FACULTY OF AGRICULTURE

Minia J. of Agric. Res. & Develop.
Vol. (38), No. 1, pp. 29-56, 2018

EVALUATION OF SUNFLOWER GENOTYPES UNDER LOAMY SAND AND CLAY SOIL CONDITIONS

Ezzat E. Mahdy[1], Elsayed Hassaballa[1], Abdeen Al-sheemy[2] and Heba A. A. M. Hassan [2]

1-Assiut Univ.Fac.Agric. Agron. Dept,
2- ARC, Crop Res. Inst. Oil Crops Sec.

Corresponding author: E. E. Mahdy, e-mail: ezzat_mahdy@agr.au.edu.eg

Received: 7 March (2018)   Accepted: 1April (2018)

ABSTRACT

Twenty-six genotypes of sunflower (16 F_1-hybrids, four female lines, four restorer lines and two check varieties; Sakha 53 and Giza 102) were evaluated under two contrasting environments, i.e., loamy sand soil at A.R.C., Arab El-Awamer Res. Stn., and clay soil at Assiut Univ. Exper. Farm in season 2016. Genotypes mean squares of 13 studied traits was significant ($P \leq 0.01$) either in the separate or in the combined analysis. The differences between the two environments were significant for all traits except head diameter (HD). The genotype x environment interaction was significant for all traits, indicating differential responses of genotypes to the two environments. The F_1-hybrids, females and males were earlier than the two checks in days to 50% flowering. The fertile clay soil delayed days to 50% flowering than loamy sand soil. The phenotypic (PCV%) and genotypic (GCV%) coefficients of variability were low, and heritability in broad sense was intermediate (43.17%) for days to 50% flowering. The combined analysis of plant height showed high PCV (13.58%), GCV (11.81%) and heritability (75.58%). The GCV of head diameter was high and reached 15.95, 14.41 and 11.84% at loamy sand, clay soil and combined analysis; respectively. Stalk diameter was larger at clay than at loamy sand soil, and heritability estimates were 74.19, 77.05 and 66.67% at loamy sand, clay soil and combined analysis; respectively. Four of the F_1-hybrids was heavier in 100-seed weight than the checks. The GCV and heritability estimates were high for 100-seed weight. Husk % and husk; g of 100 seeds tended to be higher at loamy sand than at clay soil. The combined means of oil % showed that five hybrids significantly exceeded the better check Giza 102. Oil % was higher at loamy sand than at clay soil. Heritability estimates of oil % were high at both locations (97.86 and 86.25%) and very low (5.69%) from the combined analysis, because of the large mean squares of GxE interaction. Kernel weight in 100 seeds was higher at loamy sand than at clay soil. The GCV and heritability estimates were high for kernel weight. Number of seeds/head was higher at clay soil than at loamy sand. Three F_1-hybrids significantly exceeded Sakha53in kernel weight from the combined data. The GCV and heritability estimates were high for NS/H. Seed yield/head and oil yield/head were higher at loamy sand than at clay soil, and four F_1-hybrids were significantly better than the check. High estimates of GCV and heritability were high for NS/H. The GCV estimates in seed yield were 43.48, 39.33 and 33.57%, and heritability were 98.85, 96.67 and 75.22% at loamy sand, clay soil and combined analysis; respectively. The resulted indicated that the genetic materials should be evaluated under diverse environments to get reliable estimates of genetic parameters.

Key words: *Helianthus annuus* L., *PCV, GCV, heritability, evaluation under two environments.*

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is a wide spread edible oil crop all over the world. It ranked the second after soybean (Peniego *et al*., 2002). It is a short duration crop, and can be grown at any time of the year in tropical and sub-tropical, tolerant to drought, high oil content and yield potential. Egypt faces severe shortage of edible oil, and spends a big amount of foreign exchange on its import annually to meet about 95% of the local consumption. Genetic variability provides the breeder good opportunity to select high yielding genotypes. Mean squares of the evaluated genotypes was significant for seed yield, oil yield and most traits (Javed and Aslam, 1995; Jan *et al*., 2005; Tahir and Mehdi, 2001; Dudhe *et al*., 2017 and Khan *et al*., 2017). Egypt faces shortage in irrigation water especially in new reclaimed soil. Seed yield, oil yield, head diameter and 100 seed weight were reduced by water stress (Esmail, 2000; Tahir and Mehdi, 2001; Tahir *et al*., 2002; Reddy *et al*., 2003 and Iqbal *et al*., 2005). Sunflower genotypes showed differential response to drought stress (Rauf and Sadaqat, 2007; Salem *et al*., 2013 and Pekcan *et al*., 2016). Environmental factors had high influence on the formation of seed and oil yields/plant (Cvejic *et al*., 2015). The present study was carried out to evaluate four lines, four restorer lines and their 16 crosses under two different soil types; loamy sand and clay soil, and to identify the best hybrids at both soil type.

MATERIALS AND METHODS

A. Genetic materials

Three cytoplasmic male sterile (CMS) lines (A-Lines) and four fertility restorer lines (RF-lines) of sunflower (*Helianthus annuus* L.) were planted at Assiut Agric. Res. Stn. Agric. Res. Center in summer season 2015, to developing 16 crosses. The origin and agronomic characteristics of the seven male sterile lines (CMS) and the four restorer lines (RF-Lines) along with check varieties are presented in Table 1. The sixteen single crosses, four lines, four restorer lines and the two check varieties; Giza 102 and Sakha 53 were evaluated at 2016 season.

A. Evaluation of the crosses and their parental lines

The sixteen obtained sunflower crosses, the four testers, the four fertile lines (B-Lines) and the two check varieties; Sakha 53 and Giza 102 were evaluated at two contrasting environments; loamy sand and clay soils (Table2). Planting dates were September 10th at Assiut Agric. Res. Stn. ARC. (loamy sand soil), and on September 20th 2016 at Fac. Agric. Assiut Univ. Exper. Farm (clay soil). Randomized complete block designs (RCBD) with three replications were used in the two locations. The plot size was one row, 4-meter-long and 60 cm apart. Planting was done by hand in hills spaced 25 cm apart. Seedlings were thinned to one plant per hill after two weeks from planting in both locations. The recommended cultural practices for oil seed sunflower production were adopted throughout the growing season. Five guarded plants were tagged. At flowering, days to 50 % flowering from sowing date until 50% of the plants showed their anthesis was recorded. The following characters were recorded on the tagged plants.

1. Plant height; cm (PH): average length in cm from soil level to the tip of the head.
2. Head diameter, cm (HD): estimated as an average of maximum width of the head.
3. Stalk diameter; cm (SD): measured at 30 cm above the soil surface with digital Vernier calipers, at nearest 0.1 cm.
4. 100 seed weight; g: estimated from the bulk seeds of the guarded plants.
5. Husk percentage (Husk%): a sample of seeds were peeled to husk and kernel. Husk% = (husk weight in the sample)/sample weight * 100, and Kernel% = (kernel weight in the sample)/sample weight * 100
6. Husk in 100 seeds; g (Husk; g): estimated as Husk% * 100 seed weight
7. Oil percentage: determined by Soxcelt apparatus using petroleum ether (BP60-80 c) as solvent according to the official method (A. O. A. C. 1980)
8. Oil in 100 seeds (Oil; g): estimated as oil% * 100 seed weight.
9. Kernel in 100 seeds (kernel; g): estimated as kernel% * 100 seeds; g
10. Number of seed per head (NS/H).
11. Seed yield per head (SY/H; g): estimated as average of seed yield per head.
12. Oil yield per head (OY/H; g): estimated as oil % * average seed yield/head.

