5}$	0.552	2.182	1.221	0.998	2.798	1.777	3.502	1.228	0.891
Heritability (ns)	0.862	0.488	0.612	0.673	0.590	0.688	0.579	0.588	0.601

*, ** Significant at 0.05 and 0.01 probability levels respectively.

studied traits except No. of fruits/plant. The positive F for No. of nodes to first female flower and weight of 100 seed, and negative F for the rest, indicating that the dominance alleles are more frequent than recessive and vice verse for others respectively. The degree of dominance $(H_1/D)^{0.5}$ and heritability estimates are presented at Table (3). The degree of dominance was close to unity for No. of days to first female flower and weight of 100 seed, indicating complete dominance, the value of dominance degree was less than unity for sex ratio, suggesting parial dominance. The rest traits showed over dominance because the degree of dominance was more than unity.A similar result was obtained by El-Mighawry 1998 for no. of fruits / plants in summer squash.

Narrow sense heritability was high for all studied traits, except setting ratio. The high value of heritability indicated that a selection program would be effective for these traits. In this respect high heritability estimates were detected on squash by El-Mighawry (1998) for No. of fruits/ plant, El-Gendy (1999) for days to first female flower while El-Lithy (2002) reported low heritability for early yield on summer squash.

General (gca) specific (sca) combining ability and reciprocal differences.

The analysis of variance (Table 4) showed that mean squares due to general and specific combining ability were highly significant for studied nine traits of summer squash. These results revealed that good general combiners and profitable hybrids were present. Moreover. gca variance for all studied traits were higher in magnitude than sca. variance, suggesting the predominant role for additive variance of these traits.A similar conclusion was reported by El-Gendy (1999) for No. of days to first female flower on summer squash. The reciprocal cross differences (r.d) was highly significant for all studied traits except sex ratio, No. of nodes to first female flower and No. of fruits / plant.

Table 4. Analysis of variance for general (gca), specific (sca) and reciprocal (rca) combining ability for some of local summer squash genotypes traits.

		M.S of flowering stage traits				M.S of Yield traits				
Source of variation	d.f	Sex ratio	Setting ratio	No.of nodes to first female flower	No.of days to first female flower	Early yield/ plant (g)	No. of fruit plant	Total yield/ plant (kg)	Fruit weight (g)	Weight of 100 seeds (g)
g.c.a	3	0.533**	157.880**	8.001**	42.429**	44796.0**	25.105**	0.172**	133.160**	2.945**
s.c.a	6	0.035**	78.399**	2.236'**	8.893**	15392.82**	5.254**	0.062**	36.183**	0.944**
r.c.a	6	0.004	55.611**	0.218	5.503**	8434.405**	0.452	0.014**	55.395**	0.978**
Error	30	0.005	4.479	0.217	1.005	159.609	0.686	0.0007	5.269	0.029
g.c.a / s.c.a		15.229	2.014	3.578	4.771	2.910	4.778	2.774	3.216	3.120

*, ** Significant at 0.05 and 0.01 probability levels respectively.

The estimates of gca effect are presented in Table (5). The results revealed that most desirable gca effectes were shown by parent (1), for sex ratio,setting ratio,No. of nodes to first female flower, No. of days to first female flower, No. of fruits / plant and total yield / plant. Parent (2) was good combiner for all studied traits except six ratio and fruit weight. Parent (3) appeared as a good combiner for early yield / plant and weight of 100 seed. The fourth parent was poor combiner for most studied traits except early yield / plant. The results indicated that parents (1) and (2) were best general combiners for producing early - maturing types based on, No. of nodes to first female flower and No. of days to first female flower and parents (2), (3) and (4) based on early yield / plant. Specific combining ability and reciprocal differences of the 12 F_1 crosses are presented at Table (6). The results revealed that crosses having significant positive sca effect for various traits were (1x2) for sex ratio, (lx3) for setting ratio.Crosses (1x2), (1x3) and (1x4) for early yield / plant; and (lx2)and(1x3) for setting ratio. Crosses (1x2), (1x3) and (1x4) showed significant positive sca effect for early yield / plant; and (lx2) and (1x3) for No.of fruits / plant. For the total yield /plant the cross combinations (1x2), (1x3), (1x4) and (2x4) had the most desirable sca effects. Significant and positive sca effect was shown in crosses (1x4) for fruit weigh and (1x2) and (3x4) for weight of 100 seeds. Crosses (1x2), (1x4) and (2x3) has a desirable significant sca effect for No. of nodes to first female flower.

