The Influence of Foliar Application with Salicylic Acid, Potassium Silicate and Selenium on the Growth, Yield and Fruit Quality of Squash Plants Grown under Greenhouses

Heba H. Mohamed and Reda E. Ahmed
Protected Cultivation Dept., Horticulture Research Institute, Agriculture Research Center, Giza, Egypt

ABSTRACT

The present work were conducted in 2018/2019 and 2019/2020 seasons at Kaha Vegetable Research Farm, Qaliobia Governorate, Horticulture Research Institute (HRI), Agriculture Research Center (ARC), Egypt, under greenhouse condition. Marcella hybrid was used to investigate the influence of foliar spraying application with salicylic acid (SA) 50 ppm, potassium silicate 50 mg/l and selenium (Se) 5 mg /l on squash plants as well as the control treatment (tap water) on vegetative growth, yield, fruit quality and chemical constituents. Results cleared that, Plant height; number of leaves per plant, leaf area, and chlorophyll content are all improved by potassium silicate foliar spraying when compared to other foliar treatments. the heights values of average fruit weight, early and total yield and fruit quality obtained from spraying squash plants with potassium silicate without significant differences with salicylic acid. However, foliar spraying of the plants with potassium silicate, selenium and salicylic acid increased fruit quality (TSS, ascorbic acid and total sugars) of squash fruits. Generally, it may be suggested that the best way to produce high vegetative growth, yield, and high-quality fruits from squash plants grown in greenhouses is to spray 50 ppm of potassium silicate three times during the season.

Keywords: Squash -Salicylic acid- Potassium silicate -Selenium -Greenhouse

INTRODUCTION

Summer Squash (*Cucurbita pepo L.*) is one of the most widely consumed vegetable crops grown in Egypt. It provides a number of medical and health advantages to humans. In the spring and summer, squash is grown in the open field; in the fall and winter, it is grown under tunnels or greenhouses. The total cultivated area was 25760 fed., by an average of 9.0 tons/fed. According to the statistics of Ministry of Agriculture in Egypt (2022). The yield and quality of the fruit are impacted by the plants' exposure to cold, even though they are grown in a greenhouse. Global climate change, including variations in temperature, CO_2 levels, and the severity of extreme weather, affects plants differently at the molecular level and in terms of morphology, physiology, and developmental processes. (Gray and Brady, 2016). In this regard, it is crucial to support agricultural practices in order to ensure that crop production and environmental sustainability are balanced. One of the key components of a management strategy to improve the horticultural crops' growth, yield, and fruit quality is the foliar spraying of certain growth stimulants. Apart from this role, salicylic acid (SA) is one of an endogenous hormone-like plant growth regulator. It plays an essential part in secondary metabolism, which encourages root development and improvement by, for example, preventing ethylene biosynthesis, improving the amount and quality of proteins that are contained, and giving the plant resistance against infection and pathogenesis. (Canakci and Munzuroglu, 2007). Moreover, Hara et al., (2011) demonstrated the importance of salicylic acid as a phytohormone that is necessary for responding to biotic stressors and pathogenesis. Additionally, salicylic acid contributes to the signaling of abiotic stress responses. Salicylic acid applied to certain vegetable crops improves their quality, yield, and vegetative growth. (Omar, 2017). The squash plants grown under the high level of salicylic acid exceed in the characteristics of the number and weight fruit, early and total yield and TSS % compared with non-sprayed plants. (Abd – Elaziz et al., 2019, El-Shoura, 2020) and Al-Ahmad and Al-Jubouri, 2022). SA

