STUDIES ON THE INHERITANCE AND TYPES OF GENE ACTION FOR SOME SUMMER SQUASH CHARACTERS.

M.K. Hatem, A.K. Hatem and Manal, A. Abd Alla
Hort., Res. Institute, Agric. Res. Center, Giza, Egypt .
(Received: ....., ..., 2013)

ABSTRACT

This investigation was carried out during two summer seasons 2010 and 2011 to study the heterosis and combining ability for some traits in summer squash at El-Kanater El-Khyreia Experimental Station of Hort. Res. Institute. Six parental lines viz., M1, M2, M3, M4, M5 and M6 were used in this study. In 2010 all possible crosses, without reciprocals, were made to produce the 15 F_1s. In 2011, the 15 crosses and their parents were evaluated for some important characters. Combining ability and heterosis were measured for all studied traits .The obtained results could be summarized as follows:

(1)Highly significant differences for general and specific combining abilities were found for all studied characters.

(2) The high estimated ratio between GCA and SCA mean squares were found for most studied traits.

(3) Line M3 was the best combiner for most studied characters, followed by the lines M1 and M2.

(4) Certain crosses had high SCA effect values for certain traits. The best crosses were "M1 x M6", " M2 x M3" and " M3 x M6", since they showed significant SCA effect values for most evaluated traits.

(5) Heterosis was detected in many crosses regarding total yield indicating that using hybrids in commercial production is very important.

(6) Heritability h^2_{bs} ranged from 29.29 for fruit number in early yield to 97.23 for number of days to first pistillate flower, the low (h^2_{bs}) values in some traits could be attributed to the low magnitude of total genetic variance and / or due to the high magnitude of environmental variance.

Key words: *Cucurbita pepo* L., Combing ability, Heterosis, Heritability.

INTRODUCTION

Summer squash, (*Cucurbita pepo* L.) is one of the important popular vegetable crops in Egypt. The cultivated area in 2010 according to statistics of the Ministry of Agriculture, reached about 83093 feddans around year for the all season and its production reached, nearly 1032015 tons with an average of 12.420 ton/fed.

Summer squash (*Cucurbita pepo* L.) is grown in many temperate and subtropical regions, ranking high in economic importance among vegetable crops worldwide (Paris, 1996).

Lopez- Anido et al. (1998) reported in Summer squash the importance of non-additive gene actions for most vegetative characters. Also they reported the importance of additive and non-additive gene actions for total fruit number and precocious production.

Al-Hamdany and Al-lelah (2011) found in summer squash that GCA was significant for: fruit length and diameter, number of fruits/plant and total yield, while SCA was significant for: female flowering, percentage of flower, fruit length and diameter, number of fruits /plant and total yield.

The expression of heterosis depends on the differences in the gene frequencies of the parental stocks, whether cultivars or inbreds. If the superiority of the hybrid combination is large, it is assumed that the two parents are more genetically diverse than those that manifest little or no heterosis (Hallauer and Miranda, 1988).

El-Gendy, (1999) found in summer squash high heritability in broad sense with a values of (h^2_{bs} 73.61%) for number of male flowers/plant, 70.59% for number of female flowers/plant, 78.66% for total weight of fruit/plant, 89.61% for fruit length, 87.84% for fruit diameter and 98.60% for fruit shape index. Aruah *et al.* (2012) found high h^2_{bs} for days to 50% flowering (68.19%), number of male flower (38.96%), number of female flower (21.99%), fruit diameter (97.259%), weight of harvested fruits/plant (20.17%) and number of fruits/plant (63.296%) are indicators of minimal environmental influence in the expressions of some characters.

MATERIALS AND METHODS

The present investigation was carried out at El-Kanater El-Khyreia Horticulture Research Station, during two successive summer seasons of 2010 and 2011.The genetic materials used in this study were six parental lines of summer squash (*Cucarbita pepo* L.) viz, M1, M2, M3, M4, M5 and M6 which were obtained from College of Horticulture, Northwest University, China.

These parental lines were at a high degree of homozygosity since they were selfed for two generations.

Seeds were sowing in the field on March 14th 2011 for studying the inheritance and types of gene actions of some traits. A randomized complete block design with three replicates was adopted. Each replicate included 21 rows (6 rows for parental lines and 15 rows for crosses), each row contained 12 plants. The distance between plants was 50 cm. The cultural practices were carried out according to the recommendations reported by Ministry of Agriculture.

Fruits were picked at three days intervals during the entire season.

The studied traits were:

(1) No. of days to first pistillate flower.
(2) No. of pistillate and staminate flowers / plant.
(3) Sex ratio. It was determined as: - No. of staminate flowers / No. of pistillate flowers
(4) Fruit Length (cm), diameter (cm) and shape index.
(5) Average fruit weight (g).
(6) Early yield as fruit number and weight (g)/plant.
(7) Total yield as fruit number and weight (9)/plant.

Statistical Procedures:-

(1) Analysis of variance was done in order to test the significant of the differences among the means of tested populations according to Cochran and Cox (1957). Differences among means for all characters were tested for significant according to the least significance differences (L.S.D.). (Snedecor and Cochran, 1990).

(2) The analysis of general and specific combining abilities (GCA and SCA) was calculated according to Griffing(1956); s method 2 model 1.

(3) Average degree of heterosis (ADH %), was expressed as percent increase or decrease of the performance above the mid-parents (MP) value and the high parent (HP) value (Sinha and Khanna, 1975).

(4) Potence ratio (PR) = $\overline{F}_1 - MP / \frac{1}{2}(\overline{P}_2 - \overline{P}_1)$. (Smith, 1952).

(5) Heritability in broad sense (h^2_{bs}). It is the ratio of genotypic variance to the phenotypic variance. Estimates of broad sense heritability were calculated as suggested by Singh and Chaudhary (1995) as follows:

$$h^2_{bs} = \sigma^2_g / \sigma^2_p .$$

RESULTS AND DISCUSSION:-

Data of the studied characters for parental line and F_1 populations are given in Table (1). The analysis of variance indicated that there were significant differences among the studied generations in all studied characters.

