Manifestation of Heterosis and The Role of The Genetic Parameters Associated with It for Some Vegetative Traits in Squash (*Cucurbita pepo*, L.)

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ABSTRACT

The main objectives of this investigation were to determine the amounts of heterosis versus the mid-parents and the better parent, nature of gene action and heritability in both broad and narrow senses. Seven squash varieties belong to the species (*Cucurbita pepo*, L.), were crossed to obtain 42 $F_{1,1r}$ hybrids according to a complete diallel crosses mating design.

The results revealed that the mean squares of genotypes which included seven parental varieties and their $F_{1,1r}$ hybrids were highly significant for all vegetative traits. The results also cleared that the mean values showed that no specific parent was superior for all vegetative traits.

The results indicated that the parents P_1 and P_6 seemed to be the best combiner for vein length (V.L.cm); number of leaves per plant (No.L./P.); leaf area (L.A.cm^2); fresh weight per plant (F.W./P.g) and dry weight per plant (D.W./P.g). Meanwhile, the GCA effects were found to be significant and positive for most vegetative traits. The parental varieties P_3, P_6 and P_7 were the best combiners for the ratio of chlorophyll in leaves (Chl.).

The estimates of heterosis versus mid-parents showed highly significant values for all studied traits. The estimates of heterosis versus better parent showed highly significant values for most vegetative traits. The results showed the importance of general and specific combining abilities. GCA was larger than their corresponding estimates of SCA for vegetative traits. Reciprocal effects (r) were significant for most studied traits. Estimation of genetic parameters showed that the additive genetic variance was very important for most studied traits. The inheritance of these traits was mostly governed by additive genetic variance rather than non-additive and cytoplasmic genetic factors. In the same time, the estimates of heritability in broad sense were larger in magnitudes than their corresponding values in narrow sense.

Keywords: squash, hybrids, heterosis, combining abilities and heritability.

INTRODUCTION

Cucurbitaceae is one of the most important botanical families for human use as favorable vegetable crop. Thus, summer squash (*Cucurbita pepo*, L.) is considered to be one of the most popular vegetable crops grown in Egypt. It is known as a vegetable marrow and is called also Kosa by the Egyptian. In Egypt, there are only two local cultivars of squash i.e. Balady, which is lately discarded for its prostrate growth habit and low yield and Eskandarani, which is high yielding and satisfies both the producer and consumer.

Heterosis has been studied in all important vegetable crops as well as cucurbits. In squash and other cucurbits, heterosis was utilized aiming to increase the productivity and quality of other traits. Many investigators studied heterosis on vegetative traits among them; Abd El-Hadi (1995) studied six inbred lines and their 30 F_1 hybrids among them (including F_1 reciprocal hybrids) in agoor. The recorded data showed the presence of highly significant values of heterosis versus the mid-parents. Similarly, Abd El-Maksoud *et al.*, (2003), in squash, showed that the average means of the means of $F_{1,1r}$ hybrids and the average over all hybrids $F_{1,1r}$ exceeded their mid-parents for all studied traits except for sex ratio and days to first female flower, which were desirable for increasing female flowers and earliness, respectively. In another study, Gabr (2003) estimated heterosis over mid-parents and the better parent. The results indicated the presence of highly significant heterosis values over mid-parents for all studied vegetative traits in squash. Abdein (2005) evaluated 12 F_1 hybrids among four varieties of summer squash and estimated the performances of F_1 and F_{1r} hybrids for vegetative traits. In the same time, when the hybrids were compared with each other (F_1 as F_{1r}) the results showed the presence of significant differences for many vegetative traits. It is also cleared that some F_1 and F_{1r} hybrids exceeded the better parent for vegetative traits.

Al-Ballat (2008) who worked on summer squash, found that heterosis over the mid-parents was highly significant with negative values for stem length. While, it was absent for number of leaves per plant. The results stated that heterosis based on the better parent was significant or highly significant with negative values for number of leaves per plant. Al-Araby, (2010) estimated heterosis over the mid-parents and the results showed significant positive values for stem length; number of male flowers/plant; number of female flowers/plant and sex ratio. Heterosis over the better parent estimates

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showed highly significant positive values for stem length. On the other hand, it was highly significant with negative values for number of leaves/plant. Jahan *et al.*, (2012) found both positive and negative heterosis for different qualitative and quantitative traits in F_1 hybrids of sweet gourd. None of the hybrids exhibited maximum heterosis for all traits, but significant and desirable level of heterosis over mid-parents and better parent was obtained in several hybrids for the different traits.

Concerning, GCA and SCA variances El-Diasty and Kash (1989) revealed that additive genetic variances were larger in magnitudes than non-additive genetic variances for most vegetative traits. Abd El-Hadi *et al.*, (2004) showed that both GCA and SCA reveled highly significant values for all studied traits in the F_1 hybrids and F_2 generations except for F.W.(g) in the F_1 hybrids for GCA. In summer squash, Al-Araby, (2010) detected high heritability estimates in broad sense for all vegetative traits. High heritability estimates in narrow sense were only detected for number of leaves/plant. While, moderate estimates of heritability in narrow sense were obtained for the stem length. Radha *et al.*, (2013) studied the nature and magnitude of gene effects for vegetative traits in bitter gourd using six generation mean analysis involving (P_1, P_2, F_1, F_2, BC_1 and BC_2). The results revealed the presence of additive, dominance gene effects and epistatic interactions for all the vegetative traits except for vine length in the cross IC-470550×IC-470558 indicating the importance of both additive and non-additive gene actions in the expression of this traits. The greater magnitude of dominance gene effect as compare to additive effect for most of the traits suggested that heterosis breeding may be more useful. Recently, Sanin *et al.*, (2014) in butternut squash studied the predominance of additive gene action over the dominance type for the traits under study suggested 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.

MATERIALS AND METHODS

The genetic materials used in the present investigation included seven squash varieties belong to the species (*Cucurbita pepo*, L.). 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. The seven varieties were chosen to represent a wide rang of variation in most studied traits.

Plants from each parental variety were self-pollinated for three successive generations to obtain inbred lines 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 to produce 21 F_1 and 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 F_{1r} reciprocal hybrids) were evaluated in a field trial in the growing summer season of 2010 at Kaha Vegetables Research Station, Kaha, Kalubia, Egypt. The crosses yielded 21 F_1 hybrids (F_1) and 21 F_1 reciprocal hybrids (F_{1r}) as shown in Table 1.

The experimental design was the Randomized Complete Blocks Design (RCBD) with three replications. Data were recorded for the following vegetative traits: vein length (V.L.cm); number of leaves per plant (No.L./P.); leaf area (L.A.cm^2); fresh weight per plant (F.W./P.g); dry weight per plant (D.W./P.g) and the ratio of chlorophyll in leaves (Chl.).

Differences among genotypic means for all vegetative studied traits were tested for significance according to F-test. The form of analysis of variance and the expectations of mean squares were as outlined by Steel and Torrie (1960).

