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OSMOTIC ADJUSTMENT AS A RAPIDLY SCREENING TOOL FOR PRE-FLOWERING DROUGHT TOLERANCE IN SUNFLOWER (*Helianthus annuus* L.)

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ABSTRACT

Complementally field experiment was conducted during 2007 season at Kafr-El- Hamam Agricultural Experiment Station of Agricultural Research Center, Sharkia Governorate, Egypt to screen thirty–three sunflower inbred lines had been selected from stock breeding materials of Oil Crops Research Section in addition to two check cultivars i.e. Sakha 53 and Giza 102 under two water treatments; watering every 15 days (control experiment) and prevented irrigation after El-mohyah irrigation (drought experiment) using osmotic adjustment. Osmotic adjustment estimated as the differences in osmotic potential at full turgor between drought and control treatments.

There was no effect of osmotic adjustment on all studied traits in the irrigated control. Oil yield per feddan rather than seed yield per feddan, was the yield characters most affected by level of osmotic adjustment. Mean squares due to irrigation levels were highly significant for all studied traits. The differences among genotypes were highly significant for all studied traits. Significant genotype x irrigation levels interaction was detected for all studied traits. The highest values for yield potential were owned to Sakha 53 and G13. Highly significant positive correlations were detected between osmotic adjustment and yield characters.

It was concluded that genotypes G 13 and cultivar Sakha 53 of high osmotic adjustment had a superiority in the direct use at drought affected soil and/or for breeding program to pursue further advancement in sunflower drought tolerance.

Keywords: Osmotic adjustment, Screening pre-flowering drought, sunflower (*Helianthus annuus* L.)

INTRODUCTION

In Egypt, sunflower (*Helianthus annuus* L.) is the most promising crop of increasing domestic production of edible oil and hence, sunflower breeders and physiologists continue to work to identify superior genotypes under drought conditions to increase sunflower oil production in new reclaimed area.

The greatest progress may be expected screening is based on some trait that contributes to stress tolerance. For such an approach to be successful, it should be established that the trait in fact contributes to tolerance to the given stress and that it is associated with high yields.

Therefore, osmotic adjustment (OA) has been suggested as a screening tool to rapidly screen sunflower genotypes for drought tolerance at pre- flowering stage because it is positively associated with yield under stress conditions, as it allows growth and results in delayed leaf death by maintaining turgor pressure and selection can be performed during early developmental phases, allowing a larger number of genotypes to be examined and reducing the time and space needed for this process (Chimenti *et al*., 2002).

Regarding mean performance of some physiological and yield characters, El-Sabbagh (2003) revealed that irrigation sunflower plants every 14 days significantly increased seed yield/plant, seed yield/feddan, seed oil % and oil yield/faddan. And added that Euroflower cultivar was superior in seed yield/plant and seed yield/faddan. Petcu *et al*. (2003) showed that hydric stress significantly reduced leaf area. Kiani *et al*. (2007) showed that the analysis of variance for osmotic pressure, osmotic pressure at full turgor and osmotic adjustment of the 78 recombinant inbred lines (RIL) and their parents (PAC2 and RHA 266) were highly significant for water treatments, sunflower genotypes and their interaction. Rauf and Sadaqat (2008) found a significant genetic variability between genotypes in sunflower for osmotic adjustment.

Regarding correlation coefficient between osmotic adjustment and yield characters, using different F3 families, Chimenti *et al*. (2002) demonstrated that osmotic adjustment (a parameter directly related to drought tolerance) contributes to yield maintenance of sunflower under pre-anthesis drought conditions, when leaf expansion and root growth are not yet ceased.

Therefore, the present investigation was carried out to identify the relative importance of osmotic adjustment as a screening tool to rapidly screen large number of entries in pre-flowering stage for drought tolerance; and it is correlation with high yield.

MATERIALS AND METHODS

Complementally field experiment was conducted under heavy clay soil, with fairly deep water table, of Kafr– El-Hamam Agricultural Experiment Station of Agricultural Research Center, Sharkia Governorate, Egypt during 2007 summer season to screen thirty–three sunflower inbred lines *(Helianthuis annuus* L.) had been selected from stock breeding materials of Oil Crops Research Section in addition to two check cultivars i.e. Sakha 53 and Giza 102 under two water treatments, watered every 15 days (control) and prevented irrigation after El-mohyah irrigation (water deficit) according to (Kiani *et al*. 2007) using osmotic adjustment as a screening tool.

