Zagazig J. Agric. Res., Vol. 49 No. (5) 2022 625-635

Plant Production Science

Available online at http://zjar.journals.ekb.eg
http:/www.journals.zu.edu.eg/journalDisplay.aspx?Journalld=1&queryType=Master

IMPACT OF MICRONUTRIENTS FOLIAR APPLICTION AND POTASSIUM FERTILIZER LEVELS ON PRODUCTIVITY AND QUALITY OF SESAME UNDER SANDY SOIL CONDITIONS

Mohamed A.T. Yasin* **and Asmaa Abdelsalam**

Agron. Dept., Fac. Agric., Zagazig Univ., Egypt

Received: 18/09/2022 ; Accepted: 28/09/2022

ABSTRACT: The desired goal of this investigation was to study the effect of eight micronutrients foliar application [Zn, Fe, Mn, Zn + Fe, Zn + Mn, Fe + Mn, Zn + Fe + Mn and control (tap water)] and three potassium fertilizer levels (check, 24 and 48 kg K_2O/fad.) on yield, their attributes and seed quality of sesame grown in sandy soil. The obtained results revealed that, foliar application of Zn + Fe + Mn led to a significant increase in most yield attributes, seed and oil yields/fad., as well as seed oil % during both seasons. Plant height, fruiting zone length, No. capsules per plant, No. and weight of seeds per capsule, weight of seeds per plant and 1000-seed weight, seed and oil yields/fad., as well as, seed oil % exhibited significant increase due to raising K level up to 48 kg K_2O/fad. It could be concluded that foliar application of Zn + Mn or Zn + Fe + Mn along with 48 kg K_2O/fad., produced the highest sesame seed and oil yields/fad.

Key words: Sesame, Zn, Fe, Mn, K, yield.

INTRODUCTION

Sesame is one of the essential oil crops in Egypt and all over the world, it contains about 50–52% oil, 20-25% protein and 16–18% carbohydrate. In Egypt, the cultivated area reached about 29000 ha which produced 38000 ton (**FAOSTAT, 2021**).

Egypt suffers from a severe shortage in the production of vegetable oils due to the increased population growth and decreased cultivated area. This in turn necessitates additional expansion in oil crops cultivated area in sandy soil and optimizing the needs of macro and micronutrients. Sesame crop can be reckoned a good choice to increasing the local plant oils production due to its stumpy duration, low water request and it’s tolerant to drought.

The decreasing of sesame yield in sandy soil has been via the unbalanced nutritional conditions of plant, particularly, the inadequate opportunity of nutrients especially micronutrients. The low water retention and nutrients leaching in sandy soil requires increased nutrients application rate especially N, P and K in this soil.

Singaravel *et al.* (2001) reveled that sesame yield could be increased due to micronutrients application which is deficient under sandy soil conditions. Zinc presents a vital role in carbohydrate metabolism, synthesis of protein and cytochrome, organizing auxin synthesis and pollen forming (**Hafeez *et al.*, 2013).** Fe plays vital role in metabolic and photosynthesis processes and has an important role in various enzymatic activities (**Gyana and Sahoo, 2015).** Manganese plays a main role in photosynthesis, reduction and oxidation processes, such like electron transfer. Furthermore, it has important role in chlorophyll production. It involved in the activation of many enzymes. Its deficit decreases yield and quality of crops (**Mousavi *et al.*, 2011).** Many investigators reported significant improvement in sesame seed yield and its attributes as well as oil percentage due to micronutrients application in different soil and agro-climatic conditions (**Eisa *et al.*, 2010;**

*** Corresponding author: Tel. :**+201000843169
E-mail address: taha_agronomy_1978@yahoo.com

Heidari *et al.*, 2011; Mahdi, 2014; Emam, 2015; El-Sherif, 2016; Shirazy *et al*., 2017; Seervi *et al*., 2018; Eifediyi *et al*., 2021; Ram *et al*., 2021).

Potassium plays an important role in many adverse conditions. Application of potassium fertilizer is one of methods to improve the performance of plants under sandy soil conditions, as it had a vital role in regulating the vital processes in the plant and increases its ability to tolerance drought stress, diseases and insects, activation of enzymes as well as its role in assimilate translocation from source to sink. Potassium is one of essential macro-nutrient for plant growth, regulates the opening and closing of stomata and transfer to regulate Co_2 uptake. Potassium encourages strong and healthy root system formation and transport photosynthesis products to the capsules and transformation into oil. In this regard, potassium fertilization had a major role in increasing yield and its components, according to the studies of **Hafiz and El-Bramawy (2012)** and **Jat *et al.* (2017). Ahmad *et al.* (2018)** observed significant increment in sesame plant height, No. of capsules/plant, No. of seeds/capsule, 1000- seed weight, seed and oil yields as well as seed oil % due to increasing K level up to 50 kg K_2O/ha. Also, **Piyush *et al.* (2019)** detected significant increment in sesame seed yield and its attributes due to raising potassium fertilizer level to 40 kg K_2O/ha. **Abdelsatar *et al.* (2021)** showed that the potassium rate of 50 Kg K_2O/fad., was found to be more efficient to increase sesame yield and its components. **Priyadarshini *et al.*, (2021)** detected significant improvement in sesame seed yield, its attributes and seed oil content (%) by increasing potassium fertilizer level from 10 to 20 kg K_2O/ha

Therefore, this study was performed to investigate the impact of foliar application of microelements (Zn, Fe, and Mn and their combination) and potassium fertilizer level on sesame yield and its attributes as well as, seed quality under sandy soil condition.

MATERIALS AND METHODS

Study Site and Objective

The present study was conducted in the Experimental Farm, Faculty of Agriculture, Zagazig University, Sharkia Governorate, Egypt through the two summer seasons of 2018 and 2019 to investigate the effect of eight foliar application of micronutrient treatments and three potassium fertilizer levels on sesame yield and its attributes as well as, seed quality cultivated in sandy soil.

