Heterosis and Genetic Behavior of Some Yield and Yield Component Traits in Squash (*Cucurbita pepo*, L.)

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ABSTRACT

An 7 x 7 complete diallel cross of squash was evaluated with parents for heterotic manifestation and evaluate the genetic behavior of yield and yield component traits. Seven different squash varieties belong to the species (*Cucurbita pepo*, L.), were used in this study. These parental varieties were: Eskandarani (P_1); Zucca Patisson custard white (P_2); All Green Bush (P_3); Courgette Orelia (P_4); Sakiz (P_5); Copi (P_6) and Gapla (P_7). The seeds of these parental varieties were obtained from different countries: (P_1) and (P_6) from Egypt; (P_2) from France; (P_3) from United Kingdom (U.K.); (P_4) from Germany; (P_5) from Turkey and (P_7) from Syria. These parental varieties were used and their 42 $F_{1,1r}$ hybrids were obtained through complete diallel crosses mating design system.

Data were recorded for seven traits: fruit length (F.L.cm); fruit diameter (F.D.cm); fruit shape index (F.Sh.I.); Total Soluble Solid% (T.S.S%); weight of fruit (W.F.g); number of fruits per plant (No.F./P.) and fruit yield per plant (F.Y./P.kg). The results also indicated that the amounts of heterosis versus mid-parents showed highly significant values for all studied traits. The estimates of heterosis versus the better parent showed highly significance for most studied traits. None of the hybrids exhibited maximum heterosis for all the traits, but significant and desirable level of heterosis over mid-parents and better parent was obtained in several hybrids for the different traits. However, GCA values were larger than their corresponding estimates of SCA for studied yield and yield component traits at both $F_{1,1r}$ hybrids. Reciprocal effects (r) were significant for most studied traits. The results indicated that the parents P_1, P_3, P_4, P_5 and P_7 were seemed to be the best combiners for fruit length (F.L.cm), fruit shape index (F.Sh.I.) and number of fruits per plant (No.F./P.). Also, P_2 was the best combiner for Total Soluble Solid% (T.S.S%). In the same time, the two parents P_2 and P_6 were the best combiners for fruit diameter (F.D.cm) and weight of fruit (W.F.g).

These results indicated that the parents P_1, P_2 and P_4 were seemed to be the best combiners for fruit yield per plant (F.Y./P.kg). All 49 genotypes (seven parents, 21 F_1's and 21 reciprocal hybrids) were evaluated in a field trial at the growing summer. The experimental design was the Randomized Complete Blocks Design (RCBD) with three replications of 2010. This study was conducted in the Kaha Research Farm of Vegetables Breeding Department, Horticultural Research Institute, (HRI), Agric. Res. Center (ARC), Giza, Egypt.

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INTRODUCTION

The manifestations of heterosis as well as the nature of gene action were studied in squash by many authors among them Gabr (2003), Abd El-Hadi *et al.*, (2004), Abdein (2005), Al-Ballat (2008) and Al-Araby (2010). They estimated heterosis for yield and some economical traits in squash. They found that heterosis was observed of only over the mid-parents but also over its beter parent for all yield and yield component traits. Thangamani, *et al.,* (2011) in bitter gourd studied full diallel analysis was carried out with 10 diversified parents to study the heterosis for yield and quality traits. In this respect, Jahan *et al.*, (2012) in sweet gourd (*Cucurbita moschata* Duch.ex Poir) found significant and desirable level of mid and better parent heterosis values in the studied hybrids for No. of fruits per plant and fruit yield per plant. Similarly, Marie *et al.*, (2012) indicated that heterosis over mid- parents was evident in all yield traits, where the hybrid (IL3×IL6) exhibited (16.89 and 57.57%) for the ratio pistilate flower % and fruit number per plant, respectively.

Concerning general and specific combining abilities, in summer squash, Helmy (1993) evaluated 15 F_1 hybrids and their parents. The obtained results concluded that the best combiner was parent6, followed by parents7 and 5, respectively, which exhibited the highest positive values of GCA effects for total fruits number and weight. El-Adl *et al.*, (1996) studied the combining ability among six inbred lines of agoor (*Cucumis melo var. chata*, L.) and regarded that the mean squares of GCA and SCA were highly significant for yield per plant. In this respect, Ana and Staub (2002) found that the combining ability was significantly influenced by year for most of yield traits. In the same time, Feyzian *et al.*, (2009) found that additive gene effects were most important with respect to average weight per fruit and yield, while genetic dominance effects were also important yield. Nahavand and Tashkandi as parents had significant positive general combining ability effects for yield and acceptable yield. Douglas *et al.*, (2011) found additive and non-additive gene effects were important in the expression of parthenocarpy and resistance to PRSV-W in summer squash.

Pradip *et al.*, (2013) in ridge gourd [*Luffa acutangula* (Roxb.) L.] studied 28 genotypes, including seven parental lines and their 21 crosses. The highly significant mean squares due to parents, hybrids and parents versus hybrids; and GCA and SCA for yield and antioxidants (Ascorbic Acid, Total Carotenoids and Total Phenolics) indicated the existence of abundant genetic variation. Recently, Sanin *et al.,* (2014) studied the predominance of additive gene action over the dominance type for the traits under study suggests that a recurrent selection program could serve as a strategy to increase the frequencies of genes that promote the expression of traits associated with seed production and starch content in butternut squash.

Iathet and Piluek (2006) found on melon, that broad heritability of number fruits per plant and plant yield were as high as (0.60 and 0.61, respectively). Fruit number per plant had highly positive correlation to yield per plant. Mishra *et al.*, (2007) observed maximum heritability for yield per plant followed by number of fruits per plant on cucumber.

MATERIALS AND METHODS

Seven different squash varieties belong to the species (*Cucurbita pepo*, L.). were used in this study. These parental varieties were: Eskandarani (P_1); Zucca Patisson custard white (P_2); All Green Bush (P_3); Courgette Orelia (P_4); Sakiz (P_5); Copi (P_6) and Gapla (P_7). The seeds of these parental varieties were obtained from different countries: (P_1) and (P_6) from Egypt; (P_2) from France; (P_3) from United Kingdom (U.K.); (P_4) from Germany; (P_5) from Turkey and (P_7) from Syria.

All these varieties represented a wide range of variability for most studied yield and yield component traits. Plants from each parental variety were self-pollinated for three successive generations to obtain an inbred from each variety. In the summer season of 2009, all single crosses including reciprocals were made among these seven varieties according to a complete diallel crosses mating design system to produce 21 F_1 hybrids and their 21 F_{1r} reciprocal hybrids. In addition, the seven parental varieties were also self-pollinated to obtain enough seeds from each variety. All 49 genotypes (seven parents, 21 F_1's and 21 reciprocal hybrids) were evaluated in a field trial at the growing summer season of 2010 at Kaha Vegetables Research Station, Kaha, Kalubia, Egypt.

The experimental design was the Randomized Complete Blocks Design (RCBD) with three replications. The plot or the experimental unit was one ridge 5.0m. long and 1.0m. wide. The distance between hills 0.5m. apart. Therefore, each ridge contained 10 hills.

Data were recorded on several randomly chosen plants within each plot for the following traits: fruit length (F.L.cm); fruit diameter (F.D.cm); fruit shape index (F.Sh.I.); Total Soluble Solid% (T.S.S%); weight of fruit (W.F.g); number of fruits per plant (No.F./P.) and fruit yield per plant (F.Y./P.kg). The significance of differences among genetic means for all studied traits were tested according to F-test. The analysis of variances and the expectations of mean squares were made according to Steel and Torrie (1960).

