J. Product. & Dev., 25(2): 231-246 (2020)

EFFECT OF FOLIAR SPRAY WITH DIFFERENT POTASSIUM SOURCES AND ZINC RATES ON GROWTH AND YIELD OF SWEET POTATO (*Ipomoea batatas* L.).

Mohamed El Nagy M. M.[1], E. H. Abou El- Salehein[1], Wafaa A. Fekry[1], and H.M. Wahdan[1]
Plant Prod. Dept. (Horticulture –Vegetables); Fac. Technol. and Development; Zagazig Univ., Zagazig, Egypt. E. mail: eelsalehein@yahoo.co.uk

ABSTRACT

Two field experiments were carried out during 2017 and 2018 seasons at Experimental Farm, Faculty of Technology and Development (Ghazala Region –Zagazig City), Sharkia Governorate (Egypt) to investigate the effect of different potassium sources and zinc fertilizer levels on growth and yield of sweet potato plant cv. Menoufia 6. The experiment was set up a randomized complete blocks design which included 7 treatments of different sources of potassium and zinc (EDDTA) rates (i.e., potassium silicate 2 mll^{-1} and 4 mll^{-1}, potassium humate, 2 mll^{-1} and 4 mll^{-1} and zinc (EDDTA), 2 mll^{-1} and 4 mll^{-1}, besides the control treatment without any addition .

***The obtained results could be summarized as follows**: application of foliar spray with zinc (EDDTA) with4 mll^{-1}, being the most effective treatment on vegetative growth and chemical composition, while 4mll^{-1} potassium silicate as foliar application caused a significantly increased in tuber yield and quality of sweet potato, followed by the treatment of 4 mll^{-1} zinc in most cases, in both growing seasons.*

***Conclusively, i**t could be concluded that, using the treatment of 4 mll^{-1} zinc (EDDTA) caused an increases in plant growth parameters and chemical composition of sweet potato plant cv. Menoufia 6, while 4 mll^{-1} potassium silicate significantly increased tuber yield and quality.*

Keywords: sweet potato, potassium silicate, potassium humate, zinc

INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) is a member of family *Convolvulaceae*. It is a herbaceous dicotyledonous plant with underground root tuber. It is important food crop in tropical and sub-tropical, where it considered as one of the cheapest source of carbohydrates, vitamins, *i.e.* vitamin A in the form of beta carotene, vitamin C and vitamin B6, as well as minerals, *i.e*. potassium manganese and iron (Abd El-Baky *et al*., 2010).

Sweet potato ranked the seventh important crop in the world – wide after wheat, rice, maize, potato, barley and cassava (CIP, 1999). Both vine and tuber roots of sweet potato were used as a food for humans and livestock. Moreover, tubers is serves as a raw material for the manufacture of starch, and alcohol. In Egypt, the cultivated area in 2018 more than 28860 feddan, which produced 387481 ton with the average yield of 13.426 ton fed^{-1} (FAO, 2018).

Sweet potato need many nutrients, especially potassium which increases the yield with larger-sized tubers (Uwah *et al*., 2013). Potassium had an essential role in the synthesis and translocation the carbohydrates to store parts (Byju and Nedunchezhiyan, 2004). As well as, it activates over 60 enzymes, promotes photosynthesis, improves the utilization of nitrogen and promotes the transport of assimilates. Potassium can still become a limiting nutrient under continuous cropping, especially with root and tuber crops. The application of potassium humate with irrigation water (14.28L.ha) significantly increased onion bulbs and dry weight (Abd El- Aal *et al*., 2005), as well as the application of foliar sources of potassium gave the highest values of leaf biochemical composition of potato plants (Salim *et al*., 2014).

Zinc is an essential element, which plays an important role in the growth and productivity of the plants. It is an important component of enzymes that drive and increase the rate of many important metabolic reactions involved in crop growth and its development (Potarzycki and Grzebisz, 2009). Sweet potato plants a positively responded to foliar application with zinc and produced a maximum roots production. Zinc is very important crop nutrient that plays a vital role in growth and development of potato by enhancing the synthesis of growth hormone and chlorophyll (Graham *et al*., 2000, Barben *et al*., 2007, Ali *et al*., 2008 and Abd El-Baky *et al*., 2010).

Therefore, this work was done to study the effect of different sources of potassium and some rates of zinc as foliar application on growth, root tuber yield and quality of sweet potato.

MATERIALS AND METHODS

Fields trials were carried out during two successive summer seasons of 2017 and 2018 at Ghazala Experimental Farm, Faculty of Technology and Development, El-Sharkia Governorate, Egypt, to investigate the effect of foliar spray with different potassium sources and zinc rates on growth, chemical constituents of foliage, yield and tuber roots quality of sweet potato CV.

