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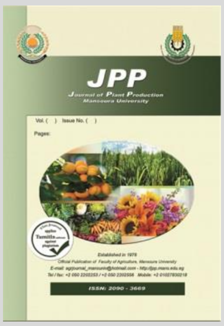
Response of Growth, Yield and Fruit Quality of Squash Plants to Foliar Application with Potassium Silicate and Magnesium Sulfate under High Temperature Stress

Nada, M. M.* and E. E. Metwaly

Vegetable and Floriculture Dept., Faculty of Agric., Mansoura University. Mansoura, Egypt.



ABSTRACT

The present study aimed to improve the green color degree of fruits under high temperature stress during this period of cultivation (beginning of July) as well as to enhance the productivity of squash cv. Esqania by using foliar spray with potassium silicate and magnesium sulfate. In the field experiment, squash plants were sprayed with potassium silicate at rates of 0, 250, 500 and 750ppm and magnesium sulfate at rates of 0, 1000 and 2000 ppm. These field experiments were performed at a private farm in Dekerness district, Dakahlia Governorate, Egypt, in summer seasons of 2018 and 2019. The obtained results referred to that increasing potassium silicate rates from 250 up to 750 ppm gradually increased plant growth, leaf pigments, fruit yield and fruit quality parameters. The best treatment in this regard was 750ppm of potassium silicate compared to other rates. In addition, magnesium sulfate at 2000ppm recorded significantly increase in the above mentioned parameters of squash plant compared to the other one under study. The highest values of all the measured parameters were obtained from the potassium silicate rate of 750ppm combined with magnesium sulfate rate at 2000 ppm compared to control during both seasons. In conclusion, the results of this study suggest that using of potassium silicate and magnesium sulfate as foliar application improved squash plants growth and productivity and fruits green color degree may be attributed to the physical role of the silicon as well as magnesium on enhancing chlorophyll formation or both under heat stress condition.

Keywords: Squash, potassium silicate, magnesium sulfate, fruit quality (green color).

INTRODUCTION

Summer squash (*Cucurbita pepo* L.) belongs to the Cucurbitaceae family, which is one of the most likable vegetable plants for nutrition of human in Egypt and worldwide (Abd El-All *et al*., 2013). It is considered one of the main vegetable plants grown in Egypt and other Mediterranean region countries. However, the summer squash has several health benefits to human and medicinal prospects. The fruits of squash contain different nutritive properties. Squash fruits are very low in calories and have major amount of fiber (Tamer *et al*., 2010). Heat stress is an important agricultural problem, which can lead to a drastic reduction in economic yield, Squash planted all the year especially in spring and summer season, in summer season, high temperature causes low productivity and poorly fruit color (Hall , 1992, Wahid *et al*., 2007 and Hasanuzzaman *et al*., 2013).

Potassium (K) is a primary nutrient that impacts most of the physiological and biochemical operations that effectiveness plant metabolism and development. It never evidence to appear a constant structural component, but it has a metabolic function (Black, 1960). Hence, for using potassium silicate as a source of silicon element, several hypotheses were made; firstly, improved photosynthetic and enzyme activity, secondly, raised K^+/Na^+ selectivity ratio and thirdly, increased amount of soluble substances in the xylem. This effect led to maximizing growth and yield by plants (Liang, 1999).

Magnesium (Mg) has a major molecular and physiological function in plants. However, it is a main component in chlorophyll molecule; it functions as a co-factor for considerable enzymatic operation correlating with hydrolysis, phosphorylation and dephosphorylation as a constitutional stabilizer for different nucleotides (Marschner, 2012). Almost about 15 - 30% of overall Mg in plants is connected with chlorophyll molecules. Furthermore, Mg plays serious role in protein synthesis that can influence structure, size and function of chloroplasts (Gransee and Führs, 2013)

The purpose of this study was to explore the response of *Cucurbita pepo* to potassium silicate and magnesium sulfate rates as foliar spray either alone or in combination to achieve the highest growth parameters, yield and its components as well as improvement the fruit green color degree and vitamin C content under high temperature conditions during summer seasons in Dakahlia Governorate, Egypt.