The amounts of heterosis were determined as the deviation of the mid-parents and the better parent as follows:

1. Heterosis from the mid-parents:

$$H^{(F_1, M.P.)}\,\% = \frac{(F_1 - M.P)}{M.P.} \times 100$$

2. Heterosis from the better parent:

$$H^{(F_1, B.P.)}\,\% = \frac{(F_1 - B.P)}{B.P.} \times 100$$

The analysis of variance of diallel crosses were made to obtain the estimates of general combining ability (G.C.A.), specific combining ability (S.C.A.) and reciprocal effect (r). The procedures of these analyses were described by Griffing (1956) method I.

The estimates of GCA variance (δ^2g) and SCA variance (δ^2s) could be expressed in terms of genetic variances according to Matzingar and Kempthorne (1956) and Cockerham (1963) with the assumption that there was no epistasis into additive and non- additive variances.

RESULTS AND DISCUSSIONS

1. Analysis of variances:-

In this investigation, many yield and yield component traits were studied. These traits included: fruit length (F.L.cm); fruit diameter (F.D.cm); fruit shape index (F.Sh.I.); Total Soluble Solid% (T.S.S%); weight of fruit (W.F.g); number of fruits per plant (No.F./P.) and fruit yield per plant (F.Y./P.kg). The analysis of variance and mean squares for yield and yield component traits for all genotypes are presented in Table 1.

The results indicated that the mean squares of all genotypes were highly significant for all yield traits. These results revealed the presence of large variations among the yield and yield component traits.

Table 1. Analysis of variance and mean squares for yield and yield component traits

S.V.	d.f.	Yield and yield component traits						
		F.L.cm	F.D.cm	F.Sh.I.	T.S.S.%	W.F.g	No.F./P.	F.Y./P.kg
Reps.	2	2.744**	0.074	0.029	0.053	63.879**	0.106	0.325*
Genotypes	48	20.989**	4.241**	4.695**	5.832**	4841.734**	168.297**	2.891**
Error	96	0.080	0.043	0.048	0.019	12.825	0.800	0.072

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

These results were expected where the genotypes in this investigation included variable genetic parental varieties, F_1 hybrids and their F_{1r} (reciprocal) hybrids. Thus, the partition of the genetic variation to its components could be made through the analysis of the complete diallel crosses mating design system.

2. The mean performance of all genotypes:

In this investigation, many yield and yield component traits were studied. The means of yield and yield component traits were obtained for the seven parental varieties, their F_1,F_{1r} (reciprocal) hybrids and the results are presented in Tables 2, 3 and 4, respectively. The results cleared that the obtained mean values showed that there was no single parent exceeded all the other parents for all yield studied traits.

The results presented in Table 2, showed that the parental variety P_2 was the lowest parent for F.L.cm, F.Sh.I. and F.Y./P.kg. In the same time P_2 was the highest parent for F.D.cm and T.S.S.% traits the P_4 was the highest parent for F.L.cm, F.Sh.I. and No.F./P. traits. while the parental variety P_7 was the highest parent for F.Y./P.kg traits. In the same time, The parental variety P_6 was the highest parent for W.F.g trait.

The parental variety P_3 had the lowest values for F.D.cm and W.F.g traits. It is also, noticed from the same table that the differences between the means of the lowest and the highest parent were always significant indicating the presence of genetic differences between the seven parental verities were used in this investigation. In general, these results suggested that there was a wide range of variation among the seven parental varieties for all studied traits.

The results are presented in Tables 3 and 4 indicated that the highest F_1 hybrid for fruit yield per plant was $P_2 \times P_3$ with the mean value of 5.86kg. Whereas, the highest F_{1r} (reciprocal) hybrid was $P_7 \times P_6$ with the mean of 5.91kg. On the other hand, F_1 hybrid $P_5 \times P_7$ was the lowest with the mean value of 3.74kg. While, $P_6 \times P_5$ F_{1r} (reciprocal) hybrid was the lowest with the mean value of 3.99kg for the same trait.

The results showed that the means of the F_1 hybrids ranged from 8.73 to 16.27cm; 2.87 to 5.97cm; 1.57 to 4.92; 3.62 to 8.17; 117.2 to 221.2 g; 21.3 to 43.8 fruits and 3.74 to 5.86kg for F.L.cm; F.D.cm; F.Sh.I.; T.S.S.%; W.F.g; No.F./P. and F.Y./P.kg., respectively. On the other hand, the mean values in the F_{1r} (reciprocal) hybrids ranged from 8.83 to 16.63cm; 3.03 to 5.73 cm; 1.58 to 4.94; 4.06 to 7.77; 113.3 to 226.1 g; 23.4 to 44.6 fruits and 3.99 to 5.91kg for the same traits, respectively.

Concerning the performances of the F_1 and F_{1r} (reciprocal) hybrids for yield and yield component traits, the results indicated that the magnitudes of the means of the F_1 and their F_{1r} (reciprocal) hybrids were close to each other for most studied traits.

Table 2. The mean performances of seven parental varieties for yield and yield component traits

No.	Parents	Yield and yield component traits						
		F.L.cm	F.D.cm	F.Sh.I.	T.S.S.%	W.F.g	No.F./P.	F.Y./P.kg
1	P_1	12.93	3.13	4.24	3.33	117.6	23.4	2.73
2	P_2	4.73 ^{L}	7.77 ^{H}	0.61 ^{L}	5.63 ^{H}	130.1	15.9	2.11 ^{L}
3	P_3	10.93	2.63 ^{L}	4.15	3.53	93.9 ^{L}	24.8	2.33
4	P_4	13.07 ^{H}	2.83	4.61 ^{H}	4.37	98.9	30.2 ^{H}	2.87
5	P_5	11.67	3.07	3.81	3.37	107.7	26.9	2.81
6	P_6	8.63	6.53	1.32	2.43 ^{L}	134.9 ^{H}	15.1 ^{L}	2.23
7	P_7	12.47	2.93	4.26	3.57	112.7	28.2	3.15 ^{H}
	$L.S.D._{0.05}$	0.45	0.33	0.35	0.22	8.68	1.44	0.43
	$L.S.D._{0.01}$	0.60	0.44	0.46	0.29	11.49	1.91	0.57

H= The highest value L= The lowest value

Table 3. The mean performances of the F_1 hybrids for yield and yield component traits

No.	F_1 hybrids	Yield and yield component traits.						
		F.L.cm	F.D.cm	F.Sh.I.	T.S.S.%	W.F.g	No.F./P.	F.Y./P.kg
1	$P_1 \times P_2$	9.27	5.77	1.61	6.13	200.1	25.2	4.94
2	$P_1 \times P_3$	13.93	3.27	4.27	4.23	121.7	37.4	4.34
3	$P_1 \times P_4$	15.67	3.43	4.56	5.17	123.1	43.1	5.26
4	$P_1 \times P_5$	14.53	3.53	4.12	4.47	125.4	41.1	4.71
5	$P_1 \times P_6$	13.43	2.87^L	4.71	3.62^L	208.1	28.2	5.79
6	$P_1 \times P_7$	16.27^H	3.43	4.74	4.27	120.2	39.2	4.55
7	$P_2 \times P_3$	9.67	5.53	1.75	7.57	213.7	28.1	5.86^H
8	$P_2 \times P_4$	11.77	4.63	2.55	8.17^H	176.7	32.8	5.17
9	$P_2 \times P_5$	9.37	5.73	1.64	7.33	188.2	28.4	4.77
10	$P_2 \times P_6$	8.97	5.97^H	1.51	6.47	221.2^H	21.3^L	4.65
11	$P_2 \times P_7$	8.73^L	5.57	1.57^L	7.43	171.8	28.6	4.55
12	$P_3 \times P_4$	16.27	3.33	4.88	4.43	117.2^L	42.9	4.83
13	$P_3 \times P_5$	15.73	3.27	4.82	4.77	124.2	39.2	4.79
14	$P_3 \times P_6$	14.83	4.33	3.42	3.83	198.2	28.6	4.87
15	$P_3 \times P_7$	14.07	3.27	4.32	4.33	117.6	39.7	4.57
16	$P_4 \times P_5$	15.93	3.37	4.74	6.27	126.2	43.8^H	5.47
17	$P_4 \times P_6$	12.73	3.07	4.16	5.27	137.8	32.3	4.51
18	$P_4 \times P_7$	14.43	2.97	4.92^H	5.77	119.9	41.9	4.88
19	$P_5 \times P_6$	13.73	3.67	3.75	4.73	154.2	28.1	4.32
20	$P_5 \times P_7$	15.53	3.27	4.76	5.47	118.9	29.7	3.74^L
21	$P_6 \times P_7$	14.67	5.17	2.84	4.07	149.3	29.2	4.28
	L.S.D.$_{0.05}$	0.45	0.33	0.35	0.22	8.68	1.44	0.43
	L.S.D.$_{0.01}$	0.60	0.44	0.46	0.29	11.49	1.91	0.57