Menoufia-6. The experimental field soil texture was clay and the physical and chemical properties of the experimental soil presented as shown in Table (1).

Table (1): Physical and chemical properties of the experimental soil

Analysis	**2018 season**
Particle size distribution (g.kg^{-1})	
Coarse sand	22
Fine sand	10
Silt	24
Clay	44
Soil Texture	Clay
EC (dS.m^{-1}) in soil paste extract	2.76
pH (in 1 soil:2.5 water suspension)	8.2
Organic Matter (%)	1.66
Plant–available of minerals (mg/kg^{-1})	
N	27.18
P	18.23
K	177.12
Si	27.02
N	27.18

EC = Electric conductivity

The experiment was set out in a randomized complete blocks design with three replications, where included 7 treatments as follows; Control (sprayed with tap water), different potassium sources, *i.e.* Potassium silicate (32 % K_2O) and potassium humate (32 % K_2O) at the rates of 2 and 4 mll^{-1} ,as well as zinc chelates (Na_2 Zn EDTA 13 %) at two concentrations (2 and 4mll^{-1}). The treatments of potassium and zinc were sprayed at 30, 60 and 90 days after transplanting, respectively.

Vine cuttings of 25 cm in length were sown at 1st of June in both growing seasons. Cutting were planted on one side of the ridge in upright vertical position and inserted in about two thirds of their length in the soil. The experimental plot area was 9 m^2 (three ridges, 4 m in length and 75 cm in width). The distance between the plant was 25cm apart.

Compost manure at 10 m^2 / fed., and calcium superphosphate (15.5% P_2O_5) at 150 Kg/fed., were added during the soil preparation. Ammonium nitrate (33.5%N) at the rate of 200 Kg/fed., and 100 Kg/fed. Potassium sulphate (48% K_2O) were applied in two portions, after the first and second months from transplanting, equal. Cultural practices were followed according to the recommendations of the Egyptian Ministry of Agriculture.

Data recorded

Vegetative growth :

Three plants were randomly chosen from each experimental unit at 120 days after transplanting to measure the plant growth and its chemical constituents.

1- Growth parameters, *i.e.* Vine length (cm) , both number of leaves and branches /plant , vine fresh weight/plant (g) and dry weight/ plant(g)

2- Plant chemical analyses**:** the concentration of nitrogen, phosphorus and potassium were determined in the dry weight of vine according to the methods described by A.O.A.C. (1995). Protein content was calculated by multiplying the percentage of total nitrogen by 6.25 as described by Pregl (1945).

3. ***Tuber yield and its components:***

At harvest time (150 days after transplanting approximately), all tuber roots of plants in each plot were counted and weighted (Kg) to calculate the average of tuber root weight, number of roots yield /plant, tuber yield per plant (Kg) and Marketable(ton/fed.). Where Marketable root yield feddan (ton/fed) are characterized by length about 20 cm, diameter 5-6 cm and weight from 100-250g.

4. ***Tuber quality:***

Ten roots tubers were randomly taken from each treatment for measuring the physical characters, i.e. average tuber root weight(g), length diameter(cm), as well as the chemical tuber quality(the nutritive value) by dried and ground the tuber to determine the content of total nitrogen, phosphorus, potassium and protein according to the methods previously described in plant chemical analyses. The percentage of dry matter and starch according to A.O.A.C. (1995). Carotene content was determined in the tuber fresh weight method as described by using the A.O.A.C. (1995).

Statistical analysis

All the data were subjected to statistical analysis of variance according to the methods described by Snedecor and Cochran (1991). The means between the treatments were done by LSD at 0.05 level of probability with SAS software (SAS Institute, 2001).

RESULTS AND DISCUSSION

Vegetative growth characters:

Data in Table (2) revealed that foliar application of various sources and rates of potassium, *i.e.* potassium silicate or humate at the levels of 2 and 4 mll^{-1}, as well as zinc at the two concentrations 2 and 4 mll^{-1} had a significant effect on the studied growth measurements of sweet potato plants expressed as vine length, both number of leaves and branches $plant^{-1}$, as well as plant fresh weight. Foliar spraying with zinc at the rate of 4 mll^{-1}, being the most effective treatment in this respect in both grown seasons, followed by the application of zinc at 2 mll^{-1} in descending order in most cases at the two growing seasons. The lowest values were recorded by the control treatment in this concern. Regarding the important role of zinc in increasing plant growth, Brady *et al.* (2002) confirmed that the increment in growth parameters by spraying zinc may be due to its role for enhanced the growth hormone biosynthesis, especially the hormone of indole acetic acid (IAA).