Table (1): Mean performance of parents and hybrids for studied characters in summer squash.

Characters / Genotypes	No. of days to first pistillate flower (♀).	No. of pistillate flowers (♀) / plant.	No. of staminate flowers (♂) / plant.	Sex ratio. ♀/♂	Fruit length (L) (cm).	Fruit diameter (D) (cm).
M1	36.67	16.00	22.33	1.39	10.83	3.80
M2	35.33	13.00	19.33	1.49	10.00	2.90
M3	31.33	17.33	20.33	1.17	13.67	3.27
M4	40.33	19.33	27.00	1.39	10.50	2.77
M5	42.67	18.67	29.00	1.59	12.50	3.00
M6	44.33	15.00	33.33	2.20	13.67	3.87
M1 x M2	34.67	13.00	20.67	1.59	10.83	3.40
M1 x M3	30.33	17.67	20.33	1.15	12.33	3.43
M1 x M4	36.67	16.67	23.67	1.42	10.17	3.27
M1 x M5	33.33	15.67	23.33	1.49	10.67	3.37
M1 x M6	40.33	16.00	27.67	1.73	11.33	3.87
M2 x M3	31.33	15.33	19.33	1.26	10.5.0	2.93
M2 x M4	36.67	14.67	23.00	1.57	10.00	2.77
M2 x M5	39.33	16.33	19.67	1.21	10.43	2.97
M2 x M6	41.33	17.33	25.67	1.49	10.67	3.83
M3 x M4	37.00	19.67	20.33	1.03	11.33	3.03
M3 x M5	33.00	17.00	22.67	1.33	12.33	3.23
M3 x M6	37.33	18.33	23.67	1.29	13.33	3.53
M4 x M5	39.33	18.33	27.00	1.48	11.5.0	2.73
M4 x M6	41.33	17.33	30.33	1.75	11.33	3.03
M5 x M6	42.33	18.67	26.00	1.41	13.17	3.20
L.S.D at 0.05	1.12	1.72	2.60	0.21	0.78	0.18
L.S.D at 0.01	1.50	2.30	3.47	0.28	1.05	0.24

Table (1) Con.

Characters / Genotypes	Fruit shape index. (L/D)	Average fruit weight (g).	Early yield fruit number/ plant.	Early yield fruit weight /plant. (g)	Total yield fruit number/ plant.	Total yield fruit weight / plant. (g)
M1	2.87	88.33	3.67	323.83	13.00	1347.00
M2	3.44	98.50	4.33	426.33	12.00	1176.00
M3	4.18	104.83	5.33	559.33	14.00	1443.00
M4	3.81	92.83	2.67	248.17	7.67	713.00
M5	4.17	106.50	3.33	354.83	8.33	883.33
M6	3.53	84.50	3.33	253.50	8.00	672.00
M1 x M2	3.18	91.17	4.67	425.50	13.33	1213.33
M1 x M3	3.59	96.33	6.67	642.50	15.00	1440.00
M1 x M4	3.12	89.50	3.33	298.33	12.67	1127.33
M1 x M5	3.17	93.50	5.33	498.00	13.00	1209.00
M1 x M6	2.93	86.33	3.67	328.50	12.00	1032.00
M2 x M3	3.58	100.33	6.33	604.17	14.33	1433.33
M2 x M4	3.61	94.00	4.00	329.00	12.33	1159.33
M2 x M5	3.52	100.50	4.33	407.67	11.67	1166.67
M2 x M6	2.78	91.00	3.67	333.67	11.33	1031.67
M3 x M4	3.74	95.67	5.33	520.78	11.67	1108.33
M3 x M5	3.81	104.83	5.33	561.89	15.00	1560.00
M3 x M6	3.78	93.33	5.33	499.28	13.33	1240.00
M4 x M5	4.20	89.33	4.67	465.17	11.33	1008.67
M4 x M6	3.82	84.33	4.00	349.11	8.33	700.00
M5 x M6	4.12	90.83	4.67	423.67	9.67	870.00
L.S.D at 0.05	0.46	3.642	0.78	75.429	0.969	94.624
L.S.D at 0.01	0.61	4.869	1.05	100.822	1.295	126.478

Data in Table (1) showed that No. of days to first pistillate flower ranged from 30.33 in (cross M1 x M3) to 44.33 days in (line M6), 13.00 pistillate flowers (♀) / plant in (line M2) and (cross M1 x M2) to 19.67 pistillate flowers / plant in (cross M3 x M4) , but in No. of staminate flowers (♂) / plant ranged from 19.33 in (line M2) and (cross M2 x M3) to 33.33 in (line M6) , while the sex ratio ranged from 1.03 in (cross M3 x M4) to 2.20 in (line M6), in fruit length ranged from 10.00 cm. in (line M2) to13.67 cm. in (lines M3 and M6), in fruit diameter the means ranged from 2.73 cm. in (cross M4 x M5) to 3.87 cm. in (line M6) and (cross M1 x M6), but in fruit shape index ranged from 2.78 in (cross M2 x M6) to 4.20 in (cross M4 x M5), in average fruit weight the means ranged from 84.33 g. in (cross M4 x M6) to 106.50 g. in (line M5), in early yield fruit number/plant the mean number ranged from 2.67 in (line M4) to 6.67 fruit in (cross M1 x M3), in total yield fruit number/ plant the number ranged from 7.667 in (line M4) to15.00 fruits in (cross M1 x M3), and the mean of total yield fruit weight / plant 672.00 g. to 1560.00 g. in (cross M3 x M5).