H= The highest value. L= The lowest value.

Table 4. The mean performances of the 21 F_{1r} hybrids for yield and yield component traits

No.	F_{1r} hybrids	Yield and yield component traits						
		F.L.cm	F.D.cm	F.Sh.I.	T.S.S.%	W.F.g	No.F./P.	F.Y./P.kg
22	$P_2 \times P_1$	8.90	5.63	1.58^L	7.77^H	193.6	27.6	5.34
23	$P_3 \times P_1$	13.73	3.07	4.52	4.53	123.2	41.1	5.04
24	$P_3 \times P_2$	10.27	5.73^H	1.79	7.37	208.8	28.2	5.77
25	$P_4 \times P_1$	15.77	3.27	4.83	6.23	125.2	39.8	4.93
26	$P_4 \times P_2$	12.67	3.53	3.59	8.07	186.6	32.1	5.23
27	$P_4 \times P_3$	16.63^H	3.37	4.94^H	5.37	117.1	38.7	4.55
28	$P_5 \times P_1$	14.77	3.27	4.56	5.57	125.7	40.9	5.01
29	$P_5 \times P_2$	8.83^L	5.47	1.62	6.87	215.3	27.6	5.76
30	$P_5 \times P_3$	12.67	3.03^L	4.19	5.07	113.3^L	38.9	4.43
31	$P_5 \times P_4$	13.47	3.13	4.33	6.37	126.1	41.3	5.32
32	$P_6 \times P_1$	14.13	4.37	3.24	4.06^L	192.8	27.1	5.22
33	$P_6 \times P_2$	12.13	4.57	2.67	5.73	226.1^H	23.4^L	4.91
34	$P_6 \times P_3$	14.27	4.43	3.22	4.57	152.3	29.2	4.41
35	$P_6 \times P_4$	13.77	3.53	3.91	5.23	216.7	31.5	5.87
36	$P_6 \times P_5$	12.23	4.27	2.87	4.33	135.7	29.5	3.99^L
37	$P_7 \times P_1$	15.73	3.27	4.82	4.67	120.8	44.6^H	5.38
38	$P_7 \times P_2$	9.37	5.33	1.76	7.47	211.1	29.4	5.73
39	$P_7 \times P_3$	14.63	3.47	4.22	5.67	114.8	36.7	4.26
40	$P_7 \times P_4$	15.17	3.33	4.55	6.53	118.1	42.9	5.04
41	$P_7 \times P_5$	14.67	3.23	4.54	5.43	128.1	41.7	5.31
42	$P_7 \times P_6$	14.23	5.17	2.76	4.77	204.7	29.1	5.91^H
	L.S.D.$_{0.05}$	0.45	0.33	0.35	0.22	8.68	1.44	0.43
	L.S.D.$_{0.01}$	0.60	0.44	0.46	0.29	11.49	1.91	0.57

H= The highest value. L= The lowest value.

At the same time, when hybrids were compared with each other, the results showed the presence of significant differences between them for many yield traits. It was obtained that some F_1 and F_{1r} (reciprocal) hybrids for yield and yield component traits exceeded the better parent and naturally exceed versus the mid-parents.

3. Heterosis:-

3.1. Heterosis from the mid-parents ($H_{M.P.}$%):-

Heterosis percentage of the 42 $F_{1,1r}$ hybrids relative to the mid-parents for the yield and yield component traits are presented in Tables 5 and 6.

The results indicated that the values of heterosis over the mid-parents for F_1 hybrids ranged from 1.55 to 51.62% for F.L.cm; -40.69 to 21.95% for F.D.cm; -35.51 to 69.34% for F.Sh.I.; 12.24 to 65.09% for T.S.S.%; 4.33 to 90.86% for W.F.g.; 8.06 to 63.55% for No.F./P. and 25.6 to 163.9% for F.Y./P.kg. With the respect to heterosis from mid-parents ($H_{M.P.}$%) for F_1 hybrids. The results reveled that 19;9;11;21;20;21 and 21 out of the 21 F_1 hybrids and 20;6;10;21;20;21 and 21 F_{1r} hybrids out of the 21 F_{1r} hybrids exhibited highly significant desirable heterosis values for F.L.cm; F.D.cm; F.Sh.I.; T.S.S.%; W.F.g; No.F./P. and F.Y./P.kg, respectively.

While, the values of heterosis over the mid-parents for F_{1r} (reciprocal) hybrids ranged from 0.75 to 81.55%; -36.13 to 24.55%; -34.67 to 176.02%; 32.04 to 73.23%; 4.85 to 86.43%; 29.17 to 72.74% and 55.5 to 159.8% for F.L.cm; F.D.cm; F.Sh.I.; T.S.S.%; W.F.g; No.F./P. and F.Y./P.kg, respectively.

Similar results were obtained by Abd El-Hadi *et al.*, (2001); Abd El-Hadi *et al.*, (2004); Iathet and Piluek (2006); Al-Araby, (2010); Thangamani *et al.*, (2011); Jahan *et al.*, (2012) and Marie *et al.*, (2012).

3.2. Heterosis for better parent ($H_{B.P.}$%):-

Heterosis percentage of the 42 F_1 hybrids relative to the better parent for the yield and yield component traits are presented in Tables 7 and 8.

Table 5. Heterosis percentage reltive to the mid-parents of the F_1 hybrids for yield and yield component traits