application acts a main role in membrane permeability, ion uptake and transport, photosynthetic rate, transpiration and plant growth by Wang et al. (2006). Some authors reported that spraying plants with with salicylic acid significantly increased in vegetative growth, yield and fruit quality on crops. On summer squash Elwan and EL-Shatoury (2014) and Abd El-Mageed et al., (2016). Moreover, (Al-Rubaye and Atia, 2016 and Omar, 2017) on cucumber plants found the same conclusion. Selenium (Se) is considering an important component of seleno amino acids, selenoproteins, thioredoxin reductase, glutathione peroxidase and, subsequently, performs crucial biological functions in the cell (Schiavan et al., 2013 and Xiang et al., 2022). The importance of Se in relieving environmental stress has been then extensively exploited in plants (Feng et al., 2013). Foliar application of different forms of selenium has been increase progressively used to increase selenium concentrations in food crops and vegetables while enhancing yield and fruit quality. Several investigates have revealed that foliar sprays of Se significantly improved the nutritional quality of plants (Shuaimeng et al., 2017, Bakr et al., 2019, Mateus et al., 2021 and Yu et al., 2023). The beneficial effects of selenium on cucumber yield and quality were demonstrated (Hu et al., 2022), lettuce (Businelli et al., 2015), basil (Puccinelli et al., 2020). While, Liu et al. (2022) found that the weight, number, and yield of fruits were unaffected by the foliar application of selenium. On other hand, Hernandez-Hernandez et al. (2019), Neysanian et al. (2020) and Jalali et al. (2022) revealed that applying selenium increased tomato yield. Moreover, Zhu et al. (2018) showed that, selenium foliar application enhanced soluble sugars and ascorbic acid concentrations in tomato fruits. Liu et al. (2022) observed that spraying tomato plants with selenium raised their levels of TSS and total sugars, but had no effect on the ascorbic acid content in tomato fruit. Jalali et al. (2022) stated that the total soluble solids of cucumber fruits were increased by applying sodium selenite topically. Silicon is deposited in plant cell walls as silica, which promotes the structural solidity of the cell wall, the erectness of the leaves, and the development of plant strength. However, improved leaf organelle ultra-structure and photosynthetic activity (Shu and Liu, 2001). The cucumber plants' quality was improved and their vegetative growth characteristics and fruit yield increased significantly with the foliar application of silicon. (Jafari et al., 2015 and Omar, 2017). In addition, potassium silicate enhanced the squash plants' vegetative growth and raised the yield and quality (Alkharpotly et al., 2019). Moreover, Shehata and Abdelgawad (2019) mentioned that potassium silicate enhanced growth, yield, vitamin C and TSS during both seasons.

The present study aimed to investigate the response of squash plants for foliar spray treatments with salicylic acid (SA), selenium (Se) and potassium silicate (K_2SiO_3) under greenhouse condition on vegetative growth, yield and fruit quality.

MATERIALS AND METHODS

The present work were conducted in both tested seasons of 2018/2019 and 2019/2020 in a polyethylene greenhouse at the Research farm at Kaha, Qaliobia Governorate, Horticultural Research Institute, Agricultural Research Center to investigate the influence of foliar spraying with salicylic acid (SA) 50 ppm, selenium (Se) 5 mg /l and potassium silicate (K_2SiO_3)50 mg/l on squash plants on vegetative growth, yield, fruit quality and chemical constituents of Marcella squash hybrid. A randomized complete block design with three replicates was adopted. The experimental farm's soil had a pH of 7.89 and was clay loam in texture.

Marcella F1 hybrid seeds were planted in 84 cell trays with a cell diameter of 9 mm and 26.5 cm^3 of commercial peat-based substrate on October 10^{th} and 12^{th}, during the 2018/2019 and 2019/2020 seasons. The seedlings, which had two true-leaf stages, were transplanted to the greenhouse on October 24 and 26 for the first and second seasons, respectively, after 15 days. The dimensions of each experimental plot were 1.20 cm for width and 18 m for length. Transplants were spaced at 0.5 m apart, on the two sides of the ridge. The plants under plastic house were irrigated by drip irrigation with GR 16 mm and a flow rate of 2 liters per hour and the distance between the emitters is 50 cm. The average maximum and minimum temperatures during the growing months inside the greenhouse were: on October 35.5 – 19.03, November 28.20 - 17.50, December 25.30 – 10.40, January 21.50 – 6.60, February 25.39-9.85 and March 30.03-11.40. The Ministry of Agriculture's recommendation for the squash crop was followed in all standard agricultural practices.

This experiment included four treatments as following: -

- Control treatment (tap water).
- Foliar spraying with salicylic acid (SA) at 50 ppm .
- Foliar spraying with selenium (Se) at 5 mg /l .
- Foliar spraying with potassium silicate (K_2SiO_3) at 50 mg/l.

Three sprays were applied to the plants after 20 days of transplanting and at 15-day intervals throughout the two tested seasons.

