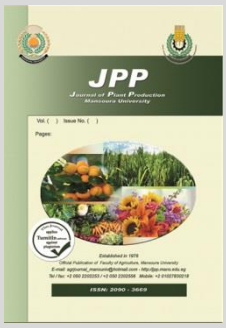
Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www.jpp.journals.ekb.eg

Effect of Nutrient Mixture and Potassium Levels Applied as Spray or to Soil on Sunflower (*Helianthus annuus* L.)Yield and its Components

Mona M. Hemeid* and S. S. EL-Tabbakh

Department of Crop Science, Faculty of Agriculture, Alexandria University, Alexandria, Egypt.



ABSTRACT

This study was carried out in 2017 and 2018 seasons to investigate effect of nutrient mixture and potassium levels applied as spray or to soil on sunflower yield and its components using split-plot design with four replicates. Main plot treatments were: K_1 (control) without K, K_2: 57 kg K_2O/ ha, K_3: 114 kg K_2O/ ha (K_1, K_2 and K_3 as soil application), K_4 (control): spraying with tap water, K_5: 0.58 kg K_2O/ ha and K_6: 1.16 kg K_2O/ ha (K_4, K_5 and K_6 as foliar application). Sub-plot treatments were 0, 1 and 2 liters of nutrients mixture per hectare. K_5 treatment produced the heaviest heads(132.0g),highest seed weight/ head(69.98g)in the first season and highest oil (41.33%) without significant differences with potassium soil application treatments in that season. (K_6) produced the thickest stems(2.28 and 2.31cm)in both seasons, largest head (20.54cm), heaviest heads (122.49g), highest shelling (52.81%) and heaviest 100-seed weight (8.26g) in the second season, whereas (K_5 and K_6) treatments gave the heaviest seed weight/ head (60.99 and 64.70 g), and highest shelling (53.03 and 53.02%) in the first season and seed yield/ ha (3.35 and 3.55ton) in the second season. Foliar application of nutrients mixture significantly increased all the studied treatments, except head diameter in 2017, stem diameter, 100-seed weight and oil percent in 2018 season. Interaction had significant effect on plant height, head weight, shelling % and harvest index in both seasons. K_5 and/ or K_6 combined with nutrient mixture foliar application, generally, increased the aforementioned traits under Alexandria Governorate.

Keywords: Sunflower, potassium levels, nutrients mixture, yield and it's Components

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is one of the four important oil crops in the world. This crop is a very important oil crop in Egypt because it can be used in human nutrition, oil industry and animal fodder (Gokhan and Gokman, 2010). Sunflower is considered insensitive to photoperiod with broad climatic adaptability and high drought tolerance. It has advantage over other oil crops such as soybeans, because of its higher oil yield per unit area (Zobiola *et al.*, 2010) and it accounts for about 13 % of all vegetable oils produced in the world (Nobre *et al*., 2011). In Egypt, many attempts have been made to maximize total production of oil crops to overcome the gap between production and consumption of edible oils by improving sunflower yield. The sunflower harvested area in Egypt was 6000hectare in 2017 with 3.33 t/ha and total seed production 20000 tons (FAO, 2019). Sunflower is very demanding for potassium (K), exceeding corn and soybeans (Uchôa *et al*., 2011), because it influences the growth and productivity of sunflower dry biomass (Prado and Leal, 2006). Unlike nitrogen and phosphorus, potassium does not form bonds with carbon or oxygen, therefore never becomes a part of protein and other organic matter, but it is an important cation involved in physiological pathways in plants, improves grains setting, increases yield quantity and quality of maize, improves drought and disease resistance (Ahmed and Mekki, 2004). Benlloch *et al.* (1994) reported that the deleterious effects associated with reduced uptake and translocation of potassium by sunflower plants grown in high sodium were alleviated by the addition of potassium to the soil.

Micronutrients requirements of sunflower plants could limit the optimum production. Kumar *et al*. (2010) reported that the application of Zn and Fe significantly increased sunflower seed yield and yield attributes besides plant growth. Generally, micronutrients play an essential role for growth and development of crops as a result of enhancing photosynthesis, increasing chlorophyll content, regulating plant hormones and enzymes in plants. The need of Egyptian soil to potassium and micronutrients became a problem because of its continuous depletion, as a result of intensive cropping, the relative absence of the compensatory effect of Nile flow after building the High Dam and for producing new crop cultivars having high yield potential (El-Ganayni, 2000).

