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Influence of different plant densities on crop yield of six safflower genotypes under Egyptian newly reclaimed soils conditions

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ABSTRACT: Safflower (Carthamus tinctorius L.) is the crop of small holder farmers and its cultivation is available only in newly reclaimed soil. Density of cultivation in these lands should be tested in a random sample of genotypes. Thus, six safflower genotypes were evaluated in the Desert Experiment Station of the Faculty of Agriculture, Cairo University in Wadi El-Natroon, El-Beheira Governorate, Egypt in 2011/2012 and 2012/2013 seasons. Six safflower genotypes were tested under three plant densities (80000, 160000 and 240000 plant ha^{-1}) in a split-plot design. The main plots were devoted to the plant densities and sub-plots to the six genotypes were to facilate the genetic dissection of salt-stress adaptive traits. Plant density of 240000 plants ha^{-1} recorded the highest values of plant height, seed and oil yield kg ha^{-1}. Meanwhile, the highest values of number of branches and capitula, petal yield, seed yield plant-^{1} were recorded at 80000 plant ha^{-1}. Line-1697 and Demo-137 surpassed the other genotypes in seed and oil yield kg ha^{-1}. Plant densities vs. genotypes interaction was significant for number of capitula, petal and seed yields $plant^{-1}$, seed index, seed oil %, seed and oil yield kg ha^{-1}. The highest seed yield (2890 kg) was realized form Line-1697 with 240000 plant ha^{-1}. Meanwhile, the highest oil yield (927.2 kg) was achieved with 240000 plant ha^{-1} by Demo-137. Phenotypic and genotypic variances among lines were highly significant.

Key words: Carthamus tinctorius, Safflower, Genotypes, Plant density, Phenotypic variance, Genotypic variance, Broad sense heritability.

INTRODUCTION

Safflower is more drought resistance than other oilseeds and can produce good yield in dry region, while its salt tolerance is a valuable asset as the area affected by some degree of salinity steadily increases world-wide (Weiss, 2000). Safflower became a major oilseed in many countries in the world like USA especially after 2nd world war when breeders produced high yielding, high oleic oil cultivars with greater resistance to biotic and abiotic stresses. But it suffered severally from competition main winter crops in Egypt, *i.e.*, berssem and wheat. Still the local edible oil production, in Egypt, is not sufficient. Safflower may play an important role in increasing edible oil production in new reclaimed soils in Egypt (Abu-Hagaza et al., 2009). The main obstacles for planting safflower are the limited genotypic materials and their narrow genetic background with respect to adaptation to these conditions in Egypt. Weiss (2000) mentioned that determination of the optimum plant population for a particular area under specific cropping condition is essential to optimize yield.

Plant densities are needed to be accurately established. The present stand (number of plants) of safflower may be insufficient to produce high yield via land races and the exotics, since a considerable number of plants may be lost during the growing season. Therefore, higher plant densities could be more suitable to compensate for this loss and insure higher yield.

Many researchers reported that plant densities had significant effect on safflower yield and its components. Yau (2009) found that plant height decreased by increasing plant density. Sharifmghaddasi and Omidi (2009) and Amoughin et al (2012a) found that increasing plant density increased plant height. By contrast, number of branches m^{-2} decreased. Number of capitula $plant^{-1}$ or m^{-2} decreased by increasing the plant density (Elfadl et al., 2009, Sharifmghaddasi and Omidi 2009, Emami et al., 2011, Amoughin et al., 2012 a and Vaghar et al., 2014,). Besides, Shahri et al (2013) reported that increasing plant density increased number of capitula per unit area but decreased 1000-seed weight. Conversely, Sharifmghaddasi and Omidi (2009) and Emami et al (2011) mentioned that 1000-seed weight was increased by increasing plant density.

Ghanem and Ash-Shormillesy (2007), in Egypt, reported that seed yield plant^{-1} decreased by increasing plant densities.

