Inbreeding Effects on Some Growth and Yield Traits of Sunflower (*Helianthus annuus* L.)

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Abstract:

The present investigation was carried out during 2010 and 2011 seasons to study the effects of inbreeding depression in sunflower. In 2010 season, Giza102 an open-pollinated cultivar of sunflower was planted at Shandaweel Agric. Res. Stn., ARC. 100 plants were selected and selfed. After harvest, 23 S_1 lines which produced enough seed were chosen for evaluation in the next season. In 2011 season, 23 S_1 lines and Giza102 were evaluated in Randomized Complete Block Design (RCBD) experiment with three replicates. Data were recorded on days to 50% flowering, days to maturity, plant height, stalk diameter, head diameter, 100-achene weight, achene yield/plant, achene yield/plot and oil content. Analysis of variance revealed highly significant differences among S_1 lines for all studied traits. Broad sense heritability showed high estimates for all the studied traits. Phenotypic coefficient of variability (P.C.V) for various traits were relatively higher than genotypic coefficient of variability (G.C.V) for the S_1 *per se*. Oil content was negatively and not significant correlated with head diameter, 100-achene weight, achene yield/plant and achene yield/plot. Achene yield/plot was positively and significant correlated with head diameter, 100-achene weight and yield/plant. The reduction of yield/plot of the S_1 lines was 2.68% of the base pop. Achene yield/plot of 10 S_1 lines *per se* were significantly or highly significantly fewer than the base pop. Giza102, while 8 S_1 lines *per se* exceeded significantly or highly significant than the base pop. Giza102. The decrease in oil content due to inbreeding was 2.25%. Most of the S_1 lines were less than the base population. The best ten S_1 lines *per se* were Nos.1, 7, 11, 14, 15, 16, 17, 18, 20 and 21, which gave the higher oil content and some other desirable character were selected and used as parents to produce the first cycle selection.

Keywords: *Sunflower, Helianthus annuus, Genetic variability, Inbreeding depression, Inbred lines*

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Introduction:

Sunflower (*Helianthus annuus* L.) is one of the most important oilseed crops in the world.

Selection for high oil in Russia began in 1860 and was largely responsible for increasing oil content from 28% to almost 50%. The cultivated area in the world was 23.70 million hectares producing 31.33 million ton with an average 1.32 ton/ha. In Egypt the cultivated area was 18 thousand hectares producing 43 thousand tons with an average 2.39 ton/ha (F. A. O, 2012). In Egypt, due to severe shortage of edible oil, whereas import amounts 90% out of consumption of vegetable oil. However, the percentage of local production amounts to be less than 10% of the total consumption. This indicates the gap between production and consumption. Thus more care should be given to this crop for increasing its productivity to minimize the gap between the production and consumption of vegetable oil.