Therefore, the present study aimed to investigate Effect of nutrient mixture and potassium levels applied as spray or to soil on Sunflower yield and its components under Alexandria Governorate.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive summer seasons of 2017 and 2018 at the Agricultural Research Station, Faculty of Agriculture, Alexandria University, Egypt to investigate the effect of nutrients mixture levels and methods of potassium application and levels on sunflower growth, yield and it's attributes of Turkish single hybrid (Sirena). A split- plot

* **Corresponding author.**
E-mail address: mona.mohamed@alexu.edu.eg
DOI: 10.21608/jpp.2020.149799

design with four replicates was used in both seasons. The main plots included six treatments (combination between three potassium levels and two application methods) as follows:

K_1 : Control (without K as soil application)
K_2 : 57 kg K_2O/ ha as soil application.
K_3 : 114 kg K_2O/ ha as soil application.
K_4 : control (sprayed with tap water only).
K_5 : 0.58 kg K_2O/ ha as foliar application.
K_6 : 1.16 kg K_2O/ ha as foliar application.

The applied levels of potassium (as potassium sulphate 48% K_2O) were applied to soil after 21 DAS (days after sowing), however potassium foliar application treatments were sprayed after 45 DAS. Nutrient mixture source in this research work was the commercial compound Mega green that is composed of 11%N, 8% P_2O_5, 6% K_2O, 0.5% Mg, 0.1% Ca, 1.3% SO_3, 0.3% Zn, 0.3% Fe, 0.2% Mn, 0.2% B and 0.2% Mo. Nutrients mixture levels were (0, 1 and 2 liters/ ha) randomly sprayed to the sub plots at 60 DAS. The preceding crops were faba bean and berseem clover. Sowing dates were May 15th and 25th in 2017 and 2018 seasons, respectively. Soil chemical and physical properties, as an average of the two seasons, were recorded in Table 1**.**

Table 1. Soil physical and chemical properties as an average of the two seasons:

Physical properties		Nutritional properties	
Clay (%)	62.5	Av. N (%)	0.12
Silt (%)	20.0	Av. P (ppm)	9.60
Sand (%)	17.5	Av. K. (meq/ L)	0.84
Texture	Clay	Organic matter (%)	0.52
Chemical properties			
pH	8.36	Cl^- (meq/ L)	15.00
EC (dS/ m)	2.23	CO_3^{-2} (meq/ L)	2.40
Ca^{2+} (meq/ L)	7.50	HCO_3^- (meq/ L)	4.00
Mg^{2+} (meq/ L)	4.00	SO_4^{-2} (meq/ L)	10.31
Na^+ (meq/ L)	35.1	$CaCO_3$ (%)	9.86
SAR	5.96		

Each sub plot contained five ridges, four meter long and 70 cm apart. Sowing was in hills spaced 20 cm apart and three seeds were sown in each hill, then thinned to one plant per hill after 21 DAS. Phosphorus as calcium mono phosphate (15.5% P_2O_5) was incorporated into the soil before sowing at a rate of (36.9 kg P_2O_5/ ha). Nitrogen fertilizer as ammonium nitrate (33.5 % N) was applied at the rate of 71.4 kg N/ ha in two equal split doses, the first was applied after 21 DAS and the second dose was applied after 36 DAS. All other cultural practices were applied uniformly as recommended for sunflower production.

Five random plants were taken from the three middle ridges of each sub plot at harvest to determine plant height (cm), stem and head diameter (cm), head weight (g), seed weight/ head (g), shelling (%), seed index (100-seed weight) (g). While seed yield/ ha was calculated by collecting the whole inner three guarded ridges in each sub plot then converted to ton/ ha. Harvest index was calculated by dividing seed yield on biological yield. Data were statistically analyzed using SAS program (ver 9.13, 2007) for each season according to Gomez and Gomez (1984). Treatments means were compared using F.L.S.D. at 5% level.

RESULTS AND DISCUSSION

As presented in Table 1 data revealed that clay soil had high levels of sodium and chloride (35.1 and 15.0 meq/ L), respectively, and that may affect potassium absorption. Also, soil pH is high (8.36) and that may affect micronutrients absorption.

Data presented in Table 2 showed that potassium treatments studied significantly affected stem diameter in the two seasons and head diameter in the second season, only, however, nutrients mixture rates and it's interaction with potassium treatments had significant effect on plant height in both seasons, and stem and head diameter in the first and second seasons, respectively.

Regarding potassium treatments effect, results indicated that K_6 treatment (foliar application with the highest potassium level of 1.16 kg K_2O/ ha) produced the thickset stem diameter (2.28 and 2.31 cm) in 2017 and 2018 seasons, respectively, and largest head diameter (20.54 cm) in 2018 season. That could be due to the antagonistic effect between soil sodium and applied potassium to the soil. Hence, higher potassium level helps to increase stem thickness (diameter) due to the role of potassium in formation of cell walls. Similar results were reported by Jebeen and Ahmad (2011) who reported that potassium foliar application significantly increased sunflower growth under non-saline or saline conditions. Ahmed and Mekki (2004) pointed out that potassium may regulate and control the activities of various essential elements and activates many enzymes, which in turn affects plant growth. Moreover Al-Doori and Al-Delymi (2014) indicated that potassium has effect on carbohydrates metabolism, starch destruction and sugars translocation.