The preceding crop was wheat (*Triticum aestivum* L.). A separate experiment was devoted for each irrigation treatment (control and water deficits). Each experiment was factorial experiment arranged in a randomized complete blocks with three replications to screen all genotypes. Each plot had 3 ridges, 60 cm apart and 3 m long, and plant population density was 5.6 plants/m^2. There were two border plants at the extremes of each ridge and two border ridges at the outer limits of the plot. Contiguous plots were separated by paths. Each treatment block was isolated from contiguous blocks by 5 canal 1.50 m apart and 44 m long to impede lateral flow of water. Within each block, genotypes plots were contiguous and randomly arranged. Planting date was on June 10 in 2007 season. Seeds were sown in hills spaced of 30 cm. apart with 2 to 3 seeds/hill. Other agricultural practices for growing sunflower were performed as recommended.

The origin and number of the used sunflower inbred lines are given in Table 1.

Table 1: The origin and name of the used sunflower inbred lines

Name of Inbred line			Origin
G1 (L19)	G7 (L990)	G13 (L245)	Bulgaria
G2 (L110)	G8 (L125)	G14 (L880)	
G3 (L350)	G9 (L460)	G15 (L885)	
G4 (L775)	G10 (L92)	G16 (L240)	
G5 (L770)	G11 (L230)	G17 (L235)	
G6 (L355)	G12 (L465)	G18 (L120)	
G19 (L10)	G24 (L11)	G29 (L40)	local inbred lines
G20 (L62)	G25 (L20)	G30 (L4)	
G21 (L34)	G26 (L8)	G31 (L16)	
G22 (L38)	G27 (L39)	G32 (L1)	
G23 (L21)	G28 (L2)	G33 (L3)	
Check cultivars	Sakha 53	Giza 102	local

Some physical and chemical analysis for soil of the experimental field is presented in Table 2.

Table 2: Some physical and chemical analysis for soil of the experimental field

Season	Available (ppm)			PH	Clay %	Silt %	Fine sand %	Texture	Water Table(m)
	N	P	K						
2007	82.0	21.0	505.0	8.8	30.2	30.2	17.1	Clay	2.23

Collected data:

-The following data were estimated as follows:

1- Physiological characters:

Before flowering stage at 40 days after sowing, the third leaf from the top of the plant in different treatments were used for measuring osmotic pressure (OP) and osmotic pressure at turgidity, and observations were made 14:00 h. where, half the lamina of sampled leaf (without the midrib vein) was used to determine osmotic pressure and the remaining leaf (lamina with midrib vein) was used for measuring osmotic pressure at full turgor.

A- Osmotic pressure (OP):

Osmotic pressure was determined using TSS (Total soluble solids) in leaf sap according to Gossav (1960). The leaves were directly taken from different treatments, immediately freezed, the sap was then extracted in the laboratory with a piston press when the frozen tissues had been thawed.Then T.S.S values converted to OP from Gossav table.

B- Osmotic pressure at full turgor (OP ft):

The remaining half (without the midrib vein)from different treatments was immediately placed in a suitable container, with distilled water for 12 h.. The sap was then extracted in the laboratory with a piston press. Then Total Soluble Solids converted to OP ft from Gossav table.

C- Osmotic adjustment:

Then osmotic adjustment (OA) is determined using the following equation according to Kiani *et al*. (2007): $OA = \Psi_s FT\ (ww) - \Psi_s FT\ (ws)$

Where: $\Psi_s FT$ (ww) is osmotic pressure at full turgor of well watered plants and $\Psi_s FT$ (ws) is osmotic pressure at full turgor of water stressed plants.

D- Leaf area index (LAI):

Leaf area index was determined by leaf area measurement. For leaf area measurement, leaf area samples were taken from ten leaves per five plants from second ridge for plot. The disk method was used in which the whole disks of 1.2 cm diameter. Total leaf area for the plants of the sample was calculated using the following formula:

Total leaf area = leaf dry weight x disk area/ disk dry weight

Leaf area index was calculated according to Watson (1958)

2- Yield characters:

A- Seed yield/feddan

In order to determine seed yield/fed, plants of three replicates from the 2nd ridges were bagged at the end of pollination for decreasing bird damages and used for estimating yield per feddan. The outer two plants from the 2nd ridge were left as border. Then seed yield/fed was calculated from the 2nd ridge for 2 meter length of each experimental unit and then transformed to kg/feddan.

