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Yield of Tomato Crop Irrigated with Untreated Industrial Sewage Effluent and Remediated with Potassium Silicate and Compost Applications

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Abstract

An experiment was conducted for the two successive seasons of 2017 and 2018 to investigate the deleterious effect of irrigating tomato plants with untreated industrial waste water and the possible ameliorating effects of compost and potassium silicate applications on the growth and production of the grown plants. Tomato seedlings of hybrid K186 were transplanted at the four-true leaf stage and irrigated with untreated waste effluent. Compost was applied during the soil preparation at rates of 0 (control), 10, 20, and 30 m^3/feddan. Potassium silicate was sprayed on the plants three times; at 20, 40 and 60 days after transplanting in the concentrations of 0 (control), 3, 4 and 5 cm^3/l. Results revealed that vegetative growth and fruit yield of treated plants were increased by increasing compost and potassium silicate rates compared by the control (without compost and potassium silicate).The interaction effect of the treatment showed an added effect of both treatments on all measured parameters. Plant length, number of leaves and number of branches increased as the application rate of compost and potassium silicate increased. Similarly, SPAD readings showed similar positive and significant trend. In the contrary, contents of Zn, Pb, Ni, Cd and Mnresponded negatively and significantly to the interaction effect of the treatments showing the highest effect with the treatment 5 cm^3 potassium silicate associated with 30 m^3 compost application compared to the control. Similar to the positive effect on vegetative growth, the positive additive effect of both treatments was clear on total fruit yield where the highest effect was recorded with the treatment combining the highest rate of application of both potassium silicate and compost. It could be concluded that potassium silicate and compost applications can ameliorate the harmful effects of heavy metals in the soil.

Keywords: Tomato, Industrial waste water, Potassium silicate, Compost, Heavy metals, Yield

1 Introduction

Egypt was classified as an arid land with a very little amount of rain fall mainly in the north coast and having the Nile Rivera's the main source of irrigation water. Officials revealed that with the ongoing agricultural expansion and climate changes, Egypt is facing a serious shortage of fresh water supply forcing the country to recycle all available sources of water. Some growers in remote areas are using raw industrial sewage effluent to fulfill their crop water needs ignoring the possible dangerous of contamination of heavy metals of such water.

The negative effects of heavy metal on many aspects of agriculture have been reported. For example, heavy metal can be leached to the underground water (He et al 2004, Rattan et al 2005) causing the spread of pollution to other layers of the aquifers. Heavy metal polluted soil can negatively affect plant growth and production causing serious economic losses (Nagajyoti et al 2010). Moreover, Arao et al (2010) and Khan et al (2008) reported high health risks for people exposed to polluted agricultural soil. The problem of heavy metal pollution to the soil is more difficult compared to other types of pollution such organic contamination because they cannot be degraded by microorganisms and last in the soil for longer time.

The application of compost decreased heavy metal concentration in plants (Ramachandran and D'souza 1998). In this respect, Sharma and Dhaliwal (2019) found that decreased concentrations of toxic metals in soils with regular application of wastewater sewage sludge with compost treatments.

Some researchers used soil amendments to change the mobility and bioavailability of such heavy metals (Bolan et al 2014, Udeigwe et al 2011). One of such amendments was compost (Paradelo et al 2011). Compost is rich with mineral ions, humic substances, and microbes which influence the immobilization of heavy metals resulting in reduction of the ecological and environmental risk of heavy metals in agricultural soils (De la Fuente et al 2011, Udovic and McBride 2012). Adsorption, complexation, precipitation, and redox reactions may all be one or more process involving heavy metal immobilization (Huang et al 2010, Lagomarsino et al 2011, Park et al 2011, Vaca-Paulin et al 2006). Thus, in addition to the benefit of compost as an alternative for waste management, its application can reduce the harmful effects on the crop, lower economic losses, and decrease human health risks from heavy metals existing in the root zone. Beneficial effects of compost on the growth and production of some vegetable crops such as green beans were reported under different levels of irrigation (Abdel-Mawgoud 2005) as well as salinity (Abdel-Mawgoud et al 2010).

Another alternative to reduce heavy metals deteriorating effects on plants is the application of some nutritional and/or beneficial elements such as silicon (Emamverdian et al 2018). Epstein (1999) described silicon (Si) as a beneficial and possibly essential element for plants, which plays important roles in plant growth and development (Ma and Yamaji 2006, Gu 2012). Many researchers reported various evidence that the application of Si to soils can alleviate Cd or Zn toxicity in many plant species, including rice (Ma et al 2015), maize (Liang et al 2005), wheat (Hussain et al 2015) and cotton (Farooq et al 2013).

Therefore, this work aims to investigate the effect of compost and potassium silicate applications, on the growth and production of tomato crop grown in soils irrigated with untreated industrial sewage effluent.