Yau (2009), Amoughin et al (2012 b) and Shahri et al (2013) reported that increasing plant density decreased seed oil %. But, Emami et al (2011) found that increasing plant density increased seed oil %. In the context, Yau (2009), Elfadl et al (2009), Sharifmghaddasi and Omidi (2009), Emami et al (2011), Amoughin et al (2012 b) and Vaghar et al (2014) found that increasing plant density increased seed and oil yield ha^{-1}. On the other hand, Sharifi et al (2012) mentioned that increasing plant density decreased seed and oil yield ha^{-1}.

Yield and yield components of safflower were significantly affected by the genotypes (Abu-Hagaza 1990, Eslam 2004, Camas et al., 2007, Mokhtassi-Bidgoli et al., 2007, Abu-Hagaza et al., 2009, Elfadl et al., 2009, Sharifi et al., 2012 and Vaghar et al., 2014). In contrast, Samanci and Ozkaynak (2003) found no significant differences among safflower genotypes in seed yield. Meanwhile, they recorded significant differences among genotypes in oil content. Sharifi et al (2012) reported that the interaction between genotypes and plant densities was significant. Camas and Esendal (2006) found that the heritability for plant height, number of branches, seed yield, 1000-seed weight and oil content were estimates as 93%, 45%, 35%, 81% and 59%, respectively.

The objectives of the present research were to examine the performance of a random sample of exotic and landraces of safflower genotypes under three plant densities to determine the optimum plant density for each genotype and to estimate some genetic parameters of these genotypes under the stress condition of the newly reclaimed soil of Wadi El-Natroon and the different densities used herein.

MATERIALS AND METHODS

Two field experiments were carried out at the Agricultural Experiments Desert Station, Faculty of Agriculture, Cairo University in Wadi El-Natroon, El-Beheira Governorate (Figure, 1), during the two winter seasons of 2011/2012 and 2012/2013 under drip irrigation system. The soil of the experimental site was considered sandy (93% sand), saline (7.5 Ec; ds/m) with a pH of 7.8 and poor in NPK nutrients, as well as, organic matter (0.30%). Also, the irrigation water is saline (4.2 Ec; ds/m) with a pH of 7.66 according to the analysis of soil and water. This reflects the nature of newly reclaimed sandy soils in Egypt.

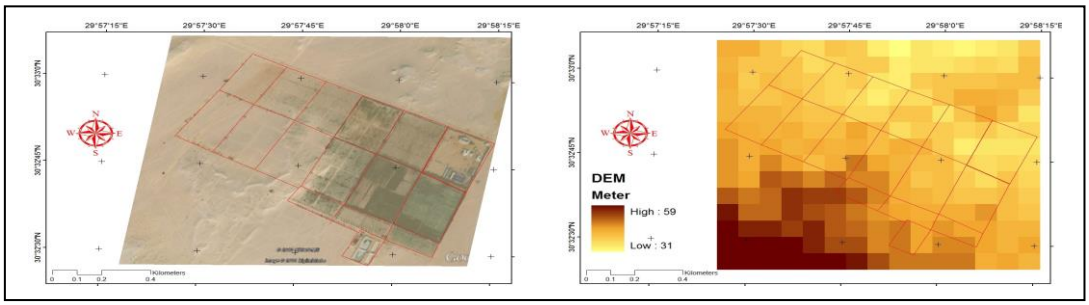

Figure1. The experimental site located between 30º32'30" and 30º 33'0" N and between 29º 57'15" and 29º58'15" E with an altitude of 31 and 59 meters above sea level

A split-plot design, in randomized complete blocks arrangements, with three replications was used. The main plots were devoted to three plant densities, *viz.,* 80, 160 and 240 thousand plants ha^{-1}. The sub-plots were allotted to a random sample of six safflower genotypes that represents land races and exotics beside the local safflower cultivar. Three of these genotypes, were local entries including Giza-1, the sole cultivar grown in Egypt, and 2 land races collected from 2 governorates as farmer's seed lots, *i.e.* Bani-Suef (Somosta center) and Aswan (Daraw center) representing middle and upper Egypt, respectively. The remaining 3 exotics *viz.* Demo-137 cv. from USA, Line-1697 from Cyprus and Line-168 from Turkey. All seeds were kindly devoted by Oil Seed Crops Research Program, Field Crops Research Institute, Agricultural Research Center (ARC), Ministry of Agriculture, Egypt.