The amounts of heterosis were determined as the percentage deviation from the means of the F_1 hybrids (F_1), F_1 reciprocal hybrids (F_{1r}) and all $F_{1,1r}$ hybrids from the average of all parents (mid-parents) or the better parent.

In this investigation all crosses of the mating design were used to estimate general combining ability (GCA) and specific combining ability (SCA). In addition, the genetic variances of reciprocal effects (r) could be also obtained. The procedures of this analysis were described by Griffing (1956) method I. The estimates of GCA variance ($\delta^2 g$) and SCA variance ($\delta^2 s$) could be expressed in terms of genetic variances according to Matzingar & Kempthorne (1956) and Cockerham (1963).

RESULTS AND DISCUSSIONS

Squash varieties possess a wide range of variation for vegetative traits. Vegetable breeders usually use this variability as a tool to improve squash varieties through selection programs or to produce F_1 hybrids to make use of hybrid vigor phenomena and to obtain highest yielding hybrids.

1. Analysis of variance:-

The present work was planned to evaluate seven parental varieties, 21 F_1 and their 21 F_{1r} (reciprocal) hybrids. Therefore, an analysis of variance was made for all genetic materials under study and the obtained results for vegetative traits are presented in Table 2.

These traits included sex traits. They were: vein length (V.L.cm); number of leaves per plant (No.L./P.); leaf area (L.A.cm^2); fresh weight per plant (F.W./P.g); dry weight per plant (D.W./P.g) and the ratio of chlorophyll in leaves (Chl.).

Table 1. The produced hybrids and their symbols

No.	Symbol	Female	Male
		F_1 hybrids	
1	$P_1 \times P_2$	Eskandarani	Zucca Patisson custard white
2	$P_1 \times P_3$	Eskandarani	All Green Bush
3	$P_1 \times P_4$	Eskandarani	Courgette Orelia
4	$P_1 \times P_5$	Eskandarani	Sakiz
5	$P_1 \times P_6$	Eskandarani	Copi
6	$P_1 \times P_7$	Eskandarani	Gapla
7	$P_2 \times P_3$	Zucca Patisson custard white	All Green Bush
8	$P_2 \times P_4$	Zucca Patisson custard white	Courgette Orelia
9	$P_2 \times P_5$	Zucca Patisson custard white	Sakiz
10	$P_2 \times P_6$	Zucca Patisson custard white	Copi
11	$P_2 \times P_7$	Zucca Patisson custard white	Gapla
12	$P_3 \times P_4$	All Green Bush	Courgette Orelia
13	$P_3 \times P_5$	All Green Bush	Sakiz
14	$P_3 \times P_6$	All Green Bush	Copi
15	$P_3 \times P_7$	All Green Bush	Gapla
16	$P_4 \times P_5$	Courgette Orelia	Sakiz
17	$P_4 \times P_6$	Courgette Orelia	Copi
18	$P_4 \times P_7$	Courgette Orelia	Gapla
19	$P_5 \times P_6$	Sakiz	Copi
20	$P_5 \times P_7$	Sakiz	Gapla
21	$P_6 \times P_7$	Copi	Gapla
		F_{1r} reciprocal hybrids	
22	$P_2 \times P_1$	Zucca Patisson custard white	Eskandarani
23	$P_3 \times P_1$	All Green Bush	Eskandarani
24	$P_3 \times P_2$	All Green Bush	Zucca Patisson custard white
25	$P_4 \times P_1$	Courgette Orelia	Eskandarani
26	$P_4 \times P_2$	Courgette Orelia	Zucca Patisson custard white
27	$P_4 \times P_3$	Courgette Orelia	All Green Bush
28	$P_5 \times P_1$	Sakiz	Eskandarani
29	$P_5 \times P_2$	Sakiz	Zucca Patisson custard white
30	$P_5 \times P_3$	Sakiz	All Green Bush
31	$P_5 \times P_4$	Sakiz	Courgette Orelia
32	$P_6 \times P_1$	Copi	Eskandarani
33	$P_6 \times P_2$	Copi	Zucca Patisson custard white
34	$P_6 \times P_3$	Copi	All Green Bush
35	$P_6 \times P_4$	Copi	Courgette Orelia
36	$P_6 \times P_5$	Copi	Sakiz
37	$P_7 \times P_1$	Gapla	Eskandarani
38	$P_7 \times P_2$	Gapla	Zucca Patisson custard white
39	$P_7 \times P_3$	Gapla	All Green Bush
40	$P_7 \times P_4$	Gapla	Courgette Orelia
41	$P_7 \times P_5$	Gapla	Sakiz
42	$P_7 \times P_6$	Gapla	Copi

Table 2. Analysis of variance and expectation of mean squares for vegetative traits

S.V.	d.f.	Vegetative traits V.L.cm	No.L./P.	L.A.cm^2	F.W./P.g	D.W./P.g	Chl.
Reps.	2	5.383	34.040**	113.570	436.738 *	59.432	0.640
Genotypes	48	788.932**	29.750**	35723.885**	17020.315**	1462.400**	61.439**
Error	96	2.777	1.404	132.955	94.233	44.969	1.550

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

The results indicated that tests of significance revealed that the mean squares of the genotypes showed highly significance for all vegetative studied traits. The significance of mean squares of genotypes suggested that the presence of large variations among these genotypes and the planned comparisons for the understanding the nature of variation and the determination of heterosis for all vegetative traits are valid.

Similar results were obtained by Gabr (2003); Abd El-Hadi *et al.*, (2004); Abdein (2005); Al-Ballat (2008); Al-Araby (2010) and Jahan *et al.*, (2012).

2. The mean performance of all genotypes:

The mean performance of all genotypes should be studied. The means of the seven parental varieties; 21 F_1 and their 21 F_{1r} (reciprocal) hybrids were determined for the previous traits and the results are presented in Tables 3, 4 and 5. The means showed that there were no specific parent, which was superior for all the vegetative traits. It also cleared that the parental variety P_6 was the highest parent for V.L.cm; No.L./P.; L.A.cm2; F.W./P.g and D.W./P.g. While, the highest parent for Chl. was P_3. On the other hand, the parental variety P_2 was the lowest parent for all vegetative traits. The differences between the means of the lowest and the highest parent were highly significant indicating the presence of genetic differences between these seven parental varieties.

The F_1 hybrids between the seven parental varieties were obtained in addition to their F_{1r} (reciprocal) hybrids. The results showed no significant differences between the means of the F_1 hybrids and their F_{1r} (reciprocal) hybrids for the most vegetative traits. The results indicated that the highest F_1 for the V.L.cm was the hybrid $P_1 \times P_6$ with the mean of 114.77cm. Whereas; the highest F_{1r} (reciprocal) hybrid was $P_6 \times P_1$ with the mean of 120.47cm for the same trait. On the other hand, F_1 hybrid $P_2 \times P_7$ was the lowest with the mean of 78.93cm for the same trait. While $P_5 \times P_2$ F_{1r} (reciprocal) hybrid was the lowest with the mean of 70.97cm for the same trait.