No.	F_1 hybrids	Yield and yield component traits.						
		F.L.cm	F.D.cm	F.Sh.I.	T.S.S.%	W.F.g	No.F./P.	F.Y./P.kg
1	$P_1 \times P_2$	4.91*	5.81*	-33.68**	36.80**	61.52**	28.07**	104.3**
2	$P_1 \times P_3$	16.76**	13.29**	1.77	23.30**	15.05**	55.08**	71.3**
3	$P_1 \times P_4$	20.51**	15.08**	3.15	34.20**	13.71**	60.50**	87.7**
4	$P_1 \times P_5$	18.16**	13.98**	2.42	33.33**	11.30**	63.55** H	69.9**
5	$P_1 \times P_6$	24.57**	-40.69** L	69.34** H	25.66**	64.79**	46.32**	133.4**
6	$P_1 \times P_7$	28.08**	13.19**	11.67**	23.67**	4.33* L	51.94**	54.8**
7	$P_2 \times P_3$	23.40**	6.41*	-26.63**	65.09** H	90.86** H	38.20**	163.9** H
8	$P_2 \times P_4$	32.21**	-12.58**	-2.37	63.33**	54.30**	42.30**	107.5**
9	$P_2 \times P_5$	14.23**	5.85*	-26.06**	62.96**	58.28**	33.07**	93.8**
10	$P_2 \times P_6$	34.16**	-16.55**	55.95**	60.33**	66.90**	37.72**	113.9**
11	$P_2 \times P_7$	1.55 L	4.05	-35.51** L	61.59**	41.52**	29.75**	73.1**
12	$P_3 \times P_4$	35.56**	21.95** H	11.38**	12.24** L	21.54**	55.78**	85.5**
13	$P_3 \times P_5$	39.23**	14.62**	21.03**	38.16**	23.23**	51.61**	86.5**
14	$P_3 \times P_6$	51.62** H	-5.45*	25.10**	28.49**	73.25**	43.31**	113.2**
15	$P_3 \times P_7$	20.23**	17.37**	2.82	22.07**	13.81**	49.78**	66.7**
16	$P_4 \times P_5$	28.84**	14.12**	12.53**	62.07**	22.15**	53.30**	92.7**
17	$P_4 \times P_6$	17.36**	-34.52**	40.21**	54.90**	17.87**	42.46**	76.7**
18	$P_4 \times P_7$	13.05**	2.89	10.87**	45.38**	13.32**	43.61**	62.1**
19	$P_5 \times P_6$	35.30**	-23.61**	45.81**	63.22**	27.11**	34.18**	71.4**
20	$P_5 \times P_7$	28.73**	8.89*	17.82**	57.69**	7.91**	8.06** L	25.6** L
21	$P_6 \times P_7$	39.02**	9.15**	1.89	35.56**	20.59**	34.93**	58.9**
$L.S.D._{0.05}$		0.34	0.25	0.26	0.16	4.37	1.09	0.32
$L.S.D._{0.01}$		0.45	0.33	0.35	0.22	5.76	1.44	0.43

*,** Significant and highly significant at 0.05 and 0.01 probability levels, respectively.
H= The highest value L= The lowest value

Table 6. Heterosis percentage reltive of the mid-parents of F_{1r} hybrids for yield and yield component traits

No.	F_{1r} hybrids	Yield and yield component traits.						
		F.L.cm	F.D.cm	F.Sh.I.	T.S.S.%	W.F.g	No.F./P.	F.Y./P.kg
22	$P_2 \times P_1$	0.75^{L}	3.36	-34.67**^{L}	73.23**^{H}	56.27**	40.63**	120.5**
23	$P_3 \times P_1$	15.08**	6.36	7.72*	32.04**^{L}	16.50**	70.42**	99.4**
24	$P_3 \times P_2$	31.06**	10.26**	-24.74**	60.73**	86.43**^{H}	38.69**	159.8**^{H}
25	$P_4 \times P_1$	21.28**	9.50**	9.25**	61.90**	15.59**	48.32**	76.2**
26	$P_4 \times P_2$	42.32**	-33.33**	37.35**	61.33**	62.92**	39.41**	110.1**
27	$P_4 \times P_3$	38.61**	23.17**	12.74**	35.86**	21.44**	40.76**	75.1**
28	$P_5 \times P_1$	20.05**	5.38	13.40**	66.17**	11.57**	62.76**	81.1**
29	$P_5 \times P_2$	7.72**	0.92	-26.98**	52.59**	81.05**	29.17**^{L}	134.3**
30	$P_5 \times P_3$	12.09**	6.43	5.21	46.86**	12.45**	50.45**	72.4**
31	$P_5 \times P_4$	8.89**	6.21	2.70	64.66**	22.08**	44.78**	87.3**
32	$P_6 \times P_1$	31.07**	-9.66**	16.54**	40.92**	52.65**	40.61**	110.2**
33	$P_6 \times P_2$	81.55**^{H}	-36.13**^{L}	176.02**^{H}	42.15**	70.65**	51.51**	125.8**
34	$P_6 \times P_3$	45.83**	-3.27	17.68**	53.07**	33.10**	46.66**	93.4**
35	$P_6 \times P_4$	26.88**	-24.56**	31.69**	53.92**	85.35**	39.07**	130.1**
36	$P_6 \times P_5$	20.53**	-11.11**	11.57*	49.43**	11.83**	40.70**	58.4**
37	$P_7 \times P_1$	23.88**	7.69	13.47**	35.27**	4.85*^{L}	72.74**^{H}	83.1**
38	$P_7 \times P_2$	8.91**	-0.31	-27.82**	62.32**	73.89**	33.54**	117.9**
39	$P_7 \times P_3$	25.07**	24.55**^{H}	0.43	59.62**	11.10**	38.70**	55.5**^{L}
40	$P_7 \times P_4$	18.80**	15.61**	2.70	64.71**	11.59**	46.92**	67.6**
41	$P_7 \times P_5$	21.55**	7.78	12.42**	56.73**	16.26**	51.42**	78.2**
42	$P_7 \times P_6$	34.91**	9.15**	-1.24	58.89**	65.30**	34.46**	119.5**
L.S.D. 0.05		0.34	0.25	0.26	0.16	4.37	1.09	0.32
L.S.D. 0.01		0.45	0.33	0.35	0.22	5.76	1.44	0.43

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

H= The highest value L= The lowest value

Table 7. Heterosis better parent of F_1 hybrids for yield and yield component traits

No.	F_1 hybrids	Yield and yield component traits.						
		F.L.cm	F.D.cm	F.Sh.I.	T.S.S.%	W.F.g	No.F./P.	F.Y./P.kg
1	$P_1 \times P_2$	-28.35**	-25.75**	-62.06**^{L}	8.88	53.78	7.40	81.2
2	$P_1 \times P_3$	7.73**	4.26	0.76	19.81	3.43	50.81	58.8
3	$P_1 \times P_4$	19.90**	9.57	-1.06	18.32	4.68	42.45	83.1
4	$P_1 \times P_5$	12.37**	12.77*	-2.67	32.67	6.60	53.10^{H}	67.6
5	$P_1 \times P_6$	3.87*	-56.12**^{L}	11.10**	8.70	54.22	20.20	112.3
6	$P_1 \times P_7$	25.77**	9.57	11.40**	19.63	2.15^{L}	39.17	44.5
7	$P_2 \times P_3$	-11.59**	-28.76**	-57.92**	34.32	64.28^{H}	13.31	151.5^{H}
8	$P_2 \times P_4$	-9.95**	-40.34**	-44.72**	44.97	35.82	8.49	80.1
9	$P_2 \times P_5$	-19.71**	-26.18**	-57.11**	30.18	44.66	5.83	69.8
10	$P_2 \times P_6$	3.86	-23.18**	13.97^{H}	14.79	63.91	34.24	108.1
11	$P_2 \times P_7$	-29.95**^{L}	-28.33**	-63.13**	31.95	32.08	1.42^{L}	44.7
12	$P_3 \times P_4$	24.49**	17.65*^{H}	5.82	1.53^{L}	18.43	41.79	68.1
13	$P_3 \times P_5$	34.86**	6.52	16.12**	34.91	15.32	45.78	70.7
14	$P_3 \times P_6$	35.67**^{H}	-33.67**	-17.53**	8.49	46.89	15.19	108.8
15	$P_3 \times P_7$	12.83**	11.36*	1.55	21.50	4.29	40.83	45.1
16	$P_4 \times P_5$	21.94**	9.78	2.79	43.51	17.18	44.76	90.6
17	$P_4 \times P_6$	-2.55	-53.06**	-9.80*	20.61	2.15^{L}	6.73	57.1
18	$P_4 \times P_7$	10.46**	1.14	6.59	32.06	6.39	38.70	54.9
19	$P_5 \times P_6$	17.71**	-43.88**	-1.82	40.59	14.28	4.71	53.9
20	$P_5 \times P_7$	24.60**	6.52	11.71**	53.27^{H}	5.50	5.56	18.8^{L}
21	$P_6 \times P_7$	17.65**	-20.92**	-33.23**	14.02	10.67	3.55	35.9
L.S.D. 0.05		0.45	0.33	0.35	0.22	8.68	1.44	0.43
L.S.D. 0.01		0.60	0.44	0.46	0.29	11.49	1.91	0.57

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

H= The highest value. L= The lowest value.