Each sub-plot consisted of 5 rows of 4 m length and 0.60 m width. The experimental plot area was 12 m^2. Seeds were sown in hills 20, 10 and 7 cm apart on 15 October in both seasons, thereafter were thinned to one plant hill^{-1} to give the three plant densities (80000, 160000 and 240000 plant ha^{-1}).

Single super-phosphate fertilizer (15.5% P_2O_5) at the rate of 72 kg P_2O_5 ha^{-1} was applied uniformly before planting. Nitrogen was added at level of 144 kg N ha^{-1}, in the form of ammonium nitrate (33.5% N). The first dose was added at 21 days from planting, and then the rest doses were applied at a 7-day interval. Potassium sulphate (50% K_2O) at the rate of 60 kg K_2O ha^{-1} was added through five equal doses at a 7-day interval. Mixture of micronutrients was also sprayed, four times, as a foliar application after thinning at 21-day intervals. Other cultural practices were carried out in the proper time according to the package-deal of ARC.

At harvest, ten guarded plants were randomly sampled from the two inner rows of each sub-plot to determine plant height (cm), number of branches plant^{-1}, number of capitula plant^{-1}, petal yield plant^{-1} (g), seed yield plant^{-1} (g), seed index (100-seed weight g). Seed oil percentage was determined according to AOAC (2000). Seed yield (kg ha^{-1}) was weighed from the whole area of each sub-plot and adjusted to yield per hectare. Oil yield (kg ha^{-1}) was calculated by multiplying seed-oil percentage by seed yield ha^{-1}. All obtained data were statistically analyzed and means were compared by LSD test according to procedures outlined by Steel et al. (1997) using MSTAT-C computer program (Freed et al., 1989). Test for homogeneity of variance was used to compare between variances over two years before deciding the validity of combined analysis.

The expected mean squares (EMS) shown in table (1) were used to estimate the genetic (δ^2_g) and genetic by year interaction (δ^2_{gy}) variances as follows according to Hallauer and Miranda (1988): $\delta^2_g = (M_3-M_2)/ry$ and $\delta^2_{gy} = (M_2-M_1)/r$, where r = number of replications and y = number of years. The phenotypic variance (δ^2_{ph}) was estimated as follows: $\delta^2_{ph} = \delta^2_g + (\delta^2_{gy}/r) + (\delta^2_e/ry)$. Heritability in the broad sense (h^2_b) was estimated using the following formula: $h^2_b = (\delta^2_g / \delta^2_{ph}) \times 100$. Genetic coefficient of variability (G.C.V %) was estimated as follows: $G.C.V = \sqrt{\frac{\sigma^2_g}{\bar{x}}} * 100$

Table 1. Expected mean squares (E.M.S) of combined analysis of variance across two years.

S.O.V.	Df		M.S.	E.M.S.
Years (Y)	y-1	= 1		
Years/reps	Y (r-1)	= 4		
Genotypes (G)	g-1	= 5	M_3	$\delta^2_e + r\,\delta^2_{gy} + ry\,\delta^2_g$
G × Y	(g-1) (y-1)	= 5	M_2	$\delta^2_e + r\,\delta^2_{gy}$
Pooled error	Y (r-1) (g-1)	= 52	M_1	δ^2_e

RESULTS AND DISCUSSION

Analysis of variance

Combined analysis of variance (Table 2) showed that highly significant differences were existed among genotypes for all studied traits. Mean squares due to plant densities were also highly significant for all studied characters. Mean squares of years were insignificant for all traits except, number of branches plant^{-1} and seed and oil yield ha^{-1}. They revealed highly significant differences in the two seasons.