The S_1 progeny selection is regarded as the quickest method of intra-population improvement (Moll and Smith, 1981) and it has been widely used in maize. The method capitalizes on genes with additive effects and it also eliminates deleterious recessive alleles. Ado *et al.* (1991) studied the Syn 1 (F_1) and Syn 2 (F_2) generations of 34 hybrids. The Syn 2 was obtained by random mating in the Syn 1. Results showed reduction in the mean of Syn 2 in comparison with the Syn1 of 68% in seed yield, 48% in head diameter, 31% in plant height and 28% in leaves/plant. Muhammad *et al.* (1992) found high heritability estimates associated with moderate genetic advance as percent of mean which was recorded for plant height, 100-seed weight and oil content suggesting that these characters were less influenced by environment but governed by both additive and non-additive gene action. Benson and Hallauer (1994) estimated inbreeding depression rate of 16 quantitative traits in unselected maize populations after recurrent selection. They found that the rate of inbreeding depression decreased for all traits in BS13 (S) C_3, BSSS (R) C_9 and BSCB1 (R) C_9 except for yield (g/plant). Rate of inbreeding depression was reduced for 13 of 16 traits in selected populations of BSSS. Souza *et al.* (1995) reported that S_1 selection would be more effective than full-sib and half-sib for decrease inbreeding depression. Ashok *et al.* (2000) found the moderate PCV and GCV values were reported for oil content. Days to 50% flowering and days to maturity exhibited low PCV and GCV values. Khan (2001) found that high heritability (h^2 b) estimates were observed for plant height, days to 50% flowering, head diameter, days to maturity, 100-seed weight, oil content, seed yield/plant and oil yield. Ahmad *et al.* (2005) found that significant genetic differences were observed among the parents, their F_1 hybrids and F_2 population for all the characters under study. Yield and leaf area showed highly significant heterosis in F_1 hybrids ranging from 102 to 309% and 46.3 to 163.9%, respectively, while inbreeding depression in the F_2 population ranged from 17 to 71% and -9.7 to 43%, respectively. No negative value of inbreeding depression was observed showing the superiority in weight of seeds of all F_1 hybrids compared to their F_2 combinations. Non of the F_2 population exceeded its F_1 hybrids and as a result no negative inbreeding depression was observed for head diameter. Inbreeding depression for the F_1 to the F_2 ranged from 8.7 to 48.1% for this character. Thitiporn and Chiraporn (2008) found high and negative correlation coefficient between days to flower and oil content. Significant positive correlation coefficients was found between seed set percent and number of seeds/head, head diameter and 100-seed weight and between number of seeds/head and oil content. The head diameter showed the highest positive direct effect on seed yield followed by plant height. Mijic *et al.* (2009) found highly significant and positive correlation between grain yield and oil yield. A positive correlation coefficient was estimated between 1000 grain weight and grain yield, and a negative one between 1000 grain weight and oil content. Mahmoud (2012) showed highly significant differences among genotypes for all studied traits. The results showed little differences in the genotypic and phenotypic coefficient of variability and gave high values of heritability for all studied traits. Muhammad *et al.* (2013) found that the seed yield had negative correlation with oil contents.

The objective of this study was to evaluate sunflower inbred lines in upper Egypt conditions and record the effects of inbreeding depression in S_1 lines to determine the desirable genotypes under these conditions and availability to use these lines in synthetic variety production after testing of their combining abilities.

Materials and Methods:

This study was carried out in the summer seasons of 2010 and 2011, at Shanadaweel Agriculture Research Station, Agri. Res. Center. Giza102 an open-pollinated cultivar of sunflower were sown on June 20th, 2010. Approximately 100 plants were selected and selfed. After harvest, 23 S_1 *per se* lines, which produced enough seed, were chosen for evaluation in the next season. In 2011 season, the experiment included twenty-three S_1 *per se* lines and Giza102. The Randomized Complete Block Design (RCBD) with three replications was used; the plot size was 1 rows, 4 meter long and 60 cm apart. Planting was done in hills spaced 25 cm apart. Seedlings were thinned to one plant per hill before the first irrigation (two weeks after planting). The cultural practices were followed as the recommendation for oil seed sunflower production. At harvest, the oil percentage was determined in the all genotypes. The traits studied in this study could be divided into three sub headings such as; earliness, growth traits and yield components.

A- Earliness traits:

1- Days to 50% flowering: number of days from sowing date to appearance of heads 50% of plants.

2- Days to maturity: was measured as number of days from sowing date until the head became yellow on plot basis.

B- Growth traits:

The following traits were taken from random sample of five guarded plants. These plants were chosen from each plot and assigned to be fixed for the following measurements.

1- Plant height (cm): average length in cm from soil level to the tip of the head.

2- Stalk diameter (cm): measured at 30cm above the soil surface with vernier-calipers, at nearest 0.1cm.

3- Head diameter (cm): estimated as an average of maximum width of the head.

C- yield and yield components:

1- 100-achene weight (g): One hundred seed were counted and weighed from the bulk of the guarded plants in grams.

2- Achene yield/plant (g): estimated as average of seed weight/head.

3- Achene yield/plot (g): measured from the adjusted seed yield/plot.

4- Oil content: random sample of seeds were taken from the seed yield of the five guarded plants. The oil content was determined by soxalet apparatus using petroleum ether (Bp40-60 c°) as solvent according to the official method (A. O. A. C. 1980).