MATERIALS AND METHODS

Two field experiments were performed at a private farm in Dekerness district, Dakahlia governorate, Egypt, in summer seasons of 2018 and 2019, to study the effect of potassium silicate (K_2SiO_3) and magnesium sulfate ($MgSO_4$) on growth and yield of squash cv. Esqania grown under drip irrigation method. Some physical and chemical analysis of soil was listed in (Table 1).

* **Corresponding author.**
E-mail address: mohnada12@gmail.com
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Table 1. Some physical and chemical parameters during the two seasons of 2018 and 2019.

Seasons	Silt %	Clay %	Sand %	Texture soil	Mg (meq./L)	PH	E.C (dSm-1)	Organic matter %	$CaCO_3$ %	N ppm	P ppm	K ppm
2018	40.2	36.5	23.3	Clay loamy	1.54	8.1	1.49	1.9	3.38	54	6.1	299
2019	40.6	36.4	21.0	Clay loamy	1.61	7.9	1.68	1.8	3.41	52	6.5	289

Squash seeds were planted manually at one sides of dripper on 2nd and 4th of July in the 1st and 2nd summer seasons, respectively. 28.8 m^2 was the area of plot. It consists of 3 dripper lines with 6 m length and 1.6 m between the dripper lines and another one with 50 cm between the dripper and the other in the same line (5250 plants per fed.). One row was left between each two plots to avoid the spray solution overlaps.

12 treatments which combination between potassium silicate at (0.0, 250, 500 and 750 ppm) and magnesium sulfate at (0, 1000 and 2000 ppm) were added every week as a foliar application after 15 days after planting.

Experimental design:

Treatments were arranged in split plots in complete randomized blocks design with three replicates. Potassium silicate was assigned in the main plots, while magnesium sulfate was allocated in the sub plots.

Measurements:

Five plants were taken at random from each plot at 40 days after planting to evaluate the following criteria for the two seasons.

1- Vegetative growth characters:

Plant height, leaves fresh weight, leaves number / plant, leaves area / plant and leaves dry matter percentage.

2- Leaves pigments contents and water relations parameters:

Chlorophyll a, b and carotenoids content were determined according to A.O.A.C. (1990). Relative water content was determined according to (Korkmaz *et al*., 2010)

3- Sex expression, fruits yield and its physical quality:

Three plants from each plot were chosen and labeled for the present study, male and female flowers for each treatment were counted two days intervals up to the end of the season. Sex ratio = (male/ female) were determined. Ten plants from each plot were chosen and labeled for the present study to measured fruits weight per plant, fruits (DM %), early yield (ton/fed) and total yield (ton/fed).

4- Fruits pigments and chemical quality:

Chlorophyll a, b, carotenoids content, Vit. C, acidity and TSS were determined according to A.O.A.C (1990).

Statistical analysis:

Data were statistically analyzed using the analysis of variance according to Snedecor and Cochran (1980). Least significance difference (LSD) was used to differentiate means at the at 5 % level of probability.

RESULTS and DISCUSSION

Vegetative growth characters:

Marked responses in squash growth characters were observed due to using the different potassium silicate rates (Table 2). The significantly highest values of plant height, leaf number /plant, leaves fresh weight/plant, leaves area/plant and leaves dry matter percentage were obtained by plants which treated with 750 ppm potassium silicate compared to the lowest rates and control in both seasons.

Table 2. Influence of potassium silicate and magnesium sulfate on vegetative growth characters of squash in 2018 and 2019 seasons.