B- Seed oil percentage:

Seed oil percentage was determined from 2nd ridge and measured according to A.O.A.C. (1980) by using soxhelt apparatus and petroleum ether as an organic solvent, and then the oil percentage was calculated on dry weight basis.

C- Oil yield/feddan:

Oil yield/fed (kg) was calculated by multiplying seed yield/fed (kg) by seed oil percentage.

D- Harvest index (HI %):

Harvest index (%) was calculated as ratio of seed yield/fed to above-ground biomass x 100.

Statistical procedures:

A regular analysis of variance of randomized complete block design of separate environment was carried out for each trait according to Snedecor and Cochran (1980). A combined analysis of variance was computed over the two irrigation treatments was performed according to Leclerg *et al*. (1962). Mean values were compared using least significant differences (LSD) at the proper level of significance.

Simple correlation coefficient between yield characters and osmotic adjustment was calculated under control and stress treatments as outlined by Svab (1973).

RESULTS AND DISCUSSION

Screening methodology for selecting tolerant genotype has become an effective tool in the hands of plant breeder as a result of merging plant breeding and plant physiological traits that are mostly highly inherited and well correlated with performance under field stress conditions. Therefore, osmotic adjustment used to screening genotypes before flowering at 40 days after sowing. Since, osmotic adjustment refer to the lowering of osmotic pressure due to the accumulation of solutes in response to water deficits, and results in the maintainance of a higher turgor potential that may contribute to limiting the effects of stress on physiological traits such as stomatal opening, photosynthesis and growth.

A- physiological characters :

Data presented in Table 3 showed mean squares of some physiological characters for 33 inbred lines as well as check cultivars i.e. Sakha 53 and Giza 102 of screening test under two irrigation treatments. It is noticeable that mean squares due to irrigation treatments were highly significant for osmotic pressure, osmotic pressure at full turgor, and leaf area index under normal irrigation and water stress conditions. These results agreed with those reported by Petcu *et al*. (2003).

The results indicate that mean squares due to the 33 sunflower genotypes and check cultivars i.e. Sakha 53 and Giza 102, were highly significant for osmotic pressure, osmotic pressure at full tuirgor, and leaf area index. Differences in osmotic pressure, osmotic pressure at full turgor and leaf area index among genotypes were reported by Kiani *et al*. (2007) and Rauf and Sadaqat (2008).

Mean squares for interaction between irrigation and genotypes were highly significant for osmotic pressure (OP), osmotic pressure at full turgor (OP ft) and leaf area index (LAI).

Table 3: Mean squares of some physiological characters for 33 inbred lines as well as check cultivars i.e. Sakha 53 and Giza 102 under two irrigation treatments

Trait / Source	D.F	Osmotic pressure	Osmotic pressure at full turgor	Leaf area index
Irrigation (I)	1	96.09 **	65.73 **	7142.79 **
Error	4	4.64	0.12	0.01
Genotypes (G)	34	50.97 **	48.18 **	405.02 **
I x G	34	9.57 **	7.68 **	78.60 **
Error	136	31.01	0.60	0.201

Data presented in Table 4 indicated that the response of sunflower genotypes to water stress treatment as indicated by osmotic adjustment (OA) provide evidence that the tolerant sunflower genotypes displayed (OA) values near from the unity due to water stress were G 13 (0.75) and Sakha 53 (0.69). These results clearing that those genotypes performed well under drought stress conditions and could be classified as a drought tolerant. The range of osmotic adjustment (OA) for water stress was 0.10 (G 24and G 27) to 0.75 (G13). In this respect, many investigators reported that, sunflower genotypes had osmotic adjustment less than unity were identified as sensitive to drought, however, sunflower genotypes exhibited osmotic adjustment values near from unity were classified as tolerant to drought (Rauf and Sadaqat,2008).

As seen in the Table 4 Interaction between soil moisture stress and sunflower genotypes was statistically significant concerning osmotic pressure, osmotic pressure at full turgor and leaf area index.