Statistical Analysis:

Analysis of variance for S_1 *per se* and testcrosses was carried out according to Steel and Torrie (1980), and the forms of the analysis are shown in Table 1. The expected mean squares were used to estimate the following genetic parameters for S_1 *per se* according to Singh and Chaudhary (1985). Means wear compared using revised L.S.D at 1 and 5% level.

1- The phenotypic and genotypic variances were calculated according to the following equation:

a- Genotypic variance $\sigma^2_g = \dfrac{M_2 - M_1}{r}$

b- phenotypic variance $\sigma^2_{ph} = \sigma^2_g + \dfrac{\sigma^2_e}{r}$

2- The phenotypic and genotypic coefficient of variation were estimated using the following formulae:

a-Phenotypic coefficient of variability (Ph.C.V) = $\dfrac{\sigma_{ph}}{\bar{x}} \times 100$

b-Genotypic coefficient of variability (G.C.V) = $\dfrac{\sigma_g}{\bar{x}} \times 100$

3- Broad sense heritability H%:

The following equation was used for estimating heritability.

Broad sense heritability (H) = $\dfrac{\sigma^2_g}{\sigma^2_{ph}} \times 100$

Table 1. Form of the analysis of variance for S_1 lines *per se* and Expected mean squares (E.M.S.).

S.O.V	D.F	MS	EMS
Rep.	r-1		
Genotypes	g-1	M_2	$\sigma^2_e + r\sigma^2_g$
Error	(r-1)(g-1)	M_1	σ^2_e

Where: σ^2_g = genotypic variance.

g = number of S_1 lines *per se*.

σ^2_e = error variance

Simple correlation coefficients were calculated among all the studied traits using the following equation:

$$r_{x.y} = \frac{Cov_{x.y}}{\sqrt{\sigma^2_x \times \sigma^2_y}}$$

Results and Discussion:

I- Evaluation of 23 S_1 lines derived from the open pollinated Giza102 of sunflower:

S_1 progeny selection scheme subsequently impose to improve population *per se*. It helps eliminate deleterious recessive alleles that became homozygous due to inbreeding followed by selection, which leads to increasing the gene frequency of favorable alleles at all loci.

Analysis of variance (Table 2) was highly significant for all the studied traits indicating a wide diversity among the S1 lines.

Table 2. Mean squares (MS), of all studied traits for S_1lines *per se* and base population.

S.O.V	d.f	MS								
		Days to 50% flowering	Days to maturity	Plant height, cm	Stalk diameter, cm	Head diameter, cm	100-achene weight, g	Achene yield/plant, g	Achene yield/plot, g	Oil content
Rep.	2	6.51	7.17	18.04	0.004	1.20	0.42	4.30	1015.16	0.27
S_1 lines	23	26.16**	30.26**	1123.92**	0.370**	18.35**	2.80**	587.23**	48860.09**	5.51**
Error	46	1.72	1.51	13.06	0.005	0.56	0.20	18.71	1047.63	0.21

** highly significant at 0.01 level of probability.

I.1. Mean performance of the 23 S_1 lines of Giza102 base population:

I.1.1. Days to 50% flowering:

Average performance of S_1 lines for days to 50 % flowering, compared with the base pop. Giza102 are presented in Table (3). It ranged from 46.00 to 60.33 with an average of 53.83 days, which was close to days to 50% flowering of the base pop. Giza102 (49.00 days). Most of the S_1 lines flowered late compared to the base pop. Giza102. 19 Out of 23 S_1 lines, were flowered significantly or highly significantly later than the base pop. Giza102. Only one line (No.1) was highly significant earlier than the base pop. Giza102. and line 6 also insignificant earlier the base population.

I.4.2. Days to maturity:

Days to maturity of S_1 lines (Table 3) ranged from 78.00 to 89.33 with an average of 84.99 days compared with the base pop. Giza102 which matured after 82.33 days. All S_1 lines matured later than their base population except lines Nos. 1, 5, 6 and 19. Lines Nos. 1, 6 and 19 matured early and highly significant earlier comparing with the base pop. Giza102.