Moreover, Mousavi *et al.*(2013) stated that zinc considered a crucial nutrient which had a particular physiological purpose, *i.e.* protein creation, carbohydrates synthesis and enzymes structure. Also, the deficiency of zinc may be attributed to small leaf size and shortened internodes, hence limiting plant growth (Acquaah, 2002) .

Obtained results are in conformity with those found by Abd El-Baky *et al.* (2010); Ahmed *et al.* (2011); Rahman *et al.*(2018) and Miyu *et al.*(2019) who concluded that zinc fertilizers improved and increased the vegetative growth parameters of plant.

The enhancement in vegetative growth of sweet potato plants by foliar applications with potassium sources might be due to that potassium is an important nutrient in many physiological and biochemical processes in plants. It had a great role in controlling various enzymes activities, protein synthesis, photosynthesis and carbohydrates translocation, and root formation(Marschner, 2012), as well as it increased the efficiency of plant to utilize nitrogen which improving plant metabolism, enhancing merstimatic activity and leaves growth (Chen *et al*., 2004). Moreover, the promotive effect of plant growth with spraying potassium silicate probably attributed to it contains soluble silicon and potassium, where potassium plays an important role in many of the regulatory function in plant (Marschner, 1995) and the role of silicon in this respect may be due to promoting desirable plant physiological processes (Korndörfer and Lepsch, 2001) , also, it plays a vital role in improving nitrogen use efficiency and iron distribution (Jugal and Ramani, 2017).

Table (2). Effect of potassium sources and zinc EDTA rates on vegetative growth characters of sweet potato during 2017and 2018 seasons

Treatment groups	Vine length (cm)	Number of leaves/plant	Number of branches/plant	Fresh weight/plant(g)	Dry weight/plant(g)
	2017season				
Control	86.66 d	94.66 c	16.33 c	388.66 d	14.00 c
Potassium Silicate 2ml l^{-1}	100.33 c	98.33 c	18.00 bc	562.66 c	16.00 b
Potassium Silicate 4 ml l^{-1}	104.33 c	116.66 b	18.33 bc	816.66 b	16.66 b
Potassium humate 2 ml l^{-1}	99.66 c	109.00 b	17.66 bc	561.33 c	16.66 b
Potassium humate 4 ml l^{-1}	102.66 c	112.33 b	18.33 bc	765.33 b	16.66 b
Zinc 2 ml l^{-1}	110.66 b	118.33 b	21.66 ab	858.66 b	17.00 b
Zinc4 ml l^{-1}	122.66 a	126.33 a	23.33 a	964.00 a	18.66 a
	2018 season				
Control	80.66 c	91.66 e	13.66 c	312.00 e	13.80 c
Potassium Silicate 2ml l^{-1}	94.33 b	95.00 de	14.33 bc	533.33 d	16.00 b
Potassium Silicate 4 ml l^{-1}	101.50 b	105.00 c	15.50 bc	532.66 d	16.33 b
Potassium humate 2 ml l^{-1}	100.00 b	101.66 cd	14.66 bc	530.00 d	16.33 b
Potassium humate 4 ml l^{-1}	103.33 b	103.33 cd	15.66 bc	719.33 c	17.23 b
Zinc 2 ml l^{-1}	106.33 b	114.66 b	17.16 b	808.00 b	17.66 b
Zinc4 ml l^{-1}	116.33 a	121.66 a	20.00 a	1001.00a	19.66 a

Mean followed by different letters are significantly different at $P \leq 0.05$ level; Duncan's multiple range test.

The previous results are in line with those obtained by Abd-All *et al*. (2017) on sweet potato and Abd El-Gawad *et al*.(2017), Mahmoud *et al*.(2019) and Shaheen *et al*.(2019) on potato who demonstrated that the application of potassium silicate promoted plant growth parameters. Such results are in harmony with those reported by Abd- All *et al*.(2017)on sweet potato and Harfoush *et al*.(2017) on potato.