Table 4: Means of osmotic adjustment as indicator for drought tolerance of sunflower genotypes and means of osmotic pressure, osmotic pressure at full turgor as well as leaf area index as affected by the interaction between irrigation treatments (Normal and drought) and sunflower genotypes

characters / Genotypes	Osmotic Pressure (bar)		Osmotic pressure at full turgor (bar)		Osmotic adjustment (bar)	Leaf area index	
	N	D	N	D		N	D
G1 (L19)	-3.41	-4.71	-0.82	-1.00	0.18	1.29	0.87
G2 (L110)	-3.75	-5.48	-0.87	-1.11	0.24	1.28	0.87
G3 (L350)	-5.48	-6.30	-1.11	-1.21	0.11	1.79	1.11
G4 (L775)	-5.68	-6.80	-1.13	-1.29	0.16	1.90	1.18
G5 (L770)	-4.88	-5.50	-1.03	-1.11	0.13	1.92	0.91
G6 (L355)	-3.75	-4.53	-0.87	-0.97	0.11	1.34	0.61
G7 (L990)	-3.93	-4.92	-0.89	-1.03	0.13	1.72	0.67
G8 (L125)	-3.59	-4.71	-0.84	-1.00	0.16	1.17	0.66
G9 (L460)	-3.93	-6.63	-0.89	-1.27	0.37	1.64	0.97
G10 (L92)	-6.42	-7.69	-1.24	-1.40	0.16	2.33	1.18
G11 (L230)	-5.09	-7.67	-1.05	-1.40	0.40	1.52	1.15
G12 (L465)	-3.93	-5.00	-0.89	-1.03	0.13	1.68	0.84
G13 (L245)	-6.30	-12.59	-1.21	-1.96	0.75	2.08	1.75
G14 (L880)	-6.18	-9.47	-1.27	-1.59	0.32	2.39	1.24
G15 (L885)	-3.41	-4.45	-0.82	-0.95	0.13	1.22	0.59
G16 (L240)	-4.14	-5.10	-0.92	-1.05	0.13	1.34	0.80
G17 (L235)	-5.48	-6.30	-1.11	-1.21	0.11	1.77	0.97
G18 (L120)	-3.75	-5.10	-0.87	-1.05	0.19	1.34	0.87
G19 (L10)	-6.36	-6.77	-1.24	-1.29	0.13	2.20	1.13
G20 (L62)	-4.76	-5.48	-1.00	-1.11	0.11	1.51	0.89
G21 (L34)	-5.38	-6.09	-1.08	-1.19	0.11	1.91	0.51
G22 (L38)	-3.41	-5.12	-0.82	-1.05	0.24	1.07	0.63
G23 (L21)	-4.95	-5.68	-1.03	-1.13	0.11	1.33	0.91
G24 (L11)	-3.98	-4.32	-0.90	-0.95	0.10	0.89	0.60
G25 (L20)	-5.30	-6.60	-1.08	-1.27	0.19	1.74	0.99
G26 (L8)	-3.75	-4.50	-0.87	-0.97	0.11	1.27	0.50
G27 (L39)	-3.59	-4.32	-0.84	-0.95	0.10	0.76	0.45
G28 (L2)	-4.61	-6.09	-0.97	-1.19	0.21	1.46	0.92
G29 (L40)	-4.95	-6.60	-1.03	-1.21	0.19	1.70	1.13
G30 (L4)	-3.42	-4.92	-0.82	-1.03	0.21	1.00	0.73
G31 (L16)	-3.77	-4.92	-0.87	-1.03	0.16	1.75	1.05
G32 (L1)	-4.04	-4.92	-0.89	-1.03	0.13	1.23	0.78
G33 (L3)	-3.42	-4.53	-0.82	-0.97	0.15	1.13	0.74
Sakha 53	-6.60	-11.39	-1.27	-1.96	0.69	1.98	1.40
Giza 102	-3.75	-4.92	-0.87	-1.03	0.16	1.19	0.72
LSD 5%	**0.79**		**0.11**			**0.064**	

Where, N= normal irrigation and D= stress treatment

Under normal irrigation, based on mean value, osmotic pressure was varied from 3.41 (G1, G15, G 22) to 6.60 (Sakha 53); osmotic pressure at full turgor was varied from 0.82 (G 1,G 15,G22,G30,G33 to 1.27 (Sakha 53 and

G14) and leaf area index was varied from 0.89 (G 24) to 2.39 (G14). Whereas, under stress conditions, based on mean value, osmotic pressure was varied from 4.32 (G24 and G27) to 12.59 (G13); osmotic pressure at full turgor was varied from 0.95 (G15, G24 and G27) to 1.96 (G13 and Sakha 53) and leaf area index was varied from 0.45 (G27) to 1.75 (G13). It is clear from these results that Sakha 53 and G10 gave high mean performance for osmotic pressure, osmotic pressure at full turgor and leaf area index under normal irrigation. Since, G13 and Sakha 53 performed well for osmotic pressure, osmotic pressure at full turgor and leaf area index under drought stress conditions and could be classified as a drought tolerance ones.