I.4.3. Plant height, cm:

Plant height of the 23 S_1 varied from 128.67 to 201.00 with an average of 158.15 cm (Table 3), compared to 153.67 cm for the base pop. Giza102, showing a small amount of inbreeding depression (2.92%). Only plant height of 9 S_1 lines decreased highly significant compared with the base population of Giza102, however 11 S_1 lines were tall and highly significant than the population Giza102. This may be due to the segregation accruing in plant height.

I.4.4. Stalk diameter, cm:

The stalk diameter of S_1 lines obtained from base population Giza102 (Table 3) ranged from 2.04

to 3.29 with an average of 2.58 cm compared to 2.40 cm for base population. The average inbreeding depression in stalk diameter was 7.50%. Only stalk diameter of 7 S_1 lines decreased significantly or highly significantly, but 12 of S_1 lines were increased highly significantly comparing the base pop. Giza102. Four of them (Nos. 4, 5, 8 & 9) were surpassed the base pop. Giza102 in amount more than 25% of stalk diameter.

I.4.5. Head diameter, cm:

Head diameter of the S_1 lines obtained from the base pop. Giza102. varied from 17.53 to 26.27 with an average of 20.71 cm (Table 3), while it was 18.73 cm for the base pop. Giza102. The average inbreeding depression in head diameter accounted 10.57%. Generally, 14 of S_1 lines showed significant or highly significant increasing in head diameter comparing to the base pop. Giza102. Moreover, six of them (Nos. 5, 9, 10, 14, 21 & 23) exceeded the base pop. Giza102 by amount of 15% (2.81 cm) of head diameter.

I.4.6. 100-achene weight, g:

The 100-achene weight of the S_1 lines obtained from pop. Giza102 (Table 4) ranged from 5.14 to 9.47 with an average of 7.73 g compared to 8.27 g for the base pop. Giza102. The decrease in 100-achene weight was 6.53%. 11 S_1 lines Out of 23, had 100-achene weight significant or highly significant less than the base pop. Giza102, but two lines (Nos. 9 & 15) increased significant or highly significant in amount of 14.5 and 10.5%, respectively. These results may be due to segregation of recessive and dominant genes controlling 100-achene weight.

I.4.7. Achene yield/plant, g:

Achene yield/plant of the S_1 lines obtained from the base pop. Giza102 varied from 49.94 to 97.25 with an average of 73.65 g/plant, while the base pop. Giza102 gaves 72.51 g (Table 4). The percentage of inbreeding depression was 1.57%. Only 7 S_1 lines were highly significant compared to the base pop. Giza102, but 9 lines (Nos. 4, 5, 9, 10, 12, 13, 15, 18 & 22) were high significant increased.

I.4.8. Achene yield/plot, g:

The achene yield/plot of S_1 lines of base population Giza102 are presented in (Table 4), ranged from 449.46 to 883.36 with an average of 662.03 g compared to 680.28 g for the base pop. Giza102. The reduction of yield was 2.68% of the base pop. Achene yield/plot of 10 S_1 lines *per se* were significantly or highly significantly in values, while 8 S_1 lines *per se* (Nos. 4, 5, 9, 10, 12, 15, 18 & 22) exceeded significantly or highly significantly compared to the base pop. Giza102 in amount of more than 7.9%.

I.4.9. Oil content:

Oil content of S_1 lines ranged from 37.19 to 42.58 with an average of 39.57%, while the base pop. Giza102 gaves 40.48% (Table 4). The decrease in oil content due to inbreeding was 2.25%. Most of the S_1 lines were less than in oil content comparing base population. The oil content of 14 S_1 lines out of 23 were significant or highly significant less compared with the base pop. Giza102, but only two lines (Nos. 15 &17) were highly significantly increased. Moreover, its remark results that the line (such as No. 9) has the highest values for achene yield/plot (883.86 g) and lowest value for oil content (37.19%), this revealed generally negative correlation between both traits.