Table 2. Mean squares of combined analysis of variance for all studied traits of six safflower genotypes evaluated under three plant densities in 2011-12 and 2012-13 seasons

Source of variation	df	Mean of squares Plant height	No. of branches plant^{-1}	No. of capitula plant^{-1}	Petal yield plant^{-1}	Seed index	Seed yield plant^{-1}	Seed yield ha^{-1}	Seed oil content	Oil yield ha^{-1}
Years (Y)	1	22.69^{ns}	16.96**	111.02^{ns}	0.08^{ns}	0.003^{ns}	81.23^{ns}	389859.23**	0.99^{ns}	32968.32**
R(Y)	4	128.10*	1.57^{ns}	20.15^{ns}	0.43^{ns}	0.14^{ns}	16.83^{ns}	10393.23^{ns}	1.97^{ns}	601.73^{ns}
Plant densities (D)	2	856.04**	151.03**	1055.09**	11.24**	8.75**	1017.46**	721727.02**	48.90**	476813.07**
YD	2	37.40^{ns}	1346^{ns}	25.52^{ns}	0.004^{ns}	0.53*	9.80^{ns}	359353.57**	0.02^{ns}	34552.52**
Error (a)	8	22.48	0.57	53.60	0.11	0.08	21.75	5163.09	1.31	910.39
Genotypes (G)	5	1422.76**	3.14**	227.78**	1.84**	1.98**	46.56**	865111.65**	94.40**	257547.95**
YG	5	108.09*	0.24^{ns}	5.30^{ns}	0.31*	0.18^{ns}	2.62^{ns}	153202.09**	0.35^{ns}	16924.62**
DG	10	61.37^{ns}	0.61^{ns}	58.36**	0.27*	0.54**	35.32**	230444.81**	0.85^{ns}	25355.97**
YDG	10	47.38^{ns}	0.68^{ns}	14.68^{ns}	0.32**	0.31*	9.74^{ns}	120945.14**	0.1^{ns}	12651.52**
Error (b)	60	39.21	0.80	17.53	0.11	0.14	5.96	22551.00	1.72	3609.68
C.V (%)		5.01	9.56	14.75	23.53	5.91	14.64	6.70	4.17	8.51

ns, * and ** indicate non-significance and significance at 5 and 1% probability levels, respectively.

All mean squares due to genotypes × plant densities were highly significant for number of capitula plant^{-1}, seed index, seed yield plant^{-1}, seed and oil yields ha^{-1}. Meanwhile, difference was significant with petal yield plant^{-1}. Significant differences shown among plant densities × years for seed index, seed and oil yields ha^{-1} only.

Genotypes × years mean squares were insignificant for all traits except plant height, petal yield plant^{-1}, seed and oil yields ha^{-1}. Finally, mean squares for the second order interaction (genotypes × plant densities × years) were highly significant for petal yield plant^{-1}, seed and oil yields ha^{-1} and significant for seed index. Confirming previous results (Elfadl et al., 2009, Sharifmghaddasi and Omidi 2009, Emami et al., 2011, Amoughin et al., 2012 (a,b) and Shahri et al., 2013).

