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Influence of potassium fertilizer on two sunflower cultivars and its reflection on the productivity

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ABSTRACT

This study was conducted in order to evaluate the effect of potassium fertilizer on growth, yield and some chemical composition of two sunflower cultivars. Two field experiments were carried out in Wadi El-Rayyan, El-Fayoum Governorate, Egypt, in the two summer seasons of 2013 and 2014 seasons, under newly reclaimed sandy soil. Two sunflower cultivars i.e. Pioneer-6480 cultivar and Haisun-354 cultivar were randomly allocated in the main plots, while the three potassium fertilizer levels i.e. control (zero K_2O), 50 kg K_2O and 75 kg K_2O/ fed., were added randomly in the sub plots. Following traits were assayed in this study; plant height, number of leaves / plant, total dry weight / plant, LA, LAI, SLA, SLW, head diameter, weight of head/ plant, weight of seeds / head, shelling percentage, seed index, seed yield / fed., straw yield / fed., biological yield / fed., harvest index, protein percentage and oil percentage. Analysis of variance showed significant difference among sunflower cultivars and also K_2O fertilizer levels on above mentioned traits. In general Pioneer-6480 cultivar surpassed the other cultivar Haisun-354. It is also clear from results that increased K_2O fertilizer level from 50 kg/ fed., to 75 kg/ fed., led to increase of vegetative growth, yield and its components and also protein and oil percentage so Pioneer-6480 cultivar with adding 75 kg K_2O/fed., under experiment site.

***Keywords*:** Sunflower, cultivars, potassium fertilizer, growth, yield and its components.

Introduction

Oil production could be increased by increasing the cultivated area of oil crops and / or increasing the productivity of these crops per unit area. Sunflower (*Helianthus annus* L.) is one of the four oily plants in the world. Oily seeds have absorbed the attraction of many formers because they can be used in human nutrition, industry and as animal fodder (Gokhan and Gokmen, 2010). The productivity of sunflower differs greatly by varietal characteristics and also by environmental conditions such as soil fertility. Continuous attempts were carried out for increasing sunflower productivity to face urgent demands of increasing population especially in Egypt. This can be obtained through breeding programs to produce highly productive and quantitative gene forms as well as adjusting to mineral respect to arrive to that strategy (Ahmed *et al*., 2016).Potassium is the third major element taken up by the plant. Plants absorb it in larger amounts as compared to other minerals except nitrogen. It utmost importance for importing drought and disease resistance and has synergistic effect with nitrogen and phosphorus (Sahai 2004).Ahmed and Mekki(2004) told that application of potassium nutrition improved grains setting and increased the yield and yield quality of maize. Oosterthuis *et al.* (1990) told that applied K gave higher seed yields than untreated plants. Therefore, the purpose of this study is to investigate the effect of rate of potassium fertilizer application on yield, yield components and some chemical compositions of two sunflower cultivars.

Materials and Methods

Two field experiments were carried out during the two successive summer seasons of 2013 and 2014 in Wadi El-Rayyan Region, El-Fayoum Governorate, Egypt, to study the effect of potassium fertilizer on growth, yield, its components and some chemical composition of two sunflower cultivars under newly reclaimed sandy soil. The experiment included six treatments with four replications

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which were the combination of two sunflower cultivars, i.e. Pioneer- 6480 and Haisun-354 and three potassium levels i.e. control (zero K_2O), 50 kg K_2O/ fed.and 75 kg K_2O/ fed. Soil samples were taken at depth of 30 cm for mechanical and chemical analysis as described by Chapman and Pratt (1961) is presented at Table (1).

Table 1: Mechanical and chemical analysis of soil at experimental sites (Average of 2013 and 2014 seasons)

Sand %	Silt %	Clay %	Texture	pH	Organic matter O.M.%	Available N ppm	Available K ppm	Available P ppm
73.89	22.61	3.50	Sandy	7.9	0.48	82.00	132.00	11.3

Split plot design with four replicate was used, where the two sunflower cultivars i.e. Pioneer - 6480 and Haisun-354 were allocated randomly in the main plots, on the other hand potassium fertilizer levels were added in the sub-plots.