The best S_1 lines in oil content and some other desirable character (Nos.1, 7, 11, 14, 15, 16, 17, 18, 20 and 21) were selected and used as parents to produce the first cycle selection. Several researches obtained different rates of inbreeding depression for several traits. Ado *et al.* (1991) showed a mean reduction in the Syn 2 in comparison with the Syn 1 of 68% in seed yield, 48% in head diameter, 31% in plant height and 28% in leaves/plant. Benson and Hallauer (1994) found that the rate of inbreeding depression decreased for all traits in BS13 (S) C3, BSSS (R)C9and BSCB1 (R) C9except for yield (g/plant), 300-kernel weight and days to anthesis in BS13 (S) C3. Souza *et al.* (1995) reported that S_1 selection would be more effective than full-sib and half-sib for decrease inbreeding depression. Vassal *et al.* (1995) reported that the inbreeding depression for grain yield of four populations ranged from 37 to 41% with an average 39%. Ahmad *et al.* (2005) found that no negative value of inbreeding depression was observed showing the superiority in weight of seeds of all F_1 hybrids compared to their F_2 combinations.

Table 3. Mean performance and inbreeding depression (ID) of S_1 lines for days to 50% flowering, days to maturity, plant height, stalk diameter and head diameter.

No. of S_1 lines	Days to 50% flowering		Days to maturity		Plant height (cm)		Stalk diameter (cm)		Head diameter (cm)	
	Mean	I.D%	Mean	I.D%	Mean	I.D%	Mean	I.D%	Mean	I.D%
1	46.00	- 6.12**	79.33	- 3.64**	130.67	-14.97**	2.09	-12.92**	18.27	-2.46
2	51.67	5.45**	87.33	6.07**	161.33	4.98**	2.53	5.42**	18.60	-0.69
3	51.33	4.76*	85.67	4.06**	155.33	1.08	2.24	-6.67**	18.45	-1.49
4	54.00	10.20**	89.33	8.50**	190.67	24.08**	3.15	31.25**	20.53	9.61**
5	51.00	4.08*	81.00	- 1.62	143.00	-6.94**	3.01	25.42**	25.43	35.77**
6	48.33	- 1.37	78.00	- 5.26**	153.67	0.00	2.04	-15.00**	20.10	7.31*
7	53.00	8.16**	84.00	2.03	134.00	-12.80**	2.26	-5.83**	20.27	8.22**
8	60.33	23.12**	88.00	6.89**	201.00	30.80**	3.07	27.92**	21.00	12.12**
9	53.00	8.16**	84.00	2.03	178.00	15.83**	3.29	37.08**	24.80	32.41**
10	54.33	10.88**	86.67	2.27*	168.67	9.76**	2.49	3.75	26.27	40.26**
11	55.33	12.92**	88.67	7.71**	130.67	-14.97**	2.66	10.83**	17.53	-6.41**
12	49.67	1.37	83.33	1.21	128.67	-16.27**	2.35	-2.08	19.00	1.44
13	54.00	10.20**	85.67	4.06**	155.67	1.30	2.61	8.75**	20.53	9.61**
14	55.33	12.92**	88.67	2.27*	171.33	11.49**	2.14	-10.83**	22.40	19.59**
15	54.00	10.20**	86.67	2.27*	149.00	-3.04	2.87	19.58**	19.47	3.95
16	55.33	12.92**	85.00	3.24**	179.67	16.92**	2.29	-4.58*	18.13	-3.20
17	54.00	10.20**	86.67	2.27*	176.33	14.75**	2.70	12.50**	19.87	6.09*
18	53.67	9.53**	82.67	2.27*	170.00	10.63**	2.73	13.75**	18.73	0.00
19	49.00	0.00	79.00	- 4.04**	163.00	6.07**	2.43	1.25	20.00	6.78*
20	53.00	8.16**	87.33	6.07**	167.00	8.67**	2.34	-2.50	20.00	6.78*
21	51.67	5.45**	85.00	3.24**	143.67	-6.51**	2.30	-4.17*	22.27	18.90**
22	55.00	12.24**	85.00	3.24**	143.33	-6.73**	2.93	22.08**	19.67	5.02
23	52.00	6.12**	87.67	6.49**	142.67	-7.16**	2.79	16.25**	24.93	33.10**
Mean	53.83		84.99		158.15		2.58		20.71	
Base pop.	49.00		82.33		153.67		2.40		18.73	
LSD'										
0.05	1.79	3.65	1.68	2.04	5.19	3.38	0.10	4.17	1.08	5.77
0.01	2.63	5.37	2.47	3.00	6.85	4.46	0.13	5.42	1.42	7.58

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

I.D = (S_1 line mean – base pop. mean)/base pop. mean x 100.