Table 1. Origin and some agronomic characteristics of CMS, restorer lines and check varieties

No.	**A. Mail Sterile (A) lines and feritle (B) lines**				**Agronomic characteristics**			
	Lines	Geogrphical origin	Lines	Geographical origin	Days to 50% flow	plant height;cm	stalk diameter; cm	head diameter; cm
2	A7	Argentine	B7	Argentine	53	164	2	18
5	A15	Russia	B15	Russia	51	175	2.2	18.2
6	A19	Argentine	B19	Argentine	54	145	2.05	17
7	A21	Russia	B21	Russia	57	148	2.08	16.6
NO.	B. Restorse (RF) Lines							
1	RF1		local		54	116	1.22	10.5
2	RF2				56	119	1.25	11
3	RF3				52	100	1.05	10.1
4	RF5				54	126	1.83	14
No.	C. Check Varieties							
1	Sakha 53		A.R.C.		56	177	2.11	19.5
2	Giza 102				52	137	1.58	12.5

Statistical analysis and procedures

Combined analysis of variance was performed as outlined by Gomez and Gomez (1984) after carrying out the homogeneity of variances using Bartlett test. Heritability in broad sense "H" was estimated as the ratio of genotypic (σ^2g) to phenotypic (σ^2p) variance (Walker 1960). The phenotypic (PCV%) and genotypic (GCV%) coefficients of variability were calculated as outlined by Burton (1952).

RESULTS AND DISCUSSION

It is obvious from Table 2 that the loamy sand soil has a light texture, resulting in a proper porosity that causes a good balance between soil moisture and air contents compared to those of clay soil that display a heavy texture. Thus, plant roots can penetrate and spread in a greater area of the loamy sand soil relative to that of the clay one. Moreover, the loamy sand soil has a good physical properties and conditions that encourage plant roots to extend in more rhizosphere area to absorb water and nutrients. Also, the irrigation water goes through the clay soil very slowly causing the root zone to be saturated with water on the charge of soil air that is necessary for root respiration and spread. For the chemical and nutritional point of view, the loamy sand soil has a lower salt content (0.68 ds/m), and higher available phosphorus "P" (29.9 mg/kg) than the clay soil (1.07 ds/m and 11.17 mg/kg; respectively), even though, both of them are not saline. The plants potentially grow under saline soil and higher nutritional soil conditions. The available P content of the loamy sand soil is extremely sufficient for plant needs. However, the available P of the clay soil is considered marginal. In conclusion, the physical properties (soil texture, porosity and water distribution) and some chemical and nutritional properties (salinity and available P) of loamy sand soil are more preferable for plant growth than those of the clay one. In other words, clay soil conditions obstruct the growth and spread of plant roots, the loamy sand ones encourage the root growth and spread.

Table 2. Some physical and chemical properties of representative soil samples in the experimental sites before sowing (0-30 cm depth)

Soil property	Assiut Res. Stn	Fac. Agric. Res.
Particle - size distribution		
Sand (%)	78.24	27.4
Silt (%)	9.76	24.3
Clay (%)	12.00	48.3
Texture grade	Loamy sand	Clay
EC (1:1 extract) dSm^{-1}	0.68	1.07
pH (1:1 suspension)	8.19	8.01
Total $CaCO_3$ (%)	25.0	3.4
Organic matter (%)	0.06	0.24
$NaHCO_3$-extractable P (mg	29.9	11.17
NH_4OAC-extractable K (mg	130	300
Total nitrogen (%)	0.04	0.08
Soluble Ca (mg kg^{-1})	100	190
Soluble Mg (mg kg^{-1})	12	72
Soluble Na (mg kg^{-1})	4.6	140
Soluble K (mg kg^{-1})	11.7	39
Soluble Cl (mg kg^{-1})	177.5	142
Soluble HCO_3 (mg kg^{-1})	610	427

* Each value represents the mean of three replications

1-Evaluation of genotypes

The 26 genotypes (16 F_1-hybrids + 4 females + 4 males + 2 check varieties) of sunflower were evaluated under two contrasting environments, i.e., loamy sand soil at Arab El-Awamer Res. Stn., and clay soil at Assiut Univ. Exper. Farm in season 2016.

The separate and combined analyses of variances for different traits are shown in Table 3. Genotypes mean squares of the 13 studied traits was significant ($P\leq0.01$) either in the separate or in combined analysis, which reflects the differences among genotypes (parents and crosses). The differences between the two environments were significant ($P\leq0.01$) for all traits except head diameter (HD). The genotypes by environment interaction was significant ($P\leq0.05$) for days to 50% flowering and significant ($P\leq0.01$) for the other traits, indicating the differential responses of genotypes to the two environments. Javed and Aslam (1995), Jan *et al*. (2005), Kumar *et al*. (2014) and Khan *et al*. (2017) found significant mean squares for genotypes environment (drought, locations or salinity) their interaction for SY/P, HD, oil %, days to maturity and 100-seed weight.

Means and variances

Table 3. Mean squares of the studied traits under loamy sand, clay soil and their combined

Source of variance		Days to 50 % Flowering			PH		
	d.f.	Loamy sand	Clay soil	Combined	Loamy sand	Clay soil	Combined
Reps	2	0.258	0.047		24.25	1023.37	
Env. (E.)	1			118.56**			31365**
Reps/Env.	4			0.16			523.881
Genotypes (G.)	25	17.748**	8.226**	19.96**	647.57**	2066.76**	2323.16**
G. X E.	25			6.03*			391.17**
Error	50	2.923	1.999		29.57	67.275	
Error com.	100			2.46			48.43
PCV%		3.79	2.45	2.53	10.7	17.26	13.58
GCV%		3.27	1.94	1.66	10.45	16.89	11.81
H%%		74.54	63.02	43.17	95.33	95.66	75.58
Source of Variance		**HD**			**SD**		
		Loamy sand	Clay soil	Combined	Loamy sand	Clay soil	Combined
Reps	2	0.275	1.246		0.042	0.025	
Env. (E.)	1			0.18			13.03**
Reps/Env.	4			0.76			0.03
Genotypes (G.)	25	24.842**	23.226**	38.43**	0.111**	0.246**	0.26**
G. X E.	25			9.64**			0.09**
Error	50	1.055	1.05		0.024	0.044	
Error com.	100			1.05			0.03
PCV%		16.34	14.79	13.58	11.66	11.97	9.69
GCV%		15.95	14.41	11.84	10.04	10.5	7.91
H%%		95.32	94.85	73.12	74.19	77.05	66.67

Table 3. Cont.

Source of Variance		100 SW			Husk %		
		Loamy sand	Clay soil	Combined	Loamy sand	Clay soil	Combined
Reps	2	0.308	1.156		0.006	0.551	
Env. (E.)	1			157.46**			23.45**
Reps/Env.	4			0.73			0.28
Genotypes (G.)	25	7.029**	2.284**	6.8**	27.424**	28.694**	40.57**
G. X E.	25			2.51**			15.55**
Error	50	0.294	0.156		1.686	0.85	
Error com.	100			0.22			1.27
PCV%		28.17	22.77	23.57	9.31	10.81	8.15
GCV%		27.58	22.28	18.79	9	10.63	5.6
H%%		95.87	95.74	63.56	93.45	96.84	47.21
Source of Variance		Husk in 100 seed ; g			Oil %		
		Loamy sand	Clay soil	Combined	Loamy sand	Clay soil	Combined
Reps	2	0.024	0.111		3.168	6	
Env. (E.)	1			14.04**			1362.33**
Reps/Env.	4			0.07			4.58
Genotypes (G.)	25	0.57**	0.209**	0.56**	49.252**	18.879**	31.55**
G. X E.	25			0.21**			36.58**
Error	50	0.026	0.016		1.206	2.36	
Error com.	100			0.02			1.78
PCV%		27.56	21.54	22.06	10.22	7.31	6.39
GCV%		26.83	21.04	15.6	10.11	6.79	1.52
H%		94.79	95.45	50.00	97.86	86.25	5.69

