Menoufia J. Soil Sci., Vol. 4 April (2019) : 57 - 69

IMPACT OF POTASSIUM AND MANGANESE ON THE QUANTITY AND QUALITY YIELDS OF SQUASH (*CUCURBITA PEPO* L.)

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Received: Jan. 29, 2019 Accepted: Feb. 10 , 2019

ABSTRACT: ***Two field experiments were performed at a private farm on the town of EL – Serw, Al – Zarqa region, Domiate Governorate, Egypt (Latitude 31^{o} 12$^{\backslash}$ N; Longitude 31^{o}37$^{\backslash}$ E) during the spring seasons of 2017 and 2018 on March 1st for the two seasons. The main targets of these experiments were to raise the productivity of squash fruits as well as improve its nutritive content and quality characteristics. Split plot design with three replicates was used where K – treatments i.e 0, 62.5 and 125 Kg K_2O fed^{-1}were allotted to the main plots however, sub plots were comprised of different foliar spraying treatments of Mn namely 0, 0.3 and 0.6 g L^{-1}.***

Data obtained revealed the following important topics :

1– K - soil application and foliar spraying of Mn had synergistic impacts on squash vegetative growth characteristics, yield and yield components as well as nutritive content and quality characteristics of squash fruits, except crude fiber and total phenol. Differences between either K levels or Mn ones for all abovementioned parameters were significant and treatments of K_2 and Mn_2 achieved the highest values.

2- Additional positive effects were observed when the addition of K and Mn simultaneously. In this concern, the best values were recorded at the treatment of $K_2 \times Mn_2$ for all the investigated parameters. In brief, the productivity of squash fruits as well as their nutritive content and quality characteristics can be improved through K – soil application and foliar spraying of Mn at levels of 125 kg K_2O fed^{-1} and 0.6 g Mn L^{-1}, respectively in a dual treatment.

Key words: ***Squash fruits & straw - Vegetative growth characteristics - Potassium - Manganese – K × Mn interaction.***

INTRODUCTION

The cucurbitaceae family is among the most important plant families supplying humans with edible products, useful fibers and several medical purposes (Majeed and Mahmoud, 1988). Cucurbits include cucumber, melon, pumpkin, squash and gourd. Among the cucurbits, squash (Curcurbita pepo L.) is one of the most vegetable crops grown extensively in tropical and sub-tropical countries of Europe and Africa. According to Egyptian Ministry of Agriculture and Land Reclamation, the total production area of squash in 2016 was 73558 fed produced 551023 ton fruits but this area increased slowly in past few years.

Special attention should be paid to potassium (K) when the fertilization of vegetables especially cucurbits, since K is the macronutrient most extracted and absorbed in largest amounts by the majority of these crops (Araújo *et al.,* 2012). The same trend occured with different cucurbits such as melon (Silva Júnior *et al.,* 2006), pumpkin (Silva *et al,* 2013) and watermelon (Almeida *et al.,* 2012 and Nogueria *et al.,* 2014). Yet, K has the strongest impact on plant growth, development and metabolism

besides it's significance for quality attributes that determine fruit marketability, firmness and visual appearance (Al-Moshileh *et al.* 2005 and Al-Moshileh *et al.,* 2017).

Foliar spraying of micronutrients offers a method of their supplying to higher plants more efficiency than methods involving root application, since it uses low rate and the micronutrient does not contact directly the soil especially when soil conditions are not suitable for ions availability (Darwesh, 2011). Among the micronutrients, manganese (Mn) plays several physiological and biochemical roles i.e. chlorophyll formation, synthesis of proteins, carbohydrate metabolism and energy transfer. Mn also acts as an activitor for many different enzymatic reactions and takes part in photosynthesis. In other words, it activates decarboxylase and dehydrogenase and it is considered a constituent of photosystem II complex (PSII-Protein), Superoxide dismutase (SOD) and phosphatase.

Therefore, the objectives of the current investigation were to improve the yield of squash towards better production and quality through studying the impact of different levels of K-soil application and foliar spraying of Mn as well as their combinations on squash growth and yield. Nutritive contents and quality of squash fruits were also taken into consideration .

METERIALS AND METHODS

Tow field experiments were performed at a private farm on the town of El – Serw, Al – Zarqa region, Domiate Governorate, Egypt (Latitude 31^{o} 12$^{\backslash}$ N; longitude 31^{o} 37$^{\backslash}$ E) during the spring seasons of 2017 and 2018 from March 1st . Random samples of the studied soils were taken prior to planting from the surface area (0 – 30 cm). Some physical and chemical characteristics of the soils under investigation were determined according to Page (1982) and Klute (1986) presented in Table 1 (a and b).