Table 4. Mean performance and inbreeding depression (ID) of S1 lines for 100-achene weight, achene yield/plant, achene yield/plot and oil content.

No. of S_1 lines	100-achene weight (g.)		Achene yield/plant (g.)		Achene yield/plot (g.)		Oil content	
	Mean	I.D%	Mean	I.D%	Mean	I.D%	Mean	I.D%
1	7.27	-12.09**	56.85	-21.60**	481.62	-29.20**	39.78	-1.73*
2	7.55	-8.71*	58.26	-19.65**	524.34	-22.92**	38.00	-6.13**
3	7.44	-10.04*	69.75	-3.81	627.78	-7.72*	38.81	-4.13**
4	7.53	-8.95*	81.55	12.47**	733.85	7.87*	39.29	-2.94**
5	8.55	3.39	93.73	29.26**	840.27	23.52**	38.38	-5.19**
6	6.71	-18.86**	51.38	-29.14**	468.42	-31.14**	37.93	-6.30**
7	8.36	1.10	62.17	-14.26**	559.56	-17.75**	40.86	0.94
8	7.17	-13.30**	63.04	-13.06**	570.36	-16.16**	39.34	-2.82**
9	9.47	14.51**	97.87	34.97**	883.86	29.93**	37.19	-8.13**
10	8.49	2.66	81.67	12.63**	747.00	9.81**	39.09	-3.43**
11	5.14	-37.85**	52.44	-27.68**	471.96	-30.62**	41.11	1.56
12	8.49	2.66	81.91	12.96**	737.16	8.36*	39.19	-3.19**
13	7.96	-3.75	79.89	10.18**	719.04	5.70	39.54	-2.32**
14	8.32	0.60	78.00	7.57	701.88	3.18	39.89	-1.46
15	9.14	10.52*	97.25	34.12**	875.28	28.66**	42.10	4.00**
16	5.88	-28.90**	49.94	-31.13**	449.46	-33.93**	39.98	-1.24
17	7.10	-14.15**	74.86	3.24	673.74	-0.96	42.58	5.19**
18	8.67	4.84	82.30	13.50**	740.58	8.86*	40.47	-0.02
19	7.50	-9.31*	68.62	-5.36	617.58	-9.22**	38.28	-5.43**
20	7.86	-4.96*	73.37	1.19	660.36	-2.93	40.22	-0.64
21	7.92	-4.23	70.20	-3.19	622.01	-8.57*	40.79	0.77
22	8.02	-3.02	90.25	24.47**	812.23	19.40**	37.58	-7.16**
23	7.25	-12.33**	78.69	8.52	708.24	4.11	39.62	-2.12*
Mean	7.73		73.65		662.03		39.57	
Base pop.	8.27		72.51		680.28		40.48	
LSD'								
0.05	0.61	7.38	6.22	8.58	46.51	6.84	0.67	1.66
0.01	0.90	10.88	8.19	11.29	61.31	9.01	0.89	2.20

*, ** significant and highly significant at 0.05 and 0.01 levels of probability, respectively.
I.D = (S1line mean – base pop. mean)/base pop. mean x 100.

I.2. Variance components and broad sense heritability:

Genotypic, phenotypic variance and broad sense heritability (H) are presented in Table (5). Results showed that genotypic variance for all studied traits were less than the phenotypic variance and this due to that the genotypic variance depend upon the effect of additive and dominance but the phenotypic variance due to the effect of genotypic and environment variance. The genotypic variance for all the studied traits were low except for plant height and achene yield/plot which were high for S_1 of Giza102 population, indicating that the more variability in the base population for plant height and yield.