Data recorded: -

1. Characters of vegetative growth:

After fifty days of transplanting, ten randomly selected plants from each plot were used to record the required growth measurements. Four measurements included plant height, number of leaves; leave area and chlorophyll content per plant were taken.

2. Characters of yield:

a. Early yield /plant: The weight of the first four fruits harvested was used to calculate as early yield.

b. Total yield /plant: The total yield was calculated using the season-long plot yield and plot area, **and** the fruit yield per plant was then calculated.

3- Fruit quality:

a. Physical fruit quality: Ten fruits were randomly selected from each experimental plot in order to measure the fruit weight, length and diameter.

b. Chemical constituents of fruits:

1. Total soluble solids (TSS): A random sample of ten fruits was selected from each experimental plot using a hand refractometer in order to measure the percentage of total soluble solid content.

2. Ascorbic acid: The method described by A. O. A. C. (1990) was used to determine the ascorbic acid.

3. Total sugars: The method described by Nelson (1974) was used to determine the total sugar content.

Statistical analysis:

The collected data were statistically analyzed using the method of Duncan's multiple range test as reported by Gomez and Gomez (1984).All statistical analysis was performed with SAS computer software.

RESULTS AND DISCUSSION

1- Vegetative growth characteristics:-

Data in **Table (1)** cleared that, the impact of foliar spray of squash plants with potassium silicate, salicylic acid, and selenium on the chlorophyll content and vegetative growth characteristics. The results indicated that, the use of potassium silicate produced the highest values for squash plant height, number of leaves per plant, leaf area, and chlorophyll content during the first and second growth years compared with the other treatments were studied .Moreover, there were no significant differences between potassium silicate application and salicylic acid in number of leaves per plant. In the second

season, the lowest values of all vegetative growth characteristics were obtained from the control treatment**.** These results are going with Jafari et al. (2015) and Omar (2017) on cucumber plants. Moreover, Alkharpotly et al. (2019) and Shehata and Abdelgawad (2019) on squash plants.

Table (1). Influence of salicylic acid, potassium silicate and selenium on vegetative growth and chlorophyll readings of squash plants in both seasons.

Treatments	Plant height (cm)		Leaves number /plant		Leaf area (cm^2)		Chlorophyll readings (SPAD)	
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Control	62.22 b	61.55 c	21.70 c	23.88 c	2073.2 d	2129.0 d	40.70 c	41.21 c
Salicylic acid	71.77 b	72.11 b	26.99 ab	28.11ab	2239.4 c	2237.9 c	42.27 bc	43.16 b
Selenium	64.11 b	63.22 b	25.55 b	26.55 b	2428.7 b	2465.1 b	43.57 b	43.70 b
K silicate	89.55 a	81.45 a	29.33 a	29.22 a	3324.7 a	3371.9 a	45.70 a	46.20 a

Values in the same column followed by the same letter do not significantly differ from each other according to Duncan's multiple range tests at 5% level.

2- Fruit yield characteristic:

Results in **Table (2)** show the effects of foliar spray of the squash "Marcella" hybrid with salicylic acid, selenium, and potassium silicate on fruit weight, early fruit yield, and total fruit yield. Results indicated that all used treatments of foliar spray enhanced fruit weight, early and total fruit yield in the both tested years compared with control. Moreover, during the two tested seasons, foliar application of potassium silicate produced the highest early and total yield of squash plants, without significant differences with salicylic acid treatment. These findings are agree with Abd–Elaziz et al. (2019), Alkharpotly et al. (2019) , El-Shoura (2020), Al-Ahmad and Al-Jubouri (2022) and Shehata and Abdelgawad (2019) on squash . These results could be explained by the significant increases in all vegetative growth parameters that were analyzed. These increases could be caused by a number of physiological processes that occur in plant cells and buds during flowering and affect the yield that follows through the stimulating effects of potassium silicate and salicylic acid. The previous results may be related to the role of salicylic acid (SA) in raising the plant defense in plant in case of phytoplasma attacks, reducing infection prodromes, favoring photosynthetic translocation and improving the productivity and quality of fruits (Lopez-Delgado et al., 2018). The enhancements in vegetative growth characteristics may be related to the fact that potassium silicate is a great source of soluble potassium and silicon. Its main functions in agricultural production systems are to regulate silica and give plants trace amounts of potassium. Moreover, potassium which is the cation found in plants K plays a crucial part in controlling plant cells' osmotic potential. Additionally, it stimulates several enzymes involved in photosynthesis and respiration Marschner (1995).