Table (1) : Mechanical and chemical characteristics of the experimental soils (surface layer, at the depth of 0 – 30 cm) before planting for the two studied seasons :

a) Physical analysis :

Season	$CaCO_3$ (%)	O.M (%)	Particle size distribution (%)				Texture class
			Coarse sand	fine sand	Silt	Clay	
1 st	2.87	1.73	2.09	31.70	36.41	29.80	Silt clay loam
2 nd	2.68	1.68	2.16	31.74	38.15	27.95	Silty clay loam

b) Chemical analysis :

Season	pH (1 : 2.5) Soil : Water suspension	EC_e (dSm^{-1}) (1 : 5) Soil Extract	Available nutrients (ppm)					
			Macro			Micro		
			N	P	K	Fe	Mn	Zn
1 st	8.05	0.97	53.8	4.66	187.5	3.17	1.48	0.64
2 nd	7.98	1.05	49.7	4.49	193.6	2.95	1.32	0.58

Each experiment included nine treatments which were the combination of three levels of potassium soil application (K_o = 0.0, K_1 = 62.5 Kg K_2O fed^{-1} and K_2 = 125.0 Kg K_2O fed^{-1}) and three rates of manganese foliar spraying (Mn_o = 0.0, Mn_1 = 0.3 g Mn L^{-1} and Mn_2 = 0.6 g Mn L^{-1}). Therefore, the experimental design was split plot design based on a randomized complete block design (RCBD) in three replications, where K – treatments were allotted to the main plots however, sub plots were comprised of different foliar spraying treatments of Mn. Each plot was comprised of three ridges 12 m length, 1 m width and 50 cm spacing between plants in row.

Organic manure was used at 20 m^3 fed^{-1}, spread and thoroughly mixed with the soil surface layer (0 – 30 cm) before seed sowing during the soil preparation. Mineral fertilizers were added as the following: calcium superphosphate (15.5%P_2O_5) was applied once during the soil preparation at a rate of 30 kg P_2O_5 fed^{-1}. N – fertilization was applied at 75 kg N fed^{-1} in three portions i.e. 25, 15 and 35 kg N fed^{-1} at 21, 35 and 50 days after sowing, respectively in the forms of ammonium sulphate (20.6% N) and urea (46% N) for the 1st addition and ammonium nitrate (33.5% N) for the 2nd and 3rd additions. However, K – treatments were soil applied in the form of potassium sulphate (48% K_2O) at levels of 0,62.5 and 125 kg K_2O fed^{-1}, corresponding to 0, half the recommended dose and the recommended dose, respectively. Treatments of K were applied directly in the planting rows at the same appointments of N – fertilization doses mentioned before. Besides, treatments of Mn (0, 0.3 and 0.6 g Mn L^{-1}) were foliar sprayed as Mn-EDTA form at 21, 35 and 50 days after sowing. Other agricultural practices were similarly performed as followed by farmers in the area.

Pure seeds of squash c.v (Rita squash F_1 Hybrid) were sown on 1st March for the two seasons under investigation.

Data recorded:

1- Chlorophyll contents a, b, (a + b) and carotene in the fresh recently expanded leaves (mg/g F.W) were determined calorimetrically as described by Sadasivam and Manickam, (1996).

2- Fruit yield was harvested at 45 days after sowing day after day intervals up to the end of the harvest time (23 harvests). For each harvest, it was measured average fruit length and diameter (cm) per plot (36 m^2) as well as total weight of fruits / plot all over the season, then calculated as total fruit yield (ton / fed). Dry weights of both fruits and straw were determined at mid harvesting season i.e. at 12th harvest, where 100 grams of either fresh fruits or straw from different samples of each treatment were oven dried at 70^o C until weight constancy.

3- Concentrations of N, P and K (%) as well as Fe, Mn and Zn (ppm) for leaves, at 60 days age as well as both fruits and straw at mid harvesting season were determined in wet digested extract used the methods described by Chapman and Pratt (1961). Then, macro – and micronutrients contents in both fruits and straw were also estimated as, Kg or g/fed, respectively.

4- The studied quality characteristics of fresh squash fruits were also estimated as follows : Crude protein percentage was determined by multiplying N % in fruits by 5.75 , according to A. O. A. C (2000). crude fiber percentage was also determined according to A. O. A. C (2000). Percentages of both total carbohydrates and sugars were

determined according to Sadasivam and Manickam, (1996). Vitamin C (ascorbic acid) content was determined by titration with 2,6 dichlorophenol indophenal blue dye (Jacobs, 1951). Phenol content was determined according to Slinked and Singleton (1977).

5- In the end of the two investigated seasons, a random sample of five plants was taken from each plot for measuring some vegetative growth characteristics of squash plants i.e plant length (cm) and number of leaves / plant.

6- For all recorded data, combined analyses of the two studied seasons were statistically analyzed according to Gomez and Gomez (1984). The least significant differences (L.S.D) test were used to compare the means of treatments at the 5% level of significance.

RESULTS AND DISCUSSION

The present study aimed to raise the productivity of squash fruits as well as improve its nutritive and biocontents. Hence, data attained herein included the influence of different levels of K – Soil application and foliar spraying of Mn and their possible combinations on photosynthetic pigments and nutrients contents of squash leaves as well as the yields of squash fruits, straw and their nutritive contents. Yet, impacts on some fruits biocharacteristics i.e. total protein, carbohydrates, sugar and crude fiber percentages as well as vitamin C and total phenol contents were also taken into consideration.

