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Combining abilities and heterosis for yield and yield components in sunflower

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ABSTRACT

The experiment was conducted at Giza Agricultural Research station, A.R.C. Egypt, during 2011and 2012 growing seasons to study heterosis and combining ability effects for in half diallel crosses of sunflower, for days to maturity, head diameter, number of seeds per plant, seed yield per plant, 100-seed weight, and oil content. The six inbred lines and 15 crosses were evaluated in a randomized complete block design with three replications. The parents Sakha-53 and L-39 were found to be good combiners for head diameter, number of seeds per plant, seed yield per plant, and 100-seed weight, while L-880 and L-245 were good combiners for days to maturity and oil content. Sakha-53 and L-39 exhibited high GCA for head diameter, number of seeds per plant, seed yield per plant, and 100-seed weight. The crosses (Sakha-53 x L-245), (L-880 x L-770) had significant SCA effects for seed yield /plant, head diameter, number of seeds/plant and 100-seed weight. A significant heterotic effect was found for all traits except number of seeds per plant in to the mid-parent so as in over the better parent.

Key words: Sunflower, half diallel, *gca* effects, *sca* effects, heterosis.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is one of the three crop species along with soybean and rapseed which account for approximately 81.8% of the world vegetable oil. Sunflower is grown on 35 million hectare in the world, producing 99 million tones seed yield (FAO STAT Database, 2014). Egypt's production of edible vegetable oils has been suffering several problems due to the lower domestic production of oil crops that resulted in failing to meet the needs of domestic consumption. Estimate of combining ability using diallel mating design is essential for selection of suitable parents for hybridization and identification of promising hybrids in breeding programs. The general combining ability and Specific combining ability variances provide estimation for additive and non additive gene action, respectively. The importance of GCA and SCA for seed yield and other related characters have been evaluated by many investigators. **Ortis *et al.* (2005)** indicated the predominant role of additive component for plant height, 1000-kernel weight and seed oil content. **Mijic *et al.* (2008)** showed that GCA variance was larger than SCA one for grain yield, oil content and oil yield. In addition GCA variance was larger than SCA variance for yield, head diameter and oil content **(Machikowa *et al.,* 2011)**. 1000-seed weight, total seeds/ plant and oil yield were under control of both additive and dominant effects, plant height and oil content were controlled by additive effects, however, over dominant effects were detected for seed yield **(Ghaffari *et al.,* 2011).**

High heterosis for yield and its components in sunflower, being cross-pollinated crops has been reported by **Goksoy *et al.,* (2000); Khan *et al.,* (2004); Kaya, (2005).** However, heterosis did not appear in all hybrid combinations of the F_1 generation **(Hladni *et al.,* 2007).** The aim of this study was to estimate the amount of heterosis in twenty one crosses obtained from six inbred lines and to select parental lines having good combining ability.

MATERIALS AND METHODS

Field experiment was carried out during the two successive seasons 2011 and 2012 at Giza Agricultural Research stations, Field Crop Research Institute, A.R.C. Egypt. The experimental material comprised six sunflower inbred lines (Sakha-53,L-880,L-770,L-245,L235 and L-39). The Origin and main characteristics of the parental lines are given in Table (1). All parents have block seeds.

Table (1): Origin, flowering and oil content of parents.

No.	Parent	Origin	Flowering	Oil %
1	Sakha53	Local variety	Medium	37.74
2	line 880	Bulgarian line	early	39.80
3	line 770	Bulgarian line	Medium	36.19
4	line 245	Bulgarian line	early	39.32
5	line 235	Bulgarian line	Medium	37.76
6	line 39	Bulgarian line	Medium	37.45

In 2011, summer growing season, the six inbred lines were crossed half diallel (without reciprocals) to obtain F_1 seeds. In 2012, the six parents and 15 F_1 crosses were grown in a randomized complete block design with three replications. Each plot consisted of 4 rows of 4 m long and spacing of 60 cm between rows and 25 cm between plants within row. Three seeds were planted per hill and later thinned to one plant per hill. All agricultural practices were done as recommended for oil seed sunflower production.

At harvest ten guarded plants were taken from each entry of each replication and the following characters were recorded: head diameter was measured in cm. seed yield was measured as average of seed weight from ten plants. A sample of 100- filled seeds (at 8% moisture content) was drawn at random from the bulked seeds of ten plants with an electronic balance. Oil content was determined according to **AOAC (1984)** using soxhlet apparatus and diethyl ether as solvent.