Table (2). Influence of salicylic acid, potassium silicate and selenium on fruit weight, early and total yield of squash plants in both seasons.

Treatments	Fruit weight (g)		Early yield plant (g)		Total yield plant (Kg)	
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Control	**82.33 b**	**82.57 c**	**17.37 b**	**547.66 c**	**1.626 c**	**1.640 c**
Salicylic acid	**91.78 a**	**96.15 a**	**638.33 a**	**697.33 a**	**1.918 a**	**2.090 a**
Selenium	**89.33 a**	**88.21 b**	**608.67 b**	**617.67 b**	**1.826 b**	**1.850 b**
K silicate	**92.00 a**	**96.40 a**	**642.67 a**	**706.67 a**	**1.925 a**	**2.117 a**

Values in the same column followed by the same letter do not significantly differ from each other according to Duncan's multiple range tests at 5% level.

3- Fruit physical characteristics: -

Data in **Table (3)** indicates the influence of foliar spray with salicylic acid , selenium and potassium silicate on the physical fruit parameters i.e., the length and diameter of squash fruit. Results detected that the foliar spray with potassium silicate increased significantly fruit length of squash in the two tested seasons. Moreover, all tested treatments increased significantly the length of squash fruit in the second season compared to the control treatment. As for fruit diameter, data found that the positive effects of fruit diameter in the first year of study were obtained from spraying squash plants with all studied treatments compared to the untreated treatment. Whereas, in the second season foliar application with salicylic acid and potassium silicate increased fruit diameter. These findings are in the same line with those mentioned by Abd – Elaziz et al., (2019) , El-Shoura (2020), Al-Ahmad and Al-Jubouri, (2022), Jafari et al. (2015) and Omar (2017) .As for enhancements in fruit length and diameter in case of salicylic acid, selenium and potassium silicate could be attributed to the response of using salicylic acid, selenium and potassium silicate as foliar spray on fruits water content which have an effect on cell structure and fruit size and thus on fruit characteristics.

Table (3). Influence of salicylic acid, potassium silicate and selenium on physical fruit characters of squash plants in both seasons.

Treatments	Fruit length (cm)		Fruit diameter (cm)	
	2018/2019	2019/2020	2018/2019	2019/2020
Control	**15.40 b**	**14.43 b**	**3.55 b**	**3.47 b**
Salicylic acid	**15.87 a**	**15.77 a**	**3.75 ab**	**3.77 a**
Selenium	**15.71 ab**	**15.80 a**	**3.66 ab**	**3.58 b**
K silicate	**15.70 ab**	**16.67 a**	**3.82 a**	**3.91 a**

Values in the same column followed by the same letter do not significantly differ from each other according to Duncan's multiple range tests at 5% level.

4- Chemical constituents of fruits: -

Results in **Table (4)** indicate that, different assigned treatments significantly increased the chemical constituents of squash fruits (the total of soluble solids, ascorbic acid and the total of sugars) during both tested seasons. However, the control treatment had the lowest values of total soluble solids, ascorbic acid and total sugars during the two growing years. These findings are similar to those of (Abd–Elaziz et al., 2019, El-Shoura, 2020, Al-Ahmad and Al-Jubouri , 2022, Jalali et al., 2022, Liu et al., 2022 and Shehata and Abdelgawad 2019). These findings are going with those found by Zhao et al. (2020) who showed that added Si gave a significant increase in the content of ascorbic acid in squash fruit. As for total sugars, data showed that all treatments gave an increase in the total sugars content in squash fruits during the two seasons of study. Moreover, these findings are in harmony with Omar (2017) who stated that, spraying cucumber plants of SA or Si at 200 , 100 ppm respectively , increased the percentage of total sugars compared to untreated treatment.

Table (4). Influence of salicylic acid, potassium silicate and selenium on chemical fruit quality of squash plants in both seasons.