I- Effect on photosynthetic pigments and nutrients contents of squash leaves:

Data recorded in Table (2) revealed that chlorophyll a, b, a + b and carotene contents in squash leaves were significantly enhanced as the addition of K or Mn. In this concern, the highest values for all abovementioned pigments were observed with the treatments of K_1 and Mn_2. The addition of K and Mn together had a favorable impact on photosynthetic pigments and the application of K_1 and Mn_2 gave the best values. Al- Moshileh *et al.* (2017) also observed that leaf chlorophyll content was correlated with K content and application of 250 ppm K gave the highest leaf K – concentration and chlorophyll percentage. Hebbarb *et al.* (2004) and Al – Jaloud *et al*. (2006) also obtained trends similar to the previous one. On the other hand, Mn plays an important role in oxidation and reduction processes in plants such as the electron transport in photosynthesis. Mn also has an essential role in chlorophyll production in photosystem II (Marschner, 1995). Marco- and micronutrients contents in squash leaves gave also the same trends attained with photosynthetic pigments. In this connection, Al-Mukhtar *et al.* (1988) and Marie and Mohammed (2010) interpreted the promoting impact of K to its physiological role in stimulating enzymes responsible for carbohydrate and protein synthesis as well as energy production. Also, K is considered the main carrier of NO^-_3 from the root through xylem to the leaves and activates reduction of NO^-_3 inside the plant to produce ammonia then to amino acids (Al-Sahaf, 1989) associated with each other to form proteins. Hence, the physiological and nutritional state of plant will improve.

On the other hand, the promoting effect of Mn may be due to its important role in chlorophyll production, activator for more than 35 different enzymes include the nitrate reducing enzyme and those responsible for carbohydrates and lipids metabolism and enzymes of dehydrogenase and decarboxylase in the kerbs cycle (TCA) (Burnell, 1988 and Marschner, 1995). Mn^{2+} in terms of biochemical function is similar to Mg^{2+}.

Both ions connect ATP with complexes enzymes (phosphotransferase and phosphokinase). Thus, under Mn deficiency, protein, carbohydrate and lipids declined and plant growth reduced (Anderson and pyliotis, 1996 and Marschner, 1995).

In addition, Orhue and Nwaoguala (2010) on pumpkin found that application of Mn up to 20 Kg ha^{-1} increased significantly the growth parameters and shoot dry weight. They also stated that as Mn levels increased, N, P, K, Ca, Mg, Mn, Zn and Cu contents of the plants increased consistently with significant differences recorded among the various Mn levels.

Table (2): Photosynthetic pigments and nutrients concentrations in squash leaves as affected by K – soil application and foliar spraying of Mn as well as their combinations*.

Treatments		Photosynthetic pigments (mg / g F. W)				Leaves nutrients concentrations					
		Chl (a)	Chl (b)	Chl (a+b)	Carotene	%			ppm		
						N	P	K	Fe	Mn	Zn
K– soil application levels (Kg K_2O fed^{-1})											
K_o		0.651	0.462	1.113	0.907	1.19	0.175	1.31	28.22	10.77	13.68
K_1		0.678	0.484	1.162	0.942	1.42	0.199	1.72	28.99	11.52	14.15
K_2		0.665	0.471	1.136	0.920	1.32	0.184	1.94	29.20	11.86	14.33
L. S. $D_{0.05}$		0.005	0.004	0.005	0.004	0.06	0.005	0.11	0.13	0.15	0.06
Mn – foliar spraying levels (g Mn L^{-1})											
Mn_o		0.625	0.443	1.069	0.868	0.98	0.149	1.44	28.24	10.31	13.69
Mn_1		0.664	0.472	1.135	0.923	1.32	0.188	1.71	28.81	11.61	14.04
Mn_2		0.705	0.502	1.206	0.978	1.64	0.222	1.82	29.36	12.23	14.43
L. S. $D_{0.05}$		0.004	0.004	0.005	0.007	0.06	0.006	0.07	0.11	0.14	0.09
K × Mn interactions											
K_o	Mn_o	0.613	0.432	1.045	0.851	0.86	0.140	1.19	27.86	10.03	13.44
	Mn_1	0.651	0.463	1.114	0.904	1.19	0.175	1.32	28.05	10.97	13.56
	Mn_2	0.689	0.492	1.181	0.967	1.53	0.211	1.41	28.76	11.32	14.03
K_1	Mn_o	0.639	0.455	1.094	0.889	1.08	0.163	1.50	28.31	10.30	13.72
	Mn_1	0.674	0.483	1.158	0.947	1.42	0.199	1.76	29.06	11.73	14.19
	Mn_2	0.720	0.512	1.233	0.991	1.75	0.235	1.88	29.59	12.51	14.55
K_2	Mn_o	0.624	0.443	1.067	0.863	0.99	0.145	1.63	28.54	10.59	13.91
	Mn_1	0.666	0.469	1.134	0.918	1.34	0.190	2.03	29.32	12.14	14.37
	Mn_2	0.705	0.501	1.206	0.978	1.64	0.219	2.17	29.74	12.86	14.71
L. S. $D_{0.05}$		0.006	0.007	0.008	0.011	0. 11	0.011	0.12	0.19	0.25	0.15

***Combined analysis of the two studied seasons .**

K_o = 0, K_1 = 62.5 Kg K_2O fed^{-1}, K_2 = 125 Kg K_2O fed^{-1}, Mn_o = 0, Mn_1 = 0.3 g Mn L^{-1}, Mn_2 = 0.6 g Mn L^{-1}.