Table 5. General combining ability effects for some traits of local summer squash inbred lines

Flowering stage traits					Yield traits				
Inbreds	Sex ratio	Setting ratio	No.of node to first femal flower	No.of days to first femal flower	Early yield /plant (g)	No.of fruits/ plant	Total yield/ plant (kg)	Fruit weight (g)	Weight of 100 seeds (g)
1	0.365**	5.645**	-0.890**	-2.620**	107.357**	1.805**	0.197**	2.082	-0.775**
2	-0.016	1.389*	-0.715**	-1.246**	-10.011**	1.231**	0.025**	-4.731	0.323**
3	-0.228**	-4.100**	1.255**	1.821**	63.416**	-1.643**	-0.128**	-1.147	0.611**
4	-0.120**	-2.933**	0.350*	2.045**	-33.930**	-1.393**	-0.095**	3.796	-0.159**
C.D.(gi)0.05	0.041	1.323	0.289	0.626	7.899	0.517	0.017	1.435	0.112
C.D.(gi)0.01	0.055	1.782	0.389	0.843	10.638	0.696	0.023	1.933	0.151
C.D.(gi-gj)0.05	0.068	2.161	0.475	1.023	12.899	0.847	0.047	2.343	0.171
C.D.(gi-gj)0.01	0.091	2.910	0.634	1.378	17.371	1.141	0.063	3.156	0.230

*, ** Significant at 0.05 and 0.01 probability levels respectively

Table 6. Specific and reciprocal combining ability effects for some traits in summer squash crosses.

	Flowering stage traits				Yield traits				
Crosses and reciprocals specific	Sex ratio	Setting ratio	No.of nodes to first female flower	No.of days to first female flower	Early yield /plant (g)	No. of fruits/ plant	Total yield/ plant	Fruit weight (g)	Weight of 100 seeds (g)
crosses 1x2	0.221**	-1.054	-0.678*	-0.993	112.137**	1.956**	0.218**	1.778	1.026**
1x3	-0.144**	6.679**	-0.478	-0.633	16.541**	1.389**	0.116**	2.579	-0.266**
1x4	0.025	4.303	-1.186**	-2.787	73.502**	0.513	0.080**	3.347*	0.276**
2x3	-0.029	-5.314	-0.619*	-0.322	-4.172	-0.351	-0.038*	1.880	-0.871**
2x4	-0.115**	6.580	0.991**	-0.019**	-2.941	0.213	0.041*	1.114	0.242*
3x4	0.086	-5.150	0.167	-0.504	-9.744	-0.616	-0.060**	1.561	0.771**
C.D(sij) 0.05	0.079	2.416	0.532	1.144	14.421	0.945	0.031	2.621	0.194
C.D(sij)0.01	0.107	3.254	0.717	1.541	19.422	1.272	0.042	3.529	0.261
C.D(sij-sik) 0.05	0.126	3.742	0.824	1.773	22.342	1.465	0.047	4.059	0.303
C.D(sij-sik)0.01	0.170	5.040	1.110	2.388	30.088	1.973	0.063	5.467	0.408
Reciprocals 2x1	0.023	-3.802*	- 0.388	-0.112	4.780	-0.358	0.020	1.757	-0.028
3x1	0.033	-5.428**	-0.112	-2.985**	124.677**	0.183	0.102**	-2.415	1.172**
4x1	-0.087	6.557**	-0.278	0.945	-36.747**	-0.897*	-0.102**	-4.862**	-0.105
3x2	0.01	- 6.157**	-0.368	-0.443	2.248	-0.300	-0.040	-0.580	0.175
4x2	- 0.058	1.262	0.407	1.250	-37.452**	0.093	-0.015	-2.430	-0.540**
4x3	0.015	-6.358**	0.333	2.222**	-83.535**	-0.54	-0.142**	11.287**	1.108**
C.D.(rij)0.05	0.098	3.056	0.674	1.448	18.242	1.196	0.041	3.315	0.242
C.D.(rij)0.01	0.132	4.116	0.908	1.950	24.567	1.611	0.055	4.464	0.325
C.D.(rij-	0.144	4.322	0.951	2.047	25.798	1.691	0.055	4.687	0.348
rik)0.05	0.194	5.820	0.281	2.757	34.743	2.278	0.074	6.312	0.468