Treatments	T.S.S (%)		Ascorbic acid (mg/100 g fw)		Total sugars (%)	
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Control	4.43 b	4.61 b	17.37 b	18.08 c	29.33 b	27.98 b
Salicylic acid	5.1 a	5.0 a	19.12 a	19.26 ab	52.86 a	47.11 a
Selenium	5.03 a	4.90 a	19.00 a	19.63 a	53.80 a	51.90 a
K silicate	5.43 a	5.30 a	19.63 a	19.75 a	54.67 a	52.61 a

Values in the same column followed by the same letter do not significantly differ from each other according to Duncan's multiple range tests at 5% level.

CONCLUSION

The study recommend with foliar application of squash plants grown under greenhouse condition in the winter season under clay loam soil with potassium silicate for enhancing the vegetative growth parameters, fruit yield and quality. Moreover, spraying squash plant with salicylic acid was an effective agricultural strategy for high early and total yield and enhancing fruit quality.

REFERENCES

A.O.A.C. (1990). Official and tentative methods of analysis. Association of Official Analytical Chemists. Washington, D.C, U.S.A.

Abd El-Mageed, T. A., Semida, W.M., Mohamed G. F. and Rady M.M. (2016). Combined effect of foliar-applied salicylic acid and deficit irrigation on physiological–anatomical responses, and yield of squash plants under saline soil. South African J. Botany, 106: 8–16.

Abd-Elaziz. S. A., Alkharpotly, A. A., Yousry M. M. and Abido, A. I. A. (2019). Effect of foliar application with salicylic acid and potassium silicate on squash plants (*Cucurbita pepo L.*) yield and quality. Fayoum J. Agric. Res. & Dev., 33: (1) 1-24.

Al-Ahmad, Z. H. O. T. and Al-Jubouri, A. A. H. (2022). The Importance of Amino Acids and Salicylic Acids for The Yield of Two Hybrids of Summer Squash (*Cucurbita pepo L.*) Eastern Journal of Agricultural and Biological Sciences (EJABS), 2(2):1-13.

Alkharpotly, A.A., Yosury M.M. and Abido, A.I. (2019).Effect of foliar application with salicylic acid and potassium silicate on squash plants (*Cucurbita pepo* L.) yield and quality. FJARD, 33(1):1-24.

Al-Rubaye, B. C. H. and Atia, E. A. (2016). The influence of foliar sprays on the growth and yield of summer squash. International J. Scientific & Engineering Research, 7 (6): 664-669.

Bakr, B.M., El-Gazzar, A.A., Noha, A. M. and Fawzy, M.I. (2019). Effect of spraying washington navel orange trees with selenium on vegetative growth, productivity and fruit quality. Arab Univ. J. Agric. Sci. (AUJAS), Ain Shams Univ., Cairo, Egypt. Special Issue, 26(2D): 2311-2323.

Businelli, D., D'Amato, R., Onofri, A., Tedeschini, E. and Tei, F. (2015). Se-enrichment of cucumber (*Cucumis sativus* L.), lettuce (*Lactuca sativa* L.) and tomato (*Solanum lycopersicum* L. Karst) through fortification in pre-transplanting. Sci. Hortic., 197: 697–704.

Canakci, S. and Munzuroglu, O. (2007). Effect of Acetylsalicylic Acid on germination growth and chlorophyll amount of cucumber (*Cucumis sativus*, L) seeds. Pakistan J. Biol. Sci., 10 (17): 2930-2934.

El-Shoura , A.M. (2020). Effect of foliar application with some treatments on summer squash (*Cucurbita pepo, L.*) tolerance to high temperature stress. Middle East Journal of Agriculture Research, 9 (2): 468-478.

Elwan, M.W.M. and EL-Shatoury, R.S.A. (2014). Alleviation of NaCl stress in summer squash 'Eskandrani' by foliar application of salicylic acid. J. Hort. Res., 22(2): 131-137.

Feng, R., Wei, C. and Tu, S. (2013). The roles of selenium in protecting plants against abiotic stresses. Environ. Exp. Bot., 87: 58-68.

Gray, B. S.H. and Brady, M. S. (2016). Plant developmental responses to climate change. Developmental Biology, 419 : 64–77.

Gomez, K. A. and Gomez, A. A. (1984). Statistical procedures for agriculture research. International Rice Research institute. Textbook (2 ED.): 84 297.