It could be regarded that the means of the 21 F_1 hybrids ranged from 78.93 to 114.77cm; 26.07 to 37.87; 296.2 to 664.9cm^2; 521.2 to 746.1g; 92.3 to 148.9g and 35.07 to 46.13 for V.L.cm; No.L./P.; L.A.cm^2; F.W./P.g; D.W./P.g and Chl., respectively. On the other hand, F_{1r} (reciprocal) hybrids ranged from 70.97 to 120.47cm; 26.93 to 36.13; 315.1 to 614.2cm^2; 729.8 to 580.8g; 93.7 to 146.2g and 34.77 to 48.07 for the same traits, respectively.

When the F_1 hybrids were compared with the F_{1r} hybrids the results showed the presence of significant differences for many traits. It is also cleared that some F_1 and F_{1r} (reciprocal) hybrids exceeded the better parent for many traits. Therefore, it would be expected the presence of heterosis values from the mid-parents and the better parent.

Table 3.The mean performances of the seven parental varieties for vegetative traits

No.	Parental varieties	Vegetative traits V.L.cm	No.L./P.	L.A.cm^2	F.W./P.g	D.W./P.g	Chl.
1	P_1	67.07	28.17	401.1	655.9	127.4	31.63
2	P_2	40.17^{L}	22.33^{L}	207.8^{L}	413.1^{L}	60.2^{L}	26.73^{L}
3	P_3	57.53	25.63	278.3	579.6	90.7	35.53^{H}
4	P_4	55.33	25.17	232.9	455.8	74.2	34.57
5	P_5	63.87	26.77	357.1	563.9	91.2	30.93
6	P_6	79.33^{H}	30.67^{H}	551.8^{H}	693.2^{H}	131.4^{H}	33.17
7	P_7	59.17	26.23	384.9	523.9	75.1	33.87
L.S.D.$_{0.05}$		2.69	1.91	18.64	15.69	10.84	2.01
L.S.D.$_{0.01}$		3.56	2.53	24.66	20.76	14.34	2.66

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

Table 4. The mean performances of the 21 F_1 hybrids for vegetative traits

No.	F_1 hybrids	Vegetative traits					
		V.L.cm	No.L./P.	L.A.cm^2	F.W./P.g	D.W./P.g	Chl.
1	$P_1 \times P_2$	101.77	35.13	429.2	676.1	134.1	39.67
2	$P_1 \times P_3$	90.73	30.13	403.6	683.7	132.9	42.53
3	$P_1 \times P_4$	93.33	30.73	408.2	686.9	132.1	37.53
4	$P_1 \times P_5$	96.33	32.93	545.8	681.5	136.1	41.13
5	$P_1 \times P_6$	114.77^{H}	37.87^{H}	664.9^{H}	735.8	146.4	38.37
6	$P_1 \times P_7$	98.03	29.33	466.5	666.2	135.3	38.47
7	$P_2 \times P_3$	82.83	27.73	327.9	614.8	126.4	36.63
8	$P_2 \times P_4$	80.47	26.07^{L}	323.2	521.2^{L}	94.5	35.07^{L}
9	$P_2 \times P_5$	85.37	28.73	386.3	566.7	99.3	36.37
10	$P_2 \times P_6$	92.73	30.87	642.8	708.8	134.3	36.83
11	$P_2 \times P_7$	78.93^{L}	27.83	394.9	544.2	94.4	35.83
12	$P_3 \times P_4$	94.83	29.93	296.2^{L}	615.9	109.2	42.37
13	$P_3 \times P_5$	88.23	28.13	565.8	586.9	94.1	38.83
14	$P_3 \times P_6$	95.77	33.23	594.9	723.5	135.1	38.93
15	$P_3 \times P_7$	94.63	30.93	390.5	613.7	112.8	40.07
16	$P_4 \times P_5$	87.63	29.07	366.2	565.6	98.8	39.47
17	$P_4 \times P_6$	87.87	31.07	561.2	703.7	133.1	36.53
18	$P_4 \times P_7$	84.07	28.77	425.9	564.6	92.3^{L}	38.33
19	$P_5 \times P_6$	97.67	31.83	556.3	734.1	142.9	45.73
20	$P_5 \times P_7$	91.43	30.37	425.1	596.2	98.9	41.43
21	$P_6 \times P_7$	100.83	34.83	558.4	746.1^{H}	148.9^{H}	46.13^{H}
L.S.D.$_{0.05}$		2.69	1.91	18.64	15.69	10.84	2.01
L.S.D.$_{0.01}$		3.56	2.53	24.66	20.76	14.34	2.66

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

Table 5. The mean performances of F_{1r} hybrids for vegetative traits

No.	F_{1r} hybrids	Vegetative traits					
		V.L.cm	No.L./P.	L.A.cm^2	F.W./P.g	D.W./P.g	Chl.
22	$P_2 \times P_1$	74.37	28.83	564.9	670.9	132.2	37.33
23	$P_3 \times P_1$	86.87	29.13	418.3	667.5	136.8	41.63
24	$P_3 \times P_2$	71.93	27.23	393.9	617.8	102.4	40.77
25	$P_4 \times P_1$	85.77	29.43	443.8	684.9	144.1	38.63
26	$P_4 \times P_2$	75.13	27.87	315.1^{L}	580.8^{L}	94.3	34.77^{L}
27	$P_4 \times P_3$	90.63	31.13	337.6	616.7	117.9	41.77
28	$P_5 \times P_1$	81.47	28.33	481.8	673.8	138.2	37.93
29	$P_5 \times P_2$	70.97^{L}	26.93^{L}	463.2	605.8	113.1	40.33
30	$P_5 \times P_3$	93.53	29.23	357.8	603.3	111.3	43.13
31	$P_5 \times P_4$	88.07	29.77	388.2	615.4	114.3	39.17
32	$P_6 \times P_1$	120.47^{H}	36.13^{H}	614.2^{H}	725.3	137.9	44.43
33	$P_6 \times P_2$	119.97	35.17	560.8	719.7	134.8	47.93
34	$P_6 \times P_3$	110.13	34.37	562.4	729.8^{H}	143.3	45.43
35	$P_6 \times P_4$	105.73	31.77	558.1	724.9	136.3	36.93
36	$P_6 \times P_5$	112.87	35.23	585.9	715.6	141.5	38.77
37	$P_7 \times P_1$	89.07	31.17	482.6	659.1	131.7	46.73
38	$P_7 \times P_2$	80.07	28.23	396.3	573.3	93.7^{L}	37.67
39	$P_7 \times P_3$	83.93	28.93	390.9	631.1	108.5	47.57
40	$P_7 \times P_4$	91.87	30.07	387.3	606.7	110.8	48.07^{H}
41	$P_7 \times P_5$	91.77	32.13	424.9	585.1	112.3	38.13
42	$P_7 \times P_6$	97.57	34.87	573.5	719.2	146.2^{H}	41.73
	L.S.D.$_{0.05}$	2.69	1.91	18.64	15.69	10.84	2.01
	L.S.D.$_{0.01}$	3.56	2.53	24.66	20.76	14.34	2.66

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

3. Heterosis:-

An important goal of most vegetable breeding programs is directed to increase the yielding capacity of the crops. This goal is achieved either by improving the characteristics of the vegetable crop through selection programs or through hybridization to produce superior F_1 hybrids.

