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Effect of water regime and varietal differences on yield, its components and chemical constituent of Sunflower plant

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Abstract : This investigation was carried in order to evaluate the effect of water regime on growth characters, yield, yield components and some chemical constituent of two sunflower cultivars. The two field experiments were conducted in Wadi El-Rayyan, El-Fayoum Governorate, Egypt, in the two summer seasons of 2014 and 2015 seasons, under newly reclaimed sandy soil. Water regime treatments i.e.(Normal irrigation, omitting the 3rd irrigation, omitting the 4th irrigation and omitting the 5th irrigation) were added in the main plots, while the two sunflower cultivars Pioneer-6480 and Haisun-354 were allocated in the sub plots. The results could be summarized as follows.

1-It is clear from data that water regime had a significant effect on growth characters at 60 and 75 days from sowing except LA (cm^2), where normal irrigation gave the highest values followed by omitting the 4th irrigation. Analysis of variance showed significant difference among water regime, where normal irrigation outweigh the other treatments followed by omitting the 4th irrigation.

2-Pioneer-6480 cultivar significant surpassed Haisun-354 cultivar in growth characters at 60 and 75 days after sowing in both seasons. Also results show that variety factor had a significant effect on yield and yield components.

3-Regarding of the interaction between sunflower cultivars and water regime results showed that there were significant differences in growth characters under study at 60 and 75 days from sowing except plant height and LA (cm^2) at 60 and 75 days from sowing and SLA (cm^2 /g) at 75 days from sowing. At the same time the value of interaction in yield and its components did not reach to the significant level except shelling percentage.

Keywords: Sunflower, cultivars, water regime, growth parameters, yield and its components.

Introduction

Sunflower (*Helianthus annus* L.)is an important source of edible oil in the world because of its high polysaturated fatty acids. Sunflower oil production can be increased by increasing area of sunflower or by increasing total seed and its oil percentage to face urgent demands of increasing population in Egypt.The productivity of sunflower differs greatly by varietal characteristics and also by the environmental conditions i.e. temperature, soil fertility and irrigation regime for that responses of different varieties to water supply is considered an important factors affecting yield of sunflower.

Water is essential at every stage of plant growth, from seed germination to plant maturation[1]. As a results of water deficit stress, the physiology of crop is disturbed this causes a large number of changes in

morphology and anatomy of plant and it had many effects on growth and yield of the crop[2,3]. Increase the irrigation interval reduced yield and its components[4]. **Anwar *et al*,**[5] told that all the yield components were affected by the number of irrigation. **Soriano *etal*,**[6] concluded that sunflower seed yield was the most sensitive to water stress after anthesis.

The aim of thisinvestigation was to study effectof water regime on growth, yield and yield components of two sunflower cultivars under sandy soil conditions.

Materials and Methods

Two field experiments were conducted during the two successive summerseasons of 2014 and 2015 in Wadi El-Rayyan Region, El-Fayoum Governorate, Egypt, to study the effect of water regime and varietal differences on growth, yield,its components and chemical composition of sunflower plants under newly reclaimed sandy soil. The experiment included eight treatments with four replications which were the combination of two sunflower cultivars, i.e. Pioneer- 6480 and Haisun-354 and four water regime treatment i.e.

1. Normal irrigation.
2. Omitting the 3rd irrigation.
3. Omitting the 4th irrigation.
4. Omitting the 5th irrigation.

Soil samples was taken at depth of 30 cm for mechanical and chemical analysis as described by[7] and presented at Table (1).

Table (1): Mechanical and chemical analysis of soil at experimental sites (Average of 2014 and 2015 seasons)

Sand %	Silt%	Clay %	Texture	pH	Organic matter O.M.%	Available Nppm	Available K ppm	Available Pppm
73.59	22.47	3.45	Sandy	8.00	0.49	84.00	134.00	12.5

Split plot design with four replications was used, where the treatments of water regime were added randomly in the main plots, on the other hand two sunflower cultivars i.e. Pioneer-6480 and Haisun-354 were allocated in the sub-plots.

Seeds which uniformity in size, shape and colorwere sown in 15th May and 17th May in two seasons, each plot contains (7) ridges, (5) meter long and 60 cm apart. Sowing was in hills spaced 20cm apart. Three seeds were sown in hills. Phosphorus as super phosphate (15.5 % P_2O_5) was mixed before sowing in the soil.Other agriculture processes were done according to normal practice recommendedby Oil Crop Research Section, Agricultural Research Centre, Ministry of Agriculture, Egypt.Plants were thinningtoone plant per hill after 20 days from sowing.Treatments of water regime were done i.e. (Normal irrigation, omitting the 3rd irrigation, omitting the 4th irrigation and omitting the 5th irrigation).