Table 8. Hetrosis better parent of F_{1r} hybrids for yield and yield component traits

No.	F_{1r} hybrids	F.L.cm	F.D.cm	F.Sh.I.	T.S.S.%	W.F.g	No.F./P.	F.Y./P.kg
22	$P_2 \times P_1$	-31.19** L	-27.47**	-62.63** L	37.87	48.78	17.92	95.6
23	$P_3 \times P_1$	6.19**	-2.13	6.66	28.30	4.73	65.73 H	84.9
24	$P_3 \times P_2$	-6.10**	-26.18**	-56.84**	30.77	60.47	13.71	147.6 H
25	$P_4 \times P_1$	20.66**	4.26	4.79	42.75	6.40	31.64	71.9
26	$P_4 \times P_2$	-3.06	-54.51** L	-22.24**	43.20	43.40	6.28	82.4
27	$P_4 \times P_3$	27.30**	18.82** H	7.11*	22.90	18.33	28.11	58.7
28	$P_5 \times P_1$	14.18**	4.26	7.76*	65.35 H	6.86	52.36	78.5
29	$P_5 \times P_2$	-24.29**	-29.61**	-57.65**	21.89	65.46	2.73 L	105.3
30	$P_5 \times P_3$	8.57**	-1.09	0.94	43.40	5.23	44.67	57.8
31	$P_5 \times P_4$	3.06	2.17	-6.18	45.80	17.12	36.71	85.3
32	$P_6 \times P_1$	9.28**	-33.16**	-23.54**	21.90	42.86	15.50	91.1
33	$P_6 \times P_2$	40.54** H	-41.20**	101.72** H	1.78 L	67.59 H	47.69	119.6
34	$P_6 \times P_3$	30.49**	-32.14**	-22.42**	29.25	12.85	17.88	89.4
35	$P_6 \times P_4$	5.36**	-45.92**	-15.28**	19.85	60.62	4.19	104.6
36	$P_6 \times P_5$	4.86*	-34.69**	-24.88**	28.71	0.54 L	9.80	42.2
37	$P_7 \times P_1$	21.65**	4.26	13.19**	30.84	2.66	58.22	70.9
38	$P_7 \times P_2$	-24.87**	-31.33**	-58.74**	32.54	62.29	4.38	82.1
39	$P_7 \times P_3$	17.38**	18.18**	-0.81	58.88	1.80	30.41	35.3 L
40	$P_7 \times P_4$	16.07**	13.64**\	-1.27	49.62	4.76	41.90	60.2
41	$P_7 \times P_5$	17.65**	5.43	6.58	52.34	13.66	47.93	68.6
42	$P_7 \times P_6$	14.17**	-20.92**	-35.28**	33.64	51.70	3.20	87.6
	$L.S.D._{0.05}$	0.45	0.33	0.35	0.22	8.68	1.44	0.43
	$L.S.D._{0.01}$	0.60	0.44	0.46	0.29	11.49	1.91	0.57

*,** Significant and highly significant at 0.05 and 0.01 probability levels, respectively.
H= The highest value. L= The lowest value.

The results indicated that the values of heterosis over the better parent for F_1 hybrids ranged from -29.95 to 35.67% for F.L.cm; -56.12 to 17.65% for F.D.cm; -62.06 to 13.97% for F.Sh.I.; 1.53 to 53.27% for T.S.S.%; 2.15 to 64.28% for W.F.g.; 1.42 to 53.10% for No.F./P. and 18.8 to 151.5% for F.Y./P.kg. While, the values of heterosis over the better parent for F_{1r} (reciprocal) hybrids ranged from -31.19 to 40.54%; -54.51 to 18.82%; -62.63 to 101.72%; 1.78 to 65.35%; 0.54 to 67.59%; 2.73 to 65.73% and 35.3 to 147.6% for F.L.cm; F.D.cm; F.Sh.I.; T.S.S.%; W.F.g; No.F./P. and F.Y./P.kg., respectively.

With the respect to heterosis from better parent ($H_{M.P.}$%) for F_1 hybrids. the results reveled that 12 and 5 out of the 21 F_1 hybrids exhibited highly significant desirable heterosis values for F.L.cm and F.Sh.I. and 14,3 and 2 F_{1r} hybrids out of the 21 F_{1r} hybrids exhibited highly significant desirable heterosis values for F.L.cm; F.D.cm and F.Sh.I., respectively.

These results were in agreement with the results obtained by Abd El-Hadi *et al.,* (2001); Abd El-Hadi *et al.*, (2004); Iathet and Piluek (2006); Al-Araby, (2010); Thangamani, *et al.,* (2011); Jahan *et al.,* (2012) and Marie *et al.,* (2012).

4. Analysis of combining ability variances:

The variance for combining ability of the seven parental varieties and their 42 F_1,$_{1r}$ hybrids for yield and yield component traits are presented in Table 9. The results revealed that the mean squares due to crosses were highly significant for all studied traits. The mean squares due to general combining ability (GCA) exhibited significant differences for all studied traits. The mean squares due to specific combining ability (SCA) were highly significant for all studied traits. It means that the additive genetic variance was more important in the inheritance of these yield traits. At the same time the mean squares due to reciprocal effect were highly significant for all studied traits.

The values of GCA mean squares were higher than those of SCA mean squares for all yield studied traits except for F.Y./P.kg. It means that additive genetic variances were more important in the inheritance of these traits. The present results are in agreement in the reported by Ana and Staub (2002); Kamooh (2002); Al-Ballat (2008); Feyzian *et al.*, (2009); Pradip *et al.*, (2013) and Sanin *et al.,* (2014).

Table 9. Analysis of combining abilities and mean squares of the F_1 hybrids for yield and yield component traits

S.V.	d.f.	Yield and yield component traits						
		F.L.cm	F.D.cm	F.Sh.I	T.S.S.%	W.F.g	No.F./P.	F.Y./P.kg
Reps.	2	0.325*	0.106	63.879**	0.053	0.029	0.074	2.744**
Crosses	41	2.184**	0.347**	0.274**	0.865**	803.395**	24.198**	1.125**
G.C.A.	6	41.230**	10.342**	10.641**	9.800**	7435.883**	281.484**	0.312**
S.C.A.	14	3.545**	0.550**	0.394**	1.263**	1220.231**	41.501**	1.884**
R.E.	21	0.720**	0.127**	0.143**	0.427**	348.693**	5.743**	0.312**
Error	82	0.08	0.043	0.048	0.019	12.825	0.800	0.072
G.C.A./ S.C.A.		0.848	1.451	2.187	0.562	0.439	0.493	0.009

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

5. Genetic parameters and heritability:

The relative magnitudes of genetic parameters were estimated for yield and yield component traits and the obtained results are shown in Table 10. The results showed that both additive (δ^2A) and non-additive genetic variances including dominance (δ^2D) were positive for all studied yield and yield component traits except δ^2A for F.Y./P.kg which were this indicated that these variances play a role in genetic expression of yield and yield component traits. It was found that the magnitudes of additive genetic variance were larger than dominance genetic variances for all studied traits except for F.Y./P.kg trait. Thus, it could be suggest that additive genetic variance predominated in the inheritance of these yield studied traits. The results also illustrated the importance of reciprocal variances which were smaller than additive genetic variances. Therefore, the cytoplasmic genetic factors also would contribute to the genetic expression of yield and yield component traits. In general, the heritability in broad sense (h^2_b%) were higher and larger than their corresponding values of heritability in narrow sense (h^2_n%) for all studied traits. The estimated values of heritability in broad sense (h^2_b%) ranged from 99.006% for F.L.cm, 97.636% for F.D.cm, 97.277% for F.Sh.I., 99.128% for T.S.S, 99.283% for W.F.g, 98.703% for No.F./P and 94.348% for F.Y./P.kg. In the same time, the highest values of h^2_n% were 82.926% for F.Sh.I. followed by 78.72% for F.D.cm and 69.316% for F.L.cm. These results are according with the results obtained by Al-Ballat (2008); Al-Araby, (2010); Pradip *et al.*, (2013) and Sanin *et al.*, (2014).