Regarding the effect nutrients mixture rates on sunflower plant growth, results presented in Table 2 indicated that foliar application generally, increased stem diameter, head diameter and plant height in the first, second and both seasons, respectively. Spraying nutrients mixture with 1 and 2 liters/ ha increased plant height by (3.24 % and 2.52 %), respectively, in 2017 and (1.86 % and 0.7 %) in 2018 season. However, these increases were (4.21 % and 2.34 %) for stem diameter in 2017 season and (3.80 and 2.10 %) for head diameter in 2018 season. These increases might be due to the trace elements vital roles on the growth enzymes activity and consequently increased the biological processes, besides their effects on photosynthesis and oxygen releasing during water photolysis process, carbohydrate synthesis and lipid metabolism. Also, these elements have important role for chloroplast durability (Al-Doori and Al-Dulaimy, 2012). These findings were in accordance with those reported by Kumar *et al.* (2010) and Al-Doori (2014) for plant height and stem diameter, in addition to Mekki (2015) for head diameter.

Concerning interaction effect of potassium treatments and nutrients mixture levels on plant growth, the obtained results in Table 4 revealed that the tallest plants (193.0, 186.93 and 186.97 cm) in 2017 season and (195.0, 190.53 and 189.47 cm) in 2018 season resulted from spraying with 0.58 and 1.16 liter/ ha of nutrients mixture combined with 0.0 kg K_2O/ ha foliar application or by spraying 0.58 kg K_2O/ ha combined with 57 kg K_2O/ ha as

soil application, respectively, beside 1.16 liter/ ha nutrients mixture without potassium soil application in the second season (188.10 cm).

Table 2. Means of sunflower growth traits as affected by potassium treatments and nutrient mixture rates in 2017 and 2018 seasons.

Factor	Plant height (cm)		Stem diameter (cm)		Head diameter (cm)	
	2017	2018	2017	2018	2017	2018
K-treatments (A):						
K_1	173.76	176.76	2.11	2.14	20.63	18.06
K_2	183.50	186.04	2.20	2.23	20.43	19.98
K_3	177.54	179.67	2.20	2.15	20.11	20.63
K_4	185.91	188.64	2.12	2.23	19.91	19.71
K_5	173.37	176.87	2.22	2.24	19.91	20.26
K_6	174.43	177.93	2.28	2.31	19.96	20.54
$L.S.D._{0.05}$	N.S.	N.S.	0.08	0.12	N.S.	0.83
Nutrient mixture rate (B) (liter/ ha):						
0	174.73	179.46	2.14	2.18	20.35	19.48
1	180.39	182.79	2.23	2.24	20.20	20.22
2	179.13	180.71	2.19	2.23	19.92	19.89
$L.S.D._{0.05}$	2.95	2.14	0.05	N.S.	N.S.	0.54
Interaction AB	**	**	**	N.S.	N.S.	**

****: significant at 0.01 level of probability.**
N.S., not significant at 0.05 level of probability.
K_1 : Control (without K as soil application)
K_2 : 57 kg K_2O/ ha as soil application.
K_3 : 114 kg K_2O/ ha as soil application.
K_4 : control (sprayed with tap water only).
K_5 : 0.58 kg K_2O/ ha as foliar application.
K_6 : 1.16 kg K_2O/ ha as foliar application.

Results presented in this table, also revealed that spraying sunflower plants with combination of 1.16 kg K_2O and 1 liter nutrients mixture/ ha produced maximum stem diameter (2.48 cm) and head diameter (21.93 cm) in the first and second seasons, respectively, besides spraying plants with 1 liter/ ha of nutrients mixture combined with 114 kg K_2O/ ha as soil application produced large heads (21.25 cm) in 2018 season. These results could be due to the effect of potassium for controlling and regulation the activities of various essential elements and activate many enzymes which it turn affects plant growth (Ahmed and Mekki, 2004).

Considering seed yield and its components and oil percent, data presented in Table 3 indicated that all the studied characters were significantly affected with potassium treatments in the two seasons, except seed yield/ ha and oil content in the first season. Nutrients mixture had significant effects on all traits, except 100-seed weight and oil content percentage in the second season. However, head weight, shelling percentage and harvest index were significantly affected with potassium treatments × nutrients mixture in both seasons and 100-seed weight in the second season, only.