*, **; significant at 0.05 and 0.01% level of probability; respectively

1.1- Days to 50% flowering

Mean days to 50% flowering at loamy sand soil was 52.04, 53.25, and 53.67 for F_1-hybrids, females and males; respectively with an overall mean of 52.92 (Table 4). The earliest hybrid was A7xRF2 (48.67 days), the earliest female was B21 (52.33 days), and the earliest male was RF2 (51.33 days). The earliest female (B21) tended to give earliest hybrids, and could be the good combiner for days to 50% flowering. Generally, the F_1-hybrids, female and males were earlier than the two check varieties. Under clay soil condition, days to 50% flowering were later in most cases than that under loamy sand soil for all genotypes. The earliest cross (A7XRF2) under loamy sand soil was not the earliest under clay soil. The effect of clay soil on delaying days to 50% flowering differed from genotype to another confirming the significant effect of GxE interaction (Table 3). The combined means indicated that the earliest three hybrids were A7xRF2 (50.83 days), A21xRF2 (51.00 day) and A21xRF3 (50.50 days), compared to 59.50 days for Sakha 53 and 56.17 days for Giza 102.

The combined means of the F_1-hybrids indicated that eight hybrids were significantly ($P \leq 0.01$) earlier than the earlier check Giza 102; A7xRF1, A7xRF2, A7xRF3, A15xRF2, A15xRF3, A21xRF1, A21xEF2 and A21xRF3, and five hybrids were significantly ($P \leq 0.05$) earlier than Giza 102; A15xRF1, A19xRF2, A19xRF3, A19xRF5 and A21xRF5.

The phenotypic (2.53%) and genotypic (1.66%) coefficients of variability in days to 50% flowering from the combined data indicated low level of variability among genotypes. Furthermore, broad sense heritability (43.17%) was intermediate.

1-2. Plant height

Mean plant height (Table 4) was 110.96, 145.71 and 128.33 cm for hybrids, 112.33, 120.92 and 116.67 cm for females, and 88.25, 104.17 and 96.21 cm for male parents at loamy sand soil, clay soil and combined data; respectively. All genotypes were shorter than the two checks; Sakha 53 and Giza 102. All genotypes gave taller plants and larger vegetative growth under clay soil than under loamy sand soil. The increase in plant height under clay soil condition was not equal from genotype to another confirming the significant ($P \leq 0.01$) GxE interaction obtained (Table 3). For example, A21xRF3 increased from 112.0 cm at loamy sand soil to 132.67 cm at clay soil, A21xRF5 increased from 113.67 to 172.67 cm, and RF3 increased in plant height from 88.67 to 92.67 cm. The genotypes combined means of plant height showed wide variability. The F_1-hybrids ranged from 118.00 to 154.17 cm, the female parents ranged from 102.67 to 124.67 cm, and the male parents ranged in plant height from 82.83 to 117.67 cm. Such wide variability (combined means) was reflected in high phenotypic (13.58%) and genotypic (11.81%) coefficient of variability, and high broad sense heritability (75.58%). Tahir and Mehdi (2001) noted coefficient of variability for PH of 4.99%. Ali *et al*. (2006) found significant genotype x environment interaction for all traits. Salem *et al*. (2013) found differential responses of genotypes to drought stress for all traits. Dudhe *et al*. (2017) reported high PCV and GCV for PH.

1-3. Head diameter

The overall mean of head diameter of the F_1-hybrids was equal under both locations (18.32 cm), and lower than that of the two checks; Sakha 53 and Giza 102. The best F_1-hybrid in head diameter was A15xRF5 at loamy sand (20.67 cm) and clay soil (22.00 cm). Head diameter varied greatly for different genotypic from 10.87 cm for RF2 to 20.67 cm for A15xRF5, and 22.47 cm for B15 under loamy sand soil, and from 10.87 cm for RF2 to 22.0 cm for A21xRF5 under clay soil. The combined means showed that none of the F_1-hybrids exceeded the better check Giza 102 in head diameter. Such variability in head diameter of different genotypes was reflected in high phenotypic and genotypic coefficient of variability (Table 3) under both environments. The genotypic coefficient of variability reached 15.95, 14.41 and 11.84% at loamy sand, clay soil and combined analysis; respectively. Dudhe *et al*. (2017) reported high PCV and GCV for HD. Furthermore, broad sense heritability was high and accounted for 95.32% under loamy sand soil, 94.85% under clay soil, and 73.12% for combined data. Head diameter of different genotypes was higher for some genotypes under loamy sand soil than under clay soil and *vice versa* for the others, confirmed the significance ($P \leq 0.01$) of GxE interaction (Table 3). These results are in agreement with those reported by Khan *et al*. (2017).

Table 4. Means of the studied traits at the two locations and their combined

Genotypes	Days to 50 % Flow.			PH ;cm			HD; cm		
	Loamy sand	Clay	Comb.	Loamy sand	Clay	Comb.	Loamy sand	Clay	Comb.
A7xRF1	52.33	54.33	53.33	117.33	138.00	127.67	17.60	19.07	18.33
A7xRF2	48.67	53.00	50.83	105.33	136.33	120.83	17.53	18.00	17.77
A7xRF3	49.00	57.67	53.33	99.67	136.67	118.17	17.87	18.33	18.10
A7xRF5	54.67	55.00	54.83	116.33	137.33	126.83	19.93	16.13	18.03
A15xRF1	52.67	55.33	54.00	124.33	184.00	154.17	18.47	18.87	18.67
A15xRF2	51.33	53.33	52.33	117.00	165.33	141.17	19.93	20.00	19.97
A15xRF3	52.33	53.33	52.83	115.33	151.33	133.33	18.80	18.53	18.67
A15xRF5	54.67	56.67	55.67	120.33	164.00	142.17	20.67	18.97	19.82
A19xRF1	54.67	55.00	54.83	107.67	126.33	117.00	17.53	18.87	18.20
A19xRF2	53.33	55.33	54.33	106.00	141.00	123.50	18.47	18.47	18.47
A19xRF3	53.33	55.33	54.33	104.67	131.33	118.00	15.47	14.80	15.13
A19xRF5	54.00	54.67	54.33	102.67	144.33	123.50	18.40	19.93	19.17
A21xRF1	50.67	54.33	52.50	103.67	136.33	120.00	16.73	17.07	16.90
A21xRF2	49.33	52.67	51.00	109.33	133.67	121.50	18.20	17.87	18.03
A21xRF3	49.33	51.67	50.50	112.00	132.67	122.33	17.40	16.20	16.80
A21xRF5	52.33	56.00	54.17	113.67	172.67	143.17	20.13	22.00	21.07