Treatments		Plant height cm. S1	Plant height cm. S2	Leaves No / plant S1	Leaves No / plant S2	Leaves FW / plant g S1	Leaves FW / plant g S2	Leaves area / plant m^2 S1	Leaves area / plant m^2 S2	Leaves DM % S1	Leaves DM % S2
Potassium silicate (ppm)											
zero		61.8	63.3	24.8	25.3	928	949	0.998	1.021	11.68	11.94
250		65.9	67.4	26.4	26.8	989	1012	1.063	1.087	12.44	12.73
500		66.1	67.7	26.3	27.2	992	1016	1.067	1.092	12.48	12.77
750		68.6	70.2	27.5	28.1	1029	1053	1.106	1.132	12.94	13.25
LSD 5%		1.4	1.3	0.6	0.4	21	20	0.023	0.022	0.26	0.28
Magnesium sulfate (ppm)											
zero		63.1	64.3	25.2	25.8	947	964	1.018	1.037	11.91	12.13
1000		66.2	67.8	26.5	27.1	994	1017	1.068	1.094	12.50	12.80
2000		67.5	69.3	27.0	27.7	1012	1040	1.088	1.119	12.73	13.09
LSD 5%		1.2	1.2	0.7	0.6	16	19	0.018	0.019	0.21	0.22
Interaction											
zero	zero	61.1	62.3	24.6	25.0	917	934	0.986	1.004	11.54	11.75
	1000	61.4	62.8	24.7	25.0	921	941	0.990	1.013	11.59	11.85
	2000	63.1	64.8	25.3	26.0	946	973	1.018	1.046	11.90	12.24
250	zero	61.9	63.1	24.6	25.3	929	945	0.999	1.016	11.68	11.89
	1000	67.1	68.6	27.0	27.3	1006	1029	1.082	1.107	12.66	12.95
	2000	68.7	70.6	27.6	28.0	1031	1060	1.109	1.140	12.97	13.34
500	zero	64.1	65.3	25.3	26.3	962	979	1.034	1.053	12.10	12.32
	1000	66.7	68.3	26.6	27.3	1000	1025	1.075	1.102	12.58	12.89
	2000	67.6	69.4	27.0	28.0	1014	1042	1.090	1.121	12.75	13.11
750	zero	65.4	66.5	26.3	26.6	981	998	1.054	1.073	12.34	12.56
	1000	69.8	71.6	28.0	28.6	1047	1074	1.126	1.155	13.18	13.51
	2000	70.5	72.5	28.3	29.0	1058	1087	1.137	1.169	13.30	13.68
LSD 5%		2.3	2.5	1.2	1.1	34	37	0.037	0.038	0.43	0.46

Generally, applying potassium silicate (K_2SiO_3) to squash plants increased vegetative growth characters which could be referred to the role of silicon (Si) in extending and encouragement plant roots resulting in enhancing the capability to take up higher nutrients amounts from the soil. Moreover, positive effect of potassium on growth parameters especially dry weights of plant (Ayub *et al.*, 2018 on okra and Abd-Elaziz *et al.*, 2018 on squash).

Generally, applying potassium silicate (K_2SiO_3) to squash plants increased vegetative growth characters which could be referred to the role of silicon (Si) in extending and encouragement plant roots resulting in enhancing the capability to take up higher nutrients amounts from the soil. Moreover, positive effect of potassium on growth parameters especially dry weights of plant (Ayub *et al.*, 2018 on okra and Abd-Elaziz *et al.*, 2018 on squash).

Data in Table2 generally, suggested that, plants sprayed with magnesium sulfate recorded the highest values of squash growth characters compared to control in both studied seasons. Plant height, leaf number /plant, leaves fresh weight/plant, leaves area /plant and leaves dry matter percentage were significantly increased under magnesium sulfate foliar spray application effect. Spraying squash plants with Mg at 2000 ppm recorded the highest values of the abovementioned plant characters compared to 1000 ppm and control. The increment of squash dry weight and dry matter % might be due to the increment of vegetative growth, i.e., plant height and number of leaves/plant as well as leaf area. Kiss (1977 and 1983) reported that Mg-treated plants were taller than Mg-deficient plants, due partially to the activating influence of magnesium on biosynthesis of auxins and gibberellins within plant tissues. However, similar results were formerly reported by Bardisi (2004) on pea, El-Hadidi *et al.* (2017) on potato and Harris *et al.* (2018) on *Capsicum annum* plants.