B-Yield characters:

Data presented in Table 5 show mean squares of seed yield/pant (g), seed yield/feddan (kg), oil percentage, oil yield/fed (kg) and harvest index for 33 inbred lines as well as check cultivars i.e., Sakha 53 and Giza 102 under two water treatments.

It is noticeable that mean squares due to irrigation treatments, were highly significant for seed yield/plant (g), seed yield/fed (kg), oil percentage, oil yield/fed (kg) and harvest index under normal irrigation and water stress conditions. The results agreed with those obtained by El-Sabbagh (2003). The results revealed that mean squares due to the 33 sunflower genotypes, and check cultivars i.e. Sakha 53 and Giza 102 were highly significant for seed yield/plant (g), seed yield/fed (kg), oil percentage, oil yield/fed (kg) and harvest index.

Mean squares for the interaction between irrigation and genotypes were highly significant for seed yield/plant (g), seed yield/feddan (kg), oil percentage, oil yield/feddan (kg) and harvest index.

Table 5: Mean squares of seed yield/plant (g), seed yield/feddan (kg), oil percentage, oil yield/feddan (kg) and harvest index for 33 inbred lines as well as check cultivars i.e., Sakha 53 and Giza 102 under two water treatments

Trait / Source	D.F	Seed yield/plant (g)	Seed yield/fed (kg)	Oil (%)	Oil yield/ fed (kg)	Harvest index
Irrigation,I	1	34149.5**	36047.7**	1035.6**	36535.5**	67203.9**
Error	4	11.24	2575.45	3.84	599.90	0.116
Geno., G	34	1597.9 **	1582.1 **	32.1 **	1058.0 **	357.8 **
I x G	34	287.35 **	284.38 **	2.38 **	205.12 **	42.32 **
Error	136	261.58	63915.61	83.94	18574.41	14.02

As seen in the Table 6 interaction between soil moisture stress and sunflower genotypes was statistically significant concerning seed yield/plant (g), seed yield/fed (kg), oil (%), oil yield/fed (kg) and harvest index. As seen in this table, under normal irrigation, based on mean value, seed yield per plant (g) was varied from 41.09 (G25) to 140.38 (G6); seed yield per feddan (kg) was varied from 458.26 (G22) to 2183.60 (G6); oil (%) was varied from 42.57 (G25) to 49.09 (G9); oil yield per feddan (kg) was varied from 203.93 (G22) to 1009.31 (G6) and harvest index was varied from 9.66 (G22) to 19.33 (G6).

Table 6: Seed yield/plant (g), seed yield/fed (kg), oil percentage, oil yield/fed (kg) and harvest index as affected by the interaction between irrigation treatments and sunflower genotypes

