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EVALUATION OF SOME PROMISING SAFFLOWER GENOTYPES UNDER DIFFERENT NITROGEN LEVELS IN SALTED AFFECTED SOILS OF WADI EL-NATROON, EGYPT

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ABSTRACT

A field experiments was carried out at the Agricultural Experiments Desert Station of the Faculty of Agriculture, Cairo University in Wadi El-Natroon, El-Beheira Governorate, Egypt, during 2006/2007 and 2007/2008 seasons to study the response of 6 local and 7 introduced safflower (Carthamus tinctorius L.) genotypes to four nitrogen levels (30,45,60 and 75 kg N/fed) under sprinkler irrigation system. The objectives of this research were to find out the best genotype(s) to be grown under the stress conditions and to determine the optimum nitrogen level for each genotype. A split-plot design was used. The main plots were devoted to the nitrogen levels and sub-plots to genotypes. Nitrogen level of 75 kg N/fed recorded the highest values of plant height, number of branches/plant, number of capitula/plant, number of seeds/capitulum, seed yield/plant, seed index, seed oil percentage, seed and oil yield/fed, as well as water use efficiency (WUE). Two local genotypes (Bani-Suef and 3 Aswan), as well as, three exotic genotypes (Demo-137, Turkey-168 and S-350) surpassed the other genotypes in seed yield, oil yield/fed and WUE. The interaction between nitrogen levels and genotypes was significant for seed oil percentage, seed yield, oil yield and WUE. The highest seed yield, oil yield and WUE were realized for Aswan genotype fertilized with 75 kg N/fed. The correlation study shows significant and positive association between seed yield and most studied characters.

Key words: ***Carthamus tinctorius, Safflower, Genotypes, Nitrogen, Reclaimed soils, Sprinkler irrigation, Correlation coefficients, WUE.***

INTRODUCTION

The local edible oil production, in Egypt, is not sufficient. There is a vast gap (90%) between production and consumption (FAO, 2004). This gap is mainly due to the limited area devoted to oil crops and increasing the average of oil consumption per capita from 12 kg to 14 kg. Consequently, the previous reasons reflect our exigent need to direct more attention to oil crops especially winter oily crops such as safflower and canola.

Safflower is one of the promising oil seed crops, which may play an important role in increasing edible oil production in Egypt. Its oil is nutritionally like olive oil but much less costly. Oleic safflower oil tends to lower blood levels of low-density lipoprotein, LDL (bad cholesterol), without affecting high-density lipoprotein, HDL (good cholesterol), (Smith, 1996). Recently, an important approach via biotechnology was developed for safflower as a new source of similar human insulin by a Canadian biotechnology company. It can produce over one kilogram of insulin per acre of safflower production, which is enough to supply 2500 patients for one year. (Nancy *et al* 2006). Such approach may encourage small farmers in developing countries to grow safflower in large areas.

It is considered a deep-rooted crop which can tolerate water stress (Drodas and Sioulas 2009). Safflower is capable to produce a high seed yield with minimum water requirements (Sharaan *et al* 1991). The salinity of the ground water causes less seed yield reduction of 15% and total biomass by 12% compared with a well-watered crop in the same soil, (Soppe and Ayars, 2003). The chance of planting safflower, in the winter season in Delta and Nile valley, faces a highly competition with various major winter crops. The newly reclaimed soils offer a great opportunity to expand safflower planting due to its ability to withstand stress conditions in these soils such as poor or low quality, salinity, water stress, sodicity problems and limitation of water resources. The main obstacles for planting safflower are the limited genotypic materials and their genetic background with respect to adaptation to these conditions in Egypt.

Leilah *et al* (1992) and Ghanem and Ash-Shormillesy (2007), stated that with increasing nitrogen level, seed yield/plant was significantly increased. Also, Mündel *et al* (2004) recorded the same result with seed yield/unit area. On the contrary, Elfadl (2007) found that the nitrogen rate did not have a significant impact on plant height, seeds/plant, number of branches and heads/plant, seed yield, as well as oil yield. This may be interpreted as ability of safflower to use residual soil-N efficiently.