Plant foliage chemical constituents

Data tabulated in Table (3) reveal that all used treatments, had a marked effect on the chemical constituents of sweet potato foliage (shoots and leaves) than unsprayed plants. The highest values of nitrogen, phosphorus and total protein content were obtained from the plants sprayed with zinc at4 mll^{-1}, followed by the treatments of zinc at 2mll^{-1} and potassium silicate at 4mll^{-1}, respectively. Moreover, the increment of potassium content in sweet potato vine was recorded by the foliar application with potassium silicate or humate at the concentration of 4mll^{-1} in comparison with the other treatments. These results are true in both growing seasons of the study. Such increase in the N, P, K and protein content in foliage by the foliar application of zinc may be due to zinc is considered the active element in biochemical process (Acquaah, 2002). Moreover, Ali *et al.* (2008) stated that zinc is needed in the carbonic enzyme that present in every photosynthetic tissues, beside it required for chlorophyll biosynthesis. In addition, Mousavi *et al*.(2013), demonstrated that zinc is the essential micronutrients for protein production in plants, the main composition of ribosome and its development. These results are in conformity with those obtained by Abd El- Baky (2010) on sweet potato and Khan *et al*.(2019) on potato.

The positive effect of as potassium silicate or humate in increasing N, P,K, and protein content of plant may be attributed to the rapid absorption by plant surface, especially leaves of the two compounds and its elements components, as well as, translocation within the plant tissues (Marschner, 1995). In this concern, Marschner (2012) observed the role of potassium in plant metabolism and many important regulatory process which increase the mineral uptake by plants.

The previously mentioned results of potassium are in agreement with those recoded by Filho *et al*.(2016) on sweet potato and Salim *et al*.(2014), Abd El-Gawad *et al*.(2017) on potato and Thummanatsakun and Yamprach (2018) on cassava, they observed that foliar application with the sources of potassium increased the chemical constituents of store parts.

Table (3). Effect of potassium sources and zinc EDTA rates on the chemical constituents of sweet potato shoots during 2017 and 2018 seasons

Treatment groups	N(%)	P(%)	K(%)	Total protein (%)
	2017 season			
Control	1.240 d	0.195 b	2.30 b	7.753 d
Potassium Silicate 2mll^{-1}	1.339 cd	0.194 b	2.40 ab	8.371 cd
Potassium Silicate 4 ml l^{-1}	1.340 cd	0.208 b	2.42 ab	8.375 cd
Potassium humate 2 ml l^{-1}	1.474 bc	0.198 b	2.31b	9.213 bc
Potassium humate 4 ml l^{-1}	1.457 bc	0.196 b	2.32 b	9.111 bc
Zinc 2 ml l^{-1}	1.625 b	0.203 b	2.42 ab	10.156 b
Zinc4 ml l^{-1}	1.832 a	0.219 a	2.66 a	11.450 a
	2018 season			
Control	1.261 c	0.187 c	2.34 b	7.883 c
Potassium Silicate 2mll^{-1}	1.548 b	0.198 b	2.40 b	9.677 b
Potassium Silicate 4 mll^{-1}	1.501 bc	0.206 b	2.63 ab	9.381 bc
Potassium humate 2 ml l^{-1}	1.390 bc	0.203 b	2.42 b	8.687 bc
Potassium humate 4 ml l^{-1}	1.436 bc	0.209 b	2.46 b	8.979 bc
Zinc 2 ml l^{-1}	1.638 b	0.206 b	2.52 b	10.864 a
Zinc4 ml l^{-1}	1.871 a	0.226 a	2.73a	11.695 a

Mean followed by different letters are significantly different at $P \leq 0.05$ level; Duncan's multiple range test.

Tuber yield and its component

Data presented in Tables (4) demonstrate that all studied foliar application either by potassium or zinc exhibited significant increases of yield parameters, followed by the foliar applications with 4mll^{-1} potassium silicate and both concentrations of zinc(4 and 2mll^{-1}), respectively. On the other hand, the lowest results mostly obtained by the control treatment (tap water). The stimulative effect of potassium in this respect may be attributed to its function in plants which include energy metabolism and enzyme activation on exchange rate and nitrogen activity, as well as its role in enhancing carbohydrates movement and translocation from shoot to storage organs, consequently increase the tuber weight (Marscher, 1995 and 2012, as well as Howeler, 2014). In general, potassium is essential for the production of sweet potato which its improvement aerial biomass fresh weight that reflected on high translocation assimilates and accumulated in the store tuber roots (Sidiky *et al* .,2019). Foliar application of different potassium sources, *i.e.* potassium silicate and potassium humate significantly increased the tuber root weight, total tuber yield and the marketable yield of sweet potato. Moreover, potassium silicate recorded the highest values than potassium humate (Abd- All *et al*., 2017).

These results are agreement with those reported by (Salim *et al*., 2014). They confirmed that foliar application with potassium silicate accelerated plant growth, yield and its components of potato plant with 2000 ppm Thummanatsakun and Yampprach (2018) reported that potassium rate at 150 µmol^{-1} increased the number, fresh weight and size of cassava tuber.