Effect of plant densities

Data in Table (3) revealed that plant height, number of branches plant^{-1}, number of capitula plant^{-1}, petal yield plant^{-1}, seed index, seed yield plant^{-1}, seed oil %, seed and oil yields ha^{-1} were significantly affected by plant densities. Table (3) showed that plant density increased plant height up to 240000 plant ha^{-1} due to reducing the light absorption inside the plant canopy and creating competition among plants. Similar trends were obtained by Sharifmghaddasi and Omidi (2009), Yau (2009) and Amoughin et al (2012a). Also, Table (3) showed that number of branches plant^{-1} was decreased by increasing plant density up to 240000 plant ha^{-1}. Decreasing of plant density may be the main cause to increase light intensity around plants and encouraged branching. This result is in harmony with that of Sharifmghaddasi and Omidi (2009) and of Amoughin et al (2012a). Increasing number of capitula plant^{-1} due to decreasing plant density was observed in Table (3), number of branches plant^{-1} may be the main cause of this increase. Confirming previous results (Elfadl et al., 2009, Sharifmghaddasi and Omidi 2009, Emami et al., 2011, Amoughin et al., 2012 (a) and Vaghar et al., 2014,). In contrast, Shahri et al. (2013) reported that increasing plant density increased number of capitula. Results in the same table revealed that seed yield plant^{-1} was increased by decreasing density levels up to 80000 plant ha^{-1}. Ghanem and Ash-Shormillesy (2007) reported similar result. Such increase may be attributed to the increase in number of branches and capitula plant^{-1}. Combined data in Table (3), showed that decreasing density levels markedly increased seed index. Similar results were obtained by Shahri et al (2013). This increase may be explained by higher dry matter accumulation partitioned to seeds. Lower plant density increased also seed oil %. Same trend was observed by Yau (2009), Amoughin et al (2012b) and Shahri et al (2013). However, Emami et al (2011) found that increasing plant densities increased seed oil %.

Table 3. Effect of plant density and genotypes on safflower yields and its components (combined data of 2011-12 and 2012-13 seasons)

Trait / Factor	Plant height (cm)	No. of branches plant^{-1}	No. of capitula plant^{-1}	Petal yield plant^{-1} (g)	Seed index (g)	Seed yield plant^{-1} (g)	Seed yield ha^{-1} (kg)	Seed oil (%)	Oil yield ha^{-1} (kg)
Plant density (D)									
80000	119.6	11.6	34.2	2.0	6.8	22.8	1749	32.6	576.5
160000	123.1	8.9	27.6	1.2	6.3	14.0	2351	31.5	743.0
240000	129.3	7.6	23.4	0.9	5.8	13.2	2624	30.3	797.5
L.S.D $_{0.05}$	2.6	0.4	4.0	0.2	0.5	2.5	39.0	0.6	16.4
Genotype (G)									
Giza-1	126.3	9.3	26.4	1.4	6.3	15.5	1982	29.6	579.5
Bani-Suef	135.8	9.1	26.1	1.2	6.0	15.9	2249	30.6	687.8
Aswan	130.0	8. 9	25.0	0.9	5.9	15.2	1978	28.5	560.3
Demo-137	124.5	9.6	29.4	1.5	6.4	17.8	2386	33.6	798.5
Line -168	114.6	10.0	34.8	1.9	6.8	19.4	2510	34.3	859.7
Line -1697	112.7	9.5	28.7	1.4	6.4	16.3	2345	32.1	748.1
L.S.D $_{0.05}$	4.2	0.6	2. 8	0.2	0.2	1.6	100.1	0.9	40.1

Table (3) showed that plant density increased seed yield ha^{-1}, such increase in seed yield may be attributed to the considerable increase in plant density. Elfadl et al (2009), Sharifmghaddasi and Omidi (2009), Yau (2009), Emami et al (2011), Amoughin et al (2012b) and Vaghar et al (2014) stated the same results, meanwhile, Shahri et al (2013) mentioned opposite trend. With respect to oil yield, it was significantly increased by increasing plant density (Table 3). This increase may be due to the increase in seed yield ha^{-1}. These results are in general agreement with those obtained by Elfadl et al (2009), Sharifmghaddasi and Omidi (2009), Yau (2009), Emami et al (2011), Amoughin et al (2012b) and Vaghar et al (2014). On the contrary, Shahri et al (2013) cleared that oil yield was depressed significantly by increasing plant density.