Seeds which uniformity in size, shape and color and sown in 17th May and 20th 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 hill. 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 recommended by Oil Crop Research Section, Agricultural Research Centre, Ministry of Agriculture, Egypt. Plants were thinning to one plant per hill after 20 days from sowing. Adding potassium fertilizer were done i.e. (control (zero), 50kg K_2O/ fed., and 75 kg K_2O/ fed.).

After 60 and 75 days from sowing Samples 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 dry weight/plant "kg". Leaves area/plant was determined according to Bremner and Taha (1966), whereas leaf area index (LAI) was determined according to Watson(1952).In addition specific leaf area (SLA) was determined according to Abdel-Gawad *et al*. (1980) and specific leaf weight (SLW) according to Pearce *et al*. (1969).

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 colorimetry Keldahl (Baethgen and Alley, 1989), while the seed oil content by Soxhlet method.

All data were subjected to statistical analysis according to procedure outlined by Gomez and Gomez (1984).Treatments means were compared by L.S.D at 5% level test. Combined analysis was made for the two growing seasons as results followed similar trend.

Results and Discussion

Growth characters:-

Effect of cultivars:

Data in Table (2) show that sunflower cultivars were significantly differed in their 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) and specific leaf weight (g/cm^2) at 60 and 75 days after sowing. Pioneer-6480 cultivar surpassed Haisun-354 cultivar in all growth characters under study at different growth stages. The superiority of Pioneer- 6480 in plant height mainly attributed to its genetic constituents (Kumar *et al.*, 2002 and Ahmed and Mekki, 2004). Also the increase of total dry weight/ plant in Pioneer- 6480 cultivar at different growth stages may be due to the increase plant height and in photosynthetic surface i.e. leaves area/ plant and LAI (table 2).The superiority in LAI in Pioneer-6480 cultivar attributed to the increase in their leaf area at different growth stages (table 2).These results could be concluded that varietal differences between sunflower cultivars may be due to

genetical differences between cultivars and growth habit as well as differences between genotypes concerning partition of dry matter. These results are in agreement with those obtained by Ahmed *et al.*, 2010, El Habbasha *et al.*, 2012, Ahmed *et al*., 2013, El Habbasha *et al.*, 2013 and Ahmed *et al.*, 2015.

Effect of potassium fertilizer:

From the data manifested in Table (2) noticeably those plants fertilized with 75 kg K_2O/ fed., rate of potassium fertilizer had higher growth vigor than that 50 kg K_2O/ fed., and unfertilized. It is clear from data in Table (2) that, in general increasing K application rate from 50 to 75 kg K2O/ fed., increased plant height, total dry weight/ plant, number of leaves/plant at different growth phases. Such enhancing effect may be attributed to the influence of K on some physiological functions such as carbohydrate metabolism and formation, breakdown of starch and translocation of sugars. In addition, potassium may control and regulate the activities of various essential elements and activate many enzymes which in turn affects plant growth (Ahmed and Mekki 2004).Addition K at rate of 75 kg K_2O/ fed., gave the highest values of LA, LAI, SLA and SLW than that of 50 kg K_2O/ fed., or unfertilized at all growth stages. The differences between the control and 50 kg K_2O/ fed., did not reach to significant level at all growth character at all growth stages in both seasons. This results are in conformity with Boulbaba *et al.,* 2005, Asghar *et a*l., 2007, Zaki *et al.,* 2013 and Ahmed *et al.*, 2015, they reported that increasing potassium fertilizer levels significantly increased all the growth characters.

Effect of interaction between cultivars and potassium fertilizer:

Data in Table (3) indicated that effect of interaction between sunflower cultivar differences and potassium fertilizer on growth characters were significant at all growth phases except plant height, number of leaves/plant and SLW at 60 days from sowing and LAI at 75 days from sowing, they did not reach to significant level. In general the best treatment for all characters was Pioneer- 6480 cultivar with 75 kg K_2O/ fed.