The increment of sweet potato yield with the treatment of 2 mll^{-1} zinc as foliar application may be due to the enhancing effect of zinc on plant growth and its chemical contents as shown in Tables (2 and 3), which affected on the activity of photosynthesis process, accumulation of metabolites and translocation to the tubers, consequently increased tuber weight and total yield.

Regarding the effect of zinc on tuber yield ,Al-Fadhly, 2016 concluded that zinc had an important role in different physiological process such as enzyme activation, protein synthesis and metabolism of carbohydrate which improvement the quantitative and qualitative of tubers Similar results were observed by Abd El-Bakey *et al*.(2010) Al- Jobori and Al- Hadithy (2014), Al-Fadhly (2016) on sweet potato and Rahman *et al*.(2018) and Miyu *et al*.(2019) on potato who stated that foliar application of zinc improved the tuber yield and its components.

Tuber quality

It is clear from such data in Tables (5) that there were a significant differences between both of potassium sources and zinc rates on the tuber

Table (4). Effect of potassium sources and zinc EDTA rates on yield and its components of sweet potato during 2017 and 2018 seasons

Treatment groups	Number of tuber/plant	Plant yield (kg)	Yield /fad. (ton /fad.)	Marketable yield (ton/fad.)
	2017season			
Control	4.33 c	0.67 d	9.14 d	8.08 d
Potassium Silicate 2mll^{-1}	6.66 ab	1.26 b	18.82 b	14.45 b
Potassium Silicate 4 ml l^{-1}	7.66 a	1.50 a	21.22 a	16.94 a
Potassium humate 2 mll^{-1}	5.66 b	0.91 c	15.91 c	11.72 bc
Potassium humate 4 ml l^{-1}	6.00 b	0.97c	16.49 bc	11.78 bc
Zinc 2 ml l^{-1}	6.00 b	1.08 bc	17.73 b	13.35 b
Zinc4 ml l^{-1}	6.33 b	1.14 bc	17.89 b	13.70 b
	2018 season			
Control	5.33 b	0.83 d	9.65 d	7.50 d
Potassium Silicate 2mll^{-1}	6.33 b	1.20 b	18.00 b	14.76 b
Potassium Silicate 4 ml l^{-1}	8.33 a	1.66 a	20.75 a	16.13 a
Potassium humate 2 ml l^{-1}	5.66 b	0.94 c	14.54 c	10.43 c
Potassium humate 4 ml l^{-1}	5.00 b	1.01 c	16.04 b	10.85 c
Zinc 2 ml l^{-1}	5.33 b	0.95 c	15.48 b	11.90 c
Zinc4 ml l^{-1}	6.00 b	1.03 b	16.19 b	12.76 c

Mean followed by different letters are significantly different at $P \leq 0.05$ level; Duncan's multiple range test.

Table (5). Effect of potassium sources and zinc EDTA rate on the chemical constituents of sweet potato tuber (nutritive value) during 2017and 2018 seasons.

Treatment groups	Physical characters			Nutritive value					
	Diameter (cm)	Weight (g)	Length (cm)	N (%)	P (%)	K (%)	Protein (%)	Carotene (mg/g)	Starch (%)
				2017 season					
Control	4.06 b	156.00 d	10.33 c	1.362d	0.235c	3.120f	8.515 d	7.382e	19.13g
Potassium Silicate 2mll^{-1}	4.80 ab	189.33 b	17.00 b	2.381b	0.236c	3.352b	14.880 b	8.307b	22.68e
Potassium Silicate 4 ml l^{-1}	5.70 a	195.66 a	17.00 b	2.302b	0.237c	3.450a	14.390b	7.748d	24.39f
Potassium humate 2 ml l^{-1}	4.10 b	160.00 d	11.33 c	2.218c	0.239c	3.100f	14.583 b	7.804d	26.44d
Potassium humate 4 ml l^{-1}	4.40 b	162.00 d	11.00 c	2.336b	0.249b	3.212d	14.598 b	8.047c	28.75c
Zinc 2 ml l^{-1}	4.40 b	180.00 c	17.66 b	2.333b	0.249b	3.230c	13.864c	8.402b	30.19b
Zinc4 ml l^{-1}	4.56 b	180.33 c	20.66 a	2.560a	0.278a	3.495a	16.000a	8.695a	32.61a
				2018 season					
Control	3.53 c	156.66 e	10.00 c	1.333d	0.241bc	2.937d	8.333 d	7.705d	20.23e
Potassium Silicate 2mll^{-1}	5.00 ab	189.66 b	17.00 b	2.357b	0.250b	3.343b	14.734 b	7.712d	22.23e
Potassium Silicate 4 ml l^{-1}	5.63 a	199.00 a	17.00 b	2.292bc	0.249b	3.432a	14.312 c	7.758d	32.48b
Potassium humate 2 ml l^{-1}	4.00 bc	165.66 de	13.00 c	2.205c	0.242bc	3.195c	13.781 c	7.715d	27.95d
Potassium humate 4 ml l^{-1}	4.10 bc	178.33 c	13.00 c	2.338b	0.235c	3.22c	14.614 b	8.202c	30.50c
Zinc 2 ml l^{-1}	4.40 bc	168.66 cd	19.00 b	2.388b	0.244bc	3.325b	14.927 b	8.325b	30.32c
Zinc4 ml l^{-1}	4.86 ab	171.33 cd	21.86 a	2.605a	0.289a	3.468a	16.281 a	8.381a	34.70a