Experimental Design and Treatments

A split plot arrangement using three replicates was used. Eight micronutrients foliar application [Zn, Fe, Mn, Zn + Fe, Zn + Mn, Fe + Mn, Zn + Fe + Mn and control (tap water)] were allocated in the main plot. Soil application of potassium fertilizer levels (check, 24 and 48 kg K_2O/fad.) were randomly distributed in the sub plots. Micronutrients *i.e.* Zn EDTA (13% Zn), Fe EDTA (12% Fe), and Mn EDTA (13% Mn) were applied at 45 and 60 days after planting, at 0.04% (0.4 g/l). Foliar application of micronutrient was performed out using tap-water (200 L/fad.). The sub plot area was 10.5 m^2 (3 width × 3.5 m length) contained 5 rows 60 cm apart. The soil of the experimental site was sandy in texture. Before planting, soil samples were taken from the experimental field at the depth of 0-30 cm to evaluate soil mechanical and chemical properties (Central Laboratory, Faculty of Agriculture, Zagazig University, Zagazig, Egypt). The analyses of the soil, showed that the soil was sandy in texture, organic matter (0.18%), available N (11.34 ppm), available P (8.46 ppm), available K (39.18 ppm), available Zn (0.8 ppm), available Fe (1.5 ppm), available Mn (1.2 ppm) and pH (8.12).

Agricultural Practices

The preceding winter crop was faba bean and wheat in first and second season, respectively. Sesame seeds were sown on May 1^{st} and 8^{th} in first and second season, respectively. Sesame seeds (Shandaweel 3 variety) were manually planted in hills, 20 cm apart and 60 cm between rows, each hill included two plants after thinning "21 days after sowing". Irrigation via drip system was done each 2-3 days. Phosphorus at level of 31 kg P_2O_5/fad., as ordinary superphosphate (15.5% P_2O_5) was band placed at planting, while potassium fertilizer at the tested levels in the form of potassium sulphate (48% K_2O) was applied in one dose applied just after thinning. Nitrogen fertilizer in the form of ammonium sulphate (20.5% N) was fertigated in three doses, the first was 10 kg before planting immediately, the second was 30 kg at 21 days after sowing and the third was 30 kg at 35 days after planting. Other agricultural practices were applied as recommended for growing sesame. Harvest was done after 120 and 105 days after sowing in first and second season, respectively.

Studied Characters

Yield and yield attributes:

At harvest, five guarded plants were taken randomly from each experimental plot to evaluate plant height (cm), No. branches/plant, fruiting zone length (cm), No. capsules/plant, No. seeds/capsule, weight of seeds/capsule (g), and weight of seeds/plant (g). Plants of two rows from each treatment (4.2 m^2) were harvested to determine 1000- seed (g) weight and seed yield (kg/fad.).

Seed quality

Sufficient amount of dried sesame seeds were milled to fine powder. Then, constant samples of dried fine powder were used to determine oil content in sesame seeds as stated by **AOAC (1980).** Where, seed oil content was determined using Soxhlet apparatus and extracted by petroleum ether (60- 80°C) for a period of 12 hours. Thereafter, oil yield/fad., was evaluated by multiplying seed oil content (%) by seed yield/fad.

Statistical Analysis

The obtained data of both seasons were statistically analyzed as mentioned by **Gomez and Gomez (1984)** using the computer MSTAT statistical analysis package **(MSTAT-C, 1991)**. Least significant differences (LSD) method was used to test the differences between treatment means at 5% level of probability as described by **Steel *et al*. (1997)**.

RESULTS AND DISCUSSION

Micronutrient Foliar Application Effect

Seed yield and its attributes

Results given in Tables 1, 2 and 3 indicate that foliar application of micronutrients treatments had a marked effect on all studied yield attributes in both seasons, except number of branches/plant which showed no significant response to foliar application of micronutrients treatments.

It could be noticed that, foliar application of Zn caused significant increase in number of capsules/plant and 1000-seed weight during both seasons as well as, weight of seeds/capsule and seed yield/fad., in the second season, as compared with control treatment.

Foliar application of Fe significantly increased each of fruiting zone length, weight of seeds/ capsule, 1000-seed weight and seed yield/fad., in the second season as well as, number of capsules/plant during both seasons, as compared with control treatment.

Meantime, foliar application of Mn led to significant increment in plant height, number of capsules/plant, 1000-seed weight and seed yield/ fad., during both seasons and weight of seeds/ capsule in the first season as well as, weight of seeds/plant during the second season, as compared with control treatment.

Plant height, number of capsules/plant, and seed yield/fad., during both seasons as well as, fruiting zone length and number of seeds/ capsule during the second season exhibited significant increase due to foliar application of Zn + Fe, as compared with control treatment.

Moreover, foliar application of Zn + Mn significantly enhanced all studied traits except number of branches/plant and weight of seeds/plant during both seasons as well as, number of capsules/plant during the second season.

Finally, foliar application of Zn + Mn or Zn + Fe + Mn significantly increased all studied traits except number of branches/plant during through the two seasons.

The obtained results clearly showed that the highest values of seed yield/fad., was recorded under foliar application of Zn + Mn or Zn + Fe + Mn. The obtained results was expected, since these two treatments showed higher values of most yield attributes mentioned and discussed above.