Statistical and genetical analysis

The analysis of variance was calculated according to **Steel and Torri (1980)**. There after estimates of combining ability were carried out using method 2, Model 1 of **Griffing (1956)** for the diallel formed by parental (p) and their F_1's $p(p-1)/2$, totaling $n = p(p+1)/2$ treatments considered of fixed line effects.

Heterosis was calculated as a percentage increase or decrease in the F_1 mean from its mid and better parents.

RESULTS AND DISCUSSION

The mean performance of six parents and their 15 crosses for studied characters are presented in (Table 2).The mean values of parents showed wide differences with a range of (14.80-20.55), (98.5-103.8), (545.03-698.57), (32.26-42.61), (4.72-6.32) and (36.19-39.80) for head diameter, days to maturity, number of seeds per plant, seed yield per plant. 100-seed weight and oil content, respectively.

Mean performance for sunflower crosses ranged from 87.47 (P_2 x P_4) to 117.8 (P_3x P_5) for days to maturity ; 545.17 (P_2x P_4) to 999.3 (P_1x P_4) for total seeds/plant ; 15.26 cm (P_2x P_4) to 25.28 cm (P_5x P_6) for head diameter ; 4.62 g (P_2x P_4) to 7.64g (P_5x P_6) for 100 seed weight ; 33.27 g (P_2x P_4) to 55.11 g (P_5x P_6) for seed yield/plant and from 35.66% (P_5x P_6) to 40.59% (P_2x P_4) for oil content.

These results indicated that the cross (P_5x P_6) gave the lowest value for seed oil content (35.66%) with the highest value for seed yield/ plant

(55.11g). On the other hand, the cross (P_2x P_4) had the highest mean performance for seed oil content (40.59%) with lowest value for seed yield/plant (33.27g). So, efforts to increase seed oil content through breeding have had considerable success, but high oil lines usually have significant reduced yield.

Table (2): Mean performance of the different parents and their crosses for the studied traits.

Genotypes	**Days to maturity**	**Head diameter (cm)**	**Seeds/plant**	**Seed yield/plant(g)**	**100-seed weight (g)**	**Oil percent**
(P_1)Sakha53	**100.83**	**20.55**	**698.57**	**42.61**	**6.32**	**37.737**
(P_2) line880	**95.53**	**16.70**	**545.03**	**34.23**	**5.02**	**39.800**
(P_3) line770	**100.00**	**19.43**	**615.23**	**40.17**	**6.14**	**36.193**
(P_4) line245	**93.23**	**14.80**	**506.40**	**32.26**	**4.72**	**39.320**
(P_5) line235	**99.17**	**18.32**	**564.53**	**37.76**	**5.50**	**37.760**
(P_6) line39	**100.03**	**20.41**	**657.47**	**42.31**	**6.27**	**37.447**
P_1x P_2	**112.60**	**24.15**	**952.07**	**52.65**	**7.30**	**38.797**
P_1x P_3	**92.00**	**23.66**	**791.53**	**53.76**	**7.40**	**38.177**
P_1x P_4	**112.73**	**23.36**	**999.33**	**53.11**	**7.37**	**37.710**
P_1x P_5	**109.40**	**25.23**	**919.07**	**54.99**	**7.63**	**36.923**
P_1x P_6	**109.17**	**23.07**	**890.63**	**54.66**	**7.43**	**37.193**
P_2x P_3	**104.80**	**24.28**	**884.00**	**52.93**	**7.34**	**38.523**
P_2x P_4	**87.47**	**15.26**	**545.17**	**33.27**	**4.62**	**40.590**
P_2x P_5	**90.17**	**19.77**	**699.00**	**43.10**	**5.86**	**40.280**
P_2x P_6	**110.50**	**24.04**	**919.37**	**52.39**	**7.26**	**38.757**
P_3x P_4	**103.43**	**22.51**	**838.10**	**49.08**	**6.51**	**39.923**
P_3x P_5	**112.83**	**24.47**	**1022.93**	**53.34**	**7.37**	**38.380**
P_3x P_6	**110.33**	**23.55**	**919.07**	**51.33**	**7.10**	**39.183**
P_4x P_5	**87.77**	**17.06**	**675.00**	**39.37**	**5.46**	**40.230**
$P_4$5x P_6	**105.60**	**23.26**	**885.23**	**50.70**	**7.03**	**39.263**
P_5x P_6	**109.53**	**25.28**	**911.60**	**55.11**	**7.64**	**35.660**
L.S.D 0.05 0.01	7.48 10.01	3.38 4.53	166.64 222.95	7.486 10.015	1.03 1.37	1.845 2.468

Mean squares of all traits revealed significant differences among sunflower genotypes (Table 3). The differences among crosses were highly significant for all traits. Parents also differed significantly for all traits. However, parents × crosses interaction was significant for all characters.