With respect to potassium treatments effect, results pointed out that the heaviest heads (132.0 g in 2017 and 122.49 g in 2018) and heaviest seed weight / head (69.98 g in 2017 and 64.70 g in 2018) were produced by using K_5 and K_6 treatments, respectively. Similar effect was noticed on shelling percentage, where K_5 and K_6 treatments in the first season and K_6 treatment in the second season produced maximum percentages of shelling (53.03, 53.02 and 52.81 %), respectively. That might be due to the effect of foliar application which accelerates potassium absorption by plants and the essential role of that macronutrient in photosynthesis, production and translocation of photothynthates from leaves to heads and seeds in sodic soils.

Table 3. Means of sunflower seed yield and its attributes as affected by potassium treatments and nutrient mixture rates in 2017 and 2018 seasons.

Factor	Head weight (g)		Seed weight/ head (g)		Shelling (%)		100-seed weight (g)		Seed yield (t/ ha)		Harvest index (%)		Oil content (%)	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
K Treatments (A):														
K_1	120.79	112.46	61.11	56.63	50.54	50.37	6.24	7.53	3.35	3.11	20.71	21.64	43.23	41.67
K_2	127.93	102.26	66.50	52.97	51.97	51.80	6.67	7.75	3.65	2.91	21.77	22.55	43.57	41.52
K_3	115.41	119.78	60.52	62.53	52.41	52.20	6.75	7.73	3.32	3.43	21.76	22.52	44.41	41.55
K_4	120.99	103.80	62.50	53.07	51.61	51.12	6.39	7.64	3.43	2.91	21.95	22.80	42.87	40.70
K_5	132.0	117.04	69.98	60.99	53.03	52.10	6.73	8.11	3.84	3.35	22.82	23.68	42.90	41.33
K_6	118.19	122.49	62.65	64.70	53.02	52.81	6.80	8.26	3.44	3.55	20.22	23.98	43.75	39.73
$L.S.D._{0.05}$	8.47	7.49	5.21	3.79	0.08	0.07	0.36	0.48	N.S.	0.21	0.08	0.06	N.S	1.10
Nutrient mixture (B) (liter/ ha):														
0	116.22	106.49	60.17	54.75	51.71	51.39	6.37	7.85	3.30	3.0	21.64	22.53	42.99	40.93
1	124.03	119.30	64.46	61.71	51.97	51.72	6.71	7.77	3.54	3.39	22.08	22.90	43.85	41.12
2	127.41	113.13	66.99	59.0	52.62	52.09	6.72	7.90	3.68	3.24	22.39	23.16	43.52	41.21
$L.S.D._{0.05}$	8.33	7.55	5.28	3.89	0.08	0.05	0.29	N.S	0.29	0.21	0.04	0.05	0.56	N.S
Interaction AB	*	*	N.S.	N.S.	**	**	N.S.	*	N.S.	N.S.	**	**	N.S.	N.S.

****: significant at0.05 and 0.01 levels of probability, respectively.**
N.S., not significant at 0.05 level of probability.
K_1 : Control (without K as soil application)
K_2 : 57 kg K_2O/ ha as soil application.
K_3 : 114 kg K_2O/ ha as soil application.
K_4 : control (sprayed with tap water only).
K_5 : 0.58 kg K_2O/ ha as foliar application.
K_6 : 1.16 kg K_2O/ ha as foliar application

These results agreed with those reported by Ahmed and Mekki (2004) and Akram *et al.* (2007) who reported that foliar potassium application promoted uptake of K^+ and reduced Na^+ absorption and realized (N^+/ K^+) ionic homeostasis. Al-Taher *et al.* (2013) also found that increasing potassium levels as foliar application significantly increased plant yield as a result of translocation of photosynthates towards seeds resulting in

more filled seeds. Regarding 100-seed weight, potassium soil application (K_2 and K_3 treatments) and foliar application (K_5 and K_6 treatments) gave the heaviest 100-seed weights (6.67, 6.75, 6.73 and 6.80 g), respectively, in the first season, however, (K_6 treatment) produced maximum 100-seed weight (8.26 g) in the second season.

The effect of potassium on seed yield was obvious in the second season since the high potassium level as soil application (114 kg K_2O/ ha) or sprayed plants with (0.58 or 1.16 kg K_2O/ ha) produced the highest seed yield (3.43, 3.35 and 3.55 ton/ ha), respectively. Conversely, sprayed sunflower plants with (1.16 kg K_2O/ ha) gave the lowest oil content (39.73 %) in 2018 season. That could be due to the relation between potassium and each of oil and protein contents in all crops (Page *et al*., 1982), where potassium has role in fatty acids structure and that caused more accumulation of oil towards seeds (Lahmood, 2006 and Adnan, 2011).