Broad sense heritability for S_1 of pop. Giza102 estimates are indicating the expressivity of trait with which a genotype can be assessed by its phenotype and its effective utilization in judging the phenotypic selection. High heritability estimates were observed for plant height, stalk diameter, achene yield/plot, head diameter, achene yield/plant, oil content, days to maturity, days to 50% flowering and 100-achene weight, and their values were 98.84, 98.39, 97.86, 96.90, 96.81, 96.20, 95.04, 93.46 and 92.55%, respectively. Similar results were reported by Muhammad *et al.* (1992), Ashok *et al.* (2000) and Khan (2001). Moreover, the high values of heritability were recorded for seed yield, 100-seed weight, days to 50% flowering, days to maturity, plant height, head diameter and oil yield Seneviratne *et al.* (2004). Heritability values alone cannot provide any indication of the amount of progress that would result from selection because heritability in broad sense includes both additive and non-additive gene action Ashok *et al.* (2000).

Estimates of genotypic and phenotypic coefficient of variability for all the studied traits for S_1 lines *per se* that obtained from pop. Giza102 are listed in Table (5).

Phenotypic coefficient of variability for various traits were relatively higher than genotypic one for the S_1 lines that obtained from pop. Giza102. The phenotypic coefficient of variability for achene yield/plot, achene yield/plant, stalk diameter, 100-achene weight and plant height were 19.25, 19.01, 13.70,12.51 and 12.25%, respectively. These values were high comparing to S_1 lines for the another traits, head diameter, days to 50% flowering, days to maturity and oil content, which were 12.00, 5.61, 3.74 and 3.43%, respectively. These results revealed that the different effects of environmental conditions on studied traits.

Table 5. Variance components (genotypic variance (σ2g), phenotypic variance(σ2ph), genotypic coefficient of variance (GCV), phenotypic coefficient of variance (PCV) and broad sense heritability (H %) of all studied traits for S1lines and base population.

V. C	MS								
	Days to 50% flowering	Days to maturity	Plant height, cm	Stalk diameter, cm	Head diameter, cm	100-achene weight, g	Achene yield/plant, g	Achene yield/plot, g	Oil content
σ^2 g	8.15	9.58	370.29	0.122	5.93	0.87	189.51	15937.49	1.77
σ^2 Ph	8.72	10.08	374.64	0.124	6.12	0.94	195.75	16286.70	1.84
G.C.V%	5.42	3.65	12.18	13.59	11.80	12.04	18.70	19.05	3.36
P.C.V%	5.61	3.74	12.25	13.70	12.00	12.51	19.01	19.25	3.43
H%	93.46	95.04	98.84	98.39	96.90	92.55	96.81	97.86	96.20

Genotypic coefficient of variability for achene yield/plot, achene yield/plant, stalk diameter, plant height and 100-achene weight for S_1 lines that obtained from pop.Giza102 were 19.05, 18.70, 13.59, 12.18 and 12.04%, respectively, and were high compared to the another traits of S_1 lines from pop. Giza102, head diameter, days to 50% flowering, days to maturity and oil content, which were 11.80, 5.42, 3.65 and 3.36%, respectively. These results of genetic variability are in accordance with those obtained for phenotypic variability in the base population Giza102. These results are in harmony with the results of Teklewold *et al.* (1999), Ashok *et al.* (2000) and Mahmoud (2012).

I.3. Correlation coefficients between yield, yield component and days to 50% flowering for S_1 *per se* obtained from population of Giza102 of sunflower:

Oil content was negatively and not significant correlated with head diameter, 100-achene weight, achene yield/plant and achene yield/plot (Table 6).

Achene yield/plot was positively and significant correlated with head diameter, 100-achene weight and yield/plant.

The correlation coefficients between each pairs of yield components was positive and highly significant for achene yield/plant with head diameter and 100-achene weight, and 100-achene weight with head diameter.