Mean followed by different letters are significantly different at $P \leq 0.05$ level; Duncan's multiple range test.

quality of sweet potato as physical characters, *i.e.* average tuber weight, length and diameter, as well as tuber nutritive value, *i.e.* N, P, K. protein, carotene.

The results in Table (5) demonstrated that there were a significant differences between potassium silicate, potassium humate and zinc fertilizer rates on the tuber quality of sweet potato (the nutritive value), *i.e.* N, P, K, protein, carotene and starch contents. Potassium silicate at 4mll^{-1}, being the most effective on the nutritive values of tuber of sweet potato followed by potassium silicate 2mll^{-1}. These results are true in both growing seasons.

Respecting the role of potassium in increasing the quality of sweet potato, Marschner,1995, stated that potassium plays a key role in carbohydrates metabolism and photosynthesis. He added that potassium plays an important role of crop quality, it improves the size of tuber and stimulates root growth, as well as, it is necessary for the translocation of sugars and formation of carbohydrates.

Regarding the effect of zinc in increasing the quality of tuber of sweet potato, Khan *et al*., 2019, concluded that zinc has a vital metabolic role in growth of plants and their development. It has particular physiological purpose, that act in all living systems, such as facilitation of protein creation, and a positive effect on crops production and improving quality (MouSavi *et al*., 2013).

The obtained results are confirmed with those of Byju and Nedunchezhiyan, 2004 and Abd El-Baky *et al*., 2010 they concluded that potassium or zinc fertilizers increased the yield and quality of potato or sweet potato plants.

Conclusively, it could be concluded that, using the treatment of4 mll^{-1} zinc (EDDTA) caused an increases in plant growth and chemical composition of sweet potato plant cv. Menoufia 6, while 4mll^{-1} potassium silicate significantly increased tuber yield and quality.

REFERENCES

Abd El-Aal,. F; M.R. Shafeek; A.A. Ahmed and A.M. Shaheen (2005). Response of growth and yield of onion plants to potassium fertilizer and potassium humate. *J. Agric. Sci. Mansoura Univ.*, 30(1): 441-452.

Abd El-Baky, M.M.H., A.A. Ahmed, M. A. El-Nemr and M.F. Zaki (2010). Effect of potassium fertilizer and foliar zinc application on yield and quality of sweet potato. *Res. J. of Agric. and Bio. Sci*., 6(4): 386-394.

Abd El-Gawad, H.G., N.A.I. Abu El-Azm and M.S. Hikal (2017). Effect of potassium silicate on tuber yield and biochemical constituents of potato plants grown under drought stress conditions. *Middle East J. Agric. Res*., 6(3): 718-731.

Abd-All, A. E., A. E. El-Namas, and E. M. EL-Naggar (2017). Effect of humic acid and foliar application of different potassium sources on yield, quality and water use efficiency of sweet potato grown under drip irrigation in sandy soil. *Alexandria Science Exchange*, 38(3), 544.

Acquaah, G. (2002). *Horticulture Principles And Practices* (2^{nd} ed.). Upper Saddle River, USA: Prentice Hall.

Ahmed, A. A., Abd EL-Baky, M. M. H., Zaki, M. F. and Faten S., Abd elaal, (2011). Effect of foliar application of active yeast extract and zinc on growth, yield and quality of potato plant (*solanum tuberosum* L.). *J. Appl. Sci. Res.*, 7(12): 2479-2488.

Al-Fadhly, J. T. M. (2016). Response of potato (*Solanum tuberosum* L.) to foliar application of zinc and manganese which fertilized by organic fertilizer. *IOSR J. Agric. and Veterinary Sci.*, 9(4): 87-91.

Ali, S., A. R. Khan, G. Mairaj, M. Arif, M. Fida, and S. Bibi (2008). Assessment of different crop nutrient management practices for yield improvement. *Aust. J. Crop Sci*., 2(3): 150-157.