Spraying sunflower plants with higher potassium level (1.16 kg K_2O/ ha produced the highest harvest indices (20.22 and 23.98 %) in 2017 and 2018 seasons, respectively, as shown in Table 3. That might be due to potassium acceleration effect on shelling percentage and 100-seed weight. These results were in conformity with Boulbaba *et al.* (2005), Asghar *et al.* (2007), Zaki *et al.* (2013) and Ahmed *et al.* (2015) who reported that increasing potassium levels significantly increased sunflower growth, yield and it's attributes.

On the other hand, results presented in that table indicated that spraying sunflower plants with (1 or 2 liters/ ha) of nutrients mixture, generally, increased all the studied traits in the two seasons of study, however these increases did not reach significance level for 100-seed weight and oil content in the second season. Many researchers reported that nutrients mixture activate sunflower plant growth, oil and seed yields and seed yield components such as Siddique *et al.* (2009), Kumar *et al.* (2010), Al-Amery *et al*. (2011), Al-Doori (2014) and Mekki (2015).

Considering potassium treatments × nutrients mixture interaction effects on head weight, shelling percentage and harvest index in 2017 and 2018 seasons and 100-seed weight in 2018 season, results presented in Table 4 showed that the heaviest heads in the first season (139.23 g) resulted from spraying plants with 0.58 kg K_2O/ ha, however spraying plants with 1 liter nutrients mixture/ ha without or with 114 K_2O/ ha as soil application produced the heaviest heads (127.16 and 134.06 g), respectively, in the second season. Also in that season, spraying plants with 0.58 kg K_2O/ ha combined with 2 liters nutrients mixture and spraying 1.16 kg K_2O/ ha combined with 1 or 2 liters of nutrients mixture produced maximum head weights (127.29, 127.25 and 128.47 g), respectively. That cleared the acceleration effect of nutrients mixture and potassium on translocation of metabolites and photosynthates to heads and other organs of plant. These results agreed with those reported by Sepher *et al.* (2002) and Jyothi and Anjaiah (2018).

Table 4. Means of sunflower traits as affected by potassium treatments and nutrient mixture rates interactions:

K-Treatments	Nutrients mixture (liter)	Plant height (cm)		Stem diameter (cm)	Head diameter (cm)	Head weight (g)		Shelling (%)		100-seed weight (g)	Harvest index (%)	
		2017	2018	2017	2018	2017	2018	2017	2018	2018	2017	2018
	0	176.43	175.47	1.94	16.70	106.70	107.76	50.13	49.92	7.82	20.43	21.45
K_1	1	165.78	166.70	2.21	18.43	118.46	127.16	50.30	50.24	7.60	20.76	21.55
	2	179.05	188.10	2.17	19.05	137.20	102.46	51.20	50.95	7.18	20.93	21.93
	0	179.57	186.60	2.22	20.03	122.87	104.13	51.53	51.28	7.93	21.48	22.12
K_2	1	186.97	189.47	2.28	20.53	128.33	100.85	52.10	51.91	7.11	21.84	22.64
	2	183.98	182.07	2.09	19.37	132.59	101.81	52.29	52.22	8.20	21.98	22.90
	0	172.60	184.13	2.10	20.09	98.29	108.97	52.09	51.86	7.65	21.21	22.27
K_3	1	178.27	180.27	2.16	21.25	122.51	134.06	52.42	52.20	8.33	21.83	22.45
	2	181.76	174.60	2.32	20.56	125.44	116.32	52.74	52.53	7.22	22.24	22.86
	0	177.78	180.53	2.23	20.73	102.75	102.28	51.21	50.81	7.93	21.36	22.38
K_4	1	193.00	195.00	2.03	18.87	126.52	106.72	51.20	51.22	7.73	22.17	22.95
	2	186.93	190.53	2.10	19.53	133.70	102.40	52.42	51.34	7.27	22.33	23.06
	0	170.77	172.53	2.22	19.87	139.23	104.05	52.52	51.83	7.69	22.53	23.35
K_5	1	180.30	183.80	2.24	20.30	131.47	119.78	52.85	52.13	7.87	22.72	23.67
	2	169.03	174.27	2.21	20.60	125.31	127.29	53.73	52.33	8.78	23.20	24.02
	0	171.22	177.53	2.11	19.47	127.47	111.75	52.80	52.62	8.07	22.85	23.59
K_6	1	178.03	181.53	2.48	21.93	116.88	127.25	52.92	52.63	7.96	23.18	24.16
	2	174.03	174.72	2.27	20.21	110.21	128.47	53.34	53.20	8.77	23.63	24.20
L.S.D.0.05		7.24	7.71	0.13	1.03	20.41	13.07	0.20	0.14	0.76	0.10	0.12