Hybid mean	52.04	54.60	53.32	110.96	145.71	128.33	18.32	18.32	18.32
B7	53.67	54.00	53.83	98.33	107.00	102.67	13.93	17.80	15.87
B15	52.67	53.67	53.17	122.00	126.33	124.17	22.47	13.20	17.83
B19	54.33	54.33	54.33	114.33	129.00	121.67	18.73	17.73	18.23
B21	52.33	53.67	53.00	114.67	121.33	118.00	16.13	16.80	16.47
Female mean	53.25	53.92	53.58	112.33	120.92	116.63	17.82	16.38	17.10
RF1	56.00	55.00	55.50	86.00	101.33	93.67	13.13	13.13	13.13
RF2	51.33	54.00	52.67	79.00	86.67	82.83	10.87	10.87	10.87
RF3	54.00	53.00	53.50	88.67	92.67	90.67	11.13	13.73	12.43
RF5	53.33	53.67	53.50	99.33	136.00	117.67	16.07	17.53	16.80
Male mean	53.67	53.92	53.79	88.25	104.17	96.21	12.80	13.82	13.31
Sakha 53	59.67	59.33	59.50	138.33	174.33	156.33	18.47	22.83	20.65
Giza 102	55.67	56.67	56.17	147.33	194.67	171.00	22.10	21.27	21.68
Grand mean	52.92	54.60	53.76	109.48	136.95	123.21	17.42	17.47	17.44
$RLSD_1$ 0.05	2.72	2.39	1.76	8.30	11.79	7.03	1.57	1.57	1.04
$RLSD_1$ 0.01	3.60	3.20	2.31	10.92	15.54	9.20	2.06	2.06	1.36
$RLSD_2$ 0.05	1.97	1.72	1.26	5.98	8.49	5.07	1.13	1.13	0.75
$RLSD_2$ 0.01	2.61	2.31	1.66	7.87	11.20	6.63	1.49	1.48	0.98

Table 4. Cont.

Genotypes	SD; cm			100-sw; g			Husk%		
	Loamy sand	Clay	Comb.	Loamy sand	Clay	Comb.	Loamy sand	Clay	Comb.
A7xRF1	1.58	2.11	1.85	6.18	4.43	5.31	25.99	29.71	27.85
A7xRF2	1.49	2.09	1.79	6.55	4.06	5.30	27.05	28.16	27.61
A7xRF3	1.54	2.03	1.78	7.25	4.04	5.64	31.31	28.98	30.15
A7xRF5	1.68	1.91	1.80	5.92	3.47	4.70	28.81	28.85	28.83
A15xRF1	1.53	2.08	1.81	6.24	4.03	5.14	26.60	27.06	26.83
A15xRF2	1.50	2.20	1.85	7.82	4.07	5.94	27.58	21.43	24.51
A15xRF3	1.57	2.23	1.90	6.25	3.94	5.10	24.72	25.17	24.94
A15xRF5	1.74	2.07	1.91	5.97	3.87	4.92	26.94	27.66	27.30
A19xRF1	1.63	2.19	1.91	5.44	3.52	4.48	26.43	28.06	27.24
A19xRF2	1.50	1.91	1.70	5.75	3.59	4.67	26.85	26.30	26.58
A19xRF3	1.64	2.07	1.85	5.85	2.57	4.21	25.56	27.95	26.76
A19xRF5	1.52	2.32	1.92	6.27	4.06	5.17	28.29	23.47	25.88
A21xRF1	1.39	2.16	1.78	5.81	4.03	4.92	29.64	29.13	29.39
A21xRF2	1.55	2.26	1.91	6.98	4.33	5.66	27.75	27.05	27.40
A21xRF3	1.46	1.81	1.64	6.65	3.82	5.23	27.01	26.77	26.89
A21xRF5	1.71	2.69	2.20	7.41	4.11	5.76	26.47	25.84	26.16

Hybrid mean	1.56	2.13	1.85	6.40	3.87	5.13	27.31	26.97	27.14
B7	1.23	1.92	1.57	2.18	4.59	3.39	29.07	26.23	27.65
B15	1.94	1.78	1.86	7.19	3.37	5.28	29.79	24.39	27.09
B19	1.48	1.98	1.73	6.84	3.45	5.14	28.17	27.36	27.76
B21	1.28	1.77	1.53	4.23	3.51	3.87	38.17	31.25	34.71
Female mean	1.48	1.86	1.67	5.11	3.73	4.42	31.30	27.31	29.30
RF1	1.20	1.77	1.48	3.16	2.10	2.63	27.84	34.49	31.16
RF2	1.23	1.72	1.48	2.93	1.56	2.25	29.73	34.29	32.01
RF3	1.29	1.85	1.57	2.41	1.73	2.07	29.08	24.85	26.96
RF5	1.53	2.60	2.06	4.65	3.18	3.92	29.66	29.03	29.35
Male mean	1.31	1.99	1.65	3.29	2.14	2.72	29.08	30.66	29.87
Sakha 53	1.67	2.62	2.15	5.96	5.06	5.51	33.75	30.79	32.27
Giza 102	1.94	2.68	2.31	5.81	4.97	5.39	34.97	32.80	33.88
Grand mean	1.52	2.10	1.81	5.60	3.63	4.62	28.79	28.00	28.40
$RLSD_1$ 0.05	0.26	0.35	0.20	0.83	0.60	0.47	1.98	1.33	1.14
$RLSD_1$ 0.01	0.35	0.47	0.26	1.09	0.80	0.62	2.61	1.75	1.49
$RLSD_2$ 0.05	0.19	0.26	0.14	0.60	0.44	0.34	1.43	0.95	0.82
$RLSD_2$ 0.01	0.25	0.34	0.18	0.79	0.57	0.45	1.88	1.26	1.07

Table 4. Cont.

Genotypes	Husk;g in 100 seeds			Oil%			Oil;g in 100 Seeds		
	Loamy sand	Clay	Comb.	Loamy sand	Clay	Comb.	Loamy sand	Clay	Comb.
A7xRF1	1.61	1.31	1.46	43.00	36.33	39.67	2.66	1.61	2.13
A7xRF2	1.77	1.14	1.46	37.00	32.67	34.83	2.42	1.33	1.88
A7xRF3	2.27	1.17	1.72	38.00	34.33	36.17	2.75	1.39	2.07
A7xRF5	1.70	1.00	1.35	41.67	33.33	37.50	2.47	1.16	1.81
A15xRF1	1.65	1.09	1.37	41.33	35.00	38.17	2.58	1.41	2.00
A15xRF2	2.15	0.87	1.51	33.33	32.67	33.00	2.61	1.33	1.97
A15xRF3	1.55	0.99	1.27	44.67	33.00	38.83	2.79	1.30	2.05
A15xRF5	1.61	1.07	1.34	41.00	38.33	39.67	2.45	1.49	1.97
A19xRF1	1.44	0.99	1.21	43.33	32.00	37.67	2.36	1.13	1.74
A19xRF2	1.55	0.94	1.25	39.33	32.00	35.67	2.27	1.15	1.71
A19xRF3	1.49	0.72	1.11	42.00	40.00	41.00	2.45	1.03	1.74
A19xRF5	1.77	0.95	1.36	43.67	30.67	37.17	2.74	1.25	1.99
A21xRF1	1.72	1.17	1.45	41.67	36.33	39.00	2.42	1.46	1.94
A21xRF2	1.94	1.17	1.56	42.67	32.33	37.50	2.98	1.40	2.19
A21xRF3	1.80	1.02	1.41	40.00	31.67	35.83	2.65	1.21	1.93
A21xRF5	1.96	1.06	1.51	42.67	34.33	38.50	3.16	1.41	2.29