Yield and yield components of safflower were significantly affected by the genotypes (Eslam, 2004; Camas *et al* 2007; Mokhtassi-Bidgoli *et al* 2007; Fernández-Martinez *et al* 1993; Osman and Ali, 2006; Sharaan *et al* 1991; Uslu *et al* 1998; Muñoz-Valenzuela *et al* 2007). By 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. Osman and Ali (2006) reported that the introduced lines surpassed the local cultivar in water use efficiency.

The objectives of this research were: to find out the best genotype(s) to be grown under stress in Egypt conditions and to determine the optimum nitrogen level for these genotypes under sprinkler irrigation system.

MATERIALS AND METHODS

A field experiments was carried out at the Agricultural Experiments Desert Station, Faculty of Agriculture, Cairo University in Wadi El-Natroon, El-Beheira Governorate, Egypt, during the two successive winter seasons of 2006/2007 and 2007/2008. The mechanical and chemical analysis of the soil and water analysis were carried out by the Reclamation and Development Center for desert soils, Faculty of Agriculture, Cairo University. The analyses are presented in Tables (1) and (2).

Table 1. Physical and chemical properties of soil in 2006-07 and 2007-08 seasons.

Soil properties	Season	
	2006/2007	2007/2008
	Site 1	Site 2
Physical properties		
Sand%	93.00	94.35
Silt%	4.45	3.48
Clay%	2.55	2.17
Texture	Sandy	Sandy
Chemical properties		
Soil (pH)	7.98	7.22
Ec (ds/m)	7.60	7.90
Organic Matter (%)	0.20	0.15
Total $CaCo_3$ (%)	2.30	2.20
Total N (%)	0.40	0.40
Soluble anions concentration (meq/L) (meq/100g soil)		
Cl^-	75.40	78.00
HCO_3^-	0.30	0.41
SO_4^-	0.30	0.29
Soluble cations concentration (meq/L) (meq/100g soil)		
Na^+	43.38	45.00
K^+	0.62	0.60
Ca^{++}	17.00	18.50
Mg^{++}	15.00	16.00

Table 2. Chemical analysis of water sample in 2006 and 2007 years.

Season	pH	EC		Ions concentration meq/L						
	Unit	ds/m	PPM	HCO_3^- + CO_3^-	Cl^-	$SO_4^=$	Ca^{++}	Mg^{++}	Na^+	K^+
2006	7.54	4.00	2560	4.0	32.5	9.25	4.0	6.0	35.2	0.54
2007	7.48	4.14	2650	3.5	30.3	7.43	5.50	4.50	30.8	0.43

Table (1) reveals that soil of the experimental site was considered sandy, saline and poor in nutrients (N P K), as well as organic matter. Also, Table (2) refers that irrigation water used was saline and poor in nutrients.

One experiment was conducted under sprinkler irrigation system. Each experiment included 52 treatments which were the combinations of:

1- Four nitrogen levels, *viz.*, 30, 45, 60 and 75 kg N/fed (fed = 4200 m^2).

2- Thirteen genotypes (Table, 3). Six of these genotypes, were local entries including Giza-1, a sole cultivar grown in Egypt and 5 genotypes (land races) collected from 5 governorates as farmer's seed lots representing upper, middle and north Egypt. The remaining seven safflower genotypes were imported by Oil Seed Crops Research Program, Field Crops Research Institute, Agricultural Research Center (ARC), Egyptian Ministry of Agriculture.

A split-plot design in a randomized complete block arrangement with three replications was used. The main plots were devoted to the nitrogen levels and sub-plots to the genotypes. Each experimental unit consisted of four rows, 0.75 meter apart and 3 meter long. The sub-plot area was 9 m^2 (3×3 m). Seeds were sown by hand in hills 16 cm apart on 15 October in both seasons. Plant density (70000 plant/fed) was adjusted *via* seedlings thinning to two plants/hill at 30 days after sowing to avoid competition between plants.

Table 3. Sources of safflower genotypes.