Hara, M., Furukawa, J., Sato, A. Mizoguchi, T. and Miura, K.

(2011).Abiotic stress and role of salicylic acid in plants. https://www.springer.com/gp/book/9781461406334

Hernández, H., Gutiérrez, T. Q., Pliego, G.C., Ortiz, H. O., Fuentes, A.D. H, Fuente, M.C., Reyna, J. V. and Maldonado, A. J. (2019).Impact of selenium and copper nanoparticles on yield, antioxidant system, and fruit quality of tomato plants. Plants . 8: 355.

Hu, W., Su, Y., Zhou, J., Zhu, H., Guo, J., Hue, H. and Gong, H. (2022).Foliar application of silicon and selenium improves the growth, yield and quality characteristics of cucumber in field conditions. Sci. Hortic., 294: 116770.

Jalali, P., Roosta, H.R., Khodadadi, M. , Torkashv, A.M. and and Jahromi, M.G. (2022). Effects of brown seaweed extract, silicon, and selenium on fruit quality and yield of tomato under different substrates. PLoS ONE . 17, e0277923.

Jafari, S.R., Arvin, S.M.J. and Kalantari, K. M. (2015). Response of cucumber *(Cucumis sativus L*.) seedlings to exogenous silicon and salicylic acid under osmotic stress. Acta Biologica Szegediensis, 59(1):25-33.

Liu, H., Pang, J., Li, H., Qiang, X., Zhang, Y. and Song, J. (2022).Effects of foliar-spraying selenium coupled with soil moisture on the yield and quality of tomato. Sci. Agric. Sin., 55: 4433–4444. (In Chinese with English Abstract).

Lopez-Delgado, H.A., Martínez-Gutiérrez, R., Mora-Herrera, M.E. and Torres-Valdes, Y. (2018). Induction of freezing tolerance by the application of hydrogen peroxide and salicylic acid as tuber-dip or canopy spraying in *Solanum tuberosum* L. plants. Potato Res., 1-12.

Marschner, H. (1995). Beneficial mineral elements. In: Mineral nutrition of higher plants. Inc. Sandiego. USA.

Mateus, M. P. B., Tavanti , R. F. R. ,Tavanti , T. R., Santos, E. F., Jalal, A. and A . R . Reis .(2021). Selenium biofortification enhances ROS scavenge system increasing yield of coffee plants. Ecotoxicology and Environmental Safety, (209) : 111772

Nelson, N. (1974). A photometric adaptation of the Simonyi methods for determination of glucose. J. Biology. Chem., 195: 19-23.

Neysanian, M., Iranbakhsh, A., Ahmadvand, R., Ardebili, Z.O. and Ebadi, M. (2020). Comparative efficacy of selenate and selenium nanoparticles for improving growth, productivity, fruit quality, and postharvest longevity through modifying nutrition, metabolism, and gene expression in tomato; potential benefits and risk assessment. PLoS ONE, 15(12): e0244207.

Omar, A.A.A. (2017). Improving the fruit yield and quality of the grafted cucumber plants grown under high polyethylene tunnels. M. Sc. Unpublished thesis, Fac. Agric. Mansoura Univ. Egypt, 69 p.

Puccinelli, M., Pezzarossa, B., Rosellini, I. and Malorgio, F. (2020). Selenium enrichment enhances the quality and shelf life of basil leaves. Plants. 9: 801.

Schiavon, M., Dall'acqua, S., Mietto, A., Pilon-Smits, E.A., Sambo, P., Masi, A. and Malagoli, M. (2013). Selenium fertilization alters the chemical composition and antioxidant constituents of tomato (*Solanum lycopersicon* L.). J. Agric. Food Chem., 61: 10542–10554.

Shehata, M. N. and Abdelgawad, K. F. (2019).Potassium Silicate and Amino Acids Improve Growth, Flowering and Productivity of Summer Squash under High Temperature Condition American-Eurasian J. Agric. & Environ. Sci., 19 (2): 74-86.

Shuaimeng, Z., Yinli , L., Dekai, G., Xiaojuan, A. and Fanchao, K. (2017).