Significant difference within various components indicated the presence of genetic variability in the breeding material used in the study. Significant differences among parents vs. crosses indicated the presence of heterosis in crosses that may be manifested for the development of high yielding sunflower hybrids. Significant differences have also been reported by early researchers among sunflower genotypes (**Jayalakshmi *et al.*, 2000; Ashok *et al.,* 2000; Nehru *et al.*, 2000; Laureti and Gatto, 2001; Sharma *et al.*, 2003; Gvozdenovic *et al.*, 2005; Ortis *et al.*, 2005; Habib *et al.*, 2007; Binodh *et al.*, 2008; and Khan *et al.*, 2008).**

Table (3): Significance Mean squares for sunflower yield traits and oil content.

S.O.V	df	Head diameter	Days to maturity	N.of seed/plant	Seed yield/plant	100 seed weight	Oil percent
Replication	2	4.14	0.03	7907.7	20.997	0.423	0.217
Genotypes	20	33.42**	219.13**	82146.1**	188.555**	2.984**	5.500**
Parents (P)	5	15.33**	27.73**	15757.7**	54.878**	1.416**	5.201**
Crosses (Cr)	15	25.85**	272.71**	50150.0**	122.709**	2.381**	5.672**
P vs Cr	1	229.87**	425.91**	862033.5**	1778.784**	19.276**	4.576**
Error	40	4.21	20.58	10197.7	20.578	0.386	1.250

*and ** significant at 0.05 and 0.01 level of probability, respectively.

The GCA and SCA variances provide estimation for additive and non-additive gene action, respectively

The mean squares of GCA were highly significant for days to maturity, head diameter, total seeds/plant, seed yield/plant, 100-seed weight, and oil content (%) (Table 4), indicating the importance of additive and non-additive gene effects for these characters. The mean squares of SCA were highly significant for all traits. The ratio of GCA to SCA variances were more than unity for all studied characters, except for days to maturity and number of seeds per plant, indicating that the additive gene effects were more important for the control of these characters.

The comparative estimates of GCA and SCA variances revealed the predominance of GCA variance in relation to SCA one for seed yield per plant, head diameter, 100-seed weight and oil content traits, indicating the importance of additive gene effects for controlling the inheritance of these characters. This result corroborates with the findings of **Kaya and Atakisi (2004), Mijic *et al.* (2008), and Machikowa *and Saetang* (2011), Salem and Ali (2012)**. The highly significance of additive genetic variance for sunflower studied characters, indicated that selecting genotype on the basis of seed yield and its contributing characters should be useful in developing genotypes with good performance.

Table (4): Analysis of variance for combining ability for the studied traits.

S.O.V	df	Head diameter	Days to maturity	N.of seeds/plant	Seed yield/plant	100seed weight	Oil percent
Genotypes	20	33.420**	219.13**	82146.1**	188.555**	2.984**	5.500**
GCA	5	17.722**	71.757**	20897.25**	84.884**	1.796**	3.981**
SCA	15	8.946**	73.471**	29543.64**	55.508**	0.728**	1.117**
GCA/ SCA		1.981	0.97	0.71	1.529	2.467	3.564
Error	40	1.402	6.86	3399.2	6.859	0.129	0.417

*and ** significant at 0.05 and 0.01 level of probability, respectively.

The general combining ability effects (Table 5) indicated that the lines L-880, and L-245, were good combiners for days to maturity.

Maximum negative significant GCA showed that these lines can be used for short duration crosses progeny and positive significant for oil content while Sakha-53 and L-39 was highly significant value for head diameter, number of seeds per plant, 100-seed weight and seed yield per plant.. These results were in accordance with the findings of **Goksoy *et al.* (2000), Phad *et al.* (2002), Kaya and Atakisi (2004), Shankar *et al.* (2007), Khan *et al.* (2008), Chandra *et al.* (2011) and Patil *et al.* (2012).**

Table (5): Estimates of general combining ability effects for each parent for studied traits.