Obtained data in Table 2 reveals significant differences in vegetative growth characters of squash plants among the combination treatments between potassium silicate and magnesium sulfate. Generally, the highest plant height, leaf number /plant and fresh weight of leaves /plant as well as leaf area /plant and leaves dry matter percentage were recorded under the effect of potassium silicate at 750 ppm combined with MgSO4 foliar spray at 2000 ppm treatment, followed by K2SiO3 at 750 ppm × MgSO4 at 1000 ppm combination treatment. This was confirmed in the two seasons. As already mentioned, the use of potassium silicate improves root growth, which further improves growth, as well as the entry of magnesium into the formation of chlorophyll, which increases the area of leaves, so the two factors together increase the vegetative growth characters of the squash plant. Also, Hussein and Muhammed (2017) on white eggplant and Ahmad *et al.* (2018) on potato found similar results.

Leaves pigment contents and water relations parameters:

Differently, chlorophyll a, chlorophyll b and carotenoids contents in leaves and leaf relative water content were significantly affected by potassium silicate concentration (Table 3). In the meantime, the leaf pigments were significantly increased by using the highest potassium silicate rate (750 ppm) compared to control in the two seasons. The increment in leaf relative water content due to potassium silicate at 750 ppm rate were 10.82 % and 10.91% in the first and second seasons, respectively compared to untreated plants. These results are in a good line with the results reported by Kamal (2013) on sweet pepper and Al-Gburi *et al.* (2019) on eggplant.

Table 3. Influence of potassium silicate and magnesium sulfate as foliar application on Leaves pigments contents and water relations parameters of squash in 2018 and 2019 seasons.

Treatments		Chl. a mg/100g FW		Chl. b mg/100g FW		Carotenoids mg/100g FW		Leaf relative water content %	
		S1	S2	S1	S2	S1	S2	S1	S2
Potassium silicate (ppm)									
zero		86.65	88.65	41.65	42.60	20.02	20.49	68.08	69.65
250		92.32	94.45	44.77	45.81	21.73	22.23	72.53	74.21
500		92.60	94.80	45.21	46.28	22.09	22.61	72.76	74.48
750		96.03	98.32	47.29	48.42	23.30	23.86	75.45	77.25
LSD 5%		1.98	2.40	1.01	0.97	0.52	0.53	1.55	1.66
Magnesium sulfate (ppm)									
zero		88.43	90.02	43.04	43.81	20.96	21.33	69.48	70.73
1000		92.76	94.99	45.15	46.23	21.99	22.52	72.89	74.64
2000		94.50	97.14	46.00	47.29	22.40	23.03	74.25	76.33
LSD 5%		1.57	2.76	0.79	0.93	0.41	0.54	1.24	1.32
Interaction									
zero	zero	85.66	87.21	40.26	40.98	18.92	19.26	67.30	68.52
	1000	85.96	87.94	41.40	42.33	19.94	20.40	67.54	69.09
	2000	88.34	90.81	43.28	44.49	21.21	21.80	69.41	71.35
250	zero	86.72	88.29	43.79	44.58	22.11	22.51	68.14	69.37
	1000	93.94	96.11	44.15	45.17	20.75	21.23	73.81	75.51
	2000	96.28	98.98	46.37	47.67	22.33	22.96	75.65	77.77
500	zero	89.79	91.41	44.00	44.79	21.56	21.94	70.55	71.82
	1000	93.36	95.70	47.14	48.32	23.81	24.40	73.35	75.19
	2000	94.64	97.29	44.48	45.72	20.90	21.49	74.36	76.44
750	zero	91.56	93.21	44.10	44.89	21.24	21.63	71.94	73.23
	1000	97.80	100.24	47.92	49.12	23.48	24.07	76.84	78.76
	2000	98.74	101.51	49.86	51.26	25.18	25.88	77.58	79.76
LSD 5%		3.24	5.10	1.64	1.80	0.84	1.03	2.54	2.71