In order to study heterosis as a phenomena in squash, the averages of all hybrids were compared with the averages of all hybrids versus the mid-parents ($H_{M.P.}$%) for all traits. This type of comparison would eliminate bias for certain specific hybrid with respect to its better parent ($H_{B.P}$%). The significance of heterosis was obtained for each comparison by comparing the differences against the least significant differences (L.S.D.) values.

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

Heterosis values from the mid-parents ($H_{M.P.}$%) were estimated for all hybrids and the results are presented in Tables 6 and 7.

The results cleared that the average means of the 21 F_1 hybrids and their 21 F_{1r} (reciprocal) hybrids significantly exceeded their mid-parents for all traits.

Data presented in Tables 6 and 7 gave the heterosis percentage of the 42 $F_{1,1r}$ hybrids relative to their mid-parents. All the 21 F_1 hybrids showed highly significant and positive (desirable) values for V.L.cm; No.L./P.; L.A.cm^2; F.W./P.g and Chl. While, for D.W./P.g 20 F_1 hybrids out of the 21 F_1 hybrids showed highly significant and positive (desirable) values.

The results revealed that heterotic effect of F_1 hybrids ranged from 30.50 to 89.75% for V.L.cm; 7.31 to 39.05% for No.L./P.; 14.58 to 78.11% for L.A.cm^2; 2.65 to 28.14% for F.W./P.g ; 3.50 to 67.57% for D.W./P.g and 7.87 to 42.69 for Chl. While, the heterotic effect of F_{1r} (reciprocal) hybrids ranged from 23.49 to 100.61%; 3.03 to 32.62%; 12.64 to 85.57%; 5.52 to 33.68%; 5.05 to 49.52% and 9.06 to 60.04 for V.L.cm; No.L./P.; L.A.cm^2; F.W./P.g; D.W./P.g and Chl., respectively. All the 21 F_{1r} hybrids showed highly significant and positive (desirable) values for V.L.cm; L.A.cm^2; F.W./P.g and Chl., but, 20 F_{1r} hybrids showed the same results for No.L./P. and D.W./P.g.

Table 6. Heterosis versus the mid-parents of the 21 F_1 hybrids for vegetative traits

No.	F_1 hybrids	Vegetative traits					
		V.L.cm	No.L./P.	L.A.cm^2	F.W./P.g	D.W./P.g	Chl.
1	$P_1 \times P_2$	89.75**^{H}	39.05**^{H}	40.99**	26.49**	43.05**	35.92**
2	$P_1 \times P_3$	45.64**	11.95**	18.83**	10.68**	21.78**	26.65**
3	$P_1 \times P_4$	52.45**	14.98**	28.77**	23.57**	31.05**	13.39**
4	$P_1 \times P_5$	47.06**	19.64**	43.98**	11.75**	24.59**	31.49**
5	$P_1 \times P_6$	56.79**	28.58**	39.55**	9.09**	13.19**	18.42**
6	$P_1 \times P_7$	48.67**	7.78**	18.69**	12.93**	33.66**	17.46**
7	$P_2 \times P_3$	69.51**	15.64**	34.91**	23.87**	67.57**^{H}	17.67**
8	$P_2 \times P_4$	68.46**	9.68**	46.65**	19.98**	40.58**	14.41**
9	$P_2 \times P_5$	64.01**	16.82**	36.78**	16.02**	31.28**	26.13**
10	$P_2 \times P_6$	55.16**	15.90**	69.24**	28.14**^{H}	40.20**	22.98**
11	$P_2 \times P_7$	59.21**	14.34**	33.26**	16.15**	39.59**	18.26**
12	$P_3 \times P_4$	67.99**	17.77**	15.89**	18.97**	32.43**	20.87**
13	$P_3 \times P_5$	45.32**	7.31**^{L}	78.11**^{H}	2.65**^{L}	3.50^{L}	16.85**
14	$P_3 \times P_6$	39.84**	17.99**	43.33**	13.89**	21.69**	13.34**
15	$P_3 \times P_7$	62.13**	19.15**	17.76**	11.23**	35.97**	15.47**
16	$P_4 \times P_5$	46.94**	11.79**	24.14**	10.94**	19.43**	20.51**
17	$P_4 \times P_6$	30.50**^{L}	11.15**	43.03**	22.50**	29.51**	7.87**^{L}
18	$P_4 \times P_7$	46.84**	11.86**	37.86**	15.27**	23.54**	12.03**
19	$P_5 \times P_6$	36.37**	10.72**	22.41**	16.80**	28.40**	42.69**^{H}
20	$P_5 \times P_7$	48.54**	14.52**	14.58**^{L}	9.62**	18.90**	27.88**
21	$P_6 \times P_7$	45.61**	22.37**	19.23**	22.61**	44.25**	37.64**
L.S.D.$_{0.05}$		2.03	1.44	14.09	11.86	8.19	1.52
L.S.D.$_{0.01}$		2.68	1.90	18.57	15.63	10.80	2.00

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

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

Table 7. Heterosis versus the mid-parents of the 21 F_{1r} hybrids for vegetative traits