Genotype code	Safflower genotypes	Country	Source
1	Giza-1 cv. (middle Egypt)	Egypt	ARC
2	Monofiya (north Egypt)		Ashmoon center
3	Bani-Suef (middle Egypt)		Somosta center
4	Al-Minya (middle Egypt)		Malawi center
5	Aswan (upper Egypt)		Daraw center
6	Al-Wadi Al-Jadid (upper Egypt)		Al-Kharga center
7	Demo-137 cv.	USA	ARC
8	S-350 cv.	USA	
9	Line -1697	Cyprus	
10	Line -1699	Ethiopia	
11	Line -152	India	
12	Line -159	Turkey	
13	Line -168	Turkey	

All plots were fertilized with 30 kg P_2O_5/fed before planting in the form of single super-phosphate (15.5%) as a one dose. Fifty kg K_2O/fed in the form of potassium sulphate (50%) were added dropping through five equal doses. The first dose was added at 60 days from planting, and then the rest doses were applied at 7-day intervals. Nitrogen was added dropping at levels of 30, 45, 60 or 75 kg N/fed, in the form of ammonium nitrate (33.5%). These levels were added at 7-day intervals. Mixture of micronutrients was also sprayed as a foliar application after thinning at 21-day intervals. All suitable agricultural practices were conducted in the proper time.

Studied characters

Ten plants were randomly taken from the two central rows of each plot at harvest to measure the following characters: plant height (cm) from soil surface to the top of plant, number of branches/plant, number of capitula/plant, number of seeds/capitulum, seed yield/plant (g), seed index (100-seed weight g). Seed oil percentage was determined according to AOAC (2000). Seed yield (kg/fed) was determined by weighing produced seeds from each plot. Oil yield (kg/fed) was calculated by multiplying oil percentage by seed yield/fed. Water use efficiency (WUE kg/m^3) was calculated according to the following formula described by Kanber *et al.* (1993):

WUE = Yield (kg)/the seasonal amount of applied water (m^3).

Data obtained from each season of the study were statistically analyzed according to procedures outlined by Gomez and Gomez (1984) using MSTAT-C computer program (Freed *et al* 1989). Test for homogeneity of variance was used to compare between variances across two seasons before deciding the validity of combined analysis. Differences among treatments means were compared by Least Significant Differences test (LSD) at 0.05 level of probability.

RESULTS AND DISCUSSION

Effect of nitrogen

Data in Table (4) reveal that plant height, number of branches/plant, number of capitula/plant, number of seeds/capitulum, seed yield/plant, seed index, seed oil percentage, seed and oil yield/fed, as well as WUE were significantly affected by nitrogen levels. While number of plants/fed at harvest was not affected by N levels. Table (4) shows that increasing N increased plant height and number of branches up to 75 kg N/fed. These increases reflect the importance of N application in sandy soil which is low in fertility (Table 1). Similar trends were obtained by Dordas and Sioulas (2009) who reported that N fertilization promoted the safflower growth. While Leila *et al.* (1992) explained these increases which might be due to the role of N on meristemic activity and cell division which in turn increased cell number and size. Also, Table (4) shows that number of capitula/plant was increased by adding N is to 75 kg. Increasing number of branches/plant may be the main cause of this increase.

Table 4. Effect of nitrogen levels on some characters of safflower under sprinkler irrigation (combined data of 2006-07 and 2007-08 seasons).

Characters	Nitrogen Levels (kg/feddan)				$LSD_{0.05}$
	30	45	60	75	
Number of plants (1000/fed)	68.64	68.52	68.41	68.58	NS
Plant height (cm)	97.7	101.7	105.1	110.2	3.3
Number of branches/plant	5.6	6.2	7.1	8.4	0.4
Number of capitula/plant	9.6	11.3	13.3	15.7	1.4
Number of seeds/capitulum	14.8	16.0	17.4	19.4	1.3
Seed yield/plant (g)	7.91	9.08	10.51	12.25	0.55
Seed index (g)	4.83	5.07	5.29	5.90	0.16
Seed oil percentage (%)	24.46	26.92	28.43	30.45	1.23
Seed yield (kg/fed)	502.0	556.5	647.0	752.7	34.0
Oil yield (kg/fed)	124.1	150.3	184.3	230.2	11.6
Water use efficiency (kg/m^3)	0.255	0.283	0.329	0.383	0.016