Effect of genotypes

Combined data in Table (3) cleared that there were significant differences among all genotypes in plant height, number of branches plant^{-1}, number of capitula plant^{-1}, petal yield plant^{-1}, seed index, seed yield plant^{-1}, seed oil %, seed and oil yield ha^{-1}. Line-1697, recorded the shortest plant height (112.7 cm) when compared to the rest ones. Significant differences were recorded among genotypes concerning number of branches and capitula plant^{-1}. The exotics Line-168 followed by Demo-137 produced the highest number of branches and capitula plant^{-1}.

Data in Table (3) also revealed that both the exotic genotypes, Line-168 and Demo-137 had higher values of petal and seed yield plant^{-1}, as well as, seed index. Generally, this superiority may be due to the increase in number of branches and capitula plant^{-1}. Concerning seed oil % Line-1697and Demo-137 surpassed the rest of genotypes (Table 3). Samanci and Ozkaynak (2003) reported significant differences in oil content due to different genotypes.

In general, two promising exotics genotypes, namely, Line-168 and Demo-137 outyielded the other genotypes in seed yield ha^{-1} (Table 3). This superiority may be a result of the increase in number of branches

and capitula plant^{-1}, seed yield plant^{-1} and seed index. These results are in harmony with those obtained by Osman and Ali (2006), Camas et al (2007), and Mokhtassi-Bidgoli et al (2007) who reported that there were significant differences among genotypes studied. On the other hand, Samanci and Ozkaynak (2003) found no significant difference among safflower genotypes used with respect to seed yield. Also, Osman and Ali (2006) reported that some introduced lines surpassed the commercial cultivar Giza-1 under drip irrigation system in calcareous soils of Egypt.

Effect of the interaction

No significant interaction between plant density and genotypes used was detected for plant height, number of branches plant^{-1} and seed oil %. Meanwhile, number of capitula plant^{-1}, petal and seed yields plant^{-1}, seed index and seed and oil yields ha^{-1} significantly affected by plant populations.

Results in Table (4) showed the effect of the interaction between plant density and safflower genotypes on seed and oil yields ha^{-1}. Results revealed that the highest seed and oil yields were obtained from the interaction of Line-1697 × 240000 plant ha^{-1} (2890, 900.3 kg, respectively) followed by Demo-137 × 240000 plant ha^{-1} (2796, 927.2 kg, respectively) without significant differences. In the context, Sharifi et al (2012) reported that genotypes vs. plant densities interactions were significant.

Table 4. Effect of the interaction of plant density and genotype on seed and oil yields of safflower (combined data of 2011-12 and 2012-13 seasons).

Genotype (G)	Seed yield (kg ha^{-1}) Plant density (D) (10^3 plant ha^{-1})			Oil yield (kg ha^{-1})		
	80	160	240	80	160	240
Giza-1	1416	2083	2446	444.1	613.7	680.5
Bani-Suef	1858	2460	2430	587.5	758.0	718.1
Aswan	1376	2098	2461	406.3	598.2	676.4
Demo-137	2346	2386	2796	840.3	811.7	927.2
Line -168	1919	2517	2723	661.0	852.4	882.2
Line -1697	1580	2565	2890	520.1	824.0	900.3
L.S.D$_{0.05}$ (D×G)	173.4			69.38		

Genetic parameters

Changes in the magnitude of genotypic (δ^2_g) and phenotypic (δ^2_{ph}) variances, broad-sense heritability (h^2_b) and genetic coefficient of variability (G.C.V) of studied traits for the six genotypes under three plant densities across two years are presented in Table (5). In general, changes in magnitude of δ^2_g and δ^2_{ph} varied to plant densities environment for all traits.

Genotypic variance for plant height increased by increasing plant density. Thus, the differences among genotypes were obvious under the highest plant densities.