K_1: Control (without K as soil application) **K_2: 57 kg K_2O/ ha as soil application.**
K_3: 114 kg K_2O/ ha as soil application. **K_4: control (sprayed with tap water only).**
K_5: 0.58 kg K_2O/ ha as foliar application. **K_6: 1.16 kg K_2O/ ha as foliar application**

Concerning shelling percentage, obtained results in Table (4) revealed that spraying sunflower plants with 2 liters of nutrients mixture/ ha combined with 0.58 and 1.16 kg K_2O/ ha produced the highest percentages of shelling (53.73 and 53.20 %) in 2017 and 2018, respectively. That pointed out the effectiveness of potassium as foliar application especially in sodium proned soils and the role of nutrients mixture for controlling many physiological processes in sunflower plant (Page *et al*., 1982). Similar results were reported by Al-Taher *et al.* (2013) and Ahmed *et al*. (2018).

The heaviest 100-seed weights in the second season (8.78, 8.77 and 8.20 g) resulted from spraying plants with two liters/ ha nutrients mixture combined with 0.58, 1.16 kg K_2O/ ha as foliar application or 57 kg K_2O/ ha as soil application, respectively. Also, the high values of 100-seed weights (8.07 and 8.33 g), respectively, resulted from spraying 1.16 kg K_2O/ ha only and combination between 114 kg K_2O/ ha applied to soil and spraying plants with one liter/ ha of nutrients mixture. That could be due to potassium effect on plant water balance maintenance and seed formation (Marschner, 2012). Tufail *et al.* (1990) reported that micronutrients increased seed filling and test weight. Similar results were reported by Sepher *et al.* (2002).

The highest harvest index values in the first season (23.63 %) and (24.16 and 24.20 %) in the second season resulted from spraying sunflower plants with 1.16 kg K_2O/ ha combined with 2 liters/ ha of nutrients mixture in the first season and one or two liters/ ha in the second season. That might be attributed to synergetistic effect of both potassium and nutrients mixture on carbohydrates metabolism, formation and translocation of photosynthates towards seeds resulting in more filled seeds (source/ sink efficiency) as reported by Al-Taher *et al.* (2013). Al-Doori (2014), also reported that zinc as micronutrient has a vital role in the activity of growth enzymes, which lead to increase in the biological processes and this in turn increase yield components.

CONCLUSION

In conclusion**,** potassium foliar application was more efficient than soil application. Higher potassium rates reduced the adverse effect of sodium in sodic soils. Spraying one or two liters/ ha of nutrients mixture significantly increased all the studied traits in both seasons, except head diameter in the first season and stem diameter, 100-seed weight and oil content in the second one.

REFERENCES

Adnan, Y.Y. (2011). Effect of foliar fertilization ALGATON on growth traits, seed and oil yield of sunflower *Helianthus annuus* L., Iraq flower C.V. Tekreet of Agric. Sci., 11(3): 102-109.

Ahmed, A.G. and Mekki, B.B. (2004). Effect of soil and foliar application of potassium on yield and yield components of two corn crosses. J. Agric. Sci. Mansoura Univ., 29 (10): 5421- 5429.

Ahmed, A.G.; Mohamed, Magda, H.; Hassanein, M.S.; Zaki, Nabila, M.; El-Habbasha, S.F.; Tawifk, M.M. and Mohamed, Manal, F. (2015). Effect of water regime and potassium fertilization on productivity of two chickpea (*Cicer arietinum* L.) cultivars. Inter. J. of Chem. Tech. Res., 8 (4): 1509- 1519.

Ahmed, Amal, G.; Hassanein, M.S.; Zaki, Nabila, M.; Mohamed, Magda, H. and Mohamed ,Manal, F. (2018). Influence of potassium fertilizer on two sunflower cultivars and its reflection on the productivity. Middle East J. Apple. Sci., 8 (4): 1190- 1196.

Akram, M.S.; Athar, H.U.R. and Shraf, M.A. (2007). Improving growth and yield of sunflower (*Helianthus annuus* L.) by foliar application of potassium hydroxide (KOH) under salt stress. Pak. J. Bot., 39 (3): 769- 776.

Al-Amery, M.M.; Hamza, J.H. and. Fuller, M.P (2011). Effect of boron foliar application on reproductive growth of sunflower (*Helianthus annuus* L.) Inter. J. of Agron. 5 (6): 1-5.

Al-Doori, S.A.M. (2014). Effect of different levels and timing of zinc foliar application on growth, yield and quality of sunflower genotypes (*Helianthus annuus* L., composite). College of Basic education Research J. 13, (1): 907- 922.

Al-Doori, S.A.M. and Al-Delymi,A.M.S. (2014). Effect of potassium fertilization levels on growth, yield and quality of sunflower cultivars (*Helianthus annuus* L.). Mesopotomia J. of Agric., 42 (1): 231- 241.