I- Combining ability:-

The analysis of variance for combining ability on various studied traits is shown in Table (2). Highly significant differences were observed for both general and specific combining ability in all studied traits. This result indicates the importance of both additive and non-additive gene effects in the inheritance of the studied characters. The estimated GCA/SCA mean squares ratio indicated that the additive genetic variance played the main role in the inheritance of all studied traits. The same results were found by other investigators, among them Lopez- Anido *et al.* (1998), El-Gendy, (1999) and Al-Hamdany and Al-lelah (2011).

To follow up the effect of GCA for the parental lines and SCA for the crosses, the estimated values are presented in Tables (3 and 4 respectively) for the various characters. Regarding GCA effects, the following parental lines showed highly significant positive effect values for different traits and could be considered as the best combiners : M1, M2 and M3 (for total yield fruit number/ plant and total yield fruit weight / plant.) ; M3, M4 and M5 (for No. of pistillate flowers / plant and fruit shape index); M3 (for sex ratio) ; M3,M5 and M6 (for fruit length) ; M2 , M4 and M5 (for fruit diameter) ; M2 , M3 and M5 (for average fruit weight). On the other hand, the following lines M1, M2 and M3 showed significant negative effects for No. of days to first pistillate flower and No. of staminate flowers. These lines could be considered as good combiners for breeding to these characters. The production of superior hybrids was realized when high GCA parents was used as reported by Al-Hmdany and Al-lelah (2011).

Table (2): Mean squares for combing ability (GCA and SCA) for some characters in summer squash.

Characters / Source of variation	No. of days to first pistillate flower		No. of pistillate flowers (♀) / plant		No. of staminate flowers (♂) / plant		Sex ratio ♂/♀		Fruit Length (cm)		Fruit Diameter (cm)	
	MS	F	MS	F	MS	F	MS	F	MS	F	MS	F
GCA	167.17**	360.05	28.76**	26.28	161.85**	65.05	0.51**	29.76	14.97**	28.58	1.43**	118.53
SCA	10.02**	21.59	4.31**	3.94	8.82**	3.54	0.09**	5.09	0.95**	1.81	0.07**	5.96
GCA/SCA	16.68		6.68		18.35		5.84		15.78		19.87	

*Significant at 0.05 level of probability.
**Significant at 0.01 level of probability.

Table (2)Con.

Characters / Source of variation	Fruit shape index		Average fruit weight (g)		Early yield fruit number /plant		Early yield fruit weight /plant (g)		Total yield fruit number/ plant		Total yield fruit weight / plant (g)	
	MS	F	MS	F	MS	F	MS	F	MS	F	MS	F
GCA	1.68**	21.53	452.23**	92.70	8.52**	37.36	114017.45**	54.51	46.08**	133.48	659223.52**	200.28
SCA	0.19**	2.423	18.70	3.83	1.88**	8.21	14473.59	6.92	4.84	14.03	35721.89	10.85
GCA/SCA	8.88		24.18		4.53		7.88		9.52		18.45	

*Significant at 0.05 level of probability.
**Significant at 0.01 level of probability.

Table (3): Estimated general combining ability (GCA) effects for the parental lines regarding some characters in summer squash.

Characters / Parents	No. of days to first pistillate flower	No. of pistillate flowers (♀) / plant	No. of staminate flowers (♂) / plant	Sex ratio ♂/♀	Fruit Length	Fruit Diameter
M1	-4.88**	-2.29**	-3.00**	0.01	-1.26	0.83**
M2	-2.88**	-5.41**	-8.00**	-0.02	-2.98	-0.40**
M3	-11.25**	2.08**	-8.00**	-0.65**	2.55**	-0.01
M4	3.75	3.08**	3.75**	-0.04	-1.89	-0.89**
M5	4.13	2.33**	3.38**	-0.02	1.03**	-0.46**
M6	11.13	0.21	11.87**	0.73**	2.55**	0.93**

* Significant at the 0.05 level of probability according to " T " test.
** Significant at the 0.01 level of probability according to " T " test.

Table (3) Con.

Characters / Parents	Fruit shape index	Average fruit weight	Early yield fruit number/plant	Early yield fruit weight/plant (g)	Total yield fruit number/ plant	Total yield fruit weight/ plant (g)
M1	-1.22**	-9.50**	0.00	-41.47**	3.50**	326.63**
M2	-0.54**	5.69**	0.00	0.59	1.63**	191.88**
M3	0.71**	15.50**	3.25**	373.58	5.50**	683.63**
M4	0.42**	-7.63**	-1.88**	-184.63**	-4.13**	-493.13
M5	0.81**	12.44**	0.00	43.12**	-2.00**	-98.88**
M6	-0.18	-16.50**	-1.38**	-191.19**	-4.50**	-610.13

* Significant at the 0.05 level of probability according to "T" test.
** Significant at the 0.01 level of probability according to "T" test.

For specific combining ability effects of the crosses, the best combinations were : M1×M3 , M1×M6 , M2×M6, M3×M4 , M3×M6 and M5×M6 (for No. pistillate flowers) ; M1×M6 and , M3×M5 (for average fruit weight); M1×M3,M1×M4, M1×M5, M1×M6, M2×M4 ,M2×M6, M3×M4, M3×M6, M4×M5, M4×M6 and M5×M6 (for early yield fruit number) ; M1×M2, M1×M3, M1×M4, M1×M5, M1×M6 , M2×M3, M3×M4, M4×M5, M4×M6 and M5×M6 (for early yield fruit weight) ; M1×M4, M1×M5, M1×M6, M2×M4 , M2×M6, , M3×M4, M3×M6, M4×M5 and M4×M6 (for total yield fruit number) ;M1×M4, M1×M6, M2×M3, M2×M4 , M2×M6, M3×M5 and M3×M6 (for total yield fruit weight). Meanwhile, the best combinations for No. of days to first pistillate flower) were M1×M3 , M1×M5, M2×M3, M2×M4 ,M3×M5, M4×M5 and M4×M6; M2×M5, M3×M4, M3×M6 and M5×M6 (for No. of staminate flowers (♂);M1×M3, M2×M5 , M2×M6, M3×M4 , M3×M6 and M5×M6 (for sex ratio); M1×M5, M2×M3 and M2×M6 (for fruit length) ;. M1×M3, M2×M3, M4×M6 and M5×M6 (for fruit diameter); M1×M4 M1×M5, M2×M6 and M3×M5 (for fruit shape index), these combinations gave negative SCA value. Most of these crosses were the best in fruit yield. This could be explaining by the effect of number of fruit per plant on the total fruit yield. All mentioned crosses exhibited significant positive SCA effect values. El-Gendy, (1999) and Al-Hmdany and Al-lelah (2011) found positive and negative SCA effects concerning flowering date. And found also significant negative SCA effects for early yield fruit number and weight in some crosses.