Table 5. Genotypic (δ^2_g) and phenotypic (δ^2_{ph}) variances, heritability in the broad sense (h^2_b), grand mean and (G.V.C. %) for all studied traits under lower, normal and higher plant densities (data are combined across two seasons).

Trait variances	Plant height (cm)	No. of branches plant^{-1}	No. of capitula plant^{-1}	Petal yield plant^{-1} (g)	Seed index (g)	Seed yield plant^{-1} (g)	Seed yield ha^{-1} (kg)	Seed oil (%)	Oil yield ha^{-1} (kg)
Lower density				80000 plant ha^{-1}					
δ^2_g	37.14	0.45	9.02	0.06	0.17	10.86	105728.73	5.16	21322.29
δ^2_{ph}	84.44	0.59	13.90	0.09	0.27	12.90	160939.25	5.56	28530.97
h^2_b (%)	43.99	75.60	64.93	63.65	63.86	84.22	65.69	92.80	74.73
Mean	119.63	11.62	34.15	6.79	2.01	22.80	1749.28	32.58	576.54
G.C.V (%)	5.10	5.78	8.78	3.45	20.81	14.46	18.59	6.97	25.33
Medium density				160000 plant ha^{-1}					
δ^2_g	90.29	0.03	34.42	0.03	0	1.45	10458.75	5.06	9435.39
δ^2_{ph}	100.64	0.22	36.05	0.16	0.13	2.06	75388.37	5.23	14541.13
h^2_b (%)	89.72	15.22	95.48	16.42	0	70.26	13.87	96.85	64.89
Mean	123.08	8.88	27.56	6.30	1.22	14.04	2351.39	31.47	742.98
G.C.V (%)	7.72	2.06	21.26	2.54	0.00	8.59	4.35	7.14	13.07
Higher density				240000 plant ha^{-1}					
δ^2_g	96.39	0	8.19	0.30	0.09	3.54	41045.84	5.71	13581.02
δ^2_{ph}	102.14	0.10	13.53	0.33	0.13	5.28	45390.30	6.00	14152.53
h^2_b (%)	94.37	0	60.52	90.70	69.23	67.05	90.43	95.08	93.96
Mean	129.26	7.61	23.43	5.81	0.93	13.20	2624.40	30.26	797.46
G.C.V (%)	7.59	0.00	12.23	9.43	34.13	14.26	7.72	7.88	14.61

Besides, heritability in the previous trait was medium and increased to high in the medium density and became very high in the highest density used. Thus, heritability is not a fixed number but apt to increase or decrease for different treatments. By contrast, number of branches plant^{-1} showed limited phenotypic variation under the lowest density and no genotypic variation under 240000 plant ha^{-1}. In all cases for all traits and across all plant densities, phenotypic variance was higher than genotypic variance without any exception. High

h^2 was high for seed yield plant^{-1} (84.2 %) in the lowest density and decreased with increasing density. Surprisingly, heritability for seed yield ha^{-1} was difficult to explain. It was medium (65.69%) in the lowest density used with almost no difference due to genotype in the middle density and became very high (90.43%) under the highest density used. This contradictory could not be attributed to the behavior of genotypes used but to the soil of Wadi El-Natroon. Low to zero coefficient of variability was reported by number of branches plant^{-1} in the three densities used. The highest GCV % was observed for oil yield ha^{-1} in the lowest density (25.33) followed by seed index (20.81) and seed yield ha^{-1} (18.59). On the other hand, very high genetic coefficient was obtained for seed index (34.13). This contradictory in results is a result of the nature of the newly reclaimed soil. Thus, more experiments should be done at different location and in different seasons to have accurate estimation for different genetic parameters in newly reclaimed soils and especially at Wadi El-Natroon. Similar trends were observed by Camas and Esendal (2006) mentioned that the heritability for plant height, number of branches, seed yield, 1000-seed weight and oil content versus environmental conditions were varied.

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