NS = not significant

Results in the same table reveal that seed yield/plant was increased by increasing N levels up to 75 kg N/fed Such increase may be attributed to the increase in number of branches/plant, number of capitula/plant and number of seeds/capitulum. Similar trends were obtained by Leila *et al* (1992) and Ghanem and Ash-Shormillesy (2007). Combined data in the same table, show that increasing N levels markedly increased seed index. Similar results were obtained by Strasil and Vorlicek (2002). This increase may be explained by higher dry matter accumulation that partitioned to seeds (Leila *et al* 1992). Results in Table (4) also reveal that N fertilization increased seed oil percentage up to 75 kg N/fed. On the contrary, Leila *et al* (1992), and Engel and Bergman (1997) stated that nitrogen fertilizer had a little effect on seed oil content. Abu-Hagaza (1991), Afifi (1991) and El-Nakhlawy (1991) found nonsignificant effect of nitrogen levels on seed oil percentage.

Table (4) shows that N significantly increased seed yield/fed. Such increase in seed yield/fed may be attributed to the considerable increase in plant height, number of branches/plant, number of capitula/plant, number of seeds/capitulum, seed yield/plant and seed index. These trends are in harmony with those obtained by Leila *et al* (1992), Strasil and Vorlicek (2002), Mundel *et al* (2004), and Siddiqui and Oad (2006). Dordas and Sioulas (2009), who reported that N fertilization promoted the safflower growth and increased dry matter yield, translocation and seed yield.

With respect to oil yield, it was significantly increased by nitrogen application (Table 4). This increase may be due to the increase in seed oil percentage and seed yield/fed. These results are in general agreement with those obtained by Abo-Shetaia (1990), and Siddiqui and Oad (2006). On the contrary, Engel and Bergman (1997) cleared that oil yield was depressed significantly by excess of N fertilization.

It was also obvious from Table (4) that WUE was significantly increased by nitrogen application from 0.255 kg/m^3 under 30 kg N to 0.383 kg/m^3 when 75 kg N/fad was applied. Such superiority in WUE may be attributed to the increase in seed yield/fed. Nimje (1991) reported that the WUE was increased by nitrogen application.

Effect of genotype

Combined data in Table (5) clear that there were significant differences among all genotypes in plant height, number of branches/plant, number of capitula/plant, number of seeds/capitulum, seed yield/plant and seed index. While no significant differences were observed among genotypes in number of plants/fed. In general, exotic genotypes, especially India-152, recorded the shortest plant height when compared to the local ones. While Al-Wadi Al-Jadid followed by Bani-Suef recorded the maximum plant height. Little significant differences were recorded among genotypes concerning number of branches/plant.

Table 5. Performance of some safflower genotypes under sprinkler irrigation (combined data of 2006-07 and 2007-08 seasons).

Genotype \ Character	1	2	3	4	5	6	7	8	9	10	11
Giza-1	68.58	109.1	6.8	11.3	17.0	9.94	5.21	27.00	579.5	158.9	0.295
Monofiya	68.60	107.7	6.9	12.6	16.1	10.30	5.43	28.80	637.4	186.3	0.324
Bani-Suef	68.70	111.2	7.6	14.9	19.3	11.77	5.72	27.81	737.2	206.3	0.375
Al-Minya	68.39	107.2	6.6	11.5	16.7	9.87	4.84	24.87	570.9	144.7	0.290
Aswan	68.48	104.3	7.4	14.7	18.0	10.62	5.54	28.08	698.8	198.4	0.355
Al-Wadi Al-Jadid	68.81	116.3	6.8	10.5	15.1	9.14	4.82	23.60	502.6	121.5	0.255
Demo-137	68.56	106.6	7.2	14.3	17.9	10.37	5.44	26.72	662.2	180.1	0.337
S-350	68.56	98.3	6.9	13.2	17.6	9.92	5.45	26.86	629.4	172.8	0.320
Cyprus-1697	68.44	100.3	6.6	11.9	16.4	9.59	5.23	30.12	595.4	181.0	0.303
Ethiopia-1699	68.43	100.3	6.6	11.8	16.1	9.81	5.35	27.28	620.6	171.3	0.315
India-152	68.52	92.9	6.2	10.6	15.1	8.60	5.16	28.86	527.9	153.8	0.268
Turkey-159	68.46	95.3	6.3	10.8	16.2	8.95	4.93	27.86	570.2	160.3	0.290
Turkey-168	68.46	98.4	7.0	13.8	17.9	10.32	5.44	30.49	656.7	203.7	0.334
$LSD_{0.05}$	NS	3.9	0.5	1.5	1.9	1.04	0.19	2.25	42.6	19.4	0.018

1 = Number of plants (1000/fad), 2= Plant height (cm), 3 = Number of branches/plant, 4 = Number of capitula/plant, 5 = Number of seeds/capitulum, 6 = Seed yield/Plant (g), 7 = Seed index (g), 8 = Seed oil percentage (%), 9 = Seed yield (kg/fad), 10 = Oil yield (kg/fad) and 11 = WUE (kg/m^3).
NS = not significant.