Parents		Head diameter	Days to maturity	N.of seed/plant	Seed yield/plant	100seed weight	Oil percent
P_1 (Sakha 53)		1.356**	2.73**	58.75**	3.500**	0.499**	-0.63*
P_2 (line 880)		-1.101**	-2.39**	-48.76*	-2.947**	-0.417**	0.91**
P_3 (line 770)		0.950*	0.96	25.79	1.802*	0.280*	-0.34
P_4 (line 245)		-2.333**	-4.03**	-65.52**	-4.542**	-0.667**	0.88**
P_5 (line 235)		-0.158	-0.96	-15.39	-0.618	-0.101	-0.29
P_6 (line 39)		1.286**	3.68**	45.13*	2.805**	0.406**	-0.54*
G_i	L.S.D.05	0.772	1.71	38.03	1.708	0.234	0.42
	L.S.D.01	1.033	2.28	50.88	2.286	0.313	0.56

The results of SCA effects of cross combinations are presented in Table 6.The cross combination P_1x P_4 and P_2x P_3 showed significant positive SCA for seed yield/plant (7.53, 7.45) along with 100-seed weight (1.00, 0.94), head diameter (2.95, 3.04), and number of seeds per plant (223.28, 124.15). High

seed yield is an ultimate objective of sunflower breeding and hybrid development programs. The cross combinations including P_2x P_6, P_3x P_5,

P_4x P_6, P_1x $P_5$and P_1x $P_2$with significant positive SCA effects for seed yield are suitable combinations for this trait and some of these crosses had also significant positive SCA effects for 100- seed weight, number of seeds per plant, head diameter and seed yield per plant. The crosses including P_3x P_6, P_2 x $P_5$and P_4x P_5had significant positive SCA effects for oil content and also these combinations can be superior candidate for improving high oil content. While, the crosses P_1x P_3, P_4x P_5 ,P_2x P_5 and P_2x P_4had significant negative SCA effects for days to maturity. In this connection, the involvement of both poor general combiners in some crosses or one of the parents as poor general combiner produced cross combinations with significant SCA effect in the desirable direction. These results were in conformity with the earlier findings of **Radhika *et al.* (2001), Goksoy and Turan (2005), Gvozdenovic *et al.* (2005), Ortis *et al.* (2005), Hladni *et al.* (2006), Karasu *et al.,* (2010) Chandra *et al.*, 2011), Machikowa *et al.* (2011), Ghaffrai *et al.* (2011), Salem and Ali (2012).**

Table (6): Estimates of specific combining ability effects for F_1 crosses for studied traits.

Crosses	Head diameter	Days to maturity	N.of seedplant	Seed yield/plant	100seed weight	Oil percent
P_1x P_2	2.51**	10.01**	159.25**	5.47*	0.68*	0.05
P_1x P_3	-0.03	-13.94**	-75.83	1.84	0.08	0.67
P_1x P_4	2.95**	11.79**	223.28**	7.53**	1.00**	-1.02
P_1x P_5	2.64**	5.38*	92.88	5.48*	0.69*	-0.63
P_1x P_6	-0.96	0.50	3.93	1.73	-0.01	-0.11
P_2x P_3	3.04**	3.98	124.15*	7.45**	0.94**	-0.52
P_2x P_4	-2.69**	-8.36**	-123.37*	-5.86*	-0.84*	0.33
P_2x P_5	-0.36	-8.73**	-19.67	0.04	-0.16	1.19*
P_2x P_6	2.46**	6.96**	140.17**	5.91*	0.73*	-0.08
P_3x P_4	2.51**	4.26	95.00	5.19*	0.36	0.91
P_3x P_5	2.29**	10.59**	229.71**	5.53*	0.65*	0.54
P_3x P_6	-0.08	3.44	65.32	0.10	-0.12	1.59**
P_4x P_5	-1.84	-9.49**	-26.92	-2.10	-0.31	1.16*
$P_4$5x P_6	2.91**	3.70	122.79*	5.81*	0.76*	0.45
P_5x P_6	2.76**	4.56	99.03	6.30**	0.80*	-1.98**
L.S.D 0.05	2.12	4.69	104.44	4.69	0.64	1.16