Hybrid mean	1.75	1.04	1.40	40.96	34.06	37.51	2.61	1.32	1.96
B7	0.64	1.20	0.92	25.00	36.33	30.67	0.55	1.67	1.11
B15	2.15	0.82	1.48	41.33	33.33	37.33	2.97	1.12	2.05
B19	1.93	0.94	1.44	40.33	32.00	36.17	2.76	1.10	1.93
B21	1.61	1.10	1.35	37.33	29.33	33.33	1.58	1.03	1.30
Female mean	1.58	1.02	1.30	36.00	32.75	34.38	1.96	1.23	1.60
RF1	0.88	0.72	0.80	40.33	36.67	38.50	1.28	0.77	1.02
RF2	0.87	0.54	0.70	43.33	35.33	39.33	1.28	0.55	0.91
RF3	0.70	0.43	0.57	41.33	34.33	37.83	1.00	0.60	0.80
RF5	1.37	0.92	1.15	42.33	32.67	37.50	1.97	1.04	1.51
Male mean	0.96	0.65	0.80	41.83	34.75	38.29	1.38	0.74	1.06
Sakha 53	2.01	1.56	1.78	37.33	34.00	35.67	2.22	1.72	1.97
Giza 102	2.03	1.64	1.83	36.67	38.00	37.33	2.13	1.90	2.01
Grand mean	1.60	1.01	1.31	39.98	34.09	37.03	2.26	1.24	1.75
$RLSD_1$ 0.05	0.25	0.19	0.15	1.58	2.45	1.43	0.35	0.25	0.21
$RLSD_1$ 0.01	0.33	0.25	0.19	2.08	3.24	1.87	0.46	0.33	0.27
$RLSD_2$ 0.05	0.18	0.14	0.11	1.14	1.76	1.03	0.25	0.18	0.15
$RLSD_2$ 0.01	0.23	0.18	0.14	1.45	2.33	1.35	0.33	0.24	0.19

Table 4. Cont.

Genotypes	Kernel's in 100 Seeds			NS/H			SY / H;g		
	Loamy sand	Clay	Comb.	Loamy sand	Clay	Comb.	Loamy sand	Clay	Comb.
A7xRF1	1.91	1.51	1.71	751.37	1064.71	908.04	45.97	46.92	46.45
A7xRF2	2.35	1.59	1.97	633.64	768.51	701.08	41.30	31.24	36.27
A7xRF3	2.23	1.48	1.86	663.55	686.17	674.86	47.83	27.67	37.75
A7xRF5	1.75	1.31	1.53	897.34	783.47	840.41	53.08	27.21	40.15
A15xRF1	2.00	1.53	1.77	737.47	744.61	741.04	45.81	29.81	37.81
A15xRF2	3.05	1.86	2.46	619.60	813.39	716.50	48.39	32.88	40.64
A15xRF3	1.92	1.65	1.78	719.90	761.91	740.91	44.89	29.95	37.42
A15xRF5	1.91	1.31	1.61	776.99	710.73	743.86	45.95	27.12	36.53
A19xRF1	1.64	1.40	1.52	619.97	704.04	662.01	33.73	25.01	29.37
A19xRF2	1.94	1.50	1.72	722.85	678.59	700.72	41.29	24.46	32.87
A19xRF3	1.91	0.81	1.36	470.84	537.00	503.92	27.52	13.85	20.68
A19xRF5	1.76	1.86	1.81	593.88	758.19	676.04	37.26	30.80	34.03
A21xRF1	1.67	1.39	1.53	410.79	526.72	468.75	23.79	21.23	22.51
A21xRF2	2.06	1.76	1.91	634.07	578.07	606.07	44.26	25.02	34.64
A21xRF3	2.20	1.58	1.89	662.81	461.12	561.97	43.96	17.52	30.74
A21xRF5	2.29	1.64	1.96	676.18	731.57	703.87	50.03	30.20	40.11

Hybrid mean	2.04	1.51	1.77	661.95	706.80	684.38	42.19	27.55	34.87
B7	1.00	1.72	1.36	278.16	607.12	442.64	6.09	27.54	16.81
B15	2.07	1.42	1.75	908.88	1051.17	980.03	65.10	35.37	50.24
B19	2.16	1.40	1.78	519.00	1175.05	847.03	35.43	39.98	37.71
B21	1.04	1.38	1.21	606.10	744.40	675.25	25.59	26.17	25.88
Female mean	1.57	1.48	1.52	578.04	894.44	736.24	33.05	32.26	32.66
RF1	1.01	0.61	0.81	350.61	394.29	372.45	11.12	8.14	9.63
RF2	0.79	0.47	0.63	239.26	373.55	306.41	7.21	5.66	6.44
RF3	0.71	0.70	0.71	244.54	254.33	249.44	5.67	4.41	5.04
RF5	1.31	1.22	1.26	900.12	598.80	749.46	41.13	19.01	30.07
Male mean	0.95	0.75	0.85	433.63	405.24	419.44	16.28	9.30	12.79
Sakha 53	1.72	1.78	1.75	541.28	766.58	653.93	32.23	38.04	35.14
Giza 102	1.65	1.41	1.53	878.64	650.10	764.37	51.00	31.43	41.21
Grand mean	1.74	1.38	1.56	611.43	687.26	649.35	36.11	25.72	30.91
$RLSD_1$ 0.05	0.30	0.21	0.18	96.41	145.60	84.58	4.22	4.47	3.06
$RLSD_1$ 0.01	0.40	0.28	0.23	126.94	191.54	114.82	5.57	5.89	4.01
$RLSD_2$ 0.05	0.22	0.15	0.13	69.47	104.92	60.95	3.05	3.22	2.21
$RLSD_2$ 0.01	0.29	0.20	0.17	91.47	138.20	79.68	4.01	4.25	2.89

Table 4. Cont.

Genotypes	OY/ H ;g		
	Loamy sand	Clay	Comb.
A7xRF1	19.86	16.51	18.18
A7xRF2	15.03	10.33	12.68
A7xRF3	17.63	8.75	13.19
A7xRF5	22.91	9.10	16.00
A15xRF1	18.43	11.06	14.74
A15xRF2	15.79	11.09	13.44
A15xRF3	20.56	9.66	15.11
A15xRF5	18.74	11.52	15.31
A19xRF1	13.85	7.98	10.91
A19xRF2	16.07	7.78	11.93
A19xRF3	11.68	5.42	8.55
A19xRF5	15.73	9.87	12.80
A21xRF1	9.67	7.82	8.75
A21xRF2	19.70	7.80	13.75
A21xRF3	16.92	5.69	11.31
A21xRF5	21.21	10.80	16.01

Hybrid Mean	17.11	9.45	13.29
B7	1.64	9.94	5.79
B15	27.17	12.23	19.70
B19	14.68	12.89	13.78
B21	10.51	7.91	9.21
Female Mean	13.50	10.74	12.12
RF1	4.87	3.17	4.02
RF2	3.38	2.22	2.80
RF3	2.18	1.52	1.85
RF5	17.88	6.09	11.99
Male Mean	7.08	3.25	5.16
Sakha 53	11.31	12.80	12.05
Giza 102	18.99	11.87	15.43
Grand Mean	14.62	8.80	11.72
$RLSD_1$ 0.05	1.52	1.60	1.10
$RLSD_1$ 0.01	2.00	2.11	1.44
$RLSD_2$ 0.05	1.10	1.16	0.79
$RLSD_2$0.01	1.45	1.52	1.04

RLSD1, to compare any two genotypes, RLSD2; to compare any genotype with the overall mean

1-4. Stalk diameter

Mean stalk diameter of the F_1-hybrids was larger than that of female and male parents, indicating heterosis (Table 4). For the F_1-hybrids, it was 1.56, 2.13 and 1.85 cm under loamy sand, clay soil and combined data; respectively. Stalk diameter of all genotypes was thicker under clay than under loamy sand soil. The clay soil showed larger vegetative growth (plant height and stalk diameter) than loamy sand soil. The check cultivar Giza 102 was significantly thicker than any other genotype except A21xRF5 in clay soil. Stalk diameter varied under loamy sand soil from 1.2 cm for RF1 to 1.94 cm for B15, and from 1.72 cm for RF2 to 2.69 cm for A21xRF5 under clay soil. Such variation among different genotypes showed high phenotypic and genotypic coefficient of variation (Table 3) which exceeded 10% under both locations. The increase in stalk diameter of different genotypes from loamy sand to clay soil was not consistent, indicating differential responses of genotypes to variation in environment. Therefore, the GxE for stalk diameter was significant ($P \leq 0.01$) (Table 3). Heritability in broad sense (Table 3) was high, i.e., 74.19, 77.05 and 66.67% under loamy sand soil, clay soil, and combined data; respectively.