The increment in seed yield and its attributes under foliar application of micronutrients could

Table 1. Plant height (cm), number of branches/plant and fruiting zone length (cm) of sesame as influenced by micronutrients foliar application as well as their interaction during both growing seasons

Main effects and interaction	Plant height (cm)		No. of branches/plant		Fruiting zone length (cm)	
	2018	2019	2018	2019	2018	2019
Micronutrient treatment (M)						
Tap water (control)	155.78 c	129.44 e	1.24	1.31	112.78 b	86.33 d
Zn	162.20 bc	131.30 de	1.26	1.20	120.64 b	89.89 cd
Fe	159.50 bc	134.13 cde	1.22	1.40	117.50 b	96.67 bc
Mn	166.20 b	137.50 cd	1.28	1.30	121.16 b	94.33cd
Zn + Fe	167.70 b	146.60 b	1.19	1.22	119.43 b	96.67 bc
Zn + Mn	186.30 a	156.70 a	1.29	1.17	133.77 a	108.00 a
Fe + Mn	177.90 a	139.80 bc	1.26	1.36	133.44 a	106.11 ab
Zn + Fe + Mn	183.43 a	156.80 a	1.37	1.26	136.49 a	109.56 a
F. test	**	**	NS	NS	**	**
Potassium level (K):						
Check	164.14 b	135.44 c	1.26	1.24	113.44 c	89.17 c
24 kg K_2O/fad.	172.43 a	142.17 b	1.25	1.28	125.24 b	100.58 b
48 kg K_2O/fad.	173.05 a	146.99 a	1.28	1.31	134.53 a	105.58 a
F. test	**	**	NS	NS	**	**
Interaction						
M x K	**	*	NS	NS	*	**

NS, * and ** indicated insignificant, significant ant highly significant at 0.05 and 0.01 level of probability, respectively.

Table 2. Number of capsules/plant, number of seeds/capsule and weight of seeds/capsule (g) of sesame as influenced by micronutrients foliar application as well as their interaction during both growing seasons

Main effects and interaction	No. of capsules/plant		No. of seeds/capsule		Weight of seeds/ capsule (g)	
	2018	2019	2018	2019	2018	2019
Micronutrient treatment (M)						
Tap water (control)	78.67 d	66.78 d	52.11 d	44.00 c	0.191 d	0.168 c
Zn	84.82 cd	66.56 d	57.10 bc	49.33 b	0.218 bc	0.185 bc
Fe	83.18 cd	66.42 d	56.40 bc	49.33 b	0.205 cd	0.191 b
Mn	86.02 c	72.00 c	52.90 cd	47.24 bc	0.214 c	0.186 bc
Zn + Fe	85.80 c	72.98 bc	53.40 cd	53.10 a	0.215 c	0.182 bc
Zn + Mn	93.21 ab	77.88 ab	60.30 ab	54.40 a	0.234 ab	0.214 a
Fe + Mn	86.35 bc	70.80 cd	56.50 bc	47.80 b	0.220 bc	0.191 b
Zn + Fe + Mn	94.76 a	80.49 a	61.40 a	55.04 a	0.239 a	0.202 ab
F. test	**	**	**	**	**	*
Potassium level (K):						
Check	77.70 c	65.00 c	50.82 c	44.05 c	0.191 c	0.169 c
24 kg K_2O/fad.	88.27 b	73.08 b	56.65 b	51.26 b	0.220 b	0.193 b
48 kg K_2O/fad.	93.83 a	77.14 a	61.32 a	54.79 a	0.241 a	0.208 a
F. test	**	**	**	**	**	**
Interaction						
M x K	NS	NS	NS	NS	*	NS

NS, * and ** indicated insignificant, significant ant highly significant at 0.05 and 0.01 level of probability, respectively.

Table 3. Weight of seeds/plant (g), 1000-seed weight (g) and seed yield (kg/fad.) of sesame as influenced by micronutrients foliar application as well as their interaction during both growing seasons

Main effects and interaction	Weight of seeds/plant (g)		1000-seed weight (g)		Seed yield (Kg/fad.)	
	2018	2019	2018	2019	2018	2019
Micronutrient treatment (M)						
Tap water (control)	11.71 c	11.34 d	3.44 c	3.75 d	624.44 d	564.53 d
Zn	13.08 bc	11.19 d	3.81 b	4.07 bc	673.67 c	602.94 cd
Fe	12.39 c	11.55 cd	3.79 b	4.19 ab	670.33 cd	636.83 bc
Mn	12.59 c	12.33 bc	3.74 b	4.38 a	677.89 c	617.26 c
Zn + Fe	13.10 bc	12.02 cd	3.62 bc	3.87 cd	687.78 bc	630.30 c
Zn + Mn	14.90 ab	13.27 ab	4.07 a	4.16 ab	734.67 ab	684.32 a
Fe + Mn	13.00 bc	11.77 cd	3.70 b	4.13 abc	690.44 bc	625.06 c
Zn + Fe + Mn	15.06 a	13.67 a	4.09 a	4.30 ab	743.22 a	678.69 ab
F. test	*	**	**	**	**	**
Potassium level (K)						
Check	11.73 c	10.71c	3.39 c	3.67 c	627.42 c	568.02 c
24 kg K_2O/fad.	13.36 b	12.25 b	3.86 b	4.16 b	694.00 b	618.38 b
48 kg K_2O/fad.	14.60 a	13.48 a	4.10 a	4.49 a	742.00 a	703.57 a
F. test	**	**	**	**	**	**
Interaction						
M x K	NS	NS	NS	NS	*	*

NS, * and ** indicated insignificant, significant ant highly significant at 0.05 and 0.01 level of probability, respectively.

be attributed to the high deficit of these nutrients in the field experimental soil, the vital role of these micronutrients in the metabolic processes, its importance in the forming and multiplying meristem cells and encourage growth buds and building new organs **(El-Sherif, 2016).** Also, adding of these micronutrients may be attributed to more activity of the vaccinatum tubes and consequently increase fertile flowers number that leading to more number of formed capsules **(Emam, 2015).** In this connection, many researchers recorded significant enhancement in sesame seed yield and its attributes due to micronutrients application (**Eisa *et al*., 2010; Heidari *et al*., 2011; Mahdi, 2014; Emam, 2015; Shirazy *et al*., 2017; Seervi *et al*., 2018; Ram *et al*., 2021**). Furthermore, **El-Sherif (2016)** reported that application of 400 g/fad., foliar micronutrients (Fe, Zn, Mn) significantly increased plant height, number of capsules/ plant, weight of capsules/plant, weight of seed/ plant, seed yield/fad., and seed oil percentage of sesame.