Significant heterosis effect was found over both mid and better parents for all traits except for number of seeds per plant. (Table 7). Significant heterosis to mid parent and over better parental values were observed for all crossess In general, significant positive heterosis for yield per plant was found in fourteen crosses, also in the case of heterosis over better parents 13 crosses showed the same trend. Significant positive desirable heterosis relative to mid-parents and heterosis over better parents for 100-seed weight and head diameter were found in all crosses except (P_2 x P_4) and (P_4 x P_5). For oil content eight crosses showed significant positive heterosis relative to mid-perants and only three over better parents., while for days to maturity significant negative heterosis was found in four crosses relative to mid-parents and one cross (P_1 x P_3) relative over better parent. Similar findings for heterosis were recorded by **Gangappa *et al.* (1997)** who recorded high heterotic effects for head diameter, 100-seed weight, oil content and seed yield. **Radhika *et al.* (2001)** recorded high heterotic effects for head diameter, **Mahavilatha *et al.* (2005) and Shankar et al. (2007)** for seed yield per plant and for oil content, **and Tan (2010)** for seed yield per plant, head diameter, days to physiological maturity, plant hight, 100-seed weight, stem diameter and oil content. From the results concerning heterosis relative to mid and better parents, it could be observed that the crosses (P_2x P_4) and (P_4x P_5) had significant heterosis values in negative direction for days to maturity and positive direction for oil content. Moreover, the crosses (P_2 x P_3), (P_1x P_4) and (P_5x P_6) had positive useful heterosis for head diameter, seed yield per plant and 100-seed weight. These crosses could be used in breeding program aiming to release hybrids characterized by earliness and high yield.

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Table (7): Heterosis percent relative to both mid-parent (M.P) and better parent (B.P) for studied traits.

Crosses		Head diameter		Days to maturity		N.of seed / plant		Seed yield/plant		100-seed weight		Oil percent	
		M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P
P_1x P_2		29.664**	17.537**	14.68**	17.86**	53.11	36.29	37.035**	23.564**	28.710**	15.506**	0.073	-2.521**
P_1x P_3		18.396**	15.169**	-8.38*	-8.00*	20.49	13.31	29.895**	26.185**	18.748**	17.089**	3.278**	1.166
P_1x P_4		32.195**	13.709**	16.18**	20.91**	65.87	43.05	41.879**	24.652**	33.454**	16.561**	-2.124*	-4.095**
P_1x P_5		29.800**	22.777**	9.4**	10.32**	45.52	31.56	36.842**	29.064**	29.047**	20.675**	-2.186**	-2.216*
P_1x P_6		12.656**	12.281**	8.69**	9.13*	31.36	27.49	28.725**	28.282**	17.999**	17.563**	-1.060	-1.440
P_2x P_3		34.404**	24.983**	7.19*	9.70*	52.38	43.68	42.288**	31.762**	31.522**	19.533**	1.386	-3.208**
P_2x P_4		-3.100*	-8.621**	-7.33*	-6.18	3.70	0.02	0.085	-2.795	-5.234**	-8.096**	2.604**	1.985*
P_2x P_5		12.904**	7.913**	-7.38*	-5.62	25.99	23.82	19.733**	14.132**	11.372**	6.545**	3.868**	1.206
P_2x P_6		29.531**	17.769**	13.00**	15.67**	52.91	39.83	36.898**	23.822**	28.533**	15.728**	0.345	-2.621**
P_3x P_4		31.554**	15.889**	7.05*	10.94**	49.44	36.22	35.518**	22.171**	19.853**	5.969**	5.739**	1.534
P_3x P_5		29.625**	25.944**	13.30**	13.78**	73.41	66.27	36.889**	32.783**	26.539**	19.913**	3.795**	1.642
P_3x P_6		18.216**	15.368**	10.31**	10.33**	44.43	39.79	24.456**	21.309**	14.362**	13.177**	6.419**	4.638**
P_4x P_5		3.009*	-6.895**	-8.77**	-5.86	26.06	19.57	12.439**	4.246	6.849**	-0.727	4.385**	2.314*
P_4x P_6		32.102**	13.947**	9.28**	13.26**	52.12	34.64	35.974**	19.820**	27.956**	12.115**	2.293**	-0.144
P_5x P_6		30.534**	23.861**	9.97**	10.45**	49.20	38.65	37.651**	30.250**	29.841**	21.838**	-5.168**	-5.561**
L.S.D	0.05	2.931	3.384	6.48	7.49	144.31	166.64	6.483	7.486	0.888	1.025	1.598	1.845
	0.01	3.922	4.528	8.67	10.02	193.08	222.95	8.674	10.015	1.187	1.371	2.138	2.468