1-5. 100 seed weight

The overall mean of 100 seed weight of the F_1-hybrids (Table 4) was heavier than that of both female and male parents indicating hybrid vigor. It was larger under loamy sand soil than under clay soil for all genotypes except for line B7. Under loamy sand soil, 100 seed weight of the F_1-hybrids ranged from 5.44 to 7.82 with an average of 6.40 g compared to 5.96 g for Sakha 53 and 5.81 g for Giza 102. Under clay soil, 100 seed weight of the F_1-hybrids ranged from 2.57 to 4.43 g with an average of 3.87 g compared to 5.06 g for Sakha 53 and 4.97 g for Giza 102. 100 seed weight varied from 2.41 to 7.82 g under loamy sand soil, and from 1.56 to 4.59g under clay soil. Such wide variability was reflected in high phenotypic and genotypic coefficients of variability (Table 3). The combined means of the F_1-hybrids showed that none of the F_1-hybrids was significantly heavier in 100 seed weight than the checks. The genotypic coefficient of variation was 27.58, 22.28 and 18.79% under loamy sand, clay soil and combined data; respectively. The close estimates of phenotypic and genotypic coefficients of variability under both environments resulted in very high broad sense heritability of 95.87 and 95.74% under loamy sand and clay soils; respectively (Table 3). The differential responses of the different genotypes to soil type were reflected in significant ($P \leq 0.01$) GxE. Javed and Aslam (1995) and Marinkovic *et al*. (2000) found significant mean squares for genotypes for 100-seed weight.

1-6. Husk percentage and husk in 100 seeds; g.

The overall mean of the husk % (Table 4) of the F_1-hybrids was 27.31, 26.97 and 27.14% at loamy sand soil, clay soil and combined data; respectively. Husk % of the hybrids were significantly (P≤0.01) lower than the better check variety Sakha 53 (Table 4), and significantly (P≤0.01) higher at loamy sand soil than at clay soil (Table 3), indicating to the effect of soil type on husk %. However, some hybrids and/or genotypes were higher in husk % at clay soil than at loamy sand soil, confirming the significant (P≤0.01) of GxE obtained (Table 3). The combined means of husk % varied from 24.51% for A15xRF2 to 34.71% for B21. Such variability was reflected in medium to high PCV and GCV. The GCV of husk % was 9.00, 10.63 and 5.6% at loamy sand soil, clay soil and combined data (Table 3). Phenotypic and genotypic coefficients of variation were very close to each other under both environments, and resulted in broad sense heritability of 93.45, 96.84 and 47.21% at loamy sand soil, clay soil and combined data; respectively (Table 3).

The overall means of husk in gram of 100 seed weight were in the same trend of husk %. The combined means of the F_1-hybrids were significantly (P≤0.01) lower than the better check variety Giza 102 in husk weight, except the hybrid A7xRF3. Phenotypic and genotypic coefficients of variability were high in husk in gram of 100 seed weight. The GCV was 26.83, 21.04 and 15.6% at loamy sand soil, clay soil and combined data; respectively (Table 3). The close estimates of PCV and GCV in the separate analysis of variance resulted in high unreliable estimates of heritability in broad sense of 94.79% at loamy sand soil, and 95.45% at clay soil. This could be interpreted by the inflation of the genetic variance by the confounding effects of GxE interactions. However, heritability estimated from the combined analysis was medium (50.0%), because of the GxE interaction mean square was subtracted from the genotypes mean square and showed reliable estimate of genetic variance.

1-7. Oil percentage

Oil % of all genotypes (Table 4) was higher at loamy sand soil than at clay soil except Giza 102, indicating to the effect of environment on oil % and confirming the significant (P≤0.01) environment mean squares (Table 3). Mean oil % of the F_1-hybrids was 40.96, 34.06 and 37.51% at the loamy sand soil, clay soil and the combined data; respectively, compared to 36.67, 38.0 and 37.33% for the better check cultivar Giza 102. The decrease in oil % from loamy sand to clay soil was not consistent from genotype to another, confirming the significant (P≤0.01) mean squares of GxE interaction (Table 3).

The combined means of the F_1-hybrids showed that six hybrids significantly (P≤0.05 to ≤0.01) exceeded the better check Giza 102 in oil %, i.e., A7xRF1 (39.67%), A15xRF3 (38.83%), A15xRF5 (39.67%), A19xRF3 (41.00%), A21 RF5 and A21xRF1 (39.00%). And seven hybrids showed insignificant differences with Giza 102.

The genotypic coefficient of variability of oil % was high (10.11%) at loamy sand soil, medium (6.79%) at clay soil, and very low (1.52%) from the combined data. This could be due to the large magnitude significant (P≤0.01) mean square of GxE (36.58) compared to genotypes squares (31.55). In consequence, heritability in broad sense of oil % was high at both locations (97.86 and 86.25%) and very low (5.69%) from the combined data. These results declear the importance of evaluation of the hybrids, and in general, breeding materials under a variety of environments to get reliable estimates of genetic variance and heritability. **Cvejic *et al*. (2015)** indicated that environmental factors had highest influence on the formation of seed and oil yields.

1-8. Oil in 100 seeds in gram

Mean oil in gram in 100 seeds (Table 4) of the F_1-hybrids was 2.61, 1.32 and 1.96 compared 2.13, 1.90 and 2.01 for Giza 102 at loamy sand soil, clay soil and combined data; respectively. It is obvious that oil in gram of 100 seeds was higher at loamy sand soil than at clay soil for all genotypes except B7, confirming the significant (P≤0.01) mean squares of environment (Table 3). All the F_1-hybrids exceeded the two check cultivars in oil in gram of 100 seeds under loamy sand soil, however, none of the F_1-hybrids exceed the checks under clay soil, reflecting the GxE interaction, and the check cultivars were more stable than the hybrids in this trait. The combined means of the F_1-hybrids indicated that one hybrid (A21xRF5) exceeded significantly (P≤0.01) the best check Giza 102 in oil in gram of 100 seeds and 10 hybrids showed insignificant differences with Giza 102. The combined means of the genotypes varied from 0.80 to 2.29 gram oil in 100 seeds, indicating wide variability. The genotypic coefficient of variability was high; 28.84, 22.56 and 16.13% at loamy sand soil, clay soil and combined analysis; respectively. The close estimates of phenotypic and genotypic coefficients of variability at the two locations, resulted in high broad sense heritability of 96.07% at loamy sand soil, and 93.67% at clay soil. However, it was intermediate (44.44%) as calculated from the combined analysis. This could be due to the omission of GxE mean square from the genotypes mean squares, to give reliable estimate of genetic variance. Therefore, the genetic materials should be evaluated under a series of diverse environments.

1-9. Kernels in 100 seeds; g.