No.	F_{1r} hybrids	Vegetative traits					
		V.L.cm	No.L./P.	L.A.cm^2	F.W./P.g	D.W./P.g	Chl.
22	$P_2 \times P_1$	38.66**	14.12**	85.57**^{H}	25.52**	41.02**	27.93**
23	$P_3 \times P_1$	40.50**	7.99**	23.14**	8.06**	25.42**	23.97**
24	$P_3 \times P_2$	47.20**	13.41**	62.08**	24.46**	35.67**	30.94**
25	$P_4 \times P_1$	40.14**	9.86**	40.01**	23.21**	42.99**	16.72**
26	$P_4 \times P_2$	57.29**	17.25**	42.99**	33.68**^{H}	40.38**	13.43**
27	$P_4 \times P_3$	60.60**	22.23**	32.07**	19.13**	42.98**	19.16**
28	$P_5 \times P_1$	23.49**^{L}	3.03^{L}	27.09**	10.48**	26.48**	21.15**
29	$P_5 \times P_2$	36.22**	9.63**	64.02**	24.01**	49.52**^{H}	39.88**
30	$P_5 \times P_3$	54.05**	10.87**	12.64**^{L}	5.52**^{L}	22.34**	29.79**
31	$P_5 \times P_4$	47.72**	14.49**	31.58**	20.71**	38.25**	19.59**
32	$P_6 \times P_1$	64.57**	22.69**	28.92**	7.53**	5.05^{L}	30.35**
33	$P_6 \times P_2$	100.61**^{H}	32.62**^{H}	47.65**	30.12**	40.79**	60.04**^{H}
34	$P_6 \times P_3$	60.89**	22.01**	35.50**	15.62**	28.71**	32.27**
35	$P_6 \times P_4$	57.03**	13.66**	42.23**	26.18**	32.56**	9.06**^{L}
36	$P_6 \times P_5$	57.60**	22.32**	28.93**	13.86**	27.20**	20.75**
37	$P_7 \times P_1$	41.11**	14.51**	22.80**	11.73**	30.11**	42.70**
38	$P_7 \times P_2$	61.15**	16.27**	33.71**	22.37**	38.46**	24.31**
39	$P_7 \times P_3$	43.84**	11.57**	17.89**	14.38**	30.87**	37.08**
40	$P_7 \times P_4$	60.47**	16.27**	25.37**	23.86**	48.32**	40.48**
41	$P_7 \times P_5$	49.02**	21.06**	14.52**	7.58**	35.06**	17.70**
42	$P_7 \times P_6$	40.89**	22.37**	22.45**	18.18**	41.57**	24.42**
L.S.D.$_{0.05}$		2.03	1.44	14.09	11.86	8.19	1.52
L.S.D.$_{0.01}$		2.68	1.90	18.57	15.63	10.80	2.00

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

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

These results were in agreement with the results obtained by Abd El-Hadi, (1995); Gabr, (2003); Abd El-Hadi *et al.*, (2004); Abdein, (2005); Al-Ballat, (2008); Al-Araby, (2010); Jahan *et al.*, (2012) and Sanin *et al.*, (2014).

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

Heterosis values from the better parent of all studied hybrids were estimated for vegetative traits and the results are presented in Tables 8 and 9.

Data showed heterosis percentage of the 42 $F_{1,1r}$ hybrids relative to better parent for all traits. All hybrids showed highly significant and positive values for V.L.cm. While, most hybrids were not significant for D.W./P.g. At the same time, most hybrids had positive and highly significant estimates for Chl. (17 F_1 hybrids) in the same time 8,12,12 and 6 F_1 out of the 21 F_1 hybrids showed positive and highly significant values for No.L./P.; L.A.cm^2; F.W./P.g and D.W./P.g., respectively.

The results revealed that heterotic effects of the F_1 hybrids ranged from 10.76 to 64.77% for V.L.cm; 0.11 to 24.59% for No.L./P.; 0.64 to 58.47% for L.A.cm^2; 0.31 to 14.36% for F.W./P.g; 1.34 to 39.35% for D.W./P.g and 1.45 to 37.89% for Chl. While the heterotic effects of the F_{1r} (reciprocal) hybrids ranged from 10.88 to 64.57%; 0.47 to 21.20%; 0.21 to 35.27%; 0.49 to 27.43%; 2.64 to 47.43% and 0.58 to 44.52% for V.L.cm; No.L./P.; L.A.cm^2; F.W./P.g; D.W./P.g and Chl., respectively. The results in Table 9 showed that 21;12;12;17;10 and 19 out of the 21 F_{1r} hybrids showed positive and highly significant (desirable) estimates from the better parent.These results were in agreement with the results obtained by Abd El-Hadi, (1995); Gabr, (2003); Abd El-Hadi et al., (2004); Abdein, (2005); Al-Ballat, (2008); Al-Araby, (2010) and Sanin et al., (2014).

4. Analysis of combining ability variances:

The pertinent part of the analysis of variance for combining ability of the seven parental varieties and their 42 F_1 hybrids for vegetative traits are shown in Table 10. The results revealed that the mean squares due to crosses were highly significant for all vegetative traits. Similarly, the mean squares due to general and specific combining abilities were also highly significant for all traits.

The GCA mean squares were important than SCA mean square for all vegetative traits. This indicated that additive genetic variance was more important in the inheritance of these traits. This was emphasized by the ratio of GCA/SCA which exceeds the unit.

These results were in agreement with the results obtained by Abd El-Hadi *et al.*, (2004); Abdein, (2005); Al-Ballat, (2008); Al-Araby, (2010); Radha *et al.*, (2013) and Sanin *et al.*, (2014).

5. Genetic parameters and heritability:

According to the expectation of mean squares, the variance components would be calculated and translated in terms of genetic variance components. Thus, the genetic parameters, which included additive (δ^2A); non-additive genetic variance including dominance (δ^2D); reciprocal effect (δ^2r); heritability in broad (h^2_b%) and narrow (h^2_n%) senses were estimated and the results are presented in Table 11.

The results illustrated that the magnitudes of δ^2A, were larger in magnitudes than their corresponding values of δ^2D for No.L./P.; L.A.cm^2; F.W./P.g.; and D.W./P.g traits. On the other hand, the magnitudes of δ^2D were larger for V.L.cm and Chl. In general, it appeared that both δ^2A and δ^2D were important for the inheritance of vegetative traits. The results also indicated the presence of δ^2r for all traits. Therefore, all genetic parameters played an important role in the inheritance of vegetative traits.

These results indicated that vegetative traits not only controlled by nuclear genetic factors, but also by cytoplasmic genetic factors.

The results indicated that the magnitudes of the values of heritability in broad sense (h^2_b%), were larger than their corresponding values of heritability in narrow sense (h^2_n%) for all traits. The values of heritability in narrow sense (h^2_n%) and broad sense were 23.466 and 99.082%; 44.203 and 87.507%; 65.844 and 99.026%; 64.320 and 98.555%; 59.012 and 91.978%, and 10.393 and 93.393% for V.L.cm; No.L./P.; L.A.cm^2; F.W./P.g.; D.W./P.g and Chl., respectively.

These results were in agreement with the results obtained by Abd El-Hadi *et al.*, (2004); Abdein, (2005); Al-Ballat, (2008); Al-Araby, (2010) and Sanin *et al.*, (2014).