The local genotype Bani-Suef followed by Aswan and the exotic genotype Demo-137 and Turkey-168 produced the highest number of capitula/plant and number of seeds/capitulum. This reflects their superiority in number of branches/plant. Data in Table (5) also reveal that Bani-Suef and Aswan recorded the highest seed yield/plant. Generally, this superiority may be due to the increase in number of branches/plant, number of capitula/plant, number of seeds/capitulum, seed yield/plant and seed index. Concerning seed oil content Turkey-168, Cyprus-1697 and India-152 followed by the local genotypes Monofiya and Aswan surpassed the rest of genotypes (Table 5). Samanci and Ozkaynak (2003) reported significant differences in oil content due to the different genotypes.

In general, five promising safflower genotypes (2 locals, Bani-Suef and Aswan) and 3 exotics, namely, Demo-137 Turkey-168 and S-350 outyielded the other genotypes in seed and oil yield/fed (Table 5). We can explain this superiority because of the increase in number of branches/plant, number of capitula/plant, number of seeds/capitulum, seed yield/plant and seed index. On the other hand, this superiority of the promising genotypes in seed yield/fed may be due to the high adaptability to climatic and edaphic Egyptian conditions during source and sink phases. These results are in harmony with those obtained by Camas *et al* (2007), Eslam (2004), Fernández-Martinez *et al* (1993), Mokhtassi-Bidgoli *et al* (2007), Osman and Ali (2006), Sharaan *et al* (1991), Uslu *et al* (1998) and Muñoz-Valenzuela *et al* (2007) who reported that there were significant differences among genotypes studied. On the other hand, Samanci and Ozkaynak (2003) found no significant differences among safflower genotypes they used with respect to seed yield. Also, Osman and Ali (2006) reported that some introduced lines surpassed the commercial cultivar Giza-1.

Results in Table (5) show that genotypes differed significantly in their WUE. The highest values of WUE were obtained from two local land races (Bani-Suef and Aswan) and Demo-137 followed by Turkey-168 as exotic genotypes. These genotypes are well adapted to the local environments and drought tolerant. They have good ability to consume little amount of water for producing higher seed yield. These five genotypes are valuable in any breeding program for drought tolerance. Besides, Bani-Suef shows the highest seed and oil yields (Table 5).

Effect of the interaction

A significant interaction between N levels and genotypes used was detected for number of plants/fad, plant height, number of branches/plant, number of capitula/plant, number of seeds/capitulum, seed yield/plant and seed index.

Results in Table (6) show the effect of the interaction between nitrogen levels and safflower genotypes on seed oil percentage. Results reveal that the interaction had a significant effect on seed oil percentage. The highest seed oil percentage was obtained from the interaction of Turkey-168 × 75 kg N/fad (33.36%) followed by Turkey-159 and Cyprus-1697 × 75 kg N/fad (32.88 and 32.12%) without significant differences. The lowest seed oil percentage was recorded by the local genotype Al-Wadi Al-Jadid × 30 kg N (20.57%) followed by Al-Minya × 30 kg N (21.48%).

Table 6. Seed oil percentage of safflower genotypes as affected by nitrogen levels and their interactions under sprinkler irrigation (combined data of 2006-07 and 2007-08 seasons).