Seed quality

As shown in Table 4, the obtained results exhibited that foliar application of either Zn + Mn or Zn + Fe + Mn significantly enhanced seed oil percentage during both seasons, as compared with control and the other treatments. In addition, oil yield/fad., followed the same trend of seed yield/fad., where, the highest value of oil yield/fad., was recorded under foliar application of either Zn + Mn or Zn + Fe + Mn during both seasons. The occurred increment in sesame oil yield/fad., due to foliar application of either Zn + Mn or Zn + Fe + Mn could be attributed to the increase in seed yield/fad., and seed oil percentage recorded under these two micronutrient foliar application treatments. The obtained results are in agreement with those found by **Emam (2015), El-Sherif (2016) and Seervi *et al*. (2018)** who revealed significant increase in seed oil percentage and oil yield due to mixture application of micronutrients.

Potassium Fertilizer Level Effect

Seed yield and its attributes

As shown in Tables 1, 2 and 3, that all yield attributes, with exception of number of branches/plant, were significantly affected by the studied potassium fertilizer level. Plant height, fruiting zone length, number of capsules/ plant, number of seeds/capsule, weight of seeds/

Table 4. Seed oil percentage and oil yield (kg/fad.) of sesame as influenced by micronutrients foliar application as well as their interaction during both growing seasons

Main effects and interaction	Oil percentage (%)		Oil yield (Kg/fad.)	
	2018	2019	2018	2019
Micronutrient treatment (M)				
Tap water (control)	49.11 d	50.73 c	306.73 c	285.98 c
Zn	51.09 cd	51.26 bc	344.78 b	309.85 b
Fe	51.09 cd	51.32 bc	343.40 b	327.42 b
Mn	50.57 cd	50.92 c	343.47 b	314.52 b
Zn + Fe	51.74 bc	51.45 bc	356.11 b	325.16 b
Zn + Mn	54.02 ab	53.55 ab	397.84 a	367.19 a
Fe + Mn	51.39 cd	50.47 c	355.75 b	315.96 b
Zn + Fe + Mn	54.32 a	55.08 a	404.36 a	374.10 a
F. test	*	*	**	**
Potassium level (K):				
Check	50.15 b	51.04 c	314.93 c	290.30 c
24 kg K_2O/fad.	52.02 a	51.83 b	361.56 b	320.81 b
48 kg K_2O/fad.	52.83 a	52.68 a	393.18 a	371.45 a
F. test	**	**	**	**
Interaction				
M x K	NS	NS	*	**

NS, * and ** indicated insignificant, significant ant highly significant at 0.05 and 0.01 level of probability, respectively.

capsule, weight of seeds/plant and 1000-seed weight exhibited significant increase due to raising potassium fertilizer level up to 48 kg K_2O/fad., during two seasons without significant differences between 24 and 48 kg K_2O/fad., concerning plant height and seed oil percentage in the first season.

The obtained results offered in Table 3 revealed significant and gradual increment in seed yield/fad., with each increase in potassium fertilizer level up to 48 kg K_2O/fad., during both growing seasons. The increase of seed yield/ fad., obtained by the application of 48 kg K_2O/ fad., was expected, where all yield attributes aforementioned showed significant increment due to increasing potassium fertilizer level up to 48 kg K_2O/fad., throughout both growing seasons.

The favorable impact of potassium fertilizer on yield attributes may be due to the important function of potassium in synthesis of carbohydrates, photosynthesis process and cell elongation as well as, potassium improves translocation from leaves to capsules and seeds. Potassium shows a basic role in assimilation, phloem loading and long-distance assimilates transport, in N-metabolism and in storage activities through its function as an activator of many enzymatic responses and in electrochemical activities (**Abdelsatar *et al.*, 2021).**

The obtained results are in agreement with those reported by **Hafiz and El-Bramawy (2012), Jat *et al.* (2017) and Ahmad *et al.* (2018)**. Also, **Piyush *et al.* (2019)** reported that sesame seed yield was significantly increased by increasing potassium fertilizer level up to 40 kg K_2O/ha. Moreover, **Abdelsatar *et al.* (2021)** reported that potassium level of 50 Kg K_2O/ fad., was found to be more efficient in increasing sesame yield and its components.

Seed quality

The obtained results given in Table 4 revealed significant increase in seed oil percentage due to increasing potassium fertilizer level up to 48 Kg K_2O/fad., during both seasons without significant differences between 24 and 48 Kg K_2O/fad., in the first season.

Oil yield/fad., followed the same trend of seed yield/fad. Where, oil yield/fad., exhibited significant and gradual increment due to increasing potassium fertilizer level up to 48kg K_2O/fad., through both growing seasons. The observed increase in oil yield/fad., due to increasing potassium fertilizer level could be attributed to the increase in seed yield/fad., and seed oil percentage obtained under application of 48kg K_2O/fad. These results are in agreement with those found by **Aziz *et al*. (2016) and Ahmad *et al.* (2018).** In addition, **Abdelsatar *et al*. (2021)** reported significant increase in seed oil percentage due to increasing potassium fertilizer level up to 50 kg K_2O/fad.

Interaction Effect

Plant height as influenced by the interaction between the two studied factors in the first season is showed in Table 1 and Fig. 1. It could be noted that, under foliar application of Mn and Zn + Fe, plant height revealed no significant response to potassium fertilizer level. However, under foliar application of Fe, Fe + Mn and Zn + Mn, plant height was significantly increased due to increasing potassium fertilizer level to 24 kg K_2O/fad. Moreover, plant height recorded significant increment under the application of 48 kg K_2O/fad., under foliar application of tap water, Zn and Zn + Fe + Mn.