Table 8. Heterosis versus the better parent of F_1 the 21 hybrids for vegetative traits

No.	F_1 hybrids	Vegetative traits					
		V.L.cm	No.L./P.	L.A.cm^2	F.W./P.g	D.W./P.g	Chl.
1	$P_1 \times P_2$	51.74**	24.59**^{H}	7.02**	3.08*	5.31	25.40**
2	$P_1 \times P_3$	35.29**	6.86*	0.64^{L}	4.24**	4.27	19.70**
3	$P_1 \times P_4$	39.12**	8.87*	1.78	4.72**	3.72	8.58**
4	$P_1 \times P_5$	43.59**	16.67**	36.08**	3.91**	6.88	30.03**
5	$P_1 \times P_6$	44.66**	23.34**	20.49**	6.16**	11.47**	15.68**
6	$P_1 \times P_7$	39.91**	4.02	16.31**	1.57	6.25	13.58**
7	$P_2 \times P_3$	43.97**	8.19*	17.82**	6.08**	39.35**^{H}	3.10
8	$P_2 \times P_4$	45.42**	3.44	38.74**	14.36**^{H}	27.26**	1.45^{L}
9	$P_2 \times P_5$	33.59**	7.09*	8.19**	0.51	8.96	17.56**
10	$P_2 \times P_6$	16.89**	0.11^{L}	16.48**	2.26	2.21	11.06**
11	$P_2 \times P_7$	33.69**	5.84*	2.60	3.87*	25.69**	5.81
12	$P_3 \times P_4$	64.77**^{H}	16.78**	6.44	6.26**	20.39	19.23**
13	$P_3 \times P_5$	38.08**	4.98	58.47**^{H}	1.25	3.25	9.29**
14	$P_3 \times P_6$	20.63**	8.25*	7.80**	4.56**	2.87	9.57**
15	$P_3 \times P_7$	59.89**	17.79**	1.45	5.88**	24.28**	12.76**
16	$P_4 \times P_5$	37.09**	8.46*	2.56	0.31^{L}	8.34	14.18**
17	$P_4 \times P_6$	10.76**^{L}	1.19	1.70	1.52	1.34^{L}	5.69
18	$P_4 \times P_7$	42.08**	9.66**	10.64**	7.78**	22.80**	10.90**
19	$P_5 \times P_6$	23.11**	3.69	0.81	5.91**	8.75	37.89**^{H}
20	$P_5 \times P_7$	43.04**	13.31**	10.43**	5.73**	8.45	22.34**
21	$P_6 \times P_7$	27.10**	13.46**	1.20	7.64**	13.37*	36.22**
L.S.D.$_{0.05}$		2.69	1.91	18.64	15.69	10.84	2.01
L.S.D.$_{0.01}$		3.56	2.53	24.66	20.76	14.34	2.66

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

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

L= The lowest value.

Table 9. Heterosis versus the better parent of F_{1r} the 21 hybrids for vegetative traits

No.	F_{1r} hybrids	Vegetative traits V.L.cm	No.L./P.	L.A.cm^2	F.W./P.g	D.W./P.g	Chl.
22	$P_2 \times P_1$	10.88**^{L}	2.25	40.86**	2.29	3.82	18.02**
23	$P_3 \times P_1$	30.52**	3.07	4.30	1.77	7.38	17.17**
24	$P_3 \times P_2$	25.03**	6.11	41.55**	6.59**	12.82*	14.73**
25	$P_4 \times P_1$	27.88**	4.02	10.66**	4.42**	13.16**	11.76**
26	$P_4 \times P_2$	35.78**	10.58**	35.27**^{H}	27.43**^{H}	27.08**	0.58^{L}
27	$P_4 \times P_3$	57.53**	21.20**^{H}	21.31**	6.41**	29.98**	17.54**
28	$P_5 \times P_1$	20.58**	0.47^{L}	20.12**	2.73*	8.51	19.81**
29	$P_5 \times P_2$	10.95**	0.50	29.73**	7.44**	24.10**	30.39**
30	$P_5 \times P_3$	46.37**	8.46*	0.21^{L}	4.09**	22.05**	21.39**
31	$P_5 \times P_4$	37.82**	11.07**	8.71**	9.14**	25.41**	13.31**
32	$P_6 \times P_1$	64.57**^{H}	17.70**	11.31**	4.64**	3.45	27.34**
33	$P_6 \times P_2$	51.13**	14.55**	1.62	3.83**	2.64^{L}	44.52**^{H}
34	$P_6 \times P_3$	38.78**	11.94**	1.92	6.15**	8.80	27.86**
35	$P_6 \times P_4$	33.28**	3.47	1.14	4.57**	3.73	6.85*
36	$P_6 \times P_5$	42.27**	14.55**	6.18**	3.24**	7.74	16.68**
37	$P_7 \times P_1$	32.80**	10.52**	20.33**	0.49^{L}	3.43	37.99**
38	$P_7 \times P_2$	35.32**	7.62*	2.94	9.44**	24.67**	11.22**
39	$P_7 \times P_3$	41.86**	10.29**	1.56	8.89**	19.62**	33.86**
40	$P_7 \times P_4$	55.27**	13.98**	0.61	15.80**	47.43**^{H}	39.05**
41	$P_7 \times P_5$	43.51**	19.78**	10.37**	11.68**	23.18**	12.60**
42	$P_7 \times P_6$	22.98**	13.46**	3.93*	27.54**	11.27*	23.13**
L.S.D.$_{0.05}$		2.69	1.91	18.64	15.69	10.84	2.01
L.S.D.$_{0.01}$		3.56	2.53	24.66	20.76	14.34	2.66

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

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

Table 10. Analysis of combining abilities and mean squares of all F_1 hybrids ($F_{1,1r}$ hybrids) for vegetative traits

S.V.	d.f.	Vegetative traits V.L.cm	No.L./P.	L.A.cm^2	F.W./P.g	D.W./P.g	Chl.
Reps.	2	0.640	59.432	436.738 *	113.570	34.040**	5.383
Crosses	41	205.122**	5.732**	4196.15**	2029.412**	205.283**	19.137**
G.C.A.	6	697.674**	39.060**	66561.489**	31558.387**	2501.427**	30.675**
S.C.A.	14	323.814**	8.334**	5982.334**	3650.923**	346.291**	23.921**
R.E.	21	76.664**	2.857*	2210.159**	311.262**	54.500	13.442**
Error	82	2.777	1.404	132.955	94.233	44.969	1.550
G.C.A./ S.C.A.	-	0.155	0.388	0.811	0.632	0.582	0.093

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

Table 11. The relative magnitudes of different genetic parameters and heritability for vegetative traits

Genetic parameters and heritability	Vegetative traits V.L.cm	No.L./P.	L.A.cm^2	F.W./P.g	D.W./P.g	Chl.
δ^2 A	71.00	4.968	8996.81	4196.98	330.84	2.42
δ^2 D	191.839	4.141	3495.36	2125.34	180.05	13.368
δ^2 r	36.943	0.726	1038.6	108.514	4.765	5.946
δ^2 E	2.777	1.404	132.955	94.233	44.969	1.550
h^2b%	99.082	87.507	99.026	98.555	91.978	93.343
h^2n%	23.466	44.203	65.844	64.320	59.012	10.393

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

6. General combining ability effects (g_i) for the seven parental varieties:

Positive or negative estimates of GCA effects (g_i) would indicate that a given parental variety is better or much poorer than the average of the group involved with it in the complete diallel crosses mating design system.

The general combining ability (GCA) effects of the seven parental varieties for vegetative traits are given in Table 12.