After 60 and 75 days from sowingSamples of five guarded plants were taken random from the middle ridges of each plot to measure growth characters i.e. plant height "cm", number of leaves/plant and total plant dry weight "kg". Leaves area/plant was determined according to[8], whereas leaf area index (LAI) was determined according to[9]. In addition specific leaf area (SLA) was determined according to [10]and specific leaf weight (SLW) according to[11].

At harvest, a random of five plants were taken from the middle ridges of each plot to determine head diameter (cm), weight of head/ plant (g),weight of seeds/head(g), seed index (1000 seeds/g), shelling percentage (seed weight/head weight) and harvest index (seed yield/ biological yield) were calculated. Furthermore, seed, straw and biological yields "Kg/feddan" were collected from the whole area of each experimental unit and then converted into yield per feddan. To determine protein percentage,nitrogen concentration of seed was determined by colorimetryKjeldahl[12],while the seed oil content by Soxhlet method.

All data were subjected to statistical analysis according to procedure outlined by[13]. Treatments means were compared by L.S.D at5% level test. Combined analysis was made for the two growing seasons as results followed similar trend.

Results and Discussion

Growth characters:-

1-Effect of water regime:

It is known that the vegetative characteristics of plants have a direct relation with agronomic practices among which irrigation treatments is one of the most important. Such characteristics are in direct correlation with the yield. However, water stress or deficit occurs whenever the loss of water by transpiration exceeds the rate of absorption, which many influences the growth and the yield. Data in table (2) elucidate that growth characters were affected by water regime i.e. plant height (cm), number of leaves/plant, total plant dry weight (kg). Leave area index, specific leaf area(cm^2/g), specific leaf weight (g/cm^2), while leaf area (LA) the differences were not great enough to reach the level of significance. Data presented in Table (2) show that normal irrigation surpassed all water regime treatments in all growth characters followed by omitting the 4th irrigation and omitting the 5th irrigation at 60 days and 75 days from sowing in both seasons. The reduction of growth characters especially plant height with omitting one irrigation may be mainly due to the direct effect of limited water supply, which reflects in the reduction in metabolic products [14,15,16,17].

The negative action of skipping irrigation on growth characters plant might be reduced the photosynthetic rate which resulted in impede the growth these results are in agreement with those obtained by [18,19], also,[20] who reported that early water stress affected dry matter production and biomass in plant.

2- Effect of cultivars:

Table (2) indicated that significant differences were found between sunflower cultivars Pioneer- 6480 and Haisun-354 inall growth charactersunder this study at 60 and 75 days from sowing i.e.plant height (cm), number of leaves/plant, total dry weight/plant (kg), leaf area/ plant (cm^2), Leave area index, specific leaf area (cm^2/g) andspecific leaf weight (g/cm^2).Plant height, total dry weight/ plant, leaf area/ plant, Leave area index and specific leaf area increased with advancing plant age from 60 to 75 days from sowing, at the same time number of leaves/ plant and SLW decreased with advancing plant age from the first sample (60 days from sowing)to the second sample (75 days from sowing) in both seasons.The sunflower cultivarPioneer-6480 surpassed significantly Haisun-354 cultivar in all growth parameters at the different stages of growth.It is true to mention that the differences between the two sunflower cultivars under study may be due to the genetic structure differences between cultivars, to the cultivar differences in glucose requiredfor synthesis of different chemical constituents at different plant organs, in carbon equivalent and partitioning of photosynthate among the plant organs of sunflower plant[21],also, to the great differences between genotypes for mineral elements concentrations [22].The decreasedof number of leaves/plant and specific leaf weight may be due to the differences between cultivars in migration coefficient of dry matter from vegetative organs to head also to the cultivars differences in photosynthate partitioning [21].

These results are in harmony with results mentioned by[21,23,24,25].

3- Effect of interaction between water regime and cultivars:

Data in Table (3) indicated that the interaction between water regime and sunflower cultivars was significant on some growth characters at 60 and 75 days from sowing in both seasons i.e. number of leaves/plant, total dry weight/plant, Leaf area index and specific leaf weight.While specific leaf area was significant at 60 day after sowing only. It is clear from data that the best mean values was obtained from Pioneer- 6480 cultivar with normal irrigation followed by Pioneer- 6480 with omitting the 4th irrigation.

Table (2): Effect of water regime and varietal differences on some growth parameters of sunflower plant at 60 and 75 days after sowing. (Average of 2014 and 2015 seasons).