Yield, yield components and some chemical composition:

Effect of cultivars:

Data in Table (4) revealed that the two sunflower cultivars were significantly different in their yield, yield components and some chemical composition. Pioneer- 6480 cultivar surpassed Haisun-354 cultivar in all characters under study 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. The superiority of Pioneer-6480 cultivar over Haisun-354 cultivar may be due to its superiority in growth characters at 60 and 75 days from sowing. The sunflower cultivars difference in yield, yield components and some chemical composition in our study could be due to the difference in genetic structure between the two sunflower cultivars, also, to the differences between cultivars in glucose required for synthesis of different chemical constituents compound at different plant organs, to differences in carbon equivalent and partitioning of photosynthesis between the plant organs of sunflower plant (Afifi and Ahmed 2004 and Ahmed *et al.,* 2016). Again to the great differences between genotypes for mineral element concentrations (Abou El-Seoud and Wafaa (2010).

Effect of potassium fertilizer:

Data in Table (4) indicated that in general increasing potassium fertilizer rate from zero to 50 kg K_2O/ fed., and 75 kg K_2O/ fed., significantly increased seed, straw and biological yields as well as yield components (head diameter, weight of head / plant, weight of seeds/head, seed index, shelling percentage, harvest index% and protein percentage), on the other hand, adding potassium with rate of

Table 2: Effect of varietal differences and potassium fertilizer on some growth parameters of sunflower plant at 60 and 75 days after sowing (Average of 2013 and 2014 seasons).

Characters / Treatments	Plant height (cm)		Number of leaves/ plant		Total dry weight/plant (kg)		LA (cm^2)		LAI		SLA (cm^2 /g)		SLW (g /cm^2)	
	Days													
	60	75	60	75	60	75	60	75	60	75	60	75	60	75
Cultivars														
Pioneer-6480	287.17	310.48	29.33	24.62	2.504	2.920	1339.44	1378.48	1.491	1.528	184.12	209.10	3.642	3.368
Haisun-354	273.59	304.18	26.83	21.89	2.473	2.881	1327.52	1353.15	1.477	1.506	176.59	192.43	3.530	3.264
L.S.D at 5%	2.68	3.26	o.18	0.62	0.010	0.024	2.51	4.06	0.013	0.005	1.49	2.65	0.027	0.014
Potassium fertilizer levels														
Control	273.20	304.42	26.88	21.24	2.473	2.902	1330.89	1362.83	1.477	1.513	178.03	204.16	3.567	3.332
50 kg/ fed.	273.13	304.72	26.73	23.08	2.462	2.837	1330.77	1362.33	1.483	1.510	176.89	195.00	3.562	3.355
75 kg/fed.	281.27	312.85	30.63	25.44	2.532	2.963	1338.78	1372.28	1.492	1.527	186.15	203.13	3.617	3.262
L.S.D at 5%	2.09	0.96	0.52	0.48	0.007	0.015	1.32	2.93	0.005	0.006	1.65	1.09	0.013	0.009

Table 3: Effect of interaction between varietal differences and potassium fertilizer on some growth parameters of sunflower plant at 60 and 75 days after sowing (Average of 2013 and 2014 seasons).

Characters / Treatments		Plant height (cm)		Number of leaves/ plant		Total dry weight/plant (kg)		LA (cm^2)		LAI		SLA (cm^2 /g)		SLW (g /cm^2)	
		Days													
		60	75	60	75	60	75	60	75	60	75	60	75	60	75
Cultivars x potassium fertilizer levels															
Pioneer-6480	**Control**	276.33	305.38	28.21	22.28	2.500	2.930	1337.77	1373.00	1.478	1.523	183.22	210.91	3.710	3.467
	50 kg/ fed	274.14	309.83	27.74	24.44	2.477	2.870	1335.31	1373.89	1.478	1.520	181.35	203.54	3.707	3.467
	75 kg/ fed	284.13	316.24	32.03	27.14	2.537	2.960	1345.23	1388.55	1.500	1.540	187.78	212.84	3.760	3.170
Haisun-354	**Control**	270.22	303.47	25.55	20.19	2.447	2.873	1324.00	1352.67	1.467	1.503	172.84	197.41	3.423	3.197
	50 kg/ fed	272.11	299.60	25.71	21.72	2.447	2.803	1326.22	1350.78	1.480	1.500	172.43	186.45	3.417	3.243
	75 kg/ fed	278.42	309.46	29.23	23.75	2.527	2.967	1332.33	1356.00	1.483	1.513	184.51	193.42	3.473	3.353
L.S.D. at 5%		ns	1.36	ns	0.68	0.010	0.021	1.86	4.15	0.007	n.s	2.34	1.54	n.s	0.013