The results revealed that GCA effects (g_i) gave positive and highly significant values to parent No.P_6 for all vegetative traits. The results showed desirably positive and highly significant values to the parent No.P_1 for V.L.cm; No.L./P.; L.A.cm^2; F.W./P.g and D.W./P.g but it was undesirably negative and not significant for Chl. While, the GCA effects were found to be highly significant and negative (undesirable) for parent No.P_2 for all vegetative traits. While, parents No.P_3, P_6 and P_7 were highly significant and positive (desirable) for Chl. These results also indicated that parents No.P_4 and P_7 had negative (undesirable) and highly significant GCA effects for V.L.cm; L.A.cm^2; F.W./P.g and D.W./P.g.

The results indicated that parents No.P_1 and P_6 seemed to be the best combiners for V.L.cm; No.L./P.; L.A.cm^2; F.W./P.g and D.W./P.g. Parents No.P_3, P_6 and P_7 were the best combiners for Chl.

These results were in agreement with the results obtained by Gabr, (2003); Abd El-Hadi *et al.*, (2004); Abdein, (2005); Al-Araby, (2010); Radha *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 vegetative traits are presented in Tables 13 and 14.

The F_1 hybrids $P_1 \times P_2$; $P_1 \times P_6$; $P_1 \times P_7$; $P_2 \times P_6$; $P_3 \times P_4$; $P_3 \times P_5$; $P_3 \times P_6$; $P_3 \times P_7$; $P_4 \times P_5$; $P_4 \times P_7$; $P_5 \times P_6$ and $P_5 \times P_7$ showed highly significant positive (desirable) SCA effects for V.L.cm. The F_1 hybrids $P_1 \times P_6$ and $P_2 \times P_6$ gave the highest values 13.30 and 14.44 for the same trait, respectively. On the other hand, F_{1r} (reciprocal) hybrids $P_2 \times P_1$; $P_3 \times P_2$; $P_4 \times P_1$; $P_5 \times P_1$; $P_5 \times P_2$; $P_7 \times P_1$ and $P_7 \times P_3$ showed highly significant positive (desirable) of SCA effects for V.L.cm. On the same time, the F_{1r} (reciprocal) hybrid $P_2 \times P_1$ showed highly significant value of 13.67. The F_{1r} (reciprocal) hybrids $P_6 \times P_2$; $P_6 \times P_3$; $P_6 \times P_4$; $P_6 \times P_5$ and $P_7 \times P_4$ showed highly significant negative (undesirable) SCA effects for the same trait.

Table 12. General combining ability effects (g_i) of the seven parents for vegetative traits

	Vegetative traits					
Parents	V.L.cm	No.L./P.	L.A.cm^2	F.W./P.g	D.W./P.g	Chl.
P_1	3.105**	0.959**	34.345**	44.670**	17.139**	-0.119
P_2	-9.204**	-1.826**	-44.921**	-48.068**	-12.741**	-2.595**
P_3	-1.727**	-0.683*	-46.112**	-2.591	-2.836	1.547**
P_4	-3.466**	-1.136**	-68.945**	-35.806**	-9.051**	-0.761*
P_5	-0.704	0.421–	1.340	-17.258**	-4.955**	-0.547
P_6	13.653**	3.244**	135.340**	83.789**	20.782**	1.071**
P_7	-1.656**	0.136–	-11.136**	-24.734**	-8.336**	1.404**
L.S.D(gi)$_{.0.05}$	0.816	0.580	5.649	4.755	3.285	0.609
L.S.D(gi)$_{.0.01}$	1.076	0.765	7.446	6.269	4.330	0.804

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

The F_1 hybrids $P_1 \times P_2$ and $P_1 \times P_6$ gave the highest values 2.280 and 2.565 for No.L./P., respectively. While, the F_{1r} (reciprocal) hybrid $P_2 \times P_1$ gave the highest value 3.167 for the same trait.

The F_1 hybrids $P_1 \times P_2$ and $P_2 \times P_6$ gave the highest values 61.56 and 65.49 for L.A.cm^2, respectively. While, the F_{1r} (reciprocal) hybrids $P_5 \times P_3$ and $P_6 \times P_2$ gave the highest values 44.04 and 41.00 for the same trait, respectively.

For F.W./P.g the F_1 hybrids $P_1 \times P_4$ and $P_2 \times P_6$ gave the highest values 41.40 and 42.88, respectively. While, the F_{1r} (reciprocal) hybrid $P_7 \times P_6$ gave the highest value 13.33 for the same trait.

For D.W./P.g the F_1 hybrid $P_6 \times P_7$ gave the highest value 16.98. While, the F_{1r} (reciprocal) hybrid $P_3 \times P_2$ gave the highest value 12.33 for the same trait.

For Chl. the F_1 hybrid $P_1 \times P_2$ gave the highest value 21.93. While, the F_{1r} (reciprocal) hybrid $P_6 \times P_5$ gave the highest value 3.667 for the same trait.

These results were in agreement with the results obtained by Gabr, (2003); Abd El-Hadi *et al.*, (2004); Abdein, (2005); Al-Araby, (2010); Radha *et al.*, (2013) and Sanin *et al.*, (2014).

Table 13. Specific combining ability effects (s_{ij}) of the 21 F_1 hybrids for vegetative traits

	Vegetative traits					
F_1 hybrids	V.L.cm	No.L./P.	L.A.cm^2	F.W./P.g	D.W./P.g	Chl.
$P_1 \times P_2$	6.90**	2.28*	61.56**	41.16**	10.69	21.93**
$P_1 \times P_3$	-0.153	-0.673	-23.24*	-1.98	2.62	1.45
$P_1 \times P_4$	2.585	0.112	14.59	41.40**	11.84*	-0.238
$P_1 \times P_5$	-0.843	0.065	31.97**	14.69	6.91	0.881
$P_1 \times P_6$	13.30**	2.565*	23.8*	-33.53**	-13.83*	1.26
$P_1 \times P_7$	4.78**	-1.054	5.28	7.00	6.79	2.09
$P_2 \times P_3$	0.823	-0.054	6.11	31.43**	11.84*	0.429
$P_2 \times P_4$	2.89*	-0.102	-12.89	-0.69	-1.74	-0.762
$P_2 \times P_5$	0.799	-0.150	22.33*	15.76	6.12	2.19*
$P_2 \times P_6$	14.44**	1.517	65.49**	42.88**	8.55	4.57**
$P_2 \times P_7$	2.751	-0.102	5.97	-3.93	-2.83	-0.929
$P_3 \times P_4$	10.59**	2.255*	-14.03	19.00*	7.48	2.095
$P_3 \times P_5$	5.99**	-0.293	60.68**	-20.72*	-7.62	0.881
$P_3 \times P_6$	3.79**	1.041	43.52**	9.57	3.31	0.095
$P_3 \times P_7$	5.28**	0.922	2.16	13.93	3.77	1.43
$P_4 \times P_5$	4.39**	0.827	-0.98	8.00	2.43	1.52
$P_4 \times P_6$	-0.795	-1.007	47.35**	30.62**	4.86	-2.76*
$P_4 \times P_7$	5.51**	0.541	40.83**	10.14	0.81	3.24**
$P_5 \times P_6$	4.92**	0.612	-11.27	22.57**	8.43	2.52*
$P_5 \times P_7$	6.75**	0.612	-11.29	-3.07	0.88	-0.476
$P_6 \times P_7$	-0.272	1.660	-4.13	38.21**	16.98**	2.41*
L.S.D.(s_{ij}) $_{0.05}$	2.828	2.010	19.568	16.474	11.380	2.112
L.S.D.(s_{ij}) $_{0.01}$	3.728	2.650	25.795	21.716	15.002	2.785