Characters	Plant height(cm)		Number of leaves/ plant		Total dry weight/plant (kg)		LA (cm^2)		LAI		SLA (cm^2 /g)		SLW (g /cm^2)	
Treatments	**60**	**75**	**60**	**75**	**60**	**75**	**60**	**75**	**60**	**75**	**60**	**75**	**60**	**75**
Water regime														
Normal irrigation	285.38	317.75	31.65	27.01	2.547	2.962	1339.60	1372.58	1.495	1.528	186.52	205.89	3.642	3.453
Omitting the 3rd irrigation	267.15	300.08	25.35	21.33	2.440	2.807	1333.11	1364.75	1.477	1.512	174.01	190.87	3.530	3.088
Omitting the 4th irrigation	279.25	310.55	29.03	24.54	2.508	2.930	1335.78	1368.75	1.490	1.523	184.03	200.53	3.602	3.395
Omitting the 5th irrigation	277.26	308.80	28.68	24.28	2.498	2.900	1334.77	1367.31	1.485	1.518	181.52	199.06	3.590	3.310
L.S.D at 5%	1.05	1.44	o.81	0.71	0.006	0.011	n.s	n.s	0.005	0.005	0.82	0.56	0.016	0.007
Cultivars														
Pioneer 6480	279.53	313.07	29.89	25.82	2.508	2.911	1342.36	1381.22	1.493	1.533	184.57	208.19	3.736	3.322
Haisun 354	274.99	304.53	27.47	22.76	2.489	2.888	1329.28	1355.47	1.480	1.508	178.47	189.94	3.446	3.302
L.S.D at 5%	1.12	1.49	0.43	0.47	0.005	0.010	4.75	8.22	0.003	0.004	0.37	1.60	0.008	0.006

Table (3): Effect of interaction between water regime and varietal differences on some growth parameters of sunflower plant at 60 and 75 days after sowing. (Average of 2014 and 2015 seasons).

Treatments	Characters	Plant height(cm)		Number of leaves/ plant		Total dry weight/ plant (kg)		LA (cm^2)		LAI		SLA(cm^2 /g)		SLW (g /cm^2)	
		60	75	60	75	60	75	60	75	60	75	60	75	60	75
Water regime x Cultivars															
Normal irrigation	Pioneer 6480	287.96	320.84	33.83	29.02	2.547	2.970	1345.61	1387.83	1.507	1.540	188.86	215.96	3.793	3.530
	Haisun 354	282.80	310.71	29.48	24.99	2.547	2.953	1333.00	1357.33	1.483	1.517	184.18	195.82	3.490	3.377
Omitting the 3rd irrigation	Pioneer 6480	269.78	303.70	25.47	22.57	2.457	2.847	1342.22	1372.00	1.480	1.520	177.94	200.81	3.633	2.937
	Haisun 354	264.51	296.47	25.24	20.09	2.423	2.767	1324.00	1357.50	1.473	1.503	170.08	180.74	3.397	3.240
Omitting the 4th irrigation	Pioneer 6480	280.84	314.66	30.37	25.88	2.520	2.917	1341.40	1383.83	1.497	1.540	186.91	207.80	3.750	3.500
	Haisun 354	277.66	306.43	27.69	23.21	2.497	2.943	1330.17	1353.67	1.483	1.507	181.15	193.27	3.453	3.290
Omitting the 5th irrigation	Pioneer 6480	279.52	313.07	29.89	25.82	2.507	2.910	1340.27	1381.22	1.490	1.530	184.57	208.19	3.737	3.320
	Haisun 354	274.99	304.53	27.47	22.74	2.490	2.890	1329.28	1353.39	1.480	1.507	178.47	189.94	3.443	3.300
L.S.D. at 5%		n.s	n.s	0.86	0.93	0.009	0.020	n.s	n.s	0.007	0.008	0.73	n.s	0.017	0.013

B-Yield, yield components and some chemical composition:

1-Effect of water regime:

AS can be seen from Table (4) water stress significantly decreased all characters of yield, yield components and some chemical composition i.e. head diameter "cm", weight of head / plant "g", weight of seeds/head "g" , seed index "g", shelling percentage , seed, straw and biological yields "kg"/ feddan, harvest index%, protein percentage and oil percentage in both seasons. It is clear from data that the highest mean value of all characters under study were obtained from normal irrigation followed by omitting the 4th irrigation and then by omitting the 5th irrigation. Effect of water stress is usually accompanied with limited photosynthesis and decrease in photosynthesis leads to decrease in yield[26]. If water stress occurs during earliest stages of sunflower growth, leaf area expansion goes down slowly but when water stress occurs during reproductive stages leaf aging leads to leaf area reduction [27], seed yield will be decreased [28]. It is clear that water stress decreases cell division and cell elongation. Many investigators reported that small leaves because of water stress lead to low seed yield and protein and oil percentages[29,30].Seed index was decreased also with water deficit. It clear that normal irrigation increase leaf area and thereby increased rate of photosynthesis and better translocation of photosynthtes from leaves and stem to sink. These results are in harmony with obtained by [31,32,33].