Table (4): Estimates of specific combining ability (SCA) effects for the studied F_1 crosses regarding some characters in summer squash.

Parents	Characters	SCA effect				
		M2	M3	M4	M5	M6
M1	No. of days to first pistillate flower.	-0.39	-5.01**	-1.02	-11.39**	517.61**
	No. of pistillate flowers (♀) / plant.	-3.48**	3.02**	-0.98	-3.23**	236.89**
	No. of staminate flowers (♂) / plant	0.86	-0.14	-1.89	-2.52	332.98**
	Sex ratio. ♂/♀	0.44**	-0.26*	-0.06	0.15	21.28**
	Fruit Length.	2.29**	1.27	-0.79	-2.2**	162.77**
	Fruit Diameter.	0.02	-0.26*	0.12	-0.01	51.91**
	Fruit shape index .	0.60*	0.57*	-0.54*	-0.79**	47.28**
	Average fruit weight .	-5.04**	0.64	3.27	-4.79*	1379.14**
	Early yield fruit number/plant.	0.71	3.46**	-1.41**	2.71**	70.09**
	Early yield fruit weight (g)/plant.	52.62**	330.64**	-143.65**	227.60**	6517.91**
	Total yield fruit number/ plant.	-0.55	0.57	3.20**	2.07**	202.57**
	Total yield fruit weight (g)/ plant.	-240.50	-52.25	186.50	37.25	19027.5**
M2	No. of days to first pistillate flower.		-4.018**	-3.02**	4.61**	3.61**
	No. of pistillate flowers (♀) / plant.		-0.86	-3.86**	1.89	7.02**
	No. of staminate flowers (♂) / plant		1.86	1.11	-8.52**	0.98
	Sex ratio. ♂/♀		0.11	0.41**	-0.69**	-0.58**
	Fruit Length .		-2.52**	0.42	-1.20	-2.02**
	Fruit Diameter.		-0.54**	-0.17	0.01	1.22**
	Fruit shape index.		-0.13	0.24	-0.43	-1.65**
	Average fruit weight.		-2.55	1.58	1.02	1.46
	Early yield fruit number/plant.		2.46**	-1.41**	-0.29	-0.91*
	Early yield fruit weight (g)/plant.		173.58**	-93.71*	-85.46*	-73.15
	Total yield fruit number/ plant.		0.45	4.07**	-0.05	1.45**
	Total yield fruit weight (g)/ plant.		62.50**	417.25**	45.00	151.25**
M3	No. of days to first pistillate flower.			6.36**	-6.02**	-0.02
	No. of pistillate flowers (♀) / plant.			3.64**	-3.61**	2.52*
	No. of staminate flowers (♂) / plant			-6.89**	0.48	-5.02**
	Sex ratio. ♂/♀			-0.56**	0.32**	-0.55**
	Fruit Length.			-1.11	-1.02	0.46
	Fruit Diameter.			0.26**	0.43**	-0.06
	Fruit shape index.			-0.61*	-0.79**	0.10
	Average fruit weight.			-3.23	4.21*	-1.36
	Early yield fruit number/plant.			1.34**	-0.54	0.84*
	Early yield fruit weight (g)/plant.			108.65**	4.22	50.71
	Total yield fruit number/ plant.			-1.80**	6.07**	3.57**
	Total yield fruit weight (g)/ plant.			-227.50**	733.25**	284.50**

* Significant at 0.05 level of probability according to the (T) test.
** Significant at 0.01 level of probability according to the (T) test

Table (4)Con.

Parents	Characters	SCA effect				
		M2	M3	M4	M5	M6
M4	No. of days to first pistillate flower.				-2.02**	-3.0**
	No. of pistillate flowers (♀) / plant.				-0.61	-1.48
	No. of staminate flowers (♂) / plant				1.73	3.23**
	Sex ratio. ♂/♀				0.14	0.22*
	Fruit Length.				0.92	-1.11
	Fruit Diameter.				-0.19	-0.68**
	Fruit shape index.				0.66*	0.52*
	Average fruit weight.				-19.17**	-5.23*
	Early yield fruit number/plant.				2.59**	1.96**
	Early yield fruit weight (g)/plant.				272.26**	158.41**
	Total yield fruit number/ plant.				4.70**	-1.80**
	Total yield fruit weight (g)/ plant.				256.00	- 158.75**
M5	No. of days to first pistillate flower.					-0.39
	No. of pistillate flowers (♀) / plant.					3.27**
	No. of staminate flowers (♂) / plant					-9.39**
	Sex ratio. ♂/♀					-0.82**
	Fruit Length.					1.48*
	Fruit Diameter.					-0.61**
	Fruit shape index.					1.02**
	Average fruit weight.					-5.79**
	Early yield fruit number/plant.					2.09**
	Early yield fruit weight (g)/plant.					154.33**
	Total yield fruit number/ plant.					0.07
	Total yield fruit weight (g)/ plant.					-43.56

* Significant at 0.05 level of probability according to the (T) test.