II- Effect on some vegetative growth characteristics as well as yield and yield parameters of squash:

Data presented in Table (3) show that plant lenght (cm) and number of leaves / plant, as two characteristics of vegetative growth, were gradually enhanced by the addition of either potassium or manganese. K_2 and Mn_2 treatments gave the best values. Data presented also showed that the addition of K and Mn simultaneously had a favorable impact on the tow characteristics mentioned before and the highest values were observed when the addition of K_2 and Mn_2 together.

Table (3) : Some Vegetative growth characteristics, fruits and straw yields as well as some yield components as affected by K soil application foliar spraying of Mn and their combinations*.

Treatments		Plant length (cm)	Leaves No./ Plant	Fruit yield components			Fruit yield (ton fed^{-1})		Straw yield (ton fed^{-1})
				Fruit length (cm)	Fruit diameter (cm)	Fruit Weight (kg/plant)	Fresh	Dry	Dry
K – soil application levels (Kg K_2O fed^{-1})									
K_o		123.9	44.89	13.04	3.08	2.51	19.96	1.16	2.46
K_1		143.1	55.56	13.66	3.39	2.80	22.40	1.37	2.73
K_2		151.2	60.22	13.83	3.48	2.95	23.57	1.48	2.81
L. S. $D_{0.05}$		1.17	1.15	0.21	0.23	0.01	0.20	0.01	0.04
Mn foliar spraying levels (g Mn L^{-1})									
Mn_o		123.4	44.56	13.02	3.06	2.49	19.80	1.15	2.45
Mn_1		137.1	53.56	13.47	3.31	2.73	21.84	1.32	2.67
Mn_2		157.8	62.56	14.04	3.58	3.04	24.29	1.55	2.94
L. S. $D_{0.05}$		1.07	1.11	0.05	0.08	0.01	0.19	0.01	0.02
K × Mn interactions									
K_o	Mn_o	114.9	40.67	12.67	2.90	2.36	18.64	1.07	2.36
	Mn_1	119.0	42.33	12.90	3.00	2.42	19.34	1.11	2.40
	Mn_2	137.8	51.67	13.57	3.33	2.74	21.91	1.31	2.63
K_1	Mn_o	125.2	44.67	13.10	3.07	2.49	19.90	1.16	2.46
	Mn_1	142.1	56.00	13.70	3.40	2.81	22.49	1.38	2.74
	Mn_2	162.1	66.00	14.17	3.70	3.10	24.80	1.59	3.00
K_2	Mn_o	130.1	48.33	13.30	3.20	2.61	20.85	1.23	2.52
	Mn_1	150.3	62.33	13.80	3.53	2.96	23.69	1.48	2.86
	Mn_2	173.2	70.00	14.40	3.70	3.27	26.16	1.74	3.19
L. S. $D_{0.05}$		1.86	1.92	0.09	0.13	0.03	0.35	0.02	0.04

***Combined analysis of the two studied seasons .**
K_o = 0, K_1 = 62.5 Kg K_2O fed^{-1}, K_2 = 125 Kg K_2O fed^{-1}, Mn_o = 0, Mn_1 = 0.3 g Mn L^{-1}, Mn_2 = 0.6 g Mn L^{-1}.

Data shown in Table (3) also revealed that both fresh and dry weights of squash fruits and fruits yield components studied herein namely fruit weight (Kg / plant) as well as length and diameter (cm) were all significantly affected by the addition of either K or Mn at different levels. The maximum values for both squash fruit yield and its components were occurred. When the addition of K2 or / and Mn_2 . K soil application simultaneously with foliar spraying of Mn had additional positive impacts on all above – mentioned parameters. Straw yield also took a trend similar to the previous one.

Enhancing of squash fruit yield as the addition of K might be interpreted on the basis of the critical demand of plant physiological activation for K during flowering and fruit setting stages. So, the soil application of K result in increasing the amount of available K in soil which accompanied with achieving the biological operations favorably which help in increasing number of fruits, average fruit weight and total yield (Marie and Mohammed, 2010). Fernandes *et al*. (2016) also reported that K significantly influenced fruit diameter, pulp thickness, fruit mass and yield the zucchini crop. Moreover, Silva Júnior *et al*. (2006) on melon, (Araújo *at al*. (2012) on squash, Nogueira *et al*. (2014) on water melon, Silva *et al*. (2013) on pumpkin and Fernandes *et al*. (2016) on Zucchini recorded linear models for yield in response to K doses. They attributed that to the large demand of vegetable crops for K which is the macronutrient most extracted by the majority of these plants. While, Grangeiro and Cecilio Filho (2006) observed that the yield of seedless watermelon showed a quadratic behaviour in response to K doses. The lowest yield attained with the least dose of K can be explained on the basis on its importance in the plants, being vital for photosynthesis. So, K deficiency cause a reduction in the photosynthetic rate and an increase in respiration, leading to decrease in the accumulation of carbohydrates (Novais *et al*., 2007). Another important effect of K in the plant is related to the permeability of plant cell membranes and stomatal opening / closure, so that, when there is a lack of K in the plant, the stomata do not open regularly, which causes smaller entry of carbon dioxide and, therefore, lower photosynthetic intensity, result in yield reduction (Taiz and Zieger, 2009).