2- Effect of cultivars:

Data in Table (4) indicated that the yield and its components of the two sunflower cultivars were significant different for all characters of yield and its components under study in both seasons. Pioneer- 6480 cultivar was superior in its yield and yield components compared with Haisun-354 cultivar. The superiority of grain yield/fed., and straw yield/fed., in Pioneer-6480 cultivar mainly due to the increase in some yield components. The cultivar differences may be due to the differences in genetic structure between the two sunflower cultivars, to the differences in growth characters and to the differences in photosynthetic partitioning that previously indicated [34,35,22]. These results are in good agreement with those reported by [36-38].

3- Effect of interaction between water regime and cultivars:

It is obvious from Table (5) that effect of the interaction between water regime and sunflower cultivar failed to reach level of significance at all characters of yield and yield components in both seasons except shelling percentage normal irrigation with Pioneer- 6480 cultivar or Haisun-354 cultivar did not differ with Pioneer- 6480 cultivar with omitting the 4th irrigation or 5th irrigation. All results revealed that the best treatment was Pioneer-6480 cultivar with normal irrigation followed by omitting the 4th irrigation.

Table (4): Effect of water regime and varietal differences on yield , its components and chemical constituent of sunflower plant.(Average of 2014 and 2015 seasons).

Characters / Treatments	Head diameter (cm)	Weight of head/ plant (g)	Weight of seeds /head (g)	Shelling %	Seed index (g)	Seed yield (kg) /feddan	Straw yield (kg) /feddan	Biological yield (kg) /feddan	Harvest index %	Protein %	Oil %
Water regime											
Normal irrigation	28.01	351.30	187.97	53.51	87.76	1047.93	4215.57	5266.16	19.918	17.310	37.168
Omitting the 3rd irrigation	22.26	341.92	177.52	51.99	80.01	960.10	4096.96	5027.81	19.102	17.223	37.047
Omitting the 4th irrigation	25.25	347.67	184.12	53.04	84.04	1008.39	4172.40	5180.37	19.460	17.272	37.110
Omitting the5th irrigation	25.17	346.79	183.20	52.85	83.93	1005.47	4161.64	5154.33	19.490	17.267	37.107
L.S.D at 5%	0.89	1.05	0.72	0.27	0.60	13.29	10.97	43.96	0.353	0.010	0.015
Cultivars											
Pioneer 6480	26.54	352.37	186.77	53.04	86.61	1039.35	4225.35	5259.14	19.746	17.344	37.141
Haisun 354	23.81	341.47	179.63	52.65	81.26	971.60	4097.93	5049.69	19.239	17. 192	37.075
L.S.D. at 5%	0.47	1.04	0.83	0.22	0.66	8.04	9.20	30.04	0.248	0.124	0.007

Table (5): Effect of interaction between water regime and varietal differences on yield , its components and chemical constituent of sunflower plant. (Average of 2014 and 2015 seasons).

Treatments	Characters	Head diameter (cm)	Weight of head/plant (g)	Weight of seeds /head (g)	Shelling %	Seed index (g)	Seed yield (kg) /feddan	Straw yield (kg) /feddan	Biological yield (kg) /feddan	Harvest index %	Protein %	Oil %
Water regime x Cultivars												
Normal irrigation	Pioneer 6480	29.43	357.29	190.85	53.42	90.04	1080.44	4287.38	5351.15	20.157	17.393	37.200
	Haisun 354	26.60	345.31	185.09	53.60	85.48	1015.41	4143.76	5159.17	19.680	17.227	37.137
Omitting the 3rd irrigation	Pioneer 6480	23.45	346.87	181.37	52.44	82.95	995.32	4150.38	5145.70	19.343	17.293	37.077
	Haisun 354	21.07	336.96	173.67	51.54	77.08	924.88	4043.54	4909.92	18.860	17.153	37.017
Omitting the 4th irrigation	Pioneer 6480	26.74	353.19	188,10	53.26	86.86	1042.28	4238.30	5280.58	19.740	17.347	37.150
	Haisun 354	23.76	342.14	180.14	52.81	81.21	974.50	4106.49	5080.16	19.180	17.197	37.037
Omitting the 5th irrigation	Pioneer 6480	26.53	352.12	186.77	53.04	86.61	1039.35	4225.35	5259.14	19.743	17.343	37.137
	Haisun 354	23.81	341.47	179.63	52.65	81.25	971.60	4097.93	5049.52	19.237	17.190	37.077
L.S.D. at 5%		n.s	n.s	n.s	0.43	n.s	n.s	n.s	n.s	n.s	n.s	n.s

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