** Significant at 0.01 level of probability according to the (T) test

II - Average degree of heterosis:-

1. No. of days to first pistillate flower

Regarding number of days to first pistillate flower, nine crosses gave high significant negative heterosis values from the MP, indicating dominance towards the short period to flowering. The remaining three ones were statistically similar to MP, indicating no- dominance for the character. Partial dominance was shown by the cross M2 x M4, since it gave significant negative and positive ADH values based on MP and BP, respectively, the potence ratios for this crosses was -0.47. Over dominance for short period to flowering of pistillate flowers was shown in one cross, i.e. M1 x M5. Their estimated ADH value, from the early parent (BP) was significantly negative or and the potence ratio was -2.11. Complete dominance for short period to flowering was shown in four crosses, i.e. M1 x M2, M1 x M3, M2 x M3 and M4 x M5. Their estimated ADH values, from the early parent (BP) were insignificant and the potence ratios for these crosses were -2.00, -1.38, -1.00 and-1.86. (Table, 5). El-Hadi and El-Gendy (2004), reported that significant negative value (-10.7%) for the number of days to first pistillate flower at the pest parent was detected.

2. No. of pistillate flowers / plant:

Over dominance for No. of pistillate flowers / plant was shown in one cross, i.e. M2 x M6. Their estimated ADH values, from the No. of pistillate flowers / plant (BP) was highly significant and the potence ratio was 3.33. Complete dominance was shown in two crosses, i.e. M3 x M6 and M5 x M6. Their estimated ADH values, from (BP) were insignificant and the potence ratios for these crosses were 1.86 and 1.00, respectively. The remaining seven ones were statistically similar to MP, indicating no-dominance for the character.

3. No. of staminate flowers / plant:-

Regarding this trait, five crosses gave significant or high significant negative heterosis values from the MP, indicating dominance towards the few No. of staminate flowers. The remaining four ones were statistically similar to MP, indicating no- dominance for the character. Partial dominance was shown by the cross M3 x M6, since it gave significant negative and positive ADH values based on MP and BP, respectively. The potence ratio for this cross was -0.49. Over dominance for the high No. of staminate flowers / plant was shown in the M5 x M6. The estimated ADH value, based on (BP) was significant and the potence ratios for this crosses was -2.67.

Table (5): Magnitude of heterosis for No. of days to first pistillate flower , No. of pistillate and staminate flowers / plant.

Hybrids	No. of days to first pistillate flower			No. of pistillate flowers (♀) / plant			No. of staminate flowers (♂) / plant		
	Heterosis (%)		PR	Heterosis (%)		PR	Heterosis (%)		PR
	MP	BP		MP	BP		MP	BP	
M1 x M2	-3.70*	-1.89	-2.00	-10.34	-18.75*	-1.00	-0.80	6.90	-0.11
M1 x M3	-10.78**	-3.19	-1.38	6.00	1.923	1.50	-4.69	0.00	-1.00
M1 x M4	-4.76*	0.00	-1.00	-5.66	-13.79**	-0.60	-4.05	5.97	-0.43
M1 x M5	-15.97**	-9.09**	-2.11	-9.62*	-16.07**	-1.25	-9.68*	4.48	-0.71
M1 x M6	-0.41	10.00**	-0.04	3.23	0.00	1.00	-0.60	23.88**	-0.03
M2 x M3	-6.00**	0.00	-1.00	1.10	-11.54*	0.08	-2.52	0.00	-1.00
M2 x M4	-3.08*	3.77*	-0.47	-9.28	-24.14**	-0.47	-0.72	18.97**	-0.04
M2 x M5	0.86	11.32**	0.09	3.16	-12.50**	0.18	-19.18**	1.72	-0.93
M2 x M6	3.77**	16.98**	0.33	23.81**	15.56**	3.33	-2.53	32.76**	-0.10
M3 x M4	3.26*	18.09**	0.26	7.27	1.724	1.33	-14.08*	0.00	-1.00
M3 x M5	-10.8**	5.32**	-0.71	-5.56	-8.93*	-1.50	-8.72	11.48	-0.48
M3 x M6	-1.32	19.15**	-0.08	13.40*	5.77	1.86	-11.80*	16.39*	-0.49
M4 x M5	-5.22**	-2.48	-1.86	-3.51	-5.17	-2.00	-4.14	0.00	-1.00
M4 x M6	-2.36	2.48	-0.50	0.97	-10.34*	0.08	0.55	12.35*	0.05
M5 x M6	-2.68*	-0.78	-1.40	10.89*	0.00	1.00	-17.02**	-11.36*	-2.67

* - Significant at 5 % level, and ** - Significant at 1% level.

4. Sex Ratio:-

For sex ratio, in Table 6, when the ADH% was estimated from the MP, all crosses gave insignificant or significant negative values, indicating no dominance or dominance toward the low sex ratio. This suggestion was supported by the calculated ADH values, based on the better parent, which was insignificant or positive significant in all crosses, except one cross, (M2 x M5) which showed hybrid vigour for the character.

5. Fruit Length

Regarding fruit length, fourteen crosses reflected insignificant ADH values, in relation to MP, while one cross, i.e. M2 x M3, showed significant negative value. This means that the short fruit is mainly controlled by no-dominance genes. Accordingly ten of the crosses exceeded the better parent in length, so significant positive value was obtained in relation to the better parent.

6. Fruit Diameter

For fruit diameter, in Table 6, complete dominance for narrow diameter was shown in three crosses, i.e. M2 x M3, M2 x M4 and M4 x M5. Their estimated ADH values, from the low diameter (BP) were no significant for the best parent and the potence ratios for these crosses were -0.82, -1.00 and-1.29. Partial dominance was shown by the crosses M4 x M6 and M5 x M6 since they gave significant negative and positive ADH values based on MP and BP, respectively, and the potence ratios for these crosses were -0.52 and -0.54. The remaining five ones were statistically similar to MP, indicating no- dominance for the character, i.e. M1 x M2, M1 x M4, M1 x M5, M3 x M4 and M3 x M6, and the potence ratios for these crosses were low (0.11, -0.03, -0.08, 0.07 and-0.11).