The interaction between foliar application of micronutrients and potassium fertilizer level affected significantly on fruiting zone length at the first season (Table 1 and Fig. 2). It can be observed that, fruiting zone length showed no significant response to potassium fertilizer level under foliar application of Zn and Mn. While, under foliar application of Fe + Mn and Zn + Mn, fruiting zone length was significantly increased due to increasing potassium fertilizer level to 24 kg K_2O/fad. However, under foliar application of tap water, Fe and Zn + Fe fruiting zone length was significantly increased by increasing potassium fertilizer level up to 48 kg K_2O/fad.

Seed yield/fad. of sesame was affected significantly by the interaction between foliar application of micronutrients and potassium fertilizer level during both seasons as shown in Table 3, Figs. 3 and 4. In the first season, seed yield/fad., showed no significant response to potassium fertilizer levels under control treatment of micronutrient foliar application. While, under foliar application of Mn and Fe + Mn seed yield/fad., was significantly increased due to increasing potassium fertilizer level to 24 kg K_2O/fad. However, under foliar application of Zn, Fe and Zn + Fe seed yield/fad., was significantly increased due to raising potassium fertilizer level from 0 or 24 kg K_2O/fad., to 48 kg K_2O/fad. Moreover, seed yield/fad., presented significant and gradual increase with each increase of potassium fertilizer level up to 48 kg K_2O/fad., under foliar application of Zn + Mn and Zn + Fe + Mn. (Fig. 3).

Also, seed yield/fad., was significantly interacted by foliar application of micronutrients and potassium fertilizer level during the second season (Fig. 4). It could be mentioned that, seed yield/fad., exhibited significant and gradual increment due to increasing potassium fertilizer level up to 48 kg K_2O/fad., under foliar application of Zn+Mn and Zn +Fe + Mn. On the other direction, seed yield/fad was significantly increased when potassium fertilizer level was increased from 0 or 24 kg K_2O/fad., to 48 kg K_2O/fad., under foliar application of other micronutrient treatments.

The obtained results illustrated in Table 4 and Figs. 5 and 6 detected significant interaction effect between the two studied factors on oil yield/fad., during both seasons. It can be reported that, under foliar application of tap water and Mn, oil yield/fad., showed no significant response to increasing potassium fertilizer levels. On the other hand, under foliar application of Zn + Mn and Zn + Fe + Mn, oil yield/fad., presented significant and gradual increment with each increase in potassium fertilizer level up to 48 kg K_2O/fad. However, under foliar application of Fe and Fe + Mn, oil yield/fad., was significantly increased due to increasing potassium fertilizer level to 24 kg K_2O/fad. While, under foliar application of Zn and Zn + Fe, oil yield/fad was significantly increased only under the application of 48 kg K_2O/fad. (Fig. 5).

As illustrated in Fig. 6 oil yield/fad., showed significant and gradual increase with each increase in potassium fertilizer level up to 48 kg K_2O/fad., under foliar application of Zn, Zn + Mn and Zn + Fe + Mn during the second season. However, under foliar application of other micronutrient treatments, oil yield/fad., was significantly increased when potassium fertilizer level was increased from 0 or 24 to 48 kg K_2O/fad.

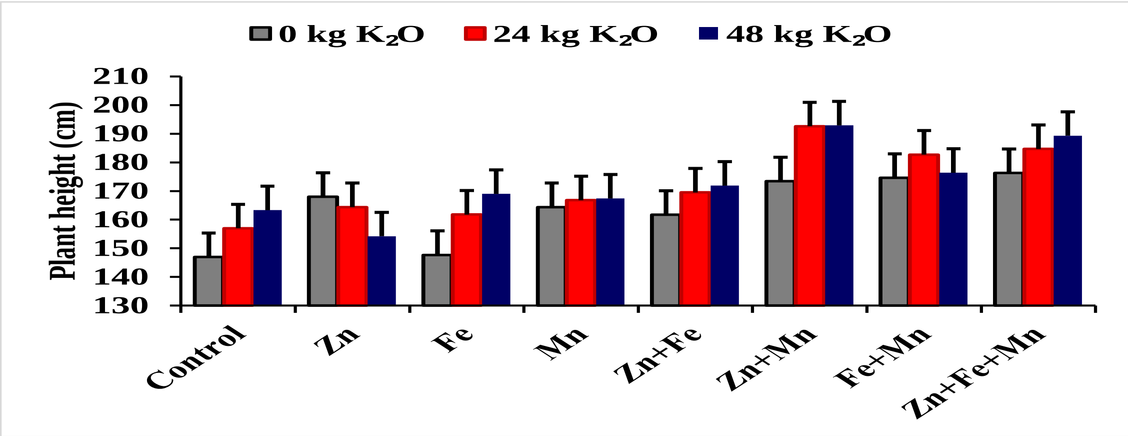

Fig. 1. Plant height (cm) as influenced by the interaction between foliar application of micronutrients and potassium fertilizer level during the first season