Al-Doori, S.A.M. and Al-Dulaimy, M.Y.H. (2012). Influence of zinc fertilization levels on growth, yield and quality of some sunflower genotypes (*Helianthus annuus* L., compositae). Research, J. 11(4): 714-730.

Al-Taher, F. M.; Yahya, K. J. and Al-Badry, S. A.M. (2013). Effect of date and quantity of potassium fertilizer application on growth, yield and oil quality of sunflower *Helianthus annuus* L., var. flame. IOSR Journal of Agric. and Veterin Sci., 4(1): 33- 40. www.iosrjournals.org.

Asghar, A.; Nadeem, M. A.; Tanveer, A.; Tahirand, M. and Hussain, M. (2007). Effect of different potash levels on the growth, yield and protein contents of chickpea (*Cicer arietinum* L.) .Pak. J. Bot., 39,523-527.

Benlloch, M.; Ojeda, M.A.; Ramos, J. and Rodriguez-Navarro, A. (1994). Salt sensitivity and low discrimination between potassium and sodium in bean plants. Plant Soil, 166: 117- 123.

Boulbaba, L.; Sifibouaziz ,Z. A.; Mainassara, L. Z. and Mokhtar, L. (2005). Response of chickpea (*Cicer arietinum* L.) to potassium fertilization. J. Agric. Soc. Sci., 1: 7-9

El-Ganayni, A.A. (2000). Interaction among irrigation intervals and N levels in corn (*Zea mays* L.) new approach for evaluating interaction. J. Agric. Sci. Mansoura Univ., 25 (4): 1909-1922.

FAO. (2019) FAOSTAT online database. Food and Agriculture Organization of the United Nations Resources, Rome, Italy. http://faostat.fao.org/.

Gangwar, M.S. and Parameswaran, P.M. (1976). Phosphorus – Sulphur relationship in sunflower .1. effect of P and S on yield. Oil Seed J., 6(3): 28-32.

Gokhan, D. and Gokman, V. (2010). Impact of roasting oily seeds and nuts on their extracted oils. Lipid Tech., 22 (8): 179-188.

Gomez, A.K. and Gomez, A.A. (1984). Statistical Procedure for Agricultural Research. 2nd edition John Wiley and Sons. Inc., New York.

Jebeen, N. and Ahmad, R. (2011). Foliar application of potassium nitrate affects the growth and nitrate reductase activity in sunflower leaves under salinity. Not. Bot. Hort. Agrobo., 39 (2): 172- 178. Available Online at www.notulaebotanicae.ro.

Jyothi, P. and Anjaiah (2018). Effect of boron and potassium on performance of sunflower (*Helianthus annuus* L). J. Sci. Agric. & Eng. 55-58. http://www.ycjournal.net/

Kumar, B.A.; Bhat, S, and Shanwad, U. (2010). Effect of micronutrients on growth and yield in sunflower (*Helianthus annuus* L). Current Advances in Agricultural Sci., 2(1): 51-52.

Lahmood, A.M. (2006). Effect of different of foliar fertilization on increasing percent of fertilization and yield seeds of two cultivars of sunflower. Technical College/ Almusaib. Al-Qadesyah J., 11 (1): 1-13.

Marschner, H. (2012). Marschner's Mineral Nutrition of Higher Plants. 3 edition. Academic Press, London. pp. 178-189

Mekki, B.E. (2015). Effect of Boron foliar application on yield and quality of some sunflower *(Helianthus annuus* L.) cultivars. J. Agric. Sci. and Techno., B5: 309- 316. doi: 10.17265/2161-6264/2015.05.002.

Nobre, R.G.; Gheyi, H.R.; Soares,F.A.L. and Cardoso,J.A.F. (2011). Sunflower Production under saline stress and nitrogen fertilization. Rev. Bras. Ciênc. Solo, 35 (3): 929- 937.

Page, A.L.; Miller, R.H. and Keeney, D.R. (1982). Methods of Soil Analysis. Part (2). Agronomy No. 9 Madison. U.S.A. SN., 1982.

Prado, R.M. and Leal, R.M. (2006). Nutritional disorders by deficiency in sunflower var. catissol-01. Pesqui. Agropecu. Trop. 36 (3): 187- 193.

Sepher, E.M.; Malakouti, J. and Rasouli, M.H. (2002). The effect of K, S and micronutrients on the yield and quality of sunflower in Iran. 17th WCSS, 14- 21.

Siddiqui, M.Z.; Oad, F.C.H.; Abbasi,M.K. and Gandahi,A.W. (2009). Effect of NPK, micronutrients and N-placement on the growth and yield of sunflower. Sarhad J. Agric., 25: 45- 52.