Data in Table 3 show that spraying squash plant with magnesium sulfate increased chlorophylls content and carotenoids content as well as relative water content in leaves compared to control in both seasons. The highest values in this concern were obtained in plants sprayed with 2000 ppm $MgSO_4$ compared to control and the lowest rate (1000 ppm) under study. However, Mg play direct role in activity of nitrogenase enzyme which, consist of two different Mg-ATP complex and enzyme protein (Srivastava and Gupta, 1996).

In addition, the Mg bond to chlorophyll makes up only a little part of the gross Mg fraction. Relying on the Mg event of the plant 20% (Marschner, 2012) and up to 35% (Cakmak and Yazici, 2010) of the element is localized in the chloroplast, and the remaining Mg is sitting in additional mobile forms.

As for chlorophyll a, chlorophyll b and carotenoids contents and relative water in leaves as affected by combination treatments between K-silicate and Mg-sulfate application data recorded in Table 3 reveal that, generally, foliar application of high level of K-silicate (750 ppm) combined with high level of Mg-sulfate (2000 ppm) gave the highest values of squash leaves pigments and leaf relative water content compared to other the combinations treatments during the two tested seasons. Furthermore, as mentioned just before, both potassium silicate and magnesium sulfate rate treatments (each alone) increased leaf pigments and relative water content of squash plants, in turn, they together might maximize their effects leading to better results in this regard compared to untreated plots.

Sex expression, fruits yield and its physical quality

Clear differences in squash sex ratio, fruits fresh weight/ plant, early yield /feddan, total yield /feddan and fruits dry matter were detected due to supplying plants with different rates of potassium silicate as presented in Table 4. The three rates of K-silicate (250, 500 and 750 ppm) were the best treatments used in raising total yield of squash per feddan with significant differences between them and control in both seasons. In the other words, the highest sex ratio of squash flowers were achieved without potassium silicate application treatment compared to the other rates under study. However, the highest early and total yield were recorded in tomato plants which treated with K_2SiO_3 (Shalaby *et al.*, 2017).

Table 4. Influence of potassium silicate and magnesium sulfate as foliar application on sex expression, fruits yield and its physical quality of squash in 2018 and 2019 seasons.