In addition, the positive effect of Mn on squash yield and its parameters was interpreted by Marschner (1995) who pointed out that Mn is considered an essential element required by all plant species for growth and reproduction. Inside the plant, Mn is a component of the water splitting protein complex, photosystem II complex (PSII); a constituent of superoxide dismutase (Mn SOD); an activator of a number of critical metabolic enzymes. Hence, Mn plays on important role in nitrogen metabolism by activating anginas and glut amyl transferase enzymes (Burnell, 1988). Mn is also required for the activation of Nicotinamide dinucleotide (NAD)–malic enzyme, a critical enzyme in the C-4 photo synthetic pathway. Since, Mn is a constituent of the PSII in all plants, Its deficiency could significantly affect leaf photosynthetic activity, dry matter accumulation and yield of all plants.

III- Effect on the contents of both macro- and micronutrients in squash fruits and straw:

Data shown in Table (4) revealed that the contents of both macro-and micronutrients in squash fruits and straw were progressively raised as increasing the levels of K soil application, up to 125 Kg fed^{-1} and Mn up to 0.6 g L^{-1} (K_2 + Mn_2). The statistical analysis of the obtained

Table 4

results showed that the differences within the levels of K on Mn addition were great enough to reach the 5% level of significance for all macro – and micronutrients in both squash fruits and straw. These results are in harmony with those obtained by Kacha *et al.* (2017) who stated that potash fertilization increased nutrients supply in rhizosphere which culminated into more absorption of nutrients by watermelon. Mohamed *et al.* (2010) also observed that nutritional contents of fruits (N, P, K, Fe, Mn, Zn and Cu) recorded their highest values when plants were sprayed by N + K. In addition, Orhue and Nwaoguala (2010) stated that as Mn levels increased, N, P, K, Ca, Mg, Mn, Zn and Cu contents of the plants increased consistently with significant differences were recorded among the various Mn levels.

IV- Effect on some quality characteristics of squash fruits :

Data in Table (5) showed clearly that as K on Mn levels increased, percentages of total protein, carbohydrate and sugar as well as vitamin C content (mg / 100g) of squash fruits increased consistently with significant differences were recorded among either the various K or Mn levels. In this concern, the highest values for all abovementioned characteristics were observed with the treatments of K_2 or / and Mn_2. Additional positive impacts were also noticed when K and Mn were added simultaneously and maximum values were attained at the treatment of $K_2 \times Mn_2$. These results are similar to those obtained by Prajapati and Modi (2012) who reported that K plays significant roles in improving all characteristics related quality and the feeding value of many crops. K also activates the enzymes responsible for synthesis of protein and starch and it is required for every major step of protein synthesis. The "reading" of the genetic code in plant cells to produce proteins and enzymes that regulate all growth processes would be impossible act without adequate K. Potassium also balances negatively amino acids like aspartate and glutamate and stabilizes protein – water layer interactions (Marschner, 1995). Prajapati and Modi (2012) also revealed that sugar produced in photosynthesis must be transported through the phloem to other parts of the plant for utilization and storage. This system uses energy in the form of ATP. If K is inadequate, less ATP is available and the transport system breaks down. Moreover, the enzyme responsible for synthesis of starch (starch syntheses) is activated by K. thus, with inadequate K, the level of starch declines while, soluble carbohydrates and N – compounds accumulate (Patil, 2011, Prajapati and Modi, 2012). Potassium deficiency can also cause reduced yield potential and quality long before visible – symptoms appear. This "hidden hunger" robs profits from the farmer who fails to keep soil K levels in the range high enough to supply adequate K at all times during the growing season. Besides, inside the plant, Mn is a component of the water splitting protein complex (PSII) a constituent of superoxide dismutase (Mn SOD) and a key activator of number of critical metalic enzymes (Marschner, 1995). Mn also plays a role in nitrogen metabolism by activating arginas and glutamyl transferase enzymes (Burnell, 1988). Mn is also required for the activation of NAD – malic enzyme, a critical enzyme in the C – 4 photosynthetic pathway. On the contrary, crude fiber percentage and total phenol content (mg / 100g) of the plant decreased consistently with increasing K or Mn levels.

Declination of crude fiber percentage and total phenol content as increasing the tested levels of K and Mn was previously observed by many investigators. In this connection, Prajapati and Modi (2012) reported that with inadequate K, soluble carbohydrates accumulate and crude fiber is considered one of different constituents of soluble carbohydrates. Oloyede *et al.* (2012) noticed the reduction in total phenolics and antioxidant activities in Mustard leaf due to increase NPK fertilization.

Table (5) : Effect of K – Soil application , foliar spraying of Mn and their combinations on some quality characteristics of squash fruits*.

Treatments		%				mg/ 100 g F. W	
		Total protein	Total carbohydrates	Total sugar	Crude fiber	V. C	Total phenol
K – soil application levels (Kg K_2O fed^{-1})							
K_o		4.87	16.86	3.47	5.50	20.20	249.91
K_1		6.37	17.83	4.20	4.84	21.86	234.19
K_2		6.96	18.15	4.45	4.61	22.24	229.04
L. S. $D_{0.05}$		0.26	0.12	0.14	0.13	0.67	1.17
Mn foliar spraying levels (g Mn L^{-1})							
Mn_o		4.82	16.86	3.46	5.50	20.09	249.84
Mn_1		6.13	17.62	4.04	4.99	21.49	238.06
Mn_2		7.25	18.36	4.62	4.45	22.72	225.24
L. S. $D_{0.05}$		0.20	0.08	0.11	0.08	0.40	2.33
K ×Mn interactions							
K_0	Mn_o	3.93	16.33	3.06	5.87	19.23	260.27
	Mn_1	4.59	16.66	3.31	5.65	19.73	253.13
	Mn_2	0.08	17.58	4.05	4.98	21.63	236.33
K_1	Mn_o	5.00	16.97	3.54	5.43	20.27	247.03
	Mn_1	6.62	17.95	4.28	4.77	22.10	233.67
	Mn_2	7.50	18.57	4.78	4.31	23.20	221.87
K_2	Mn_o	5.52	17.27	3.79	5.20	20.77	242.23
	Mn_1	7.19	18.25	4.53	4.55	22.63	227.37
	Mn_2	8.17	18.93	5.03	4.08	23.33	217.53