Genotypes	Nitrogen Levels (kg/fed)				Mean
	30	45	60	75	
Giza-1	24.67	26.34	27.76	29.25	27.00
Monofiya	25.61	29.15	29.95	30.49	28.80
Bani-Suef	25.52	26.30	28.03	31.38	27.81
Al-Minya	21.48	24.55	25.49	27.97	24.87
Aswan	26.75	26.89	28.23	30.44	28.08
Al-Wadi Al-Jadid	20.57	23.19	23.99	26.66	23.60
Demo-137	24.17	25.22	26.90	30.57	26.72
S-350	22.95	26.52	28.17	29.81	26.86
Cyprus-1697	26.88	29.77	31.69	32.12	30.12
Ethiopia-1699	23.73	27.82	28.50	29.05	27.28
India-152	26.42	27.59	29.45	31.98	28.86
Turkey-159	22.65	27.10	28.87	32.81	27.86
Turkey-168	26.52	29.57	32.52	33.36	30.49
Mean	24.46	26.92	28.43	30.45	27.56
$LSD_{0.05}$ N × G					4.51

The effect of the interaction between nitrogen levels and safflower genotypes on seed yield/fed is presented in Table (7). Results reveal that the interaction had a significant effect on seed yield/fed. The highest seed yield was obtained from the interaction of Aswan × 75 kg N/fed (910.9 kg/fed) followed by S-350 and Monofiya × 75 kg N (879.1 and 853.4 kg/fed, respectively) without significant differences. It seems that these genotypes are efficient with respect to N-uptake. They achieved their highest productivity and superiority among other entries with 75 kg N/fed. The lowest seed yield/fad was recorded by the exotic India-152 × 30 kg nitrogen followed by the local genotype Al-Wadi Al-Jadid × 30 kg nitrogen.

Table 7. Seed yield (kg/fed) of safflower genotypes as affected by nitrogen levels and their interactions under sprinkler irrigation (combined data of 2006-07 and 2007-08 seasons).

Genotypes	Nitrogen Levels (kg/fed)				Mean
	30	45	60	75	
Giza-1	451.0	553.7	619.6	693.8	579.5
Monofiya	482.5	531.5	682.2	853.4	637.4
Bani-Suef	671.9	709.6	755.7	811.7	737.2
Al-Minya	460.8	486.1	608.6	728.3	570.9
Aswan	558.4	630.6	695.3	910.9	698.8
Al-Wadi Al-Jadid	419.0	437.9	486.9	666.7	502.6
Demo-137	532.8	592.7	721.1	802.2	662.2
S-350	445.2	510.3	683.1	879.1	629.4
Cyprus-1697	533.9	594.8	652.4	600.3	595.4
Ethiopia-1699	542.8	572.9	630.1	736.5	620.6
India-152	412.0	484.4	566.9	648.4	527.9
Turkey-159	493.6	500.1	597.6	689.4	570.2
Turkey-168	521.7	630.2	710.9	763.8	656.7
Mean	502.0	556.5	647.0	752.7	614.5
$LSD_{0.05}$ N × G					85.3

Results in Table (8) show the effect of the interaction between nitrogen levels and safflower genotypes on oil yield/fad. Results reveal that the interaction had a significant effect on oil yield/fed. The highest oil yield was obtained from the interaction of Aswan × 75 kg N/fed (278.8 kg/fed) followed by Monofiya × 75 kg N/fed and S-350 × 75 kg N/fed (263.8 and 259.7 kg/fed, respectively) without significant differences. The lowest oil yield/fad was recorded by the local land race Al-Wadi Al-Jadid × 30 kg N (86.4 kg/fed) followed by Al-Minya × 30 kg N (99.0 kg/fed).

Table 8. Oil yield (kg/fed) of safflower genotypes as affected by nitrogen levels and their interactions under sprinkler irrigation (combined data of 2006-07 and 2007-08 seasons).

Genotypes	Nitrogen Levels (kg/fed)				Mean
	30	45	60	75	
Giza-1	112.9	146.0	172.4	204.2	158.9
Monofiya	124.4	153.0	204.0	263.8	186.3
Bani-Suef	170.0	186.7	212.3	256.2	206.3
Al-Minya	99.0	119.0	154.0	207.0	144.7
Aswan	150.9	170.5	193.5	278.8	198.4
Al-Wadi Al-Jadid	86.4	101.4	117.0	181.0	121.5
Demo-137	131.0	149.1	194.3	246.1	180.1
S-350	102.4	137.1	191.9	259.7	172.8
Cyprus-1697	144.3	178.6	207.1	193.9	181.0
Ethiopia-1699	128.6	159.6	180.7	216.3	171.3
India-152	110.0	132.9	165.4	207.0	153.8
Turkey-159	111.8	133.5	172.1	223.7	160.3
Turkey-168	141.8	186.8	231.7	254.7	203.7
Mean	124.1	150.3	184.3	230.2	172.2
$LSD_{0.05}$ N × G					38.87