characters / Genotypes	Seed yield/plant (g)		Seed yield/fed (kg)		Oil (%)		Oil yield/fed (kg)		Harvest index (HI %)	
	N	S	N	S	N	S	N	S	N	S
G1 (L19)	53.46	22.33	831.58	347.35	45.71	42.50	380.10	147.62	13.50	7.59
G2 (L110)	96.23	27.24	1496.83	423.72	44.74	41.60	669.72	176.27	17.23	8.55
G3 (L350)	118.99	51.15	1850.98	795.60	44.90	40.41	831.07	321.41	18.45	11.94
G4 (L775)	109.52	35.44	1703.62	551.33	44.07	39.66	750.84	218.55	17.98	9.45
G5 (L770)	80.91	45.49	1258.53	707.61	42.98	37.39	540.93	264.58	12.86	11.31
G6 (L355)	140.38	51.97	2183.60	808.36	46.23	42.99	1009.31	347.45	19.33	11.51
G7 (L990)	95.05	39.37	1478.48	612.37	46.54	41.72	688.22	255.46	17.16	10.53
G8 (L125)	44.78	20.71	696.62	322.15	47.65	44.32	331.88	142.71	12.33	7.18
G9 (L460)	60.91	31.77	947.52	494.24	49.09	45.65	465.17	225.69	14.35	9.37
G10 (L92)	68.71	20.24	1068.85	314.79	44.63	38.83	477.22	122.34	15.14	7.07
G11 (L230)	114.03	97.09	1773.72	1510.26	45.13	40.61	800.64	613.26	18.21	15.18
G12 (L465)	106.45	39.76	1655.86	618.53	44.86	40.37	742.68	249.71	17.82	10.58
G13 (L245)	93.32	83.74	1451.62	1302.55	44.72	41.68	649.01	543.06	17.04	14.49
G14 (L880)	103.69	52.19	1612.93	811.88	45.07	40.56	726.94	329.28	17.67	12.05
G15 (L885)	93.42	36.33	1453.23	565.18	48.58	45.18	705.98	255.36	17.12	10.09
G16 (L240)	69.28	30.32	1077.72	471.58	45.23	40.70	487.37	191.92	15.49	9.12
G17 (L235)	89.17	43.32	1387.12	673.91	44.39	41.32	615.71	278.47	16.17	11.04
G18 (L120)	86.59	42.52	1346.88	661.36	46.33	43.08	623.99	285.04	16.59	10.94
G19 (L10)	88.53	31.10	1377.17	483.71	44.88	39.04	618.05	188.81	16.73	9.25
G20 (L62)	61.79	25.84	961.63	401.94	45.78	39.82	440.30	160.10	14.45	8.29
G21 (L34)	42.33	19.11	658.41	297.31	44.37	39.93	292.18	118.74	11.97	6.81
G22 (L38)	29.46	15.40	458.26	239.50	44.50	41.25	203.93	98.96	9.66	5.84
G23 (L21)	34.18	14.24	531.68	221.45	44.51	40.05	236.70	88.71	10.59	5.51
G24 (L11)	30.37	11.45	472.42	178.05	44.10	39.69	208.36	70.74	9.85	4.66
G25 (L20)	41.09	19.66	639.22	307.81	42.57	37.03	272.03	113.36	11.77	6.93
G26 (L8)	66.89	21.91	1040.55	340.86	44.17	39.75	459.63	135.35	14.96	7.46
G27 (L39)	44.40	12.49	690.66	194.34	46.71	43.43	322.51	81.64	12.28	4.99
G28 (L2)	85.71	27.27	1333.19	424.24	43.86	38.15	584.81	161.88	16.53	8.57
G29 (L40)	113.25	43.77	1761.58	680.89	43.45	37.80	765.51	257.40	18.17	11.10
G30 (L4)	75.22	21.88	1170.02	345.53	43.56	37.89	509.52	130.80	15.71	7.52
G31 (L16)	61.70	23.56	959.71	366.48	44.64	40.17	428.50	147.32	14.44	7.82
G32 (L1)	50.49	20.32	785.39	316.02	44.71	40.23	351.19	127.13	13.12	7.09
G33 (L3)	58.23	20.27	905.79	315.30	47.40	44.08	429.35	139.01	13.73	7.08
Sakha 53	113.53	79.11	1765.94	1230.40	46.75	43.47	825.45	534.92	18.19	14.21
Giza 102	80.19	27.55	1247.33	428.54	44.07	38.33	549.64	164.23	16.12	8.62
L.S.D 5%	2.22		34.69		1.26		18.70		0.51	

Where, N= normal irrigation and D= stress treatment

Whereas, under stress conditions, based on mean value, seed yield per plant (g) was varied from 11.45 (G24) to 97.09 (G11); seed yield per feddan (kg) was varied from 178.05 (G24) to 1510.26 (G11); oil percentage was varied from 37.03 (G25) to 45.65 (G9); oil yield/fed was varied from 70.74 (G24) to 613.26 (G11) and harvest index was varied from 4.66 (G24) to 15.18 (G11). It is clear from these results that G6 and G9 gave high mean performance for seed yield per plant (g), seed yield per feddan (kg), oil (%), oil yield per faddan (kg) and harvest index under normal irrigation. Since, G 9 and G11 performed well for seed yield per plant (g), seed yield per feddan (kg), oil (%), oil yield per feddan (kg) and harvest index under drought conditions and could be classified as a drought tolerance ones.