Spraying foliar selenium fertilizer on quality of table grape (*Vitis vinifera* L.) from different source varieties. Scientia Horticulturae . 218: 87-94.

Shu, L.Z. and Liu, Y. H. (2001). Effects of silicon on growth of maize seedlings under salt stress. Agro. Environmental Protection, 20:38-40.

Wang, L.J., Chen, S. J., Kong, W. F., Liu, S. H. and Archibold, D. D. (2006). Salicylic acid pretreatment alleviates chilling injury and affects the antioxidant system and heat shock proteins of peaches during cold storage. Postharvest. Biol. Technol., 41:244–25.

Xiang, J., Rao , S., Chen, Q. , Zhang, W., Cheng, S., Cong, X. , Zhang, Y., Yang, X. and Xu, F. (2022).Research progress on the effects of selenium on the growth and quality of tea plants. Plants, 11:2491.

Yu, L., Chen, Q., Liao, X., Yang, X., Chao, W., Cong, X., Zhang, W., Liao, Y., Ye, J., and Qian, H. (2023). Exploring Effects of Exogenous Selenium on the Growth and Nutritional Quality of Cabbage (*Brassica oleracea* var. Capitata L.). Horticultur ae, . 9:330.

Zhao, X., Yao, Q., Zhang, Y., Hou, L., Xing, G. and Shi, Y. (2020). Effects of foliar spraying exogenous silicon and iron fertilizers on tomato fruit quality. Shandong Agric. Sci., 52: 78–84.

Zhu, Z., Zhang, Y., Liu, J., Chen, Y. and Zhang, X. (2018). Exploring the effects of selenium treatment on the nutritional quality of tomato fruit. Food Chem., 252: 9–15.

الملخص العربى

تأثير الرش الورقى بحامض السالسيلك وسليكات البوتاسيوم والسيلنيوم على النمو والمحصول وجودة ثمار نباتات الكوسة النامية تحت الصوب

هبه حنفى محمد محمد و رضا السيد أحمد حسن

قسم بحوث الزراعات المحمية - معهد بحوث البساتين – مركز البحوث الزراعية - مصر

أجريت تجربتان حقليتان خلال موسمي الزراعة 2019/2018 و 2019 /2020 بالصوب الزراعية بالمزرعة البحثية فى مدينة قها التابعة لمعهد بحوث البساتين مركز البحوث الزراعية - بمحافظة القليوبية. لدراسة تأثير الرش الورقي بحمض السالسيلك 50بتركيز جزء في المليون ، سليكات البوتاسيوم بتركيز 50 مجم/لتر والسيلنيوم بتركيز5 مجم/لتر على نباتات الكوسة بالإضافة إلى معاملة المقارنة (الرش بماء الصنبور) على النمو الخضري والإنتاجية وجودة الثمار والتركيب الكيميائي لثمار هجين مارسيلا F1 . تم تصميم التجربة باستخدام تصميم قطاعات كاملة العشوائية بثلاث مكررات. تم إجراء معاملات الرش الورقي ثلاث مرات خلال موسم النمو حيث تم اجراء أول رشة بعد 20 يومًا من الزراعة، بمعدل مرة كل أسبوعين.

أشارت النتائج المتحصل عليها إلى أن رش النباتات بسليكات البوتاسيوم أدى إلى تحسين مواصفات النمو الخضري المتمثلة فى ارتفاع النبات ،عدد الأوراق ، مساحة الورقة ومحتوى الأوراق من الكلوروفيل مقارنة بالمعاملات الأخرى. كما أعطى رش نباتات الكوسة بسليكات البوتاسيوم و حمض السالسيلك زيادة في قيم متوسط وزن الثمار والمحصول المبكر والمحصول الكلي وجودة الثمار. علاوة على ذلك، أدى رش النباتات بحمض السالسيلك والسيلنيوم وسليكات البوتاسيوم إلى زيادة محتوى الثمار من المواد الصلبة الذائبة الكلية وفيتامين ج والسكريات الكلية لثمار الكوسة.

وتوصى الدراسة: رش نباتات الكوسة المنزرعة تحت الصوب شتاء بسليكات البوتاسيوم بتركيز 50 جزء في المليون لتكوين نمو خضري قوى ومحصول عالى وثمار بجودة عالية تحت ظروف الزراعة المحمية .