The effect of nitrogen levels × safflower genotypes interaction on WUE is presented in Table (9). Data indicate that interaction between the two factors under this research had a significant effect on WUE. The highest WUE was obtained from genotypes Aswan × 75 kg N (0.463 kg/m^3) followed by S-350 × 75 kg N. (0.447 kg/m^3). The lowest WUE was obtained from the exotic genotype India-152 × 30 kg N (0.209 kg/m^3) and the local genotype Al-Wadi Al-Jadid × 30 kg N (0.213 kg/m^3).

Table 9. Water use efficiency (kg/m3) of safflower genotypes as affected by nitrogen levels and their interactions under sprinkler irrigation (combined data of 2006-07 and 2007-08 seasons).

Genotypes	Nitrogen Levels (kg/fed)				Mean
	30	45	60	75	
Giza-1	0.229	0.281	0.315	0.353	0.295
Monofiya	0.245	0.270	0.347	0.434	0.324
Bani-Suef	0.342	0.361	0.384	0.413	0.375
Al-Minya	0.234	0.247	0.309	0.370	0.290
Aswan	0.284	0.321	0.353	0.463	0.355
Al-Wadi Al-Jadid	0.213	0.223	0.247	0.339	0.255
Demo-137	0.271	0.301	0.367	0.408	0.337
S-350	0.226	0.259	0.347	0.447	0.320
Cyprus-1697	0.271	0.302	0.332	0.305	0.303
Ethiopia-1699	0.276	0.291	0.320	0.374	0.315
India-152	0.209	0.246	0.288	0.330	0.268
Turkey-159	0.251	0.254	0.304	0.350	0.290
Turkey-168	0.265	0.320	0.361	0.388	0.334
Mean	0.255	0.283	0.329	0.383	0.312
$LSD_{0.05}$ N × G					0.036

The product moment correlation coefficients between seed yield/fed and most traits were significant and positive (Table 10). A significant and positive association was observed between seed yield and number of branches/plant (0.0.84**), number of capitula/plant (0.95**), Number of seeds/Capitulum (0.89**), seed yield/plant (0.91**), seed index (0.89**), oil yield/fed (0.91**) and WUE (1). These results are in general agreement with those obtained by Tunçtürk and Vahdettin (2004) who found positive and significant relationships among seed yield and plant height, number of capitula/plant, 1000-seed weight, seed oil percentage and oil yield. Siddiqui and Oad (2006) showed that the entire crop attributes they measured *viz.*, plant height, number of branches/plant, number of capsules/plant and seed index were also positively associated with the seed yield. Abu-Hagaza (1990) mentioned that seed yield showed a significant and positive correlation with seed yield/plant and seed index. Besides, Camas *et al.* (2007) found that seed yield was correlated with other characters in the following order, oil yield, oil content, number of branches/plant, 1000-seed weight and number of seeds/head. In addition, Mokhtassi-Bidgoli *et al.* (2007) reported that high yielding genotypes were found to be closely related to1000-seed weight, number of capitula/plant, number of seeds/capitulum and harvest index.

CONCLUSION

Results of this research refer that seed yield of safflower was increased by increasing nitrogen application up to 75 kg. The level of 75 kg N/fed is recommended for economical yield. Seed yield is very closely and significantly related to number of capitula/plant (0.95) and to a lesser extent to seed yield from single plant (r=0.91).

Two promising local genotypes (Bani-Suef and Aswan), as well as 3 exotics (Demo-137, Turkey-168 and S -350) recorded higher seed and oil yields. These genotypes may be grown successfully under stress conditions in Egypt. The highest seed yield was obtained from Aswan received 75 kg N/fed. On the other hand, Cyprus-1697 and Turkey-168 recorded higher oil content (30.49% and 30.12%, respectively) when compared to the local and commercial cultivar Giza-1 (27%).

Table 10. Correlation coefficients between safflower characters under sprinkler irrigation (combined data of 2006-07 and 2007-08 seasons).