Table 6: Magnitude of heterosis for sex ratio, fruit length and fruit diameter.

Hybrids	Sex Ratio.			Fruit Length.			Fruit Diameter.		
	Heterosis (%)		PR	Heterosis (%)		PR	Heterosis (%)		PR
	MP	BP		MP	BP		MP	BP	
M1 x M2	10.52	14.08	3.37	4.00	8.33	1.00	1.49	17.24**	0.11
M1 x M3	-10.51	-1.99	-1.21	0.68	13.85**	0.06	-2.83	5.10**	-0.38
M1 x M4	1.67	1.67	0.02	-4.69	-3.17	- 3.00	-0.51	18.07**	-0.03
M1 x M5	0.34	7.16	0.05	-8.57	-1.54	- 1.20	-0.98	12.22**	-0.08
M1 x M6	-3.70	24.11**	-0.17	-7.48	4.62	- 0.65	0.87	1.75**	1.00
M2 x M3	-5.01	7.67	-0.43	-11.27**	5.00	- 0.73	-4.86	1.15**	-0.82
M2 x M4	8.67	12.17	2.78	-2.44	0.00	- 1.00	-2.35	0.00**	-1.00
M2 x M5	-21.48**	- 18.83**	-6.6	-7.26	4.33	- 0.65	0.56**	2.30**	0.33
M2 x M6	-19.24	0.22	-0.99	-9.86	6.67	- 0.64	13.30	32.18**	0.93
M3 x M4	-19.59**	-11.93	-2.25	-6.21	7.94	- 0.47	0.56	9.64**	0.07
M3 x M5	-3.38	13.64	-0.23	-5.73	-1.33	- 1.29	3.19	7.78**	0.75
M3 x M6	-23.40**	10.23	-0.77	-2.44	-2.44	- 0.33	-0.93	8.16**	-0.11
M4 x M5	-1.01	5.73	-0.16	0.00	9.52	0.00	-5.20	-1.20**	-1.29
M4 x M6	-2.78	25.30**	-0.12	-6.21	7.94	- 0.47	- 8.54**	9.64*	-0.52
M5 x M6	-25.59**	-11.13	-1.57	0.64	5.33	0.14	-6.8**	6.67**	-0.54

* - Significant at 5 % level, and ** - Significant at 1% level.

7. Fruit shape index

Regarding fruit shape index, in table (7) fourteen crosses reflected insignificant ADH values, in relation to MP, while one cross (M2 x M6), showed significant negative value. This means that fruit shape index is controlled mostly by no-dominance genes.

8. Average fruit weight

For average fruit weight, none of the studied crosses showed dominance or over dominance for the heavy fruit. All crosses showed insignificant or significant negative heterosis values from the MP indicating incomplete dominance or dominance toward the small fruited parent.

The estimated ADH value based on the long fruited parent (BP) support this suggestion. The estimated potence ratio was in accordance with the postulated theory.

9. Early yield fruit number/plant

Estimated ADH% in relation to the MP showed that nine crosses exceeded the MP in early fruit number in table 7, indicating dominance towards the better parent in this respect. When the ADH for these crosses was calculated from BP, six ones showed hybrid vigour for the trait, since they exceeded the BP number of early fruits. The remaining crosses exhibited no-dominance or dominance for the low value.

Table (7): Magnitude of heterosis for Fruit shape index, average fruit weight and early yield/plant (fruit number).

Hybrids	Fruit shape index			Average fruit weight			Early yield fruit number/plant		
	Heterosis (%)		PR	Heterosis (%)		PR	Heterosis (%)		PR
	MP	BP		MP	High parent		MP	BP	
M1 x M2	0.90	10.92	-0.10	-2.41	-7.45**	-0.44	16.67	7.69	2.00
M1 x M3	1.70	24.97**	-0.09	-0.26	-8.11**	-0.03	48.15**	25.00**	2.60
M1 x M4	-6.44	8.83	0.46	-1.20	-3.59	-0.48	5.26	-9.09	0.33
M1 x M5	-9.90	10.45	0.54	-4.02*	-12.21**	-0.43	52.38**	45.45**	11.00
M1 x M6	-8.49	2.09	-0.81	-0.10	-2.26	-0.04	10.00	0.00	1.00
M2 x M3	-5.99	4.17	-0.61	-1.31	-4.29*	-0.42	31.03**	18.75*	3.00
M2 x M4	-0.37	4.94	0.07	-1.74	-4.57*	-0.59	14.29	-7.69	0.60
M2 x M5	-7.54	2.23	-0.79	-1.95	-5.63**	-0.50	13.04	0.00	1.00
M2 x M6	-20.27**	-19.19	-15.14	-0.55	-7.61**	-0.07	0.00	-15.38	0.00
M3 x M4	-6.38	-1.75	-1.35	-3.20	-8.74**	-0.53	33.33**	0.00	1.00
M3 x M5	-8.74	-8.56	-43.80	-0.79	-1.56	-1.00	23.08*	0.00	1.00
M3 x M6	-2.12	6.89	0.25	-1.41	-10.97**	-0.13	28.00**	0.00	1.00
M4 x M5	5.35	10.33	1.19	-10.37**	-16.12**	-1.51	55.56**	40.00**	5.00
M4 x M6	4.18	8.21	-1.12	-4.89**	-9.17**	-1.04	41.18**	33.33*	7.00
M5 x M6	7.01	16.60*	-0.85	-4.89**	-14.71**	-0.42	47.37**	55.56**	9.00

* - Significant at 5 % level, and ** - Significant at 1% level.