L. S. $D_{0.05}$	0.35	0.16	0.17	0.13	0.70	4.03

***Combined analysis of the two studied seasons**

K_o = 0, K_1 = 62.5 Kg K_2O fed^{-1}, K_2 = 125 Kg K_2O fed^{-1}, Mn_o = 0, Mn_1 = 0.3 g Mn L^{-1}, Mn_2 = 0.6 g Mn L^{-1}.

REFERENCES

Al – Jaloud, A. A., A. H. Abdel Gadir, A. H. Errebhi, M. A. Baig, M.S. Al – Asker and H. B. Sarhan (2006). The effect of fertigating different levels of nitrogen, phosphorus and potassium on greenhouse cucumber yield. Acta Hort., 710 : 359 – 363.

Almeida, E. I. B., M. C. de M. Correa, G. N. Nobrega, E. A. R. Pinheiro and F. F. Lima (2012). Crescimento e marcha de absorção de macronutrientes para a cultivar de melancia Crimson Sweet. Revista Agro @ mbiente, 6 : 205 – 214.

Al–Moshileh, A. M., M. A. Errebhi and M. I. Motawei (2005). Effect of various potassium and nitrogen rates and splitting methods on potato under sandy soil and arid environmental conditions. Emirates journal of Agricultural Science, 17 (1) : 1 –9.

Al-Moshileh, A. M., M. A. Errebhi and H. A. Obiadalla – Ali (2017). Effect of potassium fertilization on tomato and cucumber plants under greenhouse conditions. Bioscience Research, 14 (1) : 68 – 74.

Al-Mukhtar, F. A., F. M. Hummadi and F. H. Al – Sahaf (1988). Effect of different levels of NPK fertilizer on growth and yield of two summer squash cultivars. Acta Hort., 220 : 253 – 258.

Al–Sahaf, F. H. (1989). Practical Plant Nutrition. Ministry of higher eduction and scientific research. Baghdad univ. Iraq.

Anderson, J. M and N. A. Pyliotis (1996). Studies with manganese deficient chloroplasts. Biochemistry and Biophysics Acta, 189 : 280 – 293.

Araújo, H. S., B. R. de Quadros, A. I. I. Cardoso and C. V Correa (2012). Doses de potássio em cobertura na cultura da abóbora. Pesquisa Agropecuaria trotpical, (42) : 469 – 475.

A.O.A.C. (2000). Association of Official Agricultural Chemists, Official and Tentative Methods of Analysis. 11th ed. Washington, D. C., U. S. A.

Burnell, J. N. (1988). The Biochemistry of Manganese in Plants. In Graham R. D, Hannam R, and Uren N. C. (Eds) Manganese in Soils and Plants. Kluwer Academic Publishers, Dordrecht, Netherlands, pp: 125 – 137.

Chapman, D. H. and P. E. pratt (1961). Methods of Analysis for Soil, Plant and Waters. Univ. of Calif., Div. Agric. Science, USA.

Darwesh, D. A. (2011). Effect of soil and foliar application of iron chelat on nutrient balance in lentil (*Lens esculenta* L.) by using modified dris equation. Mesopotamia J. Agric. Ric, 39 (3).

Fernandes, Carlos N. V., Bentio M. de Azevedo, C. C. Cebora, N. D Chrislene, O. F. Mario and R. B. C. Fellype (2016). Potassium fertilizer applied by different methods in the zucchini crop. RevistaBrasileira de Engenharia Agricola e Ambiental, 20 (7) : 643 – 648.

Gomez, K. A. and C. M. Gomez (1984). Satistical Procedure for Agricultural Research. J. ohn Wiley and Sons Ine. Newo york.

Grangeiro, L. C. and A. B. Cecilio Filho (2006). Características de produção de frutos de melancia sem sementes em função de fontes e doses de potássio. Horticultura Brasileira, 24 : 451 – 454.

Hebbarb, S. S., B. K. Ramachandrappa, A. H. V. Nanjappaa and M. prabhakarb (2004). Studies on NPK drip fertigation in field grown tomato. European j. Agron., 21 (1) : 117 – 127.

Jacobs, M. B. (1951). The Chemical Analysis Prentice. Hall of India private Limited, New Delhi, pp. 111 – 204.

Kacha, H. L., B. P. Jethaloja, R. S. Chovatiya and JatGiriraj (2017). Growth and yield of watermelon affected by chemical fertilizers. International j. of chemical studies, 5 (4): 1701 – 1704.