Treatments		Sex ratio		Fruits FW/ plant kg		Early yield Ton/fed.		Total yield Ton/fed.		Fruits DM %	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Potassium silicate (ppm)											
zero		5.80	5.63	1.73	1.77	2.275	2.328	9.103	9.315	4.12	4.22
250		5.58	5.42	1.84	1.89	2.424	2.480	9.697	9.922	4.39	4.49
500		5.03	4.88	1.85	1.90	2.431	2.489	9.727	9.958	4.40	4.51
750		4.57	4.44	1.92	1.96	2.522	2.582	10.088	10.328	4.57	4.68
LSD 5%		0.39	0.33	0.04	0.04	0.052	0.54	0.208	0.216	0.09	0.09
Magnesium sulfate (ppm)											
zero		5.80	5.62	1.76	1.80	2.322	2.364	9.289	9.457	4.21	4.28
1000		5.20	5.05	1.85	1.90	2.436	2.495	9.744	9.981	4.41	4.52
2000		4.74	4.60	1.89	1.94	2.481	2.551	9.926	10.205	4.50	4.63
LSD 5%		0.21	0.23	0.03	0.04	0.041	0.062	0.165	0.250	0.07	0.08
Interaction											
zero	zero	6.53	6.33	1.71	1.74	2.249	2.290	8.998	9.161	4.07	4.15
	1000	5.73	5.55	1.72	1.76	2.257	2.311	9.030	9.246	4.09	4.18
	2000	5.13	5.01	1.76	1.81	2.319	2.384	9.280	9.539	4.20	4.32
250	zero	5.90	5.72	1.73	1.76	2.277	2.318	9.110	9.274	4.13	4.20
	1000	5.63	5.46	1.87	1.92	2.467	2.524	9.868	10.095	4.47	4.57
	2000	5.23	5.07	1.92	1.98	2.528	2.599	10.114	10.397	4.58	4.71
500	zero	5.63	5.46	1.79	1.82	2.358	2.400	9.432	9.602	4.27	4.35
	1000	5.03	4.88	1.86	1.91	2.451	2.513	9.807	10.052	4.44	4.55
	2000	4.43	4.30	1.89	1.94	2.485	2.555	9.942	10.220	4.50	4.63
750	zero	5.13	4.97	1.83	1.86	2.404	2.447	9.618	9.791	4.36	4.43
	1000	4.43	4.30	1.95	2.00	2.568	2.632	10.273	10.530	4.65	4.77
	2000	4.16	4.04	1.97	2.03	2.593	2.665	10.372	10.663	4.70	4.83
LSD 5%		0.52	0.50	0.06	0.08	0.085	0.115	0.340	0.462	0.15	0.17

Presented data in Table 4 show that although magnesium sulfate application to squash plants produced the highest fruits fresh weight/ plant, early yield /feddan, total yield /feddan and fruits dry matter during the two tested seasons, squash sex ratio, significantly decreased comparing to untreated control. Also the highest values of squash yields were obtained from Mg-sulfate rate at 2000 ppm compared to control and the other one under study. The increase in total yield was directly due to the increase in squash plant growth (Table 2), and high chlorophyll in leaves (Table 3). These increases might be ascribed to the favorable role of the used magnesium in pigments formation, photosynthesis activation diverted to the fruits which represented the economic part of squash plant (Hilman and Asandhi, 1987). However, Orlovius and McHoul (2015) found that there were clear increases in yield resulting from magnesium fertilizers application. Utilization of Mg fertilizers with higher solubility helps to avoid the risk of subsequent decreases in yield and economic return of potato plants.

Recorded data in Table 4 indicate that, under the all tested potassium silicate as well as magnesium sulfate rates gave significant increases in fresh yields of fruits per plant and per feddan compared to control during both seasons. Moreover, combination between 750 ppm K-silicate and 2000 ppm Mg-sulfate gave the highest values in this connection with significant between the other combinations under study (except that of 750 ppm of K-silicate combined with 1000 ppm Mg-sulfate) in both seasons. These results coincided with those reported by Abd El-Gawad *et al.* (2017) on potato plants found that potassium silicate increased yield compared to untreated plants. Also, Poberezny *et al.* (2012) who indicated that, foliar application of magnesium sulfate significantly increased carrot yield.

Fruit pigments and chemical quality

Results recorded in Table 5 shows that were gradually increased chlorophyll a, chlorophyll b and carotenoids contents in fruits, vitamin C content and total soluble solids (TSS) content by increasing potassium silicate rates from 250 to 750 ppm in both seasons. In addition, spraying squash plants with K_2SiO_3 resulted in a 16.46 and 16.58 % increases in chlorophyll b during first and second seasons, respectively. The increase in fruit pigments and chemical quality of squash plants applied with K-silicate may be due to the stimulatory effects of increasing photosynthetic and enzyme activity (Marschner, 2012). However, Hussein and Muhammed (2017) on eggplant and Abd Elwahed (2018) on tomato plant found that K_2SiO_3 application increased chlorophyll content (mg/100g as fresh weight) compared to control.