Characters	1	2	3	4	5	6	7	8	9	10	11
Seed yield (kg/fed)	1										
Number of plants (1000/fed)	-0.06	1									
Plant height (cm)	0.09	0.67*	1								
Number of branches/ Plant	0.84**	0.39	0.55*	1							
Number of capitula/Plant	0.95**	0.03	0.14	0.89**	1						
Number of seeds/Capitulum	0.89**	0.00	0.16	0.83**	0.90**	1					
Seed yield/plant (g)	0.91**	0.17	0.44	0.92**	0.88**	0.88**	1				
Seed index (g)	0.89**	0.06	-0.04	0.73**	0.86**	0.73**	0.77**	1			
Seed oil (%)	0.38	-0.42	-0.61*	0.00	0.30	0.20	0.13	0.52	1		
Oil yield (kg/fed)	0.91**	-0.21	-0.18	0.64*	0.85**	0.75**	0.75**	0.89**	0.72**	1	
WUE (kg/m^3)	1.00	-0.06	0.09	0.84**	0.95**	0.89**	0.91**	0.89**	0.39	0.91**	1

1 = Seed yield (kg/fed), 2= Number of plants (1000/fad), 3 = Plant height (cm), 4 = Number of branches/plant, 5 = Number of capitula/plant, 6 = Number of seeds/capitulum, 7 = Seed yield/Plant (g), 8 = Seed index (g), 9 = Seed oil percentage (%),10 = Oil yield (kg/fad) and 11 = WUE (kg/m^3).
*** and ** indicated at 0.05 and 0.01 probability levels, respectively.**

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تقييم بعض التراكيب الوراثية المبشرة من القرطم تحت مستويات مختلفة من التسميد النيتروجيني في الأراضي المتأثرة بالأملاح بوادي النطرون – مصر

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أجريت تجربة حقلية بمحطة التجارب الزراعية الصحراوية لكلية الزراعة جامعة القاهرة بوادي النطرون، بمحافظة البحيرة، مصر خلال موسمي ٢٠٠٦/٢٠٠٧، ٢٠٠٧/٢٠٠٨ لدراسة استجابة ٦ تراكيب وراثية محلية و ٧ مستوردات من القرطم لأربع مستويات من التسميد النيتروجيني (٣٠، ٤٥، ٦٠، ٧٥ كجم ن/فدان) تحت نظام الري بالرش وكذلك تأثير التفاعل بينهم على المحصول ومكوناته. كان الهدف من هذا البحث تحديد أفضل تركيب أوتراكيب وراثية للنمو تحت ظروف الاجهاد الصحراوي وتحديد المستوي الامثل من التسميد النتروجيني لهذه التراكيب. استخدام تصميم القطع المنشقة مرة واحدة حيث وضعت مستويات التسميد النيتروجيني في القطع الرئيسية والتراكيب الوراثية المحلية والمستوردة في القطع المنشقة. ويمكن تلخيص أهم النتائج فيما يلي: حقق مستوي التسميد النيتروجيني ٧٥ كجم ن/فدان أعلي قيم لصفات طول النبات، عدد أفرع النبات، عدد رؤوس النبات، عدد بذور الرأس، وزن بذور النبات، دليل البذرة، نسبة الزيت، محصول البذرة والزيت للفدان وكذلك كفاءة استخدام المياه. تفوق تركيبان وراثيان محليان هما (بني سويف و أسوان) وثلاثة تراكيب مستوردة هي (ديمو–١٣٧، تركيا–١٦٨ وإس–٣٥٠) علي باقي التركيب الوراثية الأخري في محصول البذور والزيت للفدان وكفاءة استخدام المياه. أظهر التفاعل بين مستويات التسميد النيتروجيني والتراكيب الوراثية تأثيراً معنوياً علي صفات نسبة الزيت بالبذور، محصول البذور، محصول الزيت وكفاءة استخدام المياه. تم الحصول علي أعلي محصول بذور، زيت وكفاءة استخدام مياه من التركيب الوراثي أسوان عند تسميده بـــ ٧٥ كجم ن/فدان. أظهرت دراسة الارتباط بين محصول البذور ومعظم الصفات المدروسة ارتباطاً معنوياً موجباً.

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