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

Table 14. Specific combining ability effects (r_{ij}) of the 21 F_{1r} hybrids for vegetative traits

	Vegetative traits					
F_{1r} hybrids	V.L.cm	No.L./P.	L.A.cm^2	F.W./P.g	D.W./P.g	Chl.
$P_2 \times P_1$	13.67**	3.167**	-67.83**	2.50	0.833	1.167
$P_3 \times P_1$	2.00	0.500	-7.50	8.17	-2.00	0.500
$P_3 \times P_2$	5.33**	0.001	-32.83**	-1.50	12.33*	-2.00*
$P_4 \times P_1$	3.67**	0.500	-17.83*	1.00	-6.00	-0.500
$P_4 \times P_2$	2.67*	-0.833	4.00	-29.50**	0.167	0.167
$P_4 \times P_3$	2.17	-0.333	-20.33*	-0.33	-4.333	0.500
$P_5 \times P_1$	7.33**	2.167*	31.83**	4.17	-1.167	1.500
$P_5 \times P_2$	7.00**	0.833	-38.5**	-19.83**	-6.833	-2.00*
$P_5 \times P_3$	-2.67*	-0.500	44.04**	-8.17	-8.667	-2.167*
$P_5 \times P_4$	0.001	-0.500	-10.83	-25.0**	-7.833	0.167
$P_6 \times P_1$	-2.83*	1.00	25.33**	5.33	4.500	-3.167**
$P_6 \times P_2$	-13.67**	-2.167*	41.00**	-5.33	0.001	-5.333**
$P_6 \times P_3$	-7.17**	-0.500	16.17*	-3.17	-4.00	-3.333**
$P_6 \times P_4$	-8.83**	-0.333	1.50	-10.67	-1.667	-0.167
$P_6 \times P_5$	-7.67**	-1.667*	-14.83	9.17	0.667	3.667**
$P_7 \times P_1$	4.67**	1.00	-8.00	3.67	1.667	-4.00**
$P_7 \times P_2$	-0.67	-0.500	-0.67	-14.67*	0.167	-0.833
$P_7 \times P_3$	5.33**	1.00	-0.33	-8.67	2.00	-3.667**
$P_7 \times P_4$	-3.83**	-0.833	19.17*	-21.00**	-9.167	-4.833**
$P_7 \times P_5$	-0.17	-1.00	0.001	5.67	-6.667	1.667
$P_7 \times P_6$	1.50	0.001	-7.50	13.33	1.167	2.167*
L.S.D.(r_{ij}) $_{0.05}$	2.333	1.658	16.143	13.591	9.388	1.743
L.S.D.(r_{ij}) $_{0.01}$	3.075	2.186	21.279	17.915	12.376	2.297

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

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الملخص العربي

تعبير قوة الهجين ودور الثوابت الوراثية المصاحبة لها في بعض الصفات الخضرية لقرع الكوسة

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تهدف هذه الدراسة إلى تقدير قيم قوة الهجين قياسا من متوسط الآباء وأفضل الآباء، وطبيعة فعل الجين، ومعامل التوريث في مداه الواسع والضيق والقدرة العامة والخاصة علي التآلف لبعض الصفات الخضرية في قرع الكوسة.

في هذه الدراسة تم إستخدام سبعة أصناف من قرع الكوسة كآباء وهى: 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) .

أظهرت الآباء مديً واسع من التباينات والإختلافات لجميع الصفات محل الدراسة. في الموسم الصيفي ٢٠٠٩ تم زراعة بذور الأصناف السبعة المستخدمة كآباء لإجراء كل التهجينات الممكنة (الهجن والهجن العكسية) بنظام التهجين الدوري الكامل كما أجريت عملية إخصاب ذاتي للأصناف المستخدمة كآباء. جميع التراكيب الوراثية تم تقييمها في تجربة حقلية في الموسم الصيفي ٢٠١٠ في تجربة ذات قطاعات كاملة العشوائية من ثلاث مكررات في المزرعة البحثية بقها محافظة القليوبية بمعهد بحوث البساتين التابع لمركز البحوث الزراعية بالجيزة.

وبعد إجراء التحليلات الإحصائية المناسبة يمكن تلخيص النتائج المتحصل عليها فيما يلي:

أشارت اختبارات المعنوية لجميع التراكيب الوراثية (٤٩ تركيباً وراثياً) إلى وجود إختلافات عالية المعنوية بين التراكيب الوراثية ولجميع الصفات الخضرية، وهذه النتائج كان من المتوقع الحصول عليها، حيث أن التراكيب الوراثية المستخدمة في هذه الدراسة متباينة المصدر والمنشأ.

أظهرت النتائج وجود إختلافات كبيرة بين هجن الجيل الأول والأول العكسي مع عدم تفوق هجين 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. القيم المحسوبة لقوة الهجين مقارنة بمتوسط الآباء تؤكد وجود قيم معنوية لقوة الهجين لجميع الصفات محل الدراسة. القيم المحسوبة لقوة الهجين مقارنة بأفضل الآباء أوضحت وجود قيماً عالية المعنوية لمعظم الصفات محل الدراسة.

أظهرت النتائج تعاظم قيم كل من القدرة العامة على التآلف (GCA) والقدرة الخاصة على التآلف (SCA). 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. كما تؤكد النتائج أن الفعل الجينى المضيف وغير المضيف لعبا الدور الأكبر في توريث هذه الصفات وكانت قيمة التباين الوراثي الراجع للإضافة أعلي من قيمة التباين الوراثي غير الإضافي لمعظم الصفات المدروسة والذي يشمل على تباين السيادة والأخير يحتوى ضمنيا على جزء من التباين الوراثي والذي يعزى إلى التفوق كما أنه لا يمكن تجاهل تأثير التهجين العكسي (العوامل السيتوبلازمية)، وكذلك تم تقدير معامل التوريث في مداه الواسع والضيق لجميع الصفات حيث كانت قيم معامل التوريث في مداه الواسع أعلي منه في مداه الضيق لجميع الصفات.

ومن النتائج السابقة يمكن لمربى النبات أن يستخدم هذه المميزات لتصميم برنامج تربية مناسب من أجل إنتاج أصناف محسنة في الأجيال الانعزالية المتقدمة للهجن المتفوقة.