6. General combining ability effects (g_i) for the parents:

The general combining ability effects (g_i) of the seven parents for yield and yield component traits are presented in Table 11.

The results revealed that the GCA effects (g_i) were computed to be positive and highly significant for desirable parents No. P_1, P_3, P_4, P_5 and P_7 for F.L.cm; F.Sh.I. and No.F./P. The results revealed that the GCA effects (g_i) were computed to be positive and highly significant for desirable parent No. P_2 for F.D.cm; T.S.S.% and W.F.g. At the same time, the results revealed that the GCA effects showed undesirable negative and highly significant values for the same parent No. P_2 for F.L.cm; F.Sh.I. and No.F./P.

Table 10. The relative magnitudes of the different genetic parameters and heritability for yield and yield component traits

Genetic parameters and heritability	Yield and yield component traits						
	F.L.cm	F.D.cm	F.Sh.I	T.S.S.%	W.F.g	No.F./P.	F.Y./P.kg
δ^2 A	5.580	1.432	1.462	1.214	887.9	34.134	-0.231
δ^2 D	2.070	0.302	0.206	0.743	721.49	24.321	1.082
δ^2 r	0.32	0.042	0.047	0.204	167.93	2.471	0.12
δ^2 E	0.08	0.043	0.048	0.019	12.825	0.800	0.072
h^2b%	99.006	97.636	97.277	99.128	99.283	98.703	94.348
h^2n%	69.316	78.724	82.926	55.688	49.599	55.299	16.875

Note: Negative values were considered equal to zero during the calculation of heritability in broad and narrow senses.

Table 11. General combining ability effects (g_i) of the seven parents for yield and yield component traits

	Yield and yield component traits						
Parents	F.L.cm	F.D.cm	F.Sh.I.	T.S.S.%	W.F.g	No.F./P.	F.Y./P.kg
P_1	0.894**	-0.408**	0.505**	-0.559**	-6.935**	1.870**	0.142*
P_2	-3.724**	1.711**	-1.738**	1.678**	40.278**	-6.438**	0.166*
P_3	0.704**	-0.336**	0.382**	-0.350**	-14.316**	1.632**	-0.119
P_4	1.251**	-0.789**	0.794**	0.297**	-15.816**	4.894**	0.142*
P_5	0.299**	-0.408**	0.283**	-0.131**	-15.125**	2.085**	-0.119
P_6	-0.295**	0.568**	-0.560**	-0.916**	25.469**	-6.295**	-0.190**
P_7	0.870**	-0.336**	0.332**	-0.017	-13.554**	2.251**	-0.023
L.S.D(gi) 0.05	0.138	0.101	0.107	0.067	1.754	0.438	0.131
L.S.D(gi) 0.01	0.182	0.133	0.141	0.089	2.31	0.577	0.173

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

While, the GCA effects were found to be and positive highly significant for desirable parent No. P_6 only for F.D.cm and W.F.g. While, the parents No. P_1, P_2 and P_4 were computed to be positive and desirably significant for F.Y./P.kg.

These results indicated that the parents No. P_1, P_3, P_4, P_5 and P_7 were seemed to be the best combiners for F.L.cm; F.Sh.I. and No.F./P. Also, the parent No. P_2 was the best combiner for T.S.S.%. In the same time, the two parents P_2 and P_6 were the best combiner for F.D.cm and W.F.g. These results indicated that the parents No. P_1, P_2 and P_4 seemed to be the best combiners for F.Y./P.kg. These results were in agreement with the results obtained by Abd El-Hadi *et al.*, (2004); Abdein (2005); Al-Ballat (2008); Pradip *et al.*, (2013) and Sanin *et al.*, (2014).

7. Specific combining ability effects (s_{ij}):

Estimates of specific combining ability effects (s_{ij}) of the 42 $F_{1,1r}$ hybrids for yield and yield components traits are presented in Tables 12 and 13.

Table 12. Specific combining ability effects (s_{ij}) of the 21 F_1 hybrids for yield and yield component traits

	Yield and yield component traits						
F_1 hybrids	F.L.cm	F.D.cm	F.Sh.I	T.S.S.%	W.F.g	No.F./P.	F.Y./P.kg
$P_1 \times P_2$	-1.037**	0.289	-0.691**	0.488**	12.72**	-1.537*	0.238
$P_1 \times P_3$	0.034	-0.163	0.091	0.017	-7.18*	3.224**	-0.142
$P_1 \times P_4$	0.653**	0.456*	-0.178	0.369**	-3.68	1.963*	0.095
$P_1 \times P_5$	0.772**	0.408*	-0.020	0.631**	-2.37	4.605**	0.357
$P_1 \times P_6$	0.201	-0.568**	0.461*	-0.083	31.23**	-0.680	0.928**
$P_1 \times P_7$	1.201**	-0.163	0.405*	-0.149	-9.78**	5.105**	0.428
$P_2 \times P_3$	0.153	0.551**	-0.380*	0.779**	34.61**	0.534	1.333**
$P_2 \times P_4$	1.605**	-0.830**	0.480*	0.631**	6.44*	1.605*	0.238
$P_2 \times P_5$	-0.442	0.456*	-0.416*	0.226	26.08**	-0.252	0.500*
$P_2 \times P_6$	1.653**	-1.020**	0.863**	0.178	7.32*	2.796**	0.238
$P_2 \times P_7$	-1.014**	0.051	-0.451*	0.445**	13.84**	0.582	0.404
$P_3 \times P_4$	1.344**	0.051	0.163	-0.506**	-3.47	1.534*	0.190
$P_3 \times P_5$	0.629*	-0.330	0.424*	0.088	-2.49	3.010**	0.285
$P_3 \times P_6$	1.224**	0.194	-0.021	0.374**	13.24**	0.891	0.357
$P_3 \times P_7$	0.058	0.099	-0.033	-0.061	-6.56*	1.677*	0.023
$P_4 \times P_5$	0.082	0.289	-0.110	0.440**	6.34*	3.248**	0.690**
$P_4 \times P_6$	-0.656**	-0.520**	0.172	0.226	16.91**	0.963	0.428
$P_4 \times P_7$	-0.490*	0.051	0.027	0.826**	-2.40	2.748**	0.261
$P_5 \times P_6$	-0.037	-0.235	0.078	0.155	-16.11**	0.439	-0.309
$P_5 \times P_7$	0.963**	-0.330	0.471*	0.255*	1.41	-1.276	-0.142
$P_6 \times P_7$	1.058**	0.694**	-0.499**	0.041	14.48**	0.605	0.595*
L.S.D.(s_{ij}) 0.05	0.480	0.351	0.371	0.233	6.077	1.517	0.455
L.S.D.(s_{ij}) 0.01	0.632	0.463	0.492	0.308	8.011	2.000	0.600