Al-Jobori, K. M. and S. A. Al-Hadithy (2014). Response of potato (*Solanum tuberosum* L.) to foliar application of iron, manganese, copper and zinc. *International J. Agric. and Crop Sci.*, 7(7): 358-363.

A.O.A.C. (1995). *Association of Official Agricultural Chemists.* Official Methods Of Analysis Association Of Official Analytical Chemists.16 ed. Washington. D. C., U.S.A.

Barben, S.A., B.A. Nichols, B.G. Hopkins, V.D. Jolley, J.W. Ellsworth and B.L. Webb (2007). Phosphorus and Zinc Interaction in Potato. Western Nutrient Management Conference, Vol. 7. Salt Laks City, UT.

Brady N.C. and R.R. Weil(2002). *The Nature and Properties of Soils*, 13^{th} ed. Upper saddle river, New Jersey: prentice hall.

Byju, G. and M. Nedunchezhiyan (2004). Potassium: A key nutrient for higher tropical tuber crops production. *Fertilizer News*, 49(3): 39 – 44.

Cecílio Filho, A. B., S. Nascimento, A. S. Silva and P. F. Vargas (2016). Agronomic performance of sweet potato with different potassium fertilization rates. *Hortic. Brasileira*, 34(4): 588-592.

Chen, Y., C. Clapp and H. Magen, (2004). Mechanisms of plant growth stimulation by humic substances: The role of organic-iron complexes. *Soil Sci. Plant Nutri*., 50: 1089-1095.

CIP (International Potato Centre). (1999). *Sweet Potato Facts: Production, Use, Consumption And Feed Use*. Lima. Peru.

FAO Stat, (2018). *Food and Agriculture Organization of the United Nations*, Rome, Italy. http:// faostat. fao.org/ site/567/ default. aspx#ancor.

Graham, R.D., R.M. Welch and H.E. Bouis (2000). Addressing micronutrient nutrition through enhancing the nutritional quality of staple foods. *Adv. Agron*., 70: 77-161.

Harfoush, E., A. H. Abdel-Razzek, F. I. El-Adgham and A. M. El-Sharkawy (2017). Effects of humic acid and chitosan under different levels of nitrogen and potassium fertilizers on growth and yield potential of potato plants (*Solanum tuberosum*, L.). *Alexandria J. Agric. Sci*., 62(1): 135-148.

Howeler, R. H. (2014). In: *Sustainable Soil And Crop Management of Cassava in Asia*, Vietnam, CIAT publication, pp.57-97.

Jugal, K., and P. V. Ramani (2017). Effect of silicon on nitrogen use efficiency, yield and N and Si contents in rice under loamy sand soil Malav. *Res. J. Chem and Environ*, 21(4): 110-118.

Khan, M.W., A.Rab, R. Ali, M. Sajid, F. Aman, I. Khan, I. Hussain and A. Ali(2019). Effect of potassium and zinc on growth, yield and tuber quality of potato. *Sarhad J. Of Agric*., 15(2) :330-335.

Korndörfer, G. H., and I. Lepsch, (2001). Effect of silicon on plant growth and crop yield. In *Studies In Plant Sci*., Vol. 8, pp. 133-147). Elsevier.

Mahmoud S. H., D.M. Salama, A. M. M. El-Tanahy and A. M. El-Bassiony (2019). Effect of prolonged restriction water supply and spraying with potassium silicate on growth and productivity of potato. Plant archives, 19(2):2585-2595.

Marschner, H., (1995). Functions of mineral nutrients: *Macronutirents*, p. 299-312. In: H. Marschner (ed.). Mineral nutrition of higher plants 2nd Edition. Academic Press, N.Y.

Marschner, P. (2012). *Marschner's Mineral Nutrition of Higher Plants*, 3rd ed.; Academic Press: London, UK. pp: 178-189.

Miyu, M., P.Sarma, S. D.Warade, B. N. Hazarika, P. Debnath, Md. Ramjan and M. T. Ansari (2019). Effect of foliar application of micronutrients on potato (*Solanum tuberosum* L.) cv."Kufri Joyti" for growth, yield & quality attributes. *Int. J. Chem.Stu*., 7(3):4813-4817.

Mousavi. S. R., M. Galavi and M. Rezaei (2013). Zinc (Zn) importance for crop production. *Rev. Int. J. Agron. plant. Prod*., 4(1):64-68.