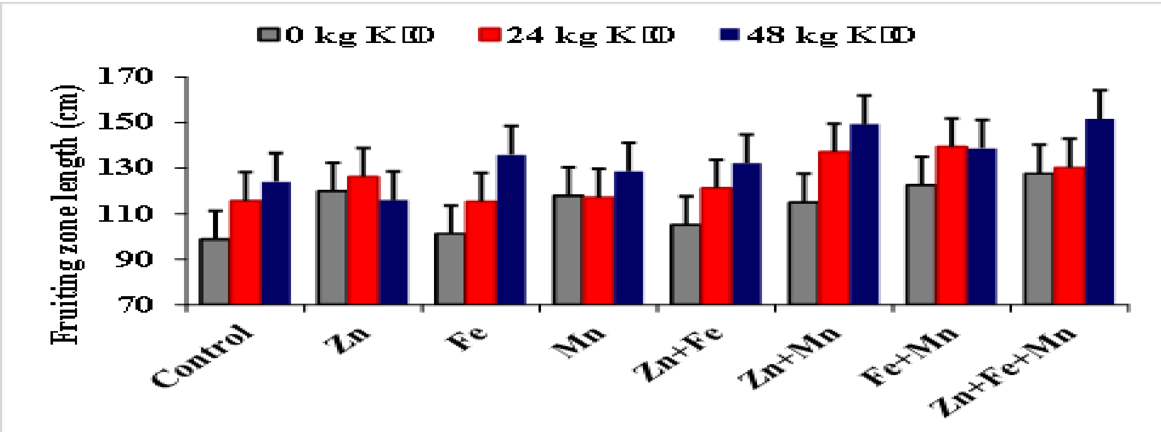

Fig. 2. Fruiting zone length (cm) as influenced by the interaction between foliar application of micronutrients and potassium fertilizer level during the first season

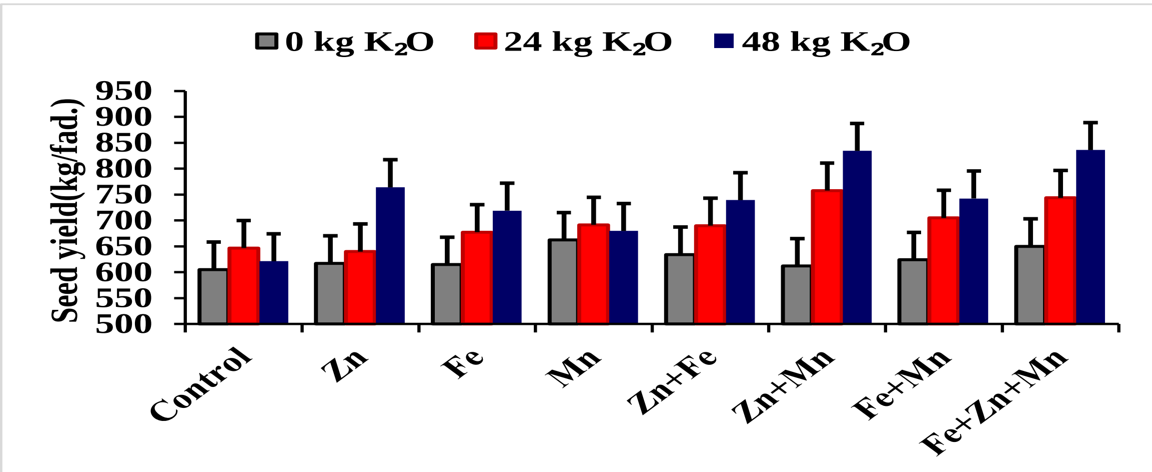

Fig. 3. Seed yield (kg/fad.) as influenced by the interaction between foliar application of micronutrients and potassium fertilizer level during the first season

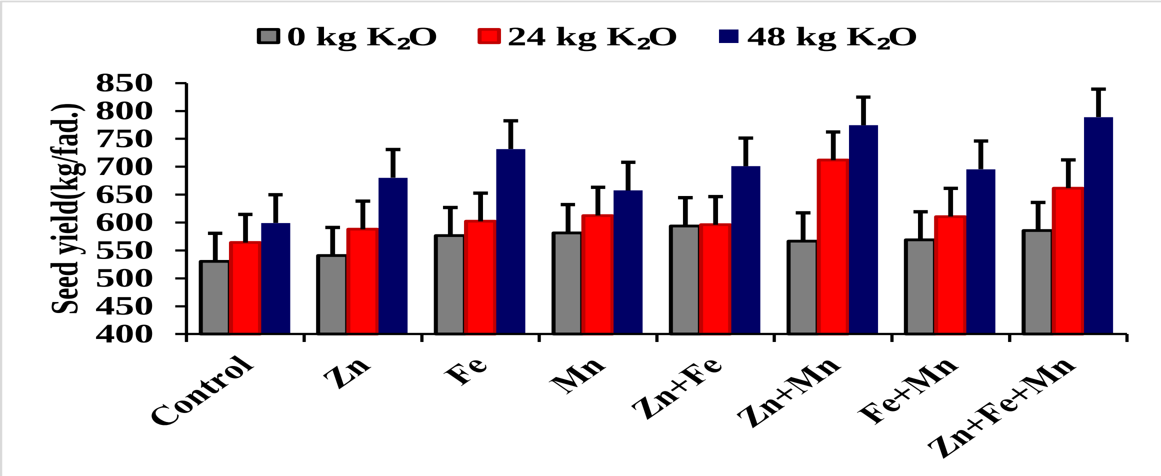

Fig. 4. Seed yield (kg/fad.) as influenced by the interaction between foliar application of micronutrients and potassium fertilizer level during the second season