10. Early yield fruit weight /plant

The same trend of inheritance early fruit weight was observed. The crosses showed dominance towards the high early yield in Table 8. From these crosses, four ones showed hybrid vigour for the trait. The no-dominance and partial or complete dominance for the high yield was observed some other crosses. In this regard, Firpo *et al.*, (1998) and El-Gendy, (1999) found heterosis over both mid and better parental values for early yield in summer squash.

Table (8): Magnitude of heterosis for early yield/plant (fruit weight), total yield/ plant (fruit number). and total yield/plant (fruit weight).

Hybrids	Early yield fruit weight/plant g			Total yield fruit number/ plant			Total yield fruit weight/ plant g		
	Heterosis (%)		PR	Heterosis (%)		PR	Heterosis (%)		PR
	MP	BP		MP	BP		MP	BP	
M1xM2	13.44	-0.20	0.98	6.67	2.56	1.67	-3.82	-9.92**	-0.56
M1xM3	45.50**	14.87**	1.71	11.11**	7.14*	3.00	3.23	-0.21	0.94
M1xM4	4.31	-7.87	0.33	22.58**	-2.56	0.88	9.45*	-16.31**	0.31
M1xM5	46.80**	53.78**	10.24	21.88**	0.00	1.00	8.41	-10.25**	0.40
M1xM6	13.80	1.44	1.13	14.29**	-7.69*	0.60	2.23	-23.39**	0.07
M2xM3	22.59**	8.02	1.67	10.26**	2.38	1.33	9.46*	-0.67	0.93
M2xM4	- 98.81**	- 99.06**	-3.74	-59.32**	- 66.67**	-2.69	- 99.58**	-1.42	-4.06
M2xM5	4.37	-4.35	0.48	14.75**	-2.78	0.82	13.31	-0.79	0.94
M2xM6	-1.84	- 21.74**	-0.07	13.33**	-5.56	0.67	11.65*	-12.27**	0.43
M3xM4	28.99**	-6.89	0.75	7.69	- 16.67**	0.26	2.81	-23.19**	0.08
M3xM5	22.93**	0.46	1.02	34.33***	7.14*	1.35	34.12**	8.11*	1.42
M3xM6	22.85*	-10.74	0.61	21.21**	-4.76	0.78	17.26**	-14.07	0.47
M4xM5	54.28**	31.09**	3.07	41.67**	36.00**	10.00	26.37**	14.19*	2.47
M4xM6	39.18*	37.72*	36.85	6.38	4.17	3.00	1.08	-1.82	0.37
M5xM6	39.29**	19.40	2.56	6.67**	16.00**	9.00	11.87*	-1.51	0.87

* - Significant at 5 % level, and ** - Significant at 1% level.

11. Total yield fruit number/ plant

Data presented in Table (8) show that most studied crosses showed dominance towards the high number of fruits, since they exceeded the mid parents significantly. Based on the better parent four crosses exhibited hybrid vigour for the high number, since significantly exceeded the BP in this respect. Incomplete and partial dominance was also observed.

12. Total yield fruit weight/ plant

The same trend of inheritance total fruit weight was observed. The crosses showed dominance towards the high total yield in table 8. From these crosses, two ones showed hybrid vigour for the trait. The no-dominance and partial or complete dominance for the high yield was observed in some other crosses. Firpo *et al.* (1998), El-Gendy, (1999) reported hybrid vigour for fruit yield and its contributing traits in squash. Marie *et al.* (2012) reported that heterosis over mid parent was evident in all yield components.

Marie *et al.* (2012) reported that heterosis over mid-parents was evident in all yield components. They added that high heterosis values for the most studied characters for the mid-parents, and high parents, indicating that genotypic values for the studied parent lines.

III - Heritability

Moderate to high values of heritability in broad sense (h_b^2) were calculated for most studied characters, while it was relatively low for other one. The obtained (h_b^2) values for the studied characters are 97.23 for No. of days to first pistillate flower, 73.96 for No. of pistillate flowers (♀),85.66 for No. of staminate flowers (♂),77.37 for sex ratio, 88.24 for fruit length, 91.69 for fruit diameter, 67.4 for fruit shape index, 89.30 for Average fruit weight , 29.29 for early yield fruit number, 31.01 for early yield fruit weight , 39.64 for total yield fruit number and 32.21% for total yield fruit weight. The low (h_b^2) values in this trait could be attributed to the low magnitude of total genetic variance and / or due to the high magnitude of environmental variance. In this respect, many authors obtained similar results among them. El-Gendy, (1999) and Aruah *et al.* (2012).

REFERENCES

Al-Hamdany, S.Y.H. and W. B.A.M. Al-Lelah (2011). Combining ability analasis for yield and its combonents in summer squash (*Cucurbita pepo* L.). J. Agric. Rafidain, Iraq. 39(1): 40-48.

Aruah, B. C.; I. M. Uguru and B. C. Oyiga (2012). Genetic variability and inter-relationship among som Nigerian pumpkin accessions (Cucurbita spp.). International Journal of plant breeding. 6(1), 34 – 41.

Cochran, W.G., and G. M. Cox (1957). Experimental Designs . Willy, New York, pp 611.

El-Gendy, S. E. A. (1999). Estimates of genetic parameters in some squash hybrids through two mating designs. Ph.D. Thesis, Fac. of Agric. Mansoura Univ. 117p.

El-Hadi, A. H. and E.A. El-Gendy (2004). Effect of genotypes by locations interaction on economical traits of squash. J. Agric. Sci., Mansoura Univ., 29(10): 5567-5587.

Firpo, I. T.; F. Lopez Anido; S. M. Garcia, and E. Cointry (1998). Heterosis in summer squash (*Cucurbita pepo* L.). Cucurbit Genetics Cooperative (CGC) 21: 43-45.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel cropping system. Australian J. of Biological Sci., 9, 463-495.