Mean kernels in 100 seeds; g (Table 4) of the F_1-hybrids was 2.04, 1.51 and 1.77 g compared to 1.72, 1.78 and 1.75 for the better check Sakha 53 at loamy sand soil, clay soil and combined means; respectively. All the F_1-hybrids exceeded Sakha 53 in kernel weight at loamy sand soil except A19 x RF1 and A21 RF1, while only two crosses exceeded it at clay soil, showing the pronounced effect of environment, confirming significant (P≤0.01) environment mean squares (Table 3). The decrease of kernels weight from loamy sand to clay soil was not consistent from genotype to another, confirming the significant

($P \leq 0.01$) GxE mean squares (Table 3). The combined means of the F_1-hybrids showed that five hybrids significant ($P \leq 0.05$ to $P \leq 0.01$) exceeded Sakha 53 in kernel weight, i.e., A7xRF2, A15xRF2, A21RF2, A21RF3 and A21xRF5.

The combined means of the genotypes varied from 0.63 g for restorer line RF2 to 2.46 g of kernels weight for A15xRF2 hybrid. Such wide variability was expressed in high phenotypic and genotypic coefficients of variation. The genotypic coefficient of variation of kernels weight was 30.67% at loamy sand soil, 26.72% at clay soil, and 23.68% from the combined analysis. Broad sense heritability estimates were high, and accounted for 95.51, 96.54 and 77.78% at loamy sand soil, clay soil and from combined analysis; respectively.

1-10. Number of seeds/head (NS/H)

Mean NS/H (Table 4) was higher at clay soil than at loamy sand soil for all genotypes except five hybrids, RF5 and the check cultivar Giza 102. These results confirm the significant ($P \leq 0.01$) mean squares of environments and GxE interaction (Table 3). The overall mean of F_1-hybrids was 661.95, 706.80 and 684.38 compared to 878.64, 650.10 and 764.37 for the better check Giza 102 at loamy sand soil, clay soil and combined data; respectively. Two F_1-hybrids; A7xRF1 and A7xRF5 exceeded significantly the better check Giza 102 in NS/H, and eight hybrids showed insignificant differences with Giza 102. The PCV and GCV of NS/H were high. The GCV was 31.3, 30.31 and 24.01% at loamy sand soil, clay soil and from the combined analysis. Broad sense heritability estimate was high, and reached 96.05, 94.1 and 73.21% at loamy sand soil, clay soil and from the combined data; respectively.

1-11. Seed yield/head; g.

Mean seed yield/head (Table 4) of the F_1-hybrids was 42.19, 27.55 and 34.27 g compared to 51.0, 31.43 and 41.21 g for the better check Giza 102 at loamy sand, clay soil and the combined data, respectively. It is clear that loamy sand soil was better in seed yield/head than the clay soil, and there was a wide difference in yield between the types of soil, confirming the significant ($P \leq 0.01$) mean squares of environment (Table 3). The decrease in seed yield/head of different genotypes from loamy sand to clay soil was not consistent, confirming the significant ($P \leq 0.01$) mean squares of GxE interaction. The combined means of the two locations of the F_1-hybrids indicated that one hybrid (A7xRF1) significantly ($P \leq 0.01$) out yielded (46.45 g) the better check Giza 102 (41.21 g), and three F_1-hybrids; A7xRF5 (40.15 g), A15xRF2 (40.64 g), and A21xRF5 (40.11 g) showed insignificant differences in seed yield/head with Giza 102.

There was a wide range in seed yield/head at the two locations. At loamy sand soil seed yield/head ranged from 5.67 g (RF3) to 53.08 g (A7xRF5), and from 4.41 g (RF3) to 46.92 g (A7xRF1) at clay soil. Such wide range in performance of different genotypes reflected in high estimates of phenotypic and genotypic coefficients of variation. The GCV was 43.48, 39.33 and 33.57% at loamy sand soil, clay soil and from the combined analysis; respectively (Table 3). Javed and Aslam (1995), Jan *et al*. (2005) and Marinkovic *et al*. (2000) reported significant mean squares for yield. Tahir and Mehdi (2001) and Tahir *et al*. (2002) reported that SY/P was reduced by stress. Rauf and Sadaqat (2007) and Salem *et al*. (2013) indicated that sunflower genotypes differed in their tolerance to drought. The interaction of genotypes x environment was significant for SY/P (Kumar e*t al*. 2014 and Khan *et al*. 2017). The close estimates of PCV and GCV at loamy sand and clay soils resulted in unreliable estimates of broad sense heritability of 98.85 and 96.67%; respectively. This could be due to that evaluation of genotypes at one site inflated the genetic variance by the confound effects of years and location. However, broad sense heritability estimated from the combined analysis of the two locations decreased to 75.22% (Table 3) because mean squares of GxE interaction was subtracted from the genotypes mean squares. For this reason broad sense heritability estimated from the combined analysis was less than estimated from separate analysis of all the studied traits.

1-12. Oil yield/head; g

Mean oil yield/head in gram (Table 4) for the F_1-hybrids was 17.11, 9.45 and 13.29 g of compared to 11.31, 12.80 and 12.05 g for Sakha 53, and 18.99, 11.87 and 15.43 g for Giza 102 at loamy sand soil, clay soil and combined data; respectively. The combined means of oil yield/head varied greatly from 1.85 g for RF3 to 19.70 g for B15, indicating wide genetic variability. The best F_1-hybrid A7xRF1 (18.18 g) surpassed significantly ($P \leq 0.01$) the better check; Giza 102 (15.43 g). Based on the combined means, the best three hybrids in oil yield/head were A7xRF1 (18.18 g), A7xRF5 (16.00 g) and A21xRF5 (16.01 g), compared to 12.05 g for Sakha 53 and 15.43 g for Giza 102. Oil yield/head of all genotypes except Sakha 53 and B7 were higher under loamy sand soil than under clay soil, confirming the significance ($P \leq 0.01$) of environment mean square (Table 3). The decrease in oil yield/head from loamy sand to clay soil was not consistent from genotype to another, confirming the significance mean square obtained ($P \leq 0.01$) for GxE interaction.

The GCV in oil yield/head was 44.54, 39.34 and 32.33% at loamy sand soil, clay soil and from combined analysis; respectively (Table 3). The close estimates of PCV and GCV in separate analysis, resulted in high unreliable estimates of broad sense heritability of 99.12 and 96.27% at loamy sand and clay soils; respectively. However, it was 67.83% from the combined analysis due to the causes mentioned before. Javed and Aslam (1995), Jan *et al*. (2005), Marinkovic *et al*. (2000) and Porto *et al*. (2008) found significant differences among genotypes for oil yield. Cvejić *et al*. (2015)

concluded that environmental factors had high influence on the formation of oil yield.

REFERENCES

Ali, S.S., Z. Manzoor, T. H. Awan and S. S. Mehdi. 2006. Evaluation of performance and stability of sunflower genotypes against salinity stress. J. Anim. Pl. Sci. 16(1-2):47-51.

A.O.A.C. 1980. Association of Official Analytical Chemists. Official methods of analysis, 13th ed. Washington DC. USA.

Burton, G.W. 1952. Quantitative inheritance in grasses. 6th Int. Grassland Cong. Proc. 1: 227-283.

Cvejić, S.,S. Jocić, I. Radeka, M. Jocković,V. Miklič, V. Mladenov, V. Lončarević. 2015. Evaluation of stability in new early-maturing sunflower hybrids. ocena stabilnosti novih ranostasnih hibrida suncokreta. J. Processing and Energy in Agriculture 5 (19): 255-258.

Dudhe M.Y, A.B. Rajguru, K.D. Bhoite and P. Madhuri. 2017. Genetic evaluation and identification of stable sunflower genotypes under semi-arid dryland conditions of telangana and maharashtra state. Sabrao Journal of Breeding and Genetics 49 (1) 83-93.

Esmail, S.E. 2000. Performance of some sunflower cultivars as affected by water irrigation regimes. J. Agric. Sci. Mansoura Univ. 25(2), 675 – 697.