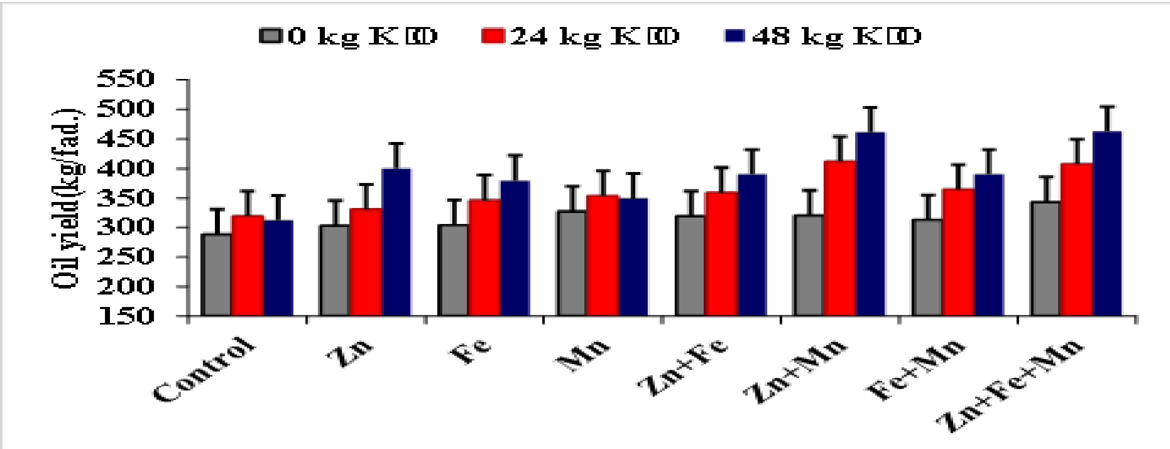

Fig. 5. Oil yield (kg/fad.) as influenced by the interaction between foliar application of micronutrients and potassium fertilizer level during the first season

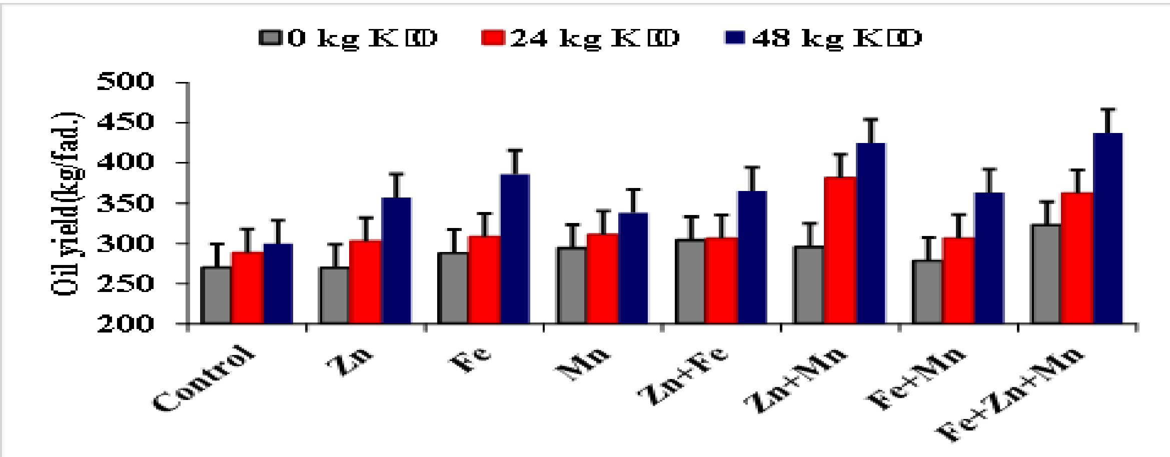

Fig. 6. Oil yield (kg/fad.) as influenced by the interaction between foliar application of micronutrients and potassium fertilizer level during the second season

Conclusion

It could be recommended that, foliar application of Zn+Mn and of Zn + Fe + Mn with 48 kg K_2O/fad., was favorable to increase seed and oil yields as well as, seed oil content (%) and most yield attributes of sesame under sandy soil conditions.

REFERENCES

Abdelsatar, M.A., H.M.M. Elmasry and M.A. Attia (2021). Role of potassium fertilizer in improving yield and its components for some sesame varieties under salt-affected soil conditions. SVU-Int. J. Agric. Sci., 3 (1): 18-30.

Ahmad, F., J. Ahmad, H. Nawaz, M.W. Abbas, M.A. Shah, S. Iqbal, Z. Mehmood and M. Ali (2018). Influence of sulphur and potassium levels on yield and yield attribute of sesame (*Sesamum indicum* L.). Int. J. Res. Studies in Agric. Sci., 4(5): 8-10.

AOAC (1980). Official Methods of Analysis. Association of Official Agriculture Chemists. 13th Ed. AOAC, Washington. D.C.

Aziz, S., Q. Darrag and O. Khalil (2016). Effect of mineral and biofertilization of phosphorus and foliar spraying with potassium on yield, its attributes and seed quality of new sesame variety. Advances in Agric. and Agric. Sci., 2 (2): 15-20.

Eifediyi, E.K., G.A. Lori; H.E. Ahamefule and A.Y. Imam (2021). The effects of zinc biofortification of seeds and NPK fertilizer application on the growth and yield of sesame (*Sesamum indicum* L.). Acta agric. Slovenica, 117 (1): 1–11.

Eisa, S.A.I., M.M. Abass and S.S. Behary (2010). Amelioration productivity of sandy soil by using amino acids, sulphur and micronutrients for sesame production. J. Ame. Sci., 6(11): 250- 257.

El-Sherif, A.M.A. (2016). Sesame (*Sesamum indicum* L.) yield and yield components influenced by nitrogen and foliar micronutrient applications in the Fayoum region, Egypt. Egypt. J. Agron., 38 (3):355-367.

Emam, S.M. (2015). Sesame varietal response to microelements foliar application and soil N fertilization in loamy sand soil. Fayoum J. Agric. Res. and Dev., 29 (1): 1-12.

FAOSTAT (2021). Food and Agricultural Organization of the United Nations (FAO), FAO Statistical Database, from http:// faostat. fao.org. December 2021.

Gomez, N.K. and A.A. Gomez (1984). Statistical Procedures for Agricultural Res. 2nd Ed. John Wiley and Sons, New York, USA, 68.

Gyana, R.R. and S. Sahoo (2015). Role of iron in plant growth and metabolism. Rev. Agric. Sci., 3:1 – 24.