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

Table 13. Specific combining ability effects (s_{ij}) of the 21 F_{1r} hybrids for yield and yield component traits

F_{1r} hybrids	Yield and yield component traits						
	F.L.cm	F.D.cm	F.Sh.I	T.S.S.%	W.F.g	No.F./P.	F.Y./P.kg
$P_2 \times P_1$	0.167	0.333*	0.026	-1.00**	3.17	-1.500*	-0.167
$P_3 \times P_1$	-0.333	-0.166	-0.280	-0.500**	-1.00	-1.667**	-0.500**
$P_3 \times P_2$	-0.167	0.001	-0.021	0.167	2.67	0.001	0.001
$P_4 \times P_1$	0.167	0.001	-0.113	-0.500**	-1.000	1.667**	0.001
$P_4 \times P_2$	-0.500*	0.166	-0.498**	0.001	-5.000	0.333	-0.167
$P_4 \times P_3$	-0.333	0.001	-0.041	-0.500**	0.171	2.000**	-0.167
$P_5 \times P_1$	0.001	0.001	-0.190	-0.667**	1.000	0.167	0.001
$P_5 \times P_2$	0.167	0.166	0.006	0.167	-13.67**	0.333	-0.500**
$P_5 \times P_3$	1.000**	0.001	0.125	0.0001	5.17*	0.001	0.333
$P_5 \times P_4$	1.333**	0.166	0.183	0.0001	0.173	1.167	0.001
$P_6 \times P_1$	-0.500*	-0.666**	0.698**	-0.167	7.50**	0.500	0.500**
$P_6 \times P_2$	-1.667**	0.666**	-0.570**	0.333**	-2.500	-1.000	0.167
$P_6 \times P_3$	0.333	-0.166	0.105	-0.500**	23.17**	-0.500	0.333
$P_6 \times P_4$	-0.333	-0.333*	0.031	0.001	-39.33**	0.500	-0.667**
$P_6 \times P_5$	0.667**	0.001	0.433**	0.500**	9.33**	-0.500	0.001
$P_7 \times P_1$	0.333	0.166	-0.031	-0.333**	-0.175	-2.500**	-0.167
$P_7 \times P_2$	-0.167	0.166	-0.088	-0.167	-19.67**	-0.333	-0.500**
$P_7 \times P_3$	-0.333	-0.166	0.036	-0.963**	1.332	1.500*	0.167
$P_7 \times P_4$	-0.333	0.001	0.186	-0.500**	1.000	-0.500	0.001
$P_7 \times P_5$	0.167	0.001	0.100	0.167	-4.834	-6.000**	-0.667**
$P_7 \times P_6$	0.333	0.001	0.048	-0.500**	-27.50**	0.167	-1.001**
L.S.D.(r_{ij}) 0.05	0.396	0.290	0.306	0.192	5.013	1.252	0.375
L.S.D.(r_{ij}) 0.01	0.522	0.382	0.404	0.253	6.609	1.650	0.495

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

The F_1 hybrids $P_2 \times P_4$ and $P_2 \times P_6$ showed highly significant positive values of 1.605 and 1.653 for F.L.cm, respectively. While, the F_{1r} (reciprocal) hybrids $P_5 \times P_3$ and $P_6 \times P_5$ showed highly significant positive effects for the same trait. At the same time, the F_{1r} (reciprocal) hybrid $P_5 \times P_3$ gave the highest value (1.000) for the same trait.

The F_1 hybrids $P_2 \times P_3$ and $P_6 \times P_7$ gave the largest and significant values for F.D.cm of 0.551 and 0.694, respectively. While, the F_{1r} (reciprocal) hybrid $P_6 \times P_2$ gave significant value of 0.666 for the same trait.

For F.Sh.I., the F_1 hybrid $P_2 \times P_6$ gave highly significant value of 0.863. At the same time, the F_{1r} (reciprocal) hybrids $P_6 \times P_1$ and $P_6 \times P_5$ gave significant values of 0.698 and 0.433 for the same trait, respectively.

For T.S.S.%, the F_1 hybrids $P_2 \times P_3$ and $P_4 \times P_7$ gave highly significant values of 0.779 and 0.826, respectively. At the same time, the F_{1r} (reciprocal) hybrids $P_6 \times P_2$ and $P_6 \times P_5$ gave values of 0.333 and 0.500 for the same trait, respectively.

For W.F.g., the F_1 hybrids $P_1 \times P_6$ and $P_2 \times P_3$ gave highly significant values of 31.23 and 34.61. At the same time, the F_{1r} (reciprocal) hybrids $P_6 \times P_3$ and $P_6 \times P_5$ gave highly significant values of 23.17 and 9.33 for the same trait.

For No.F./P., the F_1 hybrids $P_6 \times P_3$ and $P_6 \times P_5$ gave highly significant values of 4.605 and 5.105, respectively. At the same time, the F_{1r} (reciprocal) hybrids $P_4 \times P_1$ and $P_4 \times P_3$ gave highly significant values for the same trait.

The F_1 hybrids $P_1 \times P_6$ and $P_2 \times P_3$ gave highly significant values of 0.928 and 1.333 for F.Y./P.kg., respectively. At the same time, the F_{1r} (reciprocal) hybrids $P_5 \times P_3$ and $P_6 \times P_3$ gave unsignificant value of 0.333 for the same trait.

In general, the hybrids exhibited variable effects for SCA and therefore showed different mode of action in the manifestation of heterosis. At the same time, the results showed variable effect in the inheritance of the studied traits. These results were in agreement with the results that obtained by Al-Araby, (2010); Pradip *et al.*, (2013) and Sanin *et al.*, (2014).

REFERENCES

Abd El-Hadi, A. H.; M. M. Zaghloul and A. H. Gabr (2004). Nature of gene action, heterosis and inbreeding depression of yield and yield component traits in squash (*Cucurbita pepo,* L.). Zagazig J. Agric, Res., 31(6): 2707-2725.

Abd El-Hadi, A. H.; Z. A. Kosba; Z. M. El-Diasty; El-S. H. Askar and G. M. Shamloul (2001). Evaluation of F_1 hybrids among new selected inbred lines of sweet melon *(Cucumis melo var. aegyptiacus,* L.*)*.J. Agric. Sci., Mansoura Univ., 26(5): 2831-2845.

Abdein, M. A. (2005). Quantitative genetics of some economic traits in squash (*Cucurbita pepo.* L). M. Sc. Thesis, Fac. of Agric., Mansoura Univ. Egypt.

Al-Araby, A. A. (2010). Estimation of heterosis, combining ability and heritability in inter varietals crosses of summer squash (*Cucurbita pepo* L.) .Ph. D. Thesis, Fac. of Agric., Tanta Univ. Egypt.

Al-Ballat, I. A. (2008). Breeding studies on summer squash crop (*Cucurbita pepo* L.). M. Sc. Thesis, Fac. of Agric., Tanta Univ. Egypt.

Ana, I. Lopez-Sese and J. Staub (2002). Combining ability analysis of yield components in cucumber. J. Amer. Soc. Hort. Sci. 127(6): 931-937.

Cockerham, C. C. (1963). Estimation of genetic variances. Statistical Genetics and Plant Breeding. NAS-NRC, 982, pp.53-68.

Douglas, W. N.; W. R. Maluf; A. R. Figueira; G. M. Maciel; L. A. Gomes and C. A. Benavente (2011). Combining ability of summer-squash lines with different degrees of parthenocarpy and PRSV-W resistance. Genetics and Molecular Biology, 34 (4): 616-623.