Fertilizing *Cucurbita pepo* plants with 2000 ppm Mg-sulfate gave a significant increment in chlorophyll a, chlorophyll b and carotenoids contents, vitamin C content as well as TSS in fruits compared to control (Table 5). Furthermore, increasing magnesium sulfate rates gradually increased abovementioned characters. Magnesium is well qualified for its remarkable role in chlorophyll synthesis.

Moreover, magnsium plays a key role in various plant physiological processes through its key function in allosteric modulator for more than 300 enzymes (including kinases, Calvin cycle and ATPases as well as RNA polymerases), loading of phloem, being a co-factor and in chelation to nucleotidyl phosphate forms (Cowan, 2002, Shaul, 2002 and Verbruggen and Hermans, 2013).

Respecting the effect of combination, data in Table 5 show that, the combination between potassium silicate and magnesium sulfate had significant effect on chlorophyll a, chlorophyll b and carotenoids contents, vitamin C content as well as TSS in squash fruits, in the two seasons. The combination between the highest K-silicate rate (750 ppm) and Mg-sulfate (2000 ppm) recorded the highest values in this regard. Furthermore, the combined treatment of 750 ppm of K-silicate rate plus (1000 ppm of Mg-sulfate raised the fruit chlorophyll b content over the combined treatment of 0.0 ppm of K-silicate plus 0.0 ppm of Mg-sulfate by 47.01 and 49.35 % during the two seasons, respectively. However, Shahein *et al*. (2013) indicated that potassium silicate as foliar spray significantly increased chlorophyll content and TSS of lettuce plant compared to control. In addition, El-Hadidi *et al*. (2017) that foliar application of Mg levels significantly increased chlorophyll a, b and total concentrations compared to untreated potato plants.

Table 5. Influence of potassium silicate and magnesium sulfate as foliar application on fruits pigments and chemical quality of squash in 2018 and 2019 seasons.

Treatments		Chl. a mg/100g FW		Chl.b mg/100g FW		Carotenoids mg/100g FW		Vitamin C mg/100g F.W		TSS %	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Potassium silicate (ppm)											
zero		28.79	29.50	13.85	14.17	8.73	8.91	92.8	94.9	4.70	4.81
250		30.94	31.66	14.99	15.34	9.40	9.62	98.9	101.1	5.07	5.19
500		31.24	31.99	15.26	15.63	9.51	9.74	99.2	101.5	5.09	5.20
750		32.73	33.52	16.13	16.52	10.02	10.26	102.9	105.3	5.58	5.99
LSD 5%		0.69	0.67	0.36	0.41	0.21	0.34	2.12	2.32	0.18	0.12
Magnesium sulfate (ppm)											
zero		27.66	28.16	13.47	13.71	7.81	7.95	94.7	96.4	4.87	4.96
1000		32.25	33.06	15.71	16.09	9.83	10.06	99.3	101.7	5.21	5.34
2000		32.86	33.78	16.00	16.45	10.60	10.90	101.2	104.0	5.43	5.58
LSD 5%		0.53	0.70	0.27	0.42	0.16	0.34	1.68	1.85	0.20	0.29
Interaction											
zero	zero	25.88	26.34	12.16	12.38	7.22	7.35	91.8	93.4	4.52	4.60
	1000	29.57	30.37	14.24	14.57	8.98	9.19	92.1	94.2	4.72	4.83
	2000	30.91	31.78	15.15	15.57	9.99	10.27	94.6	97.2	4.85	4.99
250	zero	28.15	28.66	14.21	14.47	8.05	8.19	92.9	94.5	4.76	4.85
	1000	31.53	32.26	14.82	15.16	9.50	9.72	100.6	102.9	5.16	5.28
	2000	33.12	34.05	15.95	16.40	10.65	10.95	103.1	106.0	5.29	5.44
500	zero	28.29	28.79	13.86	14.10	8.01	8.15	96.2	97.9	4.93	5.02
	1000	33.67	34.52	17.00	17.43	10.39	10.65	100.0	102.5	5.12	5.25
	2000	31.77	32.66	14.93	15.35	10.13	10.42	101.4	104.2	5.20	5.34
750	zero	28.35	28.86	13.65	13.90	7.98	8.12	98.1	99.8	5.29	5.38
	1000	34.23	35.08	16.77	17.19	10.45	10.71	104.8	107.4	5.86	6.01
	2000	35.61	36.61	17.98	18.49	11.63	11.95	105.8	108.7	6.40	5.58
LSD 5%		1.11	1.33	0.55	0.81	0.34	0.65	3.47	3.80	0.38	0.54