Klute, A. (1986). Methods of Soil Analysis. 2nd Ed., Part 1 soil sci. Amer., Madison, Wisc. USA.

Majeed, S. H. and M. J. Mahmoud (1988). Iraq Herbs and plants in popular medical and Scientific research. First publication. Drug and Drug Education department. Biological Res. Centre, Scientific Res. Council, Iraq.

Marie, A.I. and G.H. Mohammed (2010). Effect of foliar application of potassium and IAA on growth and yield of tow cultivars of squash (*Cucurbita pepo* L.). j.Tikrit Univ. Agric. Eciences .10 (2): 229 –242

Marschner, H. (1995). Mineral Nutrition of Higher Plants. Academic Press : 324-332.

Mohamed, Hoda A., Asmaa R. Mahmoud, M. I. Ezzo and Magda M. Hafez (2010). Physiological response of growth, yield and its quality of squash (cucurbita pepo L.) to foliar application of some nutrients. Res. J. Agric. and Biol. Sciences, 6 (4): 568-576.

Nogueira, F. P., Silva, M. V. T. da, Oliveira, F. L.de, Chaves, S. W. P. and Medeiros, J. F. de. (2014). Crescimento e marcha de absorção de nutrientes da melancieira fertirrigada com diferentes doses de N e K. Revista verde de Agroecologia e Desenvolvimento Sustentavel, 9: 35 – 42.

Novais, R. E., V. H. Venegas, N. F. de Barros, R. L. Fontes, R. B. cantarutti and J. C. L. Neves (2007). Fertilidade do solo. Vicosa : Sociedade Brasileira de Ciencia do Solo, 1017 p. Cited by Fernandes, carlos N. V., Azevedo Bentio M. de, C. C. Cebora, N. D chrislene, O. F. Mario and R. B. C. Fellype (2016) Potassium fertilizer applied by different methods in the zucchini crop. RevistaBrasileira de Engenharia Agricola e Ambiental, 20 (7): 643-648.

Oloyede, F. M., I. O. Obisesan, G. O. Agbaje and E. M. Obuotor (2012). Effect of NPK fertilizer on composition of pumpkin (Cucurbilapepo Linn.) seeds. The scientific world j., Article ID 808196, 6 pages.

Orhue, E. R. and C. N. C. Nwaoguala (2010). The effect of manganese on early growth of fluted pumpkin (Telfairia occidentalis Hook F) in an ultisol. J. Tropical Agric., Food, Environ. and Extension, 9 (3): 154 – 160.

Page, A. L. (1982). Methods of Soil Analysis. 2nd Ed., Part 1, Soil Sci. Soc. Amer., Madison, Wisc., USA.

Patil, R. B. (2011). Role of potassium humate on growth and yield of soybean and black gram. International J. pharma and Bio sciences, 2 (1) : 242 – 246.

Prajapati, K. and H. A. Modi (2012). The importance of potassium in plant growth – A review. Indian J. plant sci., ISSN : 2319 – 3824.

Sadasivam, S. and A. Manickam (1996). Biochemical Methods,2nd Ed. New Age international India.

Silva, M. V. T. da, R. M. Lima, S. W. P. Chaves, A. M. A. de Medeiros, N. K. C. Silva and F. L. de Oliveira (2013). Diagnose foliar da *abóbora* submetida a de salinida diferentes níveis de e doses crescentes de nitrogenio. Agropecuaria *Científica* no Semiárido, 9 : 118 – 125.

Silva Júnior, M. J., J. F. de Mederios, F. H. T. de Oliveira and I. Dutra (2006). Acúmulo de matéria seca e absorção de nutrientes pelo meloeiro “Pele de Sapo”. RevistaBrasileira de Engenharia Agricola e Ambiental, 10 : 364-368.

Slinkard, J. and V. L. Singlelon (1977). Total phenol analysis. automation and

comparison with manual methods. Am. J. Enol. Viticult, 28 : 49 – 55 .
Taiz, L. and E. Zeiger (2009). Fisiologia Vegetal. 4 ed. Porto alegre : Artmed : 819 p. Cited by Almeida, E. I. B.; M. C. de M. Correa; G. N. Nobrega; E. A. R. Pinheiro; and F. F. Lima. (2012). Crescimento e marcha de absorção de macronutrientes para a cultivar de melancia Crimson Sweet. Revista Agro @ mbiente, 6 : 205 – 214.

تأثير البوتاسيوم والمنجنيز على إنتاجية وجودة محصول الكوسة

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الملخص العربي

أجريت تجربتان حقليتان في مزرعة خاصة في مدينة السرو التابعة لمركز الزرقا محافظة دمياط (خط عرض ٣١/١٢° شمالاً ، خط طول ٣١/٣٧° شرقاً) خلال ربيع موسمي النمو ٢٠١٧ ، ٢٠١٨ فى الأول من مارس بغرض زيادة إنتاجية ثمار الكوسة وتحسين قيمتها الغذائية وجودتها .. لذلك صممت تجربتان لقطع منشقة مرة واحدة في ثلاث مكررات حيث شغلت القطع الرئيسية بثلاث معاملات للبوتاسيوم K_0 , K_1 , K_2 (صفر, ٦٢,٥ ، ١٢٥ كجم بو٢ا / فدان على التوالى) أما معاملات الرش الورقي للمنجنيز فقد تم توزيعها عشوائياً في ثلاث معدلات Mn_0 , Mn_1 , Mn_2 (صفر ،٠,٣ ، ٠,٦ جم منجنيز / لتر على التوالى) في القطع المنشقة . وقد أشارت النتائج المتحصل عليها إلى النقاط الهامة الآتية :