Table 4: Effect of varietal differences and potassium fertilizer on yield, its components and chemical constituent of sunflower plant (Average of 2013 and 2014 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 %
Cultivars											
Pioneer- 6480	25.55	350.31	185.37	52.912	84.636	1015.63	4203.66	5215.59	19.454	17.318	37.171
Haisun-354	23.17	340.43	177.83	52.272	79.899	956.49	4090.71	5028.51	19.017	17.133	37.061
L.S.D at 5%	1.03	3.60	2.03	0.402	1.930	21.38	20.32	18.52	0.436	0.021	0.022
potassium fertilizer levels											
Control	22.74	342.52	178.45	52.092	78.937	947.24	4118.55	5057.48	18.728	17.143	37.136
50 kg/ fed	22.97	343.38	180.61	52.653	81.833	981.99	4120.58	5102.85	19.218	17. 250	37.077
75 kg/ fed	27.37	350.20	185.47	53.032	86.032	1028.95	4202.43	5205.82	19.760	17.283	37.135
L.S.D. at 5%	0.40	1.00	1.43	0.375	0.801	6.40	12.59	46.38	0.228	0.007	0.020

Table 5: Effect of interaction between varietal differences and potassium fertilizer on yield, its components and chemical constituent of sunflower plant. (Average of 2013 and 2014 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) /feddad	Harvest index %	Protein %	Oil %
Cultivars x potassium fertilizer levels												
Pioneer- 6480	**Control**	23.58	346.69	182.57	52.660	80.683	968.20	4160.28	5128.48	18.880	17.267	37.233
	50 kg/ fed	24.30	348.03	184.76	53.080	85.060	1020.73	4176.33	5197.07	19.607	17.330	37.117
	75 kg/ fed	28.76	356.20	188.78	52.997	88.163	1057.96	4274.37	5321.23	19.877	17.357	37.163
Haisun-354	**Control**	21.88	338.35	174.32	51.523	77.190	926.28	4076.83	4986.48	18.577	17.020	37.040
	50 kg/ fed	21.64	338.73	176.46	52.227	78.607	943.25	4064.83	5008.63	18.830	17.170	37.040
	75 kg/ fed	25.97	344.21	182.70	53.067	83.900	999.94	4130.48	5090.42	19.643	17.210	37.107
L.S.D. at 5%		0.57	1.41	n.s	0.530	1.133	9.04	17.81	65.59	0.323	0.010	0.028

75kg K_2O/ fed., did not differ from control in oil percentage. These may be due to increase of growth which in turn reflected positively on yield and its components of sunflower. Potassium helped to maintain sufficient rate of nitrogen fixation and N- partitioning to meet the requirement of two active sink i.e. reproductive parts and the nodules at the same time (Singh and Kataria2012).Several investigation pointed out to the positive response of yield to potassium fertilizer (Boulbaba *et al.,* 2005 and Asghar *et al*., 2007). There was a vital role of potassium in photosynthesis, translocation of photosynthates, protein synthesis, ionic balance, regulation of plant stomata and water use, activation of plant enzymes and many other processes is well recognized (Marschner 1995).Similar finding were reported by Zaki *et al*., 2013 and Ahmed *et al*., 2015.

Effect of interaction between cultivars and potassium fertilizer:

Data in Table (5) revealed that the seed yield and yield components were significantly affected by the interaction between sunflower cultivars and potassium fertilizer except weight of seed/ head "g", also protein and oil percentage were significantly affect by the same interaction. Pioneer-6480 cultivar with 75 kg / fed., potassium fertilizer recorded the highest values of seed, straw and biological yields, as well as, the other yield components and protein percentage. While the best treatment for oil percentage was Pioneer- 6480 cultivar with control (zero potassium) in both seasons.

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