*, ** Significant at 0.05 and 0.01 probability levels respectively

These crosses might be recommended for producing commercial hybrid seeds or for a promising breeding program to improve summer squash in Egypt. The estimates of reciprocal effects showed a good amount of differences between direct and reciprocal hybrids. The reciprocal differences may be attributed to maternal effects. In our study no definite genetic mechanism could be ascribed for such reciprocal differences. It is evident from the foregoing results that the crosses showing high sca effects were not always involving the two parents with good gca effects. In other cases, the high sca effects were obtained from crosses involving one parent with good gca effects, these crosses would indicate that selection program could be executed in order to select and develop superior varieties in the advanced segregating generations from promising F_1 hybrids. However, some of the crosses including parents with high gca did not exhibit high specific good combination in some traits, it may be due to the lack of genetic diversity of the parental lines of the crosses. Similar results and conclusion were reported by Chadha and Nadpuri (1980) and Kalb and Davis (1984) on musk-melon, Bhagchandani *et al* 1980 on summer squash who reported that the best sca is sometimes obtained in crosses between parents with good and poor or moderate gca.

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نوع الفعل الجينى ، قدرة التآلف و اختلافات الهجن العكسية لبعض الصفات الاقتصادية فى الكوسة

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استخدام نظام الهجن التبادلية (بما فيها الهجن العكسية) بين اربعة سلالات ابوية من الكوسة (اسكندرانى- مطروحى – كوبى – شمامى) وذلك لدراسة الفعل الجينى و القدرة على التآلف لصفات النسبة الجنسية ونسبة العقد و عدد العقد حتى خروج أول زهرة مؤنثة و عدد الأيام حتى خروج اول زهرة مؤنثة و المحصول المبكر للنبات و عدد الثمار لكل نبات و المحصول الكلى للنبات ووزن الثمرة ووزن ١٠٠ بذرة . وقد أظهرت النتائج مساهمة كل من الفعل الجينى المضيف و غير المضيف (السيادى) فى توارث الصفات تحت الدراسة و كان المكون السيادى هو الأكبر تأثيراً و بالتالى متوسط درجة السيادة زاد عن الواحد الصحيح لصفات نسبة العقد و عدد العقد لأول زهرة مؤنثة و المحصول المبكر للنبات . و عدد الثمار للنبات و المحصول الكلى للنبات ووزن الثمرة مشيراً إلى وقوعها تحت تحكم جينات ذات تأثير سيادة فائقة . كانت كفاءة التوريث بمعناها الضيق عالية لكل الصفات المدروسة ما عدا صفة نسبة العقد .

ظهرت أعلى تأثيرات القدرة العامة على التآلف بواسطة السلالات الأبوية الناتجة من الصنف الشمامى لكل من صفتى المحصول المبكر للنبات ووزن ١٠٠ بذرة و من الصنف الاسكندرانى لجميع الصفات الباقية . كانت أعلى تأثيرات للقدرة الخاصة على التآلف بالإضافة للتأثير المعنوى للهجين إسكندرانى × مطروحى لصفات النسبة الجنسية و عدد العقد لأول زهرة مؤنثة و عدد الثمار للنبات و المحصول و الكلى للنبات ووزن ١٠٠ بذرة و للهجن اسكندرانى × شمامى و أسكندرانى × كوبى لصفات نسبة العقد ووزن الثمرة على التوالى .

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