Days to 50% flowering was positively and highly significant correlated with days to maturity and positive insignificant with achene yield and head diameter but was negative insignificant with 100-achene weight. Thitiporn and Chiraporn (2008), Mijic *et al.* (2009) showed that highly significant positive correlation coefficient was estimated between grain yield and oil yield. A positive correlation coefficient was estimated between 1000-grain weight and grain yield, and a negative one between 1000-grain weight and oil content. Muhammad *et al.* (2013) found that the seed yield had negative correlation with oil contents and suggested to break it either through conventional or novel breeding techniques to breed high yielding hybrids with maximum oil contents.

Table 6. Correlation coefficients among studied traits for S_1 lines.

Traits	Days to 50% flowering	Days to maturity	Head diameter (cm)	100-achene weight (g.)	Achene yield/plant (g.)	Achene yield/plot (g.)	Oil content
Days to 50% flowering		0.660**	0.100	-0.073	0.095	0.123	0.157
Days to maturity			0.066	-0.129	0.107	0.136	0.169
Head diameter (cm)				0.420**	0.485**	0.486**	-0.208
100-achene weight (g.)					0.750**	0.731**	-0.010
Achene yield/plant (g.)						0.962**	-0.014
Achene yield/plot (g.)							-0.073
Oil content							

** highly significant at 1% level of probability.

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تأثير التربية الداخلية على بعض صفات النمو والمحصول في عباد الشمس

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الملخص:

أجريت هذة الدراسة خلال موسمى ٢٠١٠ و ٢٠١١ لدراسة تأثير التربية الداخلية فى عباد الشمس. حيث تم زراعة الصنف مفتوح التلقيح جيزة ١٠٢ من عباد الشمس فى موسم ٢٠١٠ فى محطة البحوث الزراعية بشندويل- مركز البحوث الزراعية، وتم انتخاب حوالى ١٠٠ نبات وتم تلقيحها ذاتيا، وبعد الحصاد كانت هناك ٢٣ عائلة ملقحة ذاتيا أعطت بذور تكفى للتقييم فى الموسم المقبل. فى موسم ٢٠١١ تم عمل تجربة تحتوى على ٢٣ عائلة من عائلات التلقيح الذاتى الأول بالإضافة للصنف مفتوح التلقيح جيزة ١٠٢ فى تصميم قطاعات كاملة العشوائية من ثلاث مكررات. سجلت البيانات على صفات (عدد الأيام من الزراعة حتى ٥٠% تزهير، عدد الأيام من الزراعة حتى النضج، طول النبات، قطر النبات، قطر القرص، وزن ال١٠٠ بذرة، محصول النبات الفردى، محصول القطعة التجريبية ونسبة الزيت فى البذور).

أوضح تحليل التباين وجود اختلافات عالية المعنوية بين عائلات الجيل الذاتى الأول لكل الصفات تحت الدراسة، وكانت درجة التوريث عالية لكل الصفات المدروسة. كما كان معامل الاختلاف المظهرى أعلى من معامل الاختلاف الوراثى. كان الارتباط بين نسبة الزيت وقطر القرص، وزن ال ١٠٠ بذرة، محصول النبات الفردى و محصول القطعة التجريبية سالب وغير معنوى أما عن الارتباط بين محصول القطعة التجريبية ووزن ال ١٠٠ بذرة ومحصول النبات الفردى فكان موجب ومعنوى. كان النقص نتيجة التربية الداخلية فى محصول القطعة التجريبية لعائلات الجيل الذاتى الأول ٢,٦٨% من العشيرة الأصلية، وكان هناك ١٠ عائلات نقصت بدرجة معنوية، و٨ أخرى تفوقت معنويا عن العشيرة الأصلية. وكان النقص فى صفة نسبة الزيت حوالى ٢,٢٥% . معظم عائلات الجيل الذاتى الاول كانت اقل من العشيرة الأصلية. كانت أحسن عشر عائلات هى ١، ٧، ١١، ١٤، ١٥، ١٦، ١٧، ١٨، ٢٠ و ٢١ والتى أعطت اعلي نسبة زيت فى البذور، وكانت جيدة فى الصفات الأخرى وانتخبت لاستخدامها كآباء فى إنتاج الدورة الأولى من الانتخاب.