El-Adl, A. M; Z. A. Kosba; Z. M. El-Diasty and A. H. Abd El-Hadi (1996). Types of gene action associated with the performances of hybrids among newly developed inbred lines of agoor, (*Cucumis melo var.* chate, L.). J. Agric. Sci. Mansoura Univ., 21(8): 2821-2835.

El-Sharkawy, Gehan A. M. (2000). An analytical study for the genetic behavior of some important characters of summer squash (*Cucurbita pepo,*L.) using a diallel cross system among seven inbred lines of "Eskandrani" cultivar. M. Sc. Thesis, Fac. of Agric., Alex. Univ. Egypt.

Feyzian, E.; H. Dehghani; A. M. Rezai and M. J. Javaran (2009). Diallel cross analysis for maturity and yield-related traits in melon (*Cucumis melo,* L.). Euphytica, 168(7):215-223.

Gabr, A. H. (2003). Nature of gene action and performance of hybrids in squash (*Cucurbita pepo,* L.). M.Sc. Thesis, Fac. of Agric., Mansoura Univ. Egypt.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crosses system. Aust. J. Biol. Sci., 9:pp 463-493.

Helmy, E. M. S. (1993). Development of pure lines of summer squash and their use in hybrid production. J. Agric. Sci. Mansoura Univ., 18(2): 489-498.

Iathet, C. and K. Piluek (2006). Heritability, heterosis and correlations of fruit characters and yield in Thai slicing melon (*Cucumis melo* L. var. *conomon* makino). Kasetsart Journal, Natural Sciences, 40(6):20-25.

Jahan, T. A.; A. K. M. Islam; M. G. Rasul; M. A. K. Mian and M. M. Haque (2012). Heterosis of qualitative and quantitative characters in sweet gourd (*Cucurbita moschata* Duch.ex Poir). African Journal of Food, Agriculture, Nutrition and Development, 12(3): 6186-6199.

Kamooh, A. A. (2002). Studies on general and specific combining abilities of some characters in squash (*Cucurbita pepo,* L.). J. Agric. Sci. Mansoura Univ., 27(7): 4861-4888.

Marie, A. K.; M. Y. Moualla and M. G. Boras (2012). Heterosis study of some quantity characters of squash (*Cucurbita pepo,* L.). Damascus J. of Agric. Sci., 28(1):339-354.

Matzinger, D. F. and O. Kempthorne (1956). The modified diallel Table with partial inbreeding and interactions with environment. Genetics, 41(1): 822-833.

Mishra, G.; J. R. Yadav; N. S. Parihar; J. K. Yadav; S. Kumar and Y. Alok (2007). Study on heritability and genetic advance in cucumber (*Cucumis sativus,* L.). Progressive Research 2(3):187-189.

Pradip, K.; A. D. Munshi; T. K. Behera; R. Kumar; C. Kaur and B. K. Singh (2013). Hermaphrodite inbreds with better combining ability improve antioxidant properties in ridge gourd [*Luffa acutangula* (Roxb.) L.]. Euphytica, 191(3):75–84.

Sanin, O. G.; L. V. B. Burbano; G. A. O. Narvaez; M. P. V. Restrepo; D. B. Garcia and F. A. V. Cabrera (2014). Inbreeding and gene action in butternut squash (*Cucurbita moschata*) seed starch content. Rev. Fac. Nal. Agr. Medellin, 67(1): 7169-7175.

Steel, G. D. and H. Torrie (1960). Principles and procedures of statistics. Mc. raw. Hill Book Company, INC, New York, pp 43.

Thangamani, C.; L. Pugalendhi; T. Sumathi; C. Kavitha and V. Rajashree (2011). Estimation of combining ability and heterosis for yield and quality characters in bitter gourd (*Momordica charantia* L.). Electronic Journal of Plant Breeding,

الملخص العربي

قوة الهجين والسلوك الوراثي لبعض صفات المحصول ومكوناته في قرع الكوسة

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في هذه الدراسة تم تقييم الاباء والهجن الناتجة (الهجن والهجن العكسية) من استخدام نظام التهجين الدوري الكامل (٧*٧) بين سبعة من أصناف الكوسة بغرض تقدير قيم كل من قوة الهجين والسلوك الوراثي لبعض صفات المحصول ومكوناته في قرع الكوسة.

في هذه الدراسة تم إستخدام سبعة أصناف من قرع الكوسة كآباء وهي: Eskandarani (الأب الأول)، Zucca Patisson custard white (الأب الثاني)، All Green Bush(الأب الثالث)، Courgette Orelia(الأب الرابع)، Sakiz (الأب الخامس)، Copi (الأب السادس)، Gapla، (الأب السابع)، تم الحصول علي بذور هذه الآباء من مصادر مختلفة حيث كان الأبين الأول والسادس من جمهورية مصر العربية، والأب الثاني من فرنسا والثالث من بريطانيا والرابع من المانيا والخامس من تركيا والسابع من سوريا. تم تسجيل البيانات لبعض صفات المحصول ومكوناته مثل : طول الثمرة (بالسنتيمتر)، قطر الثمرة (بالسنتيمتر)، دليل شكل الثمرة، نسبة السكريات الذائبة الكلية، متوسط وزن الثمرة (بالجرام)، عدد الثمار لكل نبات، محصول الثمار لكل نبات (بالكيلوجرام). أظهرت النتائج وجود إختلافات كبيرة بين هجن الجيل الأول والأول العكسي مع عدم تميز هجين معين بذاته لكل الصفات المدروسة، ولكن معظم التراكيب الوراثية للجيل الأول الهجين تميزت عن الآباء الداخلة في تكوينها، ولذا فإن الهجن قد فاقت آبائها في معظم الصفات محل الدراسة. كما أظهرت النتائج عدم تميز أي أب من الآباء لكل صفات المحصول ومكوناته محل الدراسة.

أظهرت النتائج وجود قيما معنوية لقوة الهجين قياساً من متوسط الآباء لجميع الصفات محل الدراسة. القيم المحسوبة لقوة الهجين مقارنة بأفضل الآباء أوضحت وجود قيم عالية المعنوية لمعظم الصفات محل الدراسة. أظهرت النتائج تعاظم قيم كل من القدرة العامة على التآلف والقدرة الخاصة على التآلف. وأوضحت النتائج أهمية القدرة العامة على التآلف لجميع الصفات التي تمت دراستها للجيل الأول الهجين، بينما كانت قيمة تأثير التهجين العكسي معنوية لمعظم الصفات المدروسة. اظهرت النتائج أن كلا من Eskandarani (الأب الأول)، All Green Bush (الأب الثالث)، Courgette Orelia(الأب الرابع)، Sakiz (الأب الخامس) ،Gapla (الأب السابع) تعتبرأفضل مصدر لصفات طول الثمرة (بالسنتيمتر)، دليل شكل الثمرة، عدد الثمار لكل نبات، بينما كان Zucca Patisson custard white (الأب الثاني) أفضل مصدر لصفة النسبة المئوية للسكريات الذائبة الكلية. بينما كان Zucca Patisson custard white (الأب الثاني) وCopi (الأب السادس) أفضل مصدرين لصفتي قطر الثمرة (بالسنتيمتر) ومتوسط وزن الثمرة (بالجرام).

جميع التراكيب الوراثية في هذه الدراسة (٤٩ تركيباً وراثياً) تم تقييمها في تجربة حقلية في الموسم الصيفي ٢٠١٠ في تجربة قطاعات كاملة العشوائية من ثلاث مكررات وقد إجريت هذه الدراسة في مزرعة قها البحثية التابعة لقسم تربية الخضر بمعهد بحوث البساتين بمركز البحوث الزراعية بالجيزة بجمهورية مصر العربية.