Tufail, A.K.; Venugopal, K.; Devaiah, C. and Seenappa, K. (1990). Effect of secondary nutrients and B on some growth characters and yield in sunflower. J. of Oil Seed Res., 7: 136- 139.

Uchöa, S.C.P.; Lvanoff, M.E.A.; Alves, J.M.A.; Sediyama, T. and Martins, A.S. (2011). Potassium fertilization in side dressing in the yield components of sunflower cultivars. Rev. Ciênc. Agron., 42 (1): 8- 15.

Zaki, N.M.; Ahmed, Amal, G.; Mohamed, Magda, H.; Tawfik, M.M. and Hassanein, M.S. (2013). Effect of skipping one irrigation and potassium fertilization on growth and yield of chickpea plants. World App. Sci. J., 27: 557- 561.

Zobiole, L.H.S.; Castro, C.; Oliveria, F.A. and Oliveira, Junior, A. (2010). Macronutrient uptake of sunflower (*Helianthus annuus* L.). Rev. Bras. Ciênc. Solo. 34 (2): 425- 433.

تأثير مخلوط العناصر الغذائية و مستويات البوتاسيوم المضاف رشا" أو الى التربة على محصول عباد الشمس ومكوناته

منى محمد حميد وسامى شعبان الطباخ

قسم علوم المحاصيل – كلية الزراعة – جامعة الاسكندرية – الاسكندرية – مصر.

أجريت هذه الدراسة خلال صيف 2017، 2018 لدراسة تأثير مخلوط العناصر الغذائية و مستويات البوتاسيوم المضاف رشا" أو الى التربة على محصول عباد الشمس صنف الهجين الفردى التركى (Sirena) أستخدم تصميم القطع المنشقة مرة واحدة فى أربع مكررات حيث وزعت معاملات السماد البوتاسى عشوائياً على القطع الرئيسية وهى: (K_1) كنترول للإضافة الأرضية، (K_2) إضافة 57 كجم K_2O/ هكتار أرضياً، (K_3) إضافة 114 كجم K_2O/ هكتار أرضياً ، (K_4) كنترول للإضافة الورقية، (K_5) الرش بمعدل 0.58 كجم K_2O/ هكتار، (K_6) الرش بمعدل 16,1 كجم K_2O/ هكتار بينما وزعت المستويات الثلاثة (صفر، 1،2 لتر/ هكتار) من مخلوط العناصر الغذائية (mega green) فى القطع الشقية - وقد أوضحت النتائج أن المعاملة (K_5) أدت إلى إنتاج أثقل الأقراص وأعلى وزن للبذور/ قرص (132.0، 69.98جم) على الترتيب فى الموسم الأول كما أدت إلى إنتاج أعلى نسبة من الزيت (41.33%) فى الموسم الثانى متساوية فى ذلك مع الإضافة للبوتاسيوم (K_1، K_2، K_3).بينما أدت المعاملة (K_6) إلى إنتاج أكثر سيقان سمكاً (2.28، 2.31 سم) فى كلا الموسمين وأكبر الأقراص قطراً (20.54 سم) وأثقل الأقراص وزناً (122.49 جم) وأعلى نسبة تفريط (52.81 %)، وأثقل وزن للمائة بذرة (8.26جم).من ناحية أخرى أدى تطبيق المعاملتين (K_5، K_6) لإنتاج أثقل وزن لبذور القرص وأعلى محصول من البذور للهكتار فى الموسم الثانى (60.99، 64.70 جم)، (3.55،3.35 طن) على الترتيب متساوياً فى ذلك مع الإضافة الأرضية للبوتاسيوم بمعدل 114 كجم K_2O/ هكتار (K3)- كذلك أدت المعاملتين (K_5، K_6) لإنتاج أعلى نسبة تفريط (53.03، 53.02%) وأقل وزن للمائة بذرة فى الموسم الأول. من ناحية أخرى فقد أدى رش مخلوط العناصر بمعدل واحد أو/ واثنين لتر/ هكتار إلى زيادة معنوية فى جميع الصفات تحت الدراسة عدا قطر القرص فى الموسم الأول وكل من قطر الساق، وزن المائة بذرة ومحتوى الزيت فى البذور فى الموسم الثانى.كما كان هناك تفاعلاً معنوياً على كل من ارتفاع النبات ووزن القرص، ونسبة التفريط ومعامل الحصاد فى موسمى الدراسة. أدى تطبيق المعاملة (K_5 أو/ و K_6) مع رش مخلوط العناصر الغذائية بوجه عام إلى زيادة معنوية فى قيم الصفات المذكورة أنفاً تحت ظروف محافظة الاسكندرية.