B- Correlation coefficient between the studied yield characters and osmotic adjustment

Correlation coefficient between the studied yield characters as well as osmotic adjustment were computed under both normal and stress conditions to demonstrate the importance of osmotic adjustment as a screening tool to enable screening large number of entries for drought tolerance. Results given in Table 7 show correlation coefficient between osmotic adjustment and its relevant yield characters under normal irrigation conditions. It is clear from the results that osmotic adjustment appears to be positive and non significantly correlated with each of; seed yield per feddan, oil percentage, oil yield per feddan and harvest index under normal irrigation conditions.

Whereas, under drought stress conditions, its clear from the data in Table 7 that, osmotic adjustment showed positive and highly significant correlated with each of; seed yield per feddan, oil yield per feddan and harvest index. But positive and non significantly correlated with oil percentage only. These results revealed that osmotic adjustment may be development sunflower plants to tolerance water stress and may have used as a selection criteria for improving sunflower genotypes under water stress conditions. In this connection, using different F3 families, Chimenti *et al.* (2002) demonstrated that osmotic adjustment, a parameter directly related to drought tolerance, contributes to yield maintenance of sunflower under pre-anthesis drought conditions, when leaf expansion and root growth are not yet ceased.

It is inferred from the correlation studies that sunflower genotypes with higher osmotic adjustment had greater seed yield/feddan, oil yield/feddan and harvest index at physiological maturity under stress conditions.

From the abovementioned data, it can be concluded that G13, Sakha 53 should be chosen as a parent to cross with other inbred lines because of its highest osmotic adjustment had a superiority in the direct use at drought affected soil and/or for breeding program to pursue further advancement in sunflower drought tolerance.

Table 7: Correlation coefficient between osmotic adjustment and yield determinations under normal irrigation and drought conditions

Treatments \ characters		Seed yield/fed	Oil percentage	Oil yield/ fed	Harvest index (%)
Normal irrgation	Osmotic adjustment	0.251	0.137	0.263	0.265
Drought Stress	Osmotic adjustment	0.646 **	0.209	0.666 **	0.549 **

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الضبط الأسموزي كأداة سريعة للفرز لتحمل الجفاف في فترة ما قبل التزهير في دوار الشمس.

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*** قسم المحاصيل- كلية الزراعة- جامعة المنصورة**

**** قسم بحوث المحاصيل الزيتية - مركز البحوث الزراعية**

أقيمت تجربة حقلية تكميلية خلال الموسم الصيفي ٢٠٠٧ في محطة البحوث الزراعية بكفر الحمام – مركز البحوث الزراعية بمحافظة الشرقية – مصر لفرز ٣٣ سلالة (المنتخبة من مخزون المواد الوراثية لقسم بحوث المحاصيل الزيتية) بالأضافة إلي صنفي مقارنة سخا ٥٣ وجيزة ١٠٢ تحت معاملتي ري (الري العادي كل ١٥ يوم ، ومنع الري بعد رية المحاياه) باستخدام الضبط الأسموزي.

وقدر الضبط الأسموزي من الفرق بين الضغط الأسموزي عند تمام الأمتلاء لمعاملتي الري العادي و الجفاف .ولم يظهر تأثير للضبط الأسموزي تحت معاملة الري العادي. كان محصول الزيت/فدان ومحصول البذور/فدان من صفات المحصول الأكثر تأثراً بالضبط الأسموزي. وتشير نتائج تحليل التباين تحت ظروف معاملتي الري إلي وجود فروق عالية المعنوية لكل الصفات تحت الدراسة. و كانت الأختلافات بين التراكيب الوراثية عالية المعنوية لكل الصفات تحت الدراسة. وكان التفاعل بين التراكيب الوراثية ومستويات الري معنوياًً لكل الصفات تحت الدراسة. وحقق صنف سخا ٥٣، والسلالة ١٣ أعلي القيم للمحصول. وأوضحت قيم الأرتباط بين الضبط الأسموزي وصفات المحصول إلي وجود تلازم موجب وعالي المعنوية.

توصي هذه الدراسة بأن التراكيب الوراثية المرتفعة في الضبط الأسموزي تكون أفضل في الاستخدام المباشر تحت ظروف الجفاف أو تستخدم في برامج تربية دوار الشمس لتحمل الجفاف.