Hafeez, B., Y.M. Khanif and M. Saleem (2013). Role of Zinc in Plant Nutrition- A Review. Ame. Exp. Agric., 3 (2): 374-391.

Hafiz, S.I. and M.A.S. El-Bramawy (2012). Response of sesame (*Sesamum indicum* L.) to phosphorus fertilization and spraying with potassium in newly reclaimed sandy soils. Int. J. Agri. Sci. Res., 1 (3): 34-40.

Heidari, M., M. Galavi and M. Hassani (2011). Effect of sulfur and iron fertilizers on yield, yield components and nutrient uptake in sesame (*Sesamum indicum* L.) under water stress. Afr. J. Biotechnol., 10 (44): 8816-8822.

Jat, R., S.R. Naga, R. Choudhary, S. Jat and M.K. Rolaniya (2017). Effect of potassium and sulphur on growth, yield attributes and yield of sesame (*Sesamum indicum* L.). Chem. Sci. Rev. and Letters, 6 (21): 184-186.

Mahdi, A.S. (2014). Effect of foliar application with iron and zinc on growth and yield of sesame. The Iraqi J. Agric. Sci., 45(1): 18-25.

Mousavi, S.R., M. Shahsavari and M. Rezaei (2011). A general overview on manganese (Mn) importance for crops production. Aust. J. Basic and Appl. Sci., 5(9): 1799-1803.

MSTAT-C. (1991). A Microcomputer program for the design, management and analysis of agronomic research experiment. MSTAT Develop. Team, Michigan State Univ., East Lansing.

Piyush, D.K., A. Thaokar, K.A. Gawali, A. Sarda, A. Nagmote and S.K. Jatav (2019). Response of sesame (*Sasamum indicum* L.) to nitrogen and potassium fertilization. J. Pharm. and Phytochem., 8(6): 411-414.

Priyadarshini, A., C. Umesha and M.R. Meshram (2021). Influence of phosphorus and potassium levels on growth, yield and economics of sesame (*Sesamum indicum* L.) under eastern Uttar Pradesh condition. Biol. Forum – An Int. J., 13 (1): 645-650.

Ram, M., R.C. Meena and M.M. Sundria (2021). Enhancing sesame productivity and profitability through zinc and iron application in western Rajasthan. The Pharma Innovation J., SP-10(10): 924-928.

Seervi, D., P. Choyal and K.S. Seervi (2018). The effect of micronutrients applied as foliar spray on yield and yield attributes and oil content of sesame crop (*Sesamum indicum* L.). J. Pharm. and Phytochem., 7 (4): 1402-1404.

Shirazy, B.J., M.M. Mahbub, T.A. Somee and S. Islam (2017). Effect of nitrogen rates and foliar spray of micronutrients on growth and yield of sesame (*Sesamum indicum* L.). Ame. J. Plant Biol., 3 (1): 1-21.

Singaravel, R., Y. Imayavaramban, K. Dhanunathan and N. Shanmughapriya (2001). Response of sesame (*Sesamum indicum* L.) to manganese and zinc nutrition. J. Oilseeds Res., 18(1): 136-138.

Steel, R.G.D., J.H. Torrie and D.H. Dickey (1997). Principles and Procedures of Statistics. A Biometrical Approach, 3rd Ed. Mc Graw Hill. Book Co. New Yourk, 172-177.

تأثير الرش الورقى بالعناصر الصغرى ومعدلات السماد البوتاسى على إنتاجية وجودة محصول السمسم تحت ظروف الأراضي الرملية

محمد عبدالسلام طه يس – أسماء عبدالسلام

قسم المحاصيل – كلية الزراعة – جامعة الزقازيق - مصر

أقيمت تجربتان حقليتان خلال الموسمين الصيفيين 2018 و 2019 في المزرعة التجريبية التابعة لكلية الزراعة - جامعة الزقازيق بمنطقة الخطارة (تربة رملية)- محافظة الشرقية- جمهورية مصر العربية، بهدف دراسة تأثير الرش الورقى بالعناصر الصغرى (الزنك، الحديد، المنجنيز، الزنك + الحديد، الزنك + المنجنيز، الحديد + المنجنيز، الزنك + الحديد + المنجنيز بالإضافة إلى معاملة الكنترول) والإضافة الأرضية للبوتاسيوم بمعدلات (صفر، 24 و 48 كجم K_2O/ فدان) على إنتاجية وجودة محصول السمسم (صنف شندويل 3). وقد أشارت نتائج التحليل الإحصائى إلى أن الرش الورقى بمخلوط الحديد والزنك والمنجنيز قد أدى إلى الحصول على أعلى القيم لمحصولى البذور والزيت وكذلك نسبة الزيت بالبذور ومعظم مساهمات المحصول فى موسمى الزراعة. أدت زيادة مستويات السماد البوتاسى إلى 48 كجم K_2O/ فدان إلى الحصول على أعلى القيم لكل من: طول المنطقة الثمرية، عدد الكبسولات/نبات، عدد البذور/الكبسولة، وزن بذور الكبسولة، وزن بذور النبات، وزن الـ 1000 بذرة ومحصول البذور والزيت فى موسمى الزراعة. من خلال نتائج هذه الدراسة يمكن التوصية بالرش الورقى بمخلوط الحديد والزنك والمنجنيز مع إضافة السماد البوتاسى بمعدل 48 كجم K_2O/ فدان لمعظمة إنتاجية محصول السمسم من البذور والزيت تحت ظروف الأراضى الرملية.

المحكمـــــون:

1- أ.د. صديق عبدالعزيز صديق محسين أستاذ المحاصيل – كلية الزراعة بمشتهر – جامعة بنها.

2- أ.د. عــادل يوســـف عبدالحميد البنا أستاذ المحاصيل المتفرغ – كلية الزراعة – جامعة الزقازيق.