١– أدت الإضافة الأرضية للبوتاسيوم وكذلك الرش الورقي للمنجنيز إلى إحداث تأثيرات إيجابية في مقاييس النمو المختلفة، المحصول ومكوناته ، القيمة الغذائية وصفات الجودة فيما عدا محتوى الألياف والفينولات لثمار الكوسة وكانت هناك فروق معنوية بين المعدلات المختبرة لكلٍ من البوتاسيوم والمنجنيز بالنسبة لجميع القياسات السابقة وقد تحققت أعلى القيم عند إضافة البوتاسيوم بمعدل ١٢٥ كجم بو٢ا ، المنجنيز بمعدل ٠,٦ جم منجنيز/ لتر (K_2 , Mn_2).

٢– أدت الإضافة الأرضية للبوتاسيوم والرش الورقي للمنجنيز معاً إلى زيادة جميع القياسات المختبرة السابق الإشارة إليها مقارنة بإضافة إي منهما منفرداً وقد تحققت أعلى القيم لجميع القياسات عند إضافة ١٢٥ كجم بو٢ا / فدان + ٠,٦ جم منجنيز / لتر (K_2 + Mn_2) ومن ثم يمكن القول أن الإضافة الأرضية للبوتاسيوم بمعدل ١٢٥ كجم / بو٢ا فدان مع الرش الورقي ثلاث مرات للمنجنيز بمعدل ٠,٦ جم / لتر يؤدي إلى زيادة إنتاجية محصول الكوسة وتحسين القيمة الغذائية وصفات الجودة للثمار.

السادة المحكمين

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Table (4): Contents of macro and micronutrients in both squash fruits combination and straw as affected by K – soil application, foliar spraying of Mn and their combinations*.

Treatments		Macronutrients (Kg fed^{-1})						Micronutrients (g fed^{-1})					
		Fruits			Straw			Fruits			Straw		
		N	P	K	N	P	K	Fe	Mn	Zn	Fe	Mn	Zn
K – Soil application levels (Kg K_2O fed^{-1})													
K_o		9.98	1.49	13.27	11.38	1.84	14.46	33.17	8.87	13.40	52.90	16.85	21.20
K_1		15.54	2.23	19.83	19.55	2.63	22.43	41.38	10.80	17.45	62.51	20.32	26.71
K_2		18.31	2.56	22.97	22.82	2.94	25.55	45.22	11.95	19.33	66.33	21.86	28.65
L. S. $D_{0.05}$		0.65	0.06	0.89	0.070	0.09	0.67	0.63	0.23	0.27	0.80	0.21	0.59
Mn – foliar spraying (g Mn L^{-1})													
Mn_o		9.72	1.49	12.88	11.02	1.83	14.55	35.08	8.37	17.96	56.77	16.67	24.58
Mn_1		14.37	2.04	18.26	17.51	2.43	20.30	39.51	10.32	16.57	60.24	19.46	25.39
Mn_2		19.74	2.76	24.92	25.22	3.15	27.59	45.19	12.93	18.65	64.73	22.90	26.59
L. S. $D_{0.05}$		0.44	0.06	0.50	0.96	0.11	0.93	0.34	0.11	0.21	0.45	0.25	0.30
K ×Mn interactions													
K_0	Mn_o	7.31	1.21	10.38	7.57	1.48	11.19	31.01	7.57	12.69	51.61	15.42	21.10
	Mn_1	8.78	1.31	11.58	9.29	1.66	12.72	31.64	8.39	12.77	51.54	16.07	20.67
	Mn_2	13.84	1.96	17.86	17.28	2.38	19.46	36.88	10.65	14.75	55.54	19.05	21.83
K_1	Mn_o	10.06	1.52	13.19	11.56	1.89	15.25	35.77	8.41	15.44	58.16	16.86	25.61
	Mn_1	15.83	2.25	20.01	20.09	2.69	22.56	41.56	10.71	17.57	62.69	20.45	26.96
	Mn_2	20.72	2.93	26.29	27.00	3.31	29.49	46.81	13.28	19.33	66.68	23.65	27.56
K_2	Mn_o	11.78	1.74	15.09	13.94	2.11	17.22	38.47	9.13	16.74	60.55	17.72	27.04
	Mn_1	18.49	2.55	23.19	23.14	2.94	25.61	45.32	11.85	19.37	66.48	21.85	28.55
	Mn_2	24.66	3.39	30.63	31.37	3.77	33.81	51.88	14.87	21.87	71.96	26.01	30.37
L. S. $D_{0.05}$		0.76	0.10	0.86	1.66	0.19	1.61	0.59	0.19	0.36	0.77	0.43	0.51

*Combined analysis of the two studied seasons

K_o = 0, K_1 = 62.5 Kg K_2O fed^{-1}, K_2 = 125 Kg K_2O fed^{-1}, Mn_o = 0, Mn_1 = 0.3 g Mn L^{-1}, Mn_2 = 0.6 g Mn L^{-1}.