CONCLUSION

From the present study, it can be concluded that K-silicate at 750 ppm and Mg-sulfate at 1000 or 2000 as a foliar application every week after 15 days after planting along with addition of the recommended doses of N, P and K to improve squash (*Cucurbita pepo* L.) growth and achieve the higher fruits yield with the highest quality especially dark green color of fruits under high temperature stress in this time from the year (beginning of July) under the same conditions of Dakahlia Governorate.

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استجابة نمو ومحصول وجودة ثمار نباتات قرع الكوسة للرش الورقي بسيليكات البوتاسيوم و سلفات الماغنسيوم تحت اجهاد الحرارة العالية

محمد مسعد ندا و السعيد السيد متولي

قسم الخضر والزينة-كلية الزراعة جامعة المنصورة, المنصورة، مصر.

تهدف الدراسة الحالية إلى تحسين درجة اللون الأخضر للثمار تحت ظروف اجهاد الحرارة العالية خلال هذه الفترة الزراعية (بداية يوليه)، وكذلك تحسين إنتاجية نبات قرع الكوسة صنف سكانيا بلستخدام الرش الورقي بسيليكات البوتاسيوم وكبريتات الماغنسيوم. في تجربة حقلية، تم رش نباتات الكوسة بسيليكات البوتاسيوم بمعدلات صفر و٢٥٠ و٥٠٠ و٧٥٠ جزء في المليون وكبريتات الماغنسيوم بمعدل صفر و١٠٠٠ و٢٠٠٠ جزء في المليون. تم إجراء هذه التجارب الحقلية في مزرعة خاصة بمركز دكرنس بمحافظة الدقهلية في مصر في موسمي الصيف لأعوام ٢٠١٨ و ٢٠١٩. أشارت النتائج المتحصل عليها إلى أن زيادة معدلات سيليكات البوتلسيوم من ٢٥٠ إلى ٧٥٠ جزء في المليون أدت إلى زيادة تدريجية فى صفات نمو النبات، أصباغ الأوراق، محصول الثمار و قياسات الجودة للثمار. كانت أفضل معاملة في هذا الصدد ٧٥٠ جزء فى المليون من سيليكات البوتاسيوم مقارنةً بالكنترول والمعدلات الأخرى تحت الدراسة. بالإضافة إلى ذلك، سجلت كبريتات الماغنيسيوم بمعدل ٢٠٠٠ جزء في المليون رشاً على الأوراق إلى زيادة معنوية في الصفات المذكورة أعلاه لنبات الكوسة مقارنة مع المعاملات الأخرى قيد الدراسة. وقد لوحظت أعلى القيم لجميع الصفات المدروسة مع سيليكات البوتاسيوم بمعدل ٧٥٠ جزء في المليون بالتداخل مع كبريتات المغنيسيوم بمعدل ٢٠٠٠ جزء في المليون مقارنة بالكنترول خلال الموسمين. عموماً، تشير نتائج هذه الدراسة إلى أن استخدام سيليكات البوتاسيوم وسلفات الماغنسيوم كرش ورقي حسنت نمو وإنتاجية قرع الكوسة ودرجة اللون الأخضر للثمار يمكن ان يعزى الى الدور الفيزيائى للسيليكون بالاضافة الى دور الماغنسيوم فى تحسين تكوين الكلوروفيل او كلاهما على حد سواء تحت ظروف الاجهاد الحرارى.