** Significant at 0.05 and 0.01 levels, respectively.

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الملخص العربى

القدره على الإئتلاف و قوه الهجين للمحصول و مكوناته فى دوار الشمس

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**** قسم المحاصيل الزيتيه ،معهد بحوث المحاصيل الحقلية ، مركز البحوث الزراعية**

أجريت هذه الدراسه فى محطة البحوث الزراعية بالجيزه خلال الموسمين الزراعين ٢٠١١و٢٠١٢ وذلك لدراسة قوه الهجين و القدرة العامة و الخاصة على الأئتلاف من خلال دراسة صفات التبكير (عدد الايام الى النضج) ومكونات المحصول وهى قطر القرص ، عدد بذور النبات ، وزن ١٠٠ بذرة و محصول النبات

بالاضافة إلى نسبة الزيت ولهذا تم اختيار ستة سلالات استخدمت كأباء ممثلة لمدى واسع من التباينات لمعظم الصفات المدروسة و هذة السلالات كانت على الترتيب التالى:

١- سخا ٥٣ ٢- سلاله ٨٨٠
٢- سلاله ٧٧٠ ٤- سلاله ٢٤٥
٥- سلاله ٢٣٥ ٦- سلاله ٣٩

تم عمل كل التهجينات الممكنة بين الاباء الستة تحت نظام التهجين نصف الدائرى فى الموسم الزراعى ٢٠١١ و فى الموسم التالى مباشرة ٢٠١٢ تم تقييم الهجن الناتجة وعددها خمسه عشر هجينا مع آبائها السته فى تجربة صممت فى قطاعات كامله العشوائيه فى ثلاث مكررات.

تم اخذ البيانات على عشره نباتات فرديه اختيرت عشوائيا من كل قطعه تجريبيه.

حللت هذه البيانات وراثيا بأستخدام طريقه جريفنج (١٩٥٦) وذلك بأستخدام النموذج الثابت الطريقه الثانيه (Model 1, Method 2).

و يمكن تلخيص أهم النتائج التى تم التوصل إليها فيما يلى:

١- اختلفت الهجن فيما بينها اختلافات معنويه فى جميع الصفات التى تم دراستها و التى ترجع إلى القدره العامه و الخاصه على الأئتلاف.

٢- كانت الأختلافات الراجعه لتأثير كلا من القدره العامه و الخاصه على الأئتلاف فعاله و معنويه لمعظم الأباء و الهجن فى جميع الصفات.

٣- أظهرت النتائج ايضا ان هناك قوه هجين ظاهره لمعظم الصفات التى تم دراستها حيث أظهر محصول النبات قيم موجبه و معنويه و بالنسبه لصفه نسبه الزيت أظهر قيم موجبه و معنويه ايضا.

و من خلال الدراسه تبين أن أفضل الأباء للتبكير هى سلاله ٨٨٠ ، سلاله ٢٤٥ وكذلك نسبه الزيت أما أفضل الأباء فكانت سخا ٥٣ ، سلاله ٣٩ و سلاله ٧٧٠ فى صفات قطر القرص ، عدد بذور النبات ، وزن ١٠٠ بذره و محصول النبات و كذلك فان أفضل الهجن هى(سلاله ٨٨٠ × سلاله٧٧٠) ،(سخا ٥٣ × سلاله٢٤٥) ،(سلاله ٢٤٥ × سلاله ٣٩) فى صفات قطر القرص ، عدد بذور النبات ، وزن ١٠٠ بذره و محصول النبات أما الهجن (سلاله ٨٨٠ × سلاله٢٤٥)، (سلاله ٢٤٥ × سلاله ٢٣٥) فكانت هى الأفضل بالنسبة لصفتى عدد الأيام إلى النضج و نسبه الزيت.

و لذلك توصى الدراسه بأستخدام هذه الأباء و كذلك الهجن فى برامج التربية لانتاج هجن دوار الشمس فى مصر.