Potarzycki Y, A. Ghanbari, M. Heydari, A.Tavassoli (2009). Effect of foliar application of certain micronutrients on qualitative and quantitative characteristic of pearl millet (*Pennisetum glacum*) under drought stress. *J. Agric. Sci*., 3(10):67-79.

Pregl, E. (1945). Quantitative organic microanalysis 4th ed. J. Chundril, London.

Rahman, M., M. Islam, M. Sheikh, M. Hossain, M. Kawochar, and M. Alam (2018). Effect of foliar application of zinc on the yield, quality and storability of potato in Tista Meander Floodplain Soil. Pertanika *J. Trop. Agric. Sci.,* 41(4):1779-1793.

Salim, B.B.M., H.G. Abd El-Gawad and A. Abou El-Yazied (2014). Effect of foliar spray of different potassium sources on growth, yield and mineral composition of potato (*Solanum tuberosum* L.). *Middle East J. Appl. Sci*., 4(4): 1197-1204.

SAS Institute (2001). SAS/STAT user's guide.Version 8.2.SAS Institute, Cary, USA.

Shaheen, A. M., M. E.Ragab, F. A. Rizk, S. H.Mahmoud, M. M.Soliman, and N. M. Omar (2019). Effect of some active stimulants on plant growth, tubers yield and nutritional values of potato plants grown in newly reclaimed soil. *The J. Anim. Plant Sc.,* 29(1): 215-255.

Sidiky, B., K. Zoumana, D. K. E.Brice, and K. J. H. Martial (2019). Effect of the organic and NPK fertilizers on the growth and yield of sweet potato (*Ipomoea batatas* (L) Lam) in the Centre of Côte d'Ivoire. *Asian J. Soil Sci. Plant Nutri*., 4(3):1-14.

Snedecor, C., and M. Cochran, (1991). *Statistical Methods*. 8th ed. Iowa State Univ. Press. Amer., Iowa, USA.

Thummanatsakun, V. and S.Yampracha (2018). Effects of interaction between nitrogen and potassium on the growth and yield of cassava. *Int. J. Agric. Tech*., 14(7), 2137-50.

Uwah, D. F., E. B.Effa, L. E.Ekpenyong, and I. E. Akpan (2013). Cassava (*Manihot esculenta Crantz*) performance as influenced by nitrogen and potassium fertilizers in Uyo, Nigeria. *J. of Animal and Plant Sci*., 23(2), 550-555.

تأثيـــر الرش بمصادر مختلفة من البوتاسيوم والزنك على نمو وانتاجية نبات البطاطا الحلوة

محمد الناجى محمد محمد - عصام حسين ابوالصالحين - وفاء عادل فكرى- حلمى محمد وهدان

قسم الإنتاج النباتى(بساتين – خضر) – كلية التكنولوجيا والتنمية – جامعة الزقازيق – مصر

أجريت تجربتان حقليتان خلال موسمين زراعين 2017-2018 في مزرعة كلية التكنولوجيا والتنمية (منطقة غزالة - مدينة الزقازيق)، محافظة الشرقية (مصر) لدراسة تأثير مصادر مختلفة من البوتاسيوم ومعدلات الزنك المخلبي على نمو وإنتاجية محصول البطاطا الحلوة. تم تصميم التجربة باستخدام قطاعات كاملة العشوائية لسبع معاملات من مصادر مختلفة من البوتاسيوم والزنك المخلبى (سليكات البوتاسيوم 2 ملليلتر/لتر و 4 ملليلتر/لتر ، هيومات البوتاسيوم 2 مللي لتر/لتر و 4 مللي لتر/لتر والزنك ، 2ملليلتر/لتر و 4 ملليلتر/لتر) بجانب معاملة الكنترول بدون أية اضافات.

أمكن تلخيص النتائج على النحو التالي : كان الرش بمعاملة الزنك (المخلبى) بمعدل 4 ملليلتر/لتر هو أفضل المعاملات في النمو الخضرى، والتركيب الكيميائي ، بينما كان الرش بسليكات البوتاسيوم بتركيز4 ملليلتر/لتر قد اعلى زيادة في المحصول الدرنات وجوده نبات البطاطا الحلوة، يليه تطبيق الزنك بمعدل 4 ملليلتر/ لتر في معظم الحالات خلال موسمي الزراعة.

التوصية: يمكن التوصية باستخدام الرش بمعاملة الزنك (المخلبى) بمعدل 4 ملليلتر/لتر للحصول علي قيم عالية في النمو الخضرى، والتركيب الكيميائي ، و الرش بسليكات البوتاسيوم بتركيز4 ملليلتر/لترللحصول علي اعلى زيادة في محصول الدرنات وجوده نبات البطاطا الحلوة.