Gomez, K.A. and A.A. Gomez. 1984. Statistical Procedures for Agricultural Research. John Wiley & Sons.

Iqbal, N., M.Y. Ashraf and M. Ashraf. 2005. Influence of water stress and exogenous glycinebetaine on sunflower achene weight and oil percentage. Int. J. Environ. Sci.Techn. 2(2): 155 – 160.

Jan, M., Farhatullah, Raziudin and G. Hassan. 2005. Combining ability analysis in sunflower. Pak. J. Biol. Sci. 8(5): 710-713.

Javed, N. and M. Aslam. 1995. Combining ability effects in sunflower F1 hybrids. Helia 18(23): 41-46.

Khan M., S. Rauf, H. Munir, M. Kausar, M.M. Hussain and E. Ashraf.2017. Evaluation of sunflower (*Helianthus annuus* L.) single cross hybrids under heat stress condition. Archives of Agronomy and Soil Science, 63(4): 525–535

Kumar P, S. Dhillon and A. Sao. 2014. Genetic analysis of sunflower genotypes under water stress Environments. Inter. J. Farm Sci. 4(4) : 26-35.

Marinkovic, R., D. Skoric, B. Dozet, and D. Jovanovic. 2000. Effect of PET1 and ANN5 cytoplasms on some quantitative traits in sunflower lines and hybrids. Helia 23(32):73-86.

Pekcan V., G. Evci, M. I.Yilmaz, A. S. B. Nalcaiyi, Ş. C. Erdal, N. Cicek, O. Arslan, Y. Ekmekci, Y. Kaya.2016. Effect of drought stress on sunflower stems and roots. Int'l Journal of Advances in Agricultural & Environmental Eng. (IJAAEE) 3(1):96-102.

Peniego, N., M. Echaide, M. Munoz, L.Fernandez, S. Torales, P. Faccio, I. Fuxan, M.

Carrera, R. Zandomeni, E.Y. Suarez, and H.E.Hopp. 2002. Microsatellite isolation and characterization in sunflower (*Helianthus annuus* L.). Genome 4: 34-43.

Porto W. S., C. G. P. Carvalho, R.J. B. Pinto, M. F. Oliveira. A. C. B. Oliveira.2008. Evaluation of sunflower cultivars for central brazil. Sci. Agric. (Piracicaba, Braz.), 65 (2):139-144,

Rauf, S. and H.A. Sadaqat. 2007. Sunflower (*Helinathus annuus* L.) germplasm evaluation for drought tolerance. Comm. Biom. Crop Sci.2: 8–16.

Reddy G., K. Dangi, S. Kumar and A.Reddy. 2003. Effect of moisture stress on seed yield and quality in sunflower (*Helianthus annuus* L). Indian J.Agron. 43: 149-153.

Salem A. H., A. E. A. Omar and M. M. A. Ali.2013. Various responses of sunflower genotypes to water stress on newly reclaimed loamy sand soil. Acta Agronomica Hungarica, 61(1): 55–69.

Tahir, M.H.N. and S.S. Mehdi. 2001. Evaluation of open pollinated sunflower (*Helianthus annuus* L.) populations under water stress and normal conditions. Int. J. Agric. Biol. 3: 236–238.

Tahir M.H.N, M. Imran and M. K. Hussain.2002. Evaluation of Sunflower (*Helianthus annuus* L.) Inbred Lines for Drought Tolerance. Int. J. Agri. Biol., 4(3):398-400.

Walker, T.T. (1960). The use of a selection index technique in the analysis of progeny row data. Emp. Cott. Growing Rev. 37:81-107.

تقييم تراكيب وراثية لدوار الشمس تحت ظروف الارض الرمليه السلتيه والطينيه

عزت السيد مهدى[1] ، السيد عبد السلام حسب الله[1] ، عابدين الشيمى[2] ،هبه عبد الرزاق عبد المجيد محمد حسن[2]

1- جامعه أسيوط – كليه الزراعه قسم المحاصيل،

2- مركز البحوث الزراعيه – قسم بحوثالمحاصيل الزيتيه

أجرى تقييم 26 تركيب وراثى من دوار الشمس (16 هجين + 4 امهات + 4 آباء + 2 كنترول) تحت ظروف الأرض الرمليه السلتيه فى محطه بحوث عرب العوامر – مركز البحوث الزراعيه ، والأرض الطينيه بمزرعه كليه الزراعه جامعه أسيوط فى عام 2016م . وكانت الفروق بين التراكيب الوراثيه عاليه المعنويه لثلاثه عشر صفه فى التحاليل المفرده والتحليل المشترك. كانت الفروق معنويه بين البيئتين لكل الصفات عدا قطر القرص وكان التفاعل بين التركيب الوراثى والبيئه معنويا لكل الصفات اشاره الى اختلاف استجابه التراكيب الوراثيه من بيئه لأخرى. كانت الهجن والأمهات والأباء أكثر تبكيراً فى الأرض الرمليه السلتيه، وكان معامل الأختلاف منخفضاً لهذه الصفه ودرجه

التوريث متوسطه (43,17%). ومن التحليل المشترك لطول النبات كان معامل الأختلاف المظهرى 13,58% والوراثى 11,81% ومعامل التوريث 75,58%. وكان معامل الأختلاف الوراثى 15,95% والوراثى 14,41% ومعامل التوريث 91,84% لقطر القرص. وبالنسبه لسمك الساق كان أكبر فى الأرض الطينيه عن الرمليه السلتيه وكان معامل التوريث له 74,19، 77,5، 66,67% فى الأرض الرمليه السلتيه، الطينيه والتحليل المشترك على الترتيب. ولم يظهر أى هجين تفوق على أصناف الكنترول فى 100 بذره. كان معامل الأختلاف الوراثى ومعامل التوريث عاليان فى وزن 100 بذره. وكان نسبه القشر ووزن القشر فى 100 بذره تميلان للأرتفاع فى الأرض الرمليه السلتيه عن الأرض الطينيه. أظهر التحليل المشترك أن خمسه هجن أعلى فى نسبه الزيت عن أفضل كنترول الصنف جيزه (102). وكانت نسبه الزيت أعلى فى الأرض الرمليه السلتيه عن الأرض الطينيه، وكان معامل التوريث لهذه الصفه عالياً فى المنطقتين (97,86 ، 86,25%) ومنخفض جداً فى التحليل المشترك (5,69%) بسبب التفاعل بين التركيب الوراثى والبيئه. كان وزن اللب فى 100 بذره أعلى فى الأرض الرمليه السلتيه عن الأرض الطينيه. وكان الأختلاف الوراثى ومعامل التوريث عالياً لوزن اللب. وبالنسبه لعدد البذور فى الرأس كان أعلى فى الأرض الطينيه عن الرمليه السلتيه، وزاد هجين عن أفضل كنترول فى عدد البذور للرأس، كذلك كان معامل الأختلاف الوراثى ومعامل التوريث عالياً لعدد البذور فى الرأس. وبالنسبه لمحصول البذور للرأس ومحصول الزيت للرأس كانا عالياً فى الأرض الرمليه السلتيه عن الطينيه، وزادت أربعه هجن عن أفضل كنترول فى هاتين الصفتين، كذلك كان معامل الأختلاف والتوريث لهاتين الصفتين عالياً حيث كان معامل الاختلاف الوراثى لصفة محصول الحبوب للرأس 43,48، 39,33، 33,57% ومعامل التوريث كان 98,85، 96,67، 75,22% فى الأرض الرمليه السلتيه، الطينيه والتحليل المشترك على الترتيب. وتوضح هذه النتائج ضروره تقييم مواد التربيه تحت ظروف عده بيئات متباينه لحسن تقدير الثوابت الوراثيه.