Hallauer, A.R. and J.B. Miranda Filho, (1988). Quantitative Genetics in Maize Breeding. 2nd edn. Iowa State University Press, Ames.

Marie, A. K.; M. Y. Moualla and M. G. Boras (2012). Heterosis Study of Some Quantity Characters of Squash *Cucurbita pepo*, L. Damascus University Journal of Agricultural Sciences, Syria. 28(1): 339 – 354.

Paris, H.S., (1996). Summer Squash: History, diversity, and distribution. Hort. Technology 6: 6–13.

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

Singh, R. K. and B. D. Chaudhary (1995). Biometrical Methods in Quantitative genetic analysis. Kalyani Publishers, New Delhi-1 1002. India, p.317.

Smith, H. H. (1952). Fixing transgressive vigour in nicotiana rustica . In heterosis , Iowa State College Press. Ames , Iowa , U.S.A.

Snedecor, G. W. and W.C. Cochran (1990). "Statistical Method". 7th ed. The Iowa State Univ. Ames. USA. 593 p.

المُلخص العربي

دِراسَات عَلى وراثة ونُظم التفاعُل الجينى لِبَعْض صِفات محصول قرع الكوسه

مَحمُود قُطب حَاتِم - أحمد قُطب حاتِم - مَنَال عَبد الرحمن عبد الله
اقسام بحوث الخُضَر - معهد بحوث البساتين - مركز البحوث الزراعية .

أجريت التجارب الخاصة بهذه الدراسة بمزرعة مَحطة بحوث البسَاتين بالقناطر الخَيرية خِلال المُوسم الصَيفي لِعَامَي ٢٠١٠ ، ٢٠١١ ، وكان الهدف من هذا البَحث هو تقدير قُدرة هذهِ السُلالات على الائتلاف وكذلك دراسة درجة قُوة الهَجين للحُصول على مزيد من المَعلومات الخاصة بوراثة بعض الصفات لمُساعدة المُربى على وضع وتنفيذ برامج التربية لتحسين محصول الكوسة والذي يُعتبر من محاصيل الخُضر الهامة في مصر .

واستخدم في هَذه الدراسة ٦ سُلالات من الكوسة نَقية وراثياً هي M1 ، M2، M3 ، M4 ،M5 ،M6 ، وأجرى التهجين فيما بينها في مُوسِم ٢٠١٠ للحُصول على بُذور الجيل الأول اللازمة للدراسة ، وفي موسِم ٢٠١١ زُرعت الآباء والهُجُن الخمسَة عشر في تجربة مُصَمَّمَه بطريقة القِطاعات الكاملةُ العَشوائية في ثلاث مُكررات - وكانت الصِفات التي تناولتها الدراسة هى. عدد الأيام حتى أول زهرة مؤنثة - عدد الأزهار المؤنثة على النبات(♀) - عدد الأزهار المذكرة على النبات (♂) - النسبة الجنسية ♀/♂ - طول الثمرة - قُطر الثمرة - مُعدل شكل الثمرة - متوسط وزن الثمرة - المحصول المبكر (عدد ووزن الثمار) - المَحصُول الكُلى (عدد ووزن الثمار) . متوسط عدد الثمار لكل نبات.

وكانت أهم النتائج المُتحصل عليها هي :

[١] كان التباين لكلٍ من القُدرة العامَّة والخاصَّة على الائتلافِ مَعنوياً لكُل الصِفات التي تم دراستها - وهذا يوضح أهمية كلا من الفعلِ المُضيف والغير مُضيف للجينات في وراثةِ هذه الصِفات .

[٢] أظهرت النسبة المحسوبة بين مُتوسط مُربع الانحرافات للقُدرة العامَّة والخاصَّة على الائتلاف أن الفعل المُضيف يَلعب دوراً أكثر أهمية من الفِعلِ الغير مُضيف في الصِفات تحت الدراسة . وهذا يُشير إلى فعالية الإنتخاب كطريقة تربية فى تَحسين مُعظم الصِفات .

[٣] اختلفت الآباء في تأثيرات القُدرة العامَّة على الائتلاف فكل سُلالة أبَوية أظهرت قُدرة عالية ومَعْنَوِيَة لعَدَد من الصِفات - واتضح مِن الدراسة أن السُلالة M3 كانت أفضَل السُلالات الأبوية مِن حيث قِيم المَعنوية العالية لمُعظم الصِفات المَدروسَة ، يَليها السُلالتين M1 ، M2 .

[٤] أوضَحت دِراسة تأثيرات القُدرة الخاصَّة على الائتلاف أن الهُجن التي يَدخل في تكوينُها أحد هذه الآباء M3، M2 ، M1 أعطت قِيم عالية ومَعنوية للقُدرة الخاصَّة على الائتلاف في مُختلف الصِفات المَدروسَة وعلى هذا يُمكن استخدام هذه السُلالات لِلاستفادة مِنها في بَرامِج تربية وتَحسين قرع الكوسة .

[٥] ظهرت كل نُظم السيادة (إنعدام سِيادة ، سِيادة جُزيئية ، سيادة تامة ، قوه الهَجين) للهُجُن تحت الدراسة في الصِفات المُختلفة . فى الهُجن التى تم إنتاجها وتقييمها -- وظهور قوة الهَجين فى صِفة كمية المحصول كعدد ووزن الثمار/ نبات مما يُشجع على إنتاج الهُجن محلياً فى الكوسة وزراعتها على النطاق التُجارى لزيادةِ الإنتاج.

[٦] أما بالنسبة لقياس معامل التوريث فقد أوضح أن القيم إختلفت بإختلاف الصفة, وفى معظم الحالات فإن جزء كبير من الإختلافات المظهرية مرجعة إلى الإختلافات الوراثية , وهذا يدل على الفروق المعنوية الملاحظة بين السلالات فى الصفات المختلفة مرجعها إلى الوراثة.