2 Materials and Methods

Seeds of tomato plant (*Solanum lycopersicum* L.) hybrid K186 were sown on 24thand 28th of April 2017 and 2018, respectively. After one month when the seedlings reached the fourth true leaf, they were transplanted in the open field in a sandy soil at a private farm in the area of Borg Al-Arab, Alexandria Governorate, Egypt. The soil physical and chemical analyses are shown in **Table 1**. Individual transplants were grown at the bottom of ridges 100 cm width and at 50 cm apart. Planting distances between plants are 50 cm. The furrow irrigation was used and plants were irrigated using water from an industrial sewage channel. The chemical analysis of the irrigation water is shown in **Table 1**. Also, heavy metals analyses in soil and irrigation water during the two seasons of study are shown in **Table 2.**

Table 1. Physical and chemical analyses of soil and irrigation water during the two seasons of the study

Soil properties	2017 season	2018 season
I. Physical analysis		
Sand (%)	89.65	88.40
Silt (%)	6.12	6.15
Clay (%)	4.23	5.45
II. Chemical analysis		
pH	7.79	7.68
EC (dS/m)	8.73	8.61
Ca^{+2} (meq/l)	34.13	33.27
Mg^{+2} (meq/l)	18.02	18.10
K^{+} (meq/l)	2.96	3.08
Na^{+} (meq/l)	35.53	37.02
Cl^{-} (meq/l)	38.05	39.21
HCO_3^{-} (meq/l)	5.70	5.84
Chemical analysis of irrigation water	2017 season	2018 season
pH	4.75	4.66
EC (ppm)	980	976
Ca^{+2} (meq/l)	4.40	4.22
Mg^{+2} (meq/l)	2.00	1.80
K^{+} (meq/l)	1.00	0.98
Na^{+} (meq/l)	9.40	8.88
Cl^{-} (meq/l)	10.00	9.63
SO_4^{-2} (meq/l)	5.80	5.84

Table 2. Heavy-metal analysis in soil and irrigation water during the two seasons of the study

	Season	Ppm							
		Ni	**Pb**	**Cr**	**Cd**	**Fe**	**Zn**	**Mn**	**Cu**
Soil	2017	0.475	0.414	0.152	0.003	3.880	1.620	7.480	1.770
	2018	0.483	0.421	0.163	0.005	3.952	1.747	7.634	1.810
Irrigation water	2017	0.222	0.010	0.00	0.068	9.350	1.805	0.539	0.671
	2018	0.123	0.21	0.00	0.071	9.342	1.818	0.547	0.683

All standard agricultural practices other than experimental treatments were applied according to the recommendations of the ministry of Agriculture, Egypt.

2.1 Experimental treatments

During the preparation of the soil and before transplanting, four levels of compost were applied namely, 0 (control), 10, 20, and 30 m^3/feddan and mixed well with the upper 50 cm of soil. A complete analysis of the applied compost is shown in **Table 3.**

Potassium silicate (SiO_2 25% - K_2O 15%) were sprayed on the plants three times starting at 20 days after transplanting and with 20 days interval. Four spraying concentrations were applied namely 0.0 (control), 3.0, 4.0 and 5.0 cm^3/l.

Table 3. Analysis of compost during the two seasons of the study

Analysis	Unit	Pure Compost
Weight of 1 m^3	Kg	653
Moisture	(%)	34
pH (H_2O) 1:10	-	6,16
EC(dsm^{-1}) 1:10	Ds/m	4,14
Total nitrogen	(%)	1,36
Ammonium nitrogen (NH_4)	Ppm	76
Nitrate nitrogen(NO_3)	Ppm	57
Organic matter	(%)	39,13
Total carbon	(%)	22,87
Ash	(%)	60,57
C/N ratio	-	1,66
Total phosphorus	(%)	0,59
Total potassium	(%)	1,32
Nematodes	-	-
Cause diseases to plant	Larva/200g	-ve
Free not cause diseases	Larva/200g	-ve

2.2 Measurements

Plant destructed samples were taken in the end of the seasons to determine plant height, and number of leaves and branches. Total yield/plant was measured by the end of the season when all ripe fruits were harvested. Zn, Mn, Pb, Ni and Cd contents were determined with a Model SOLAR 969 Atomic Absorption Spectrometer (FAO/WHO, 2001). SPAD readings at 90 days after transplanting was measured in fully expanded leaves using Minolta SPAD 501 chlorophyll meter.

2.3 Experimental design and statistical analysis

The treatments were arranged in a split plot design with four replicates where potassium silicate treatments were in the main plot and compost treatments in the sub main plots. All data collected were subjected to the statistical analysis according to Snedecor and Cochram (1968). The data of treatments were compared, using least significant difference (LSD) method at 0.05 as mentioned by Gomez and Gomez (1984).

3 Results

Data in **Table 4** show that potassium silicate spraying increased significantly plant length and number of leaves and branches per plant as the concentration of the application increased in both growing seasons.

As for the effect of compost adding, compost application showed a gradual positive effect on plant length, and number of leaves and branches per plant with the highest effect recorded with the highest rate of application (30 m^3/fed.) **Table 4**.

The interaction effect of potassium silicate and compost showed an added effect of both treatments on all measured parameters. The highest concentration of potassium silicate with the highest rate of compost gave the tallest plants and highest number of leaves and branches.

Table 4. Effect of foliar application of potassium silicate, compost adding and their interaction on plant length, and number of leaves and branches of tomato plants in 2017 and 2018 seasons

Treatments		Seasons		Seasons		Seasons	
		2017	2018	2017	2018	2017	2018
Potassium silicate		Plant length (cm)		Leaves No.		BranchesNo	
0 cm^3 / L		77.55	75.85	66.78	69.84	9.86	11.01
3 cm^3 / L		86.37	84.19	74.38	77.08	10.74	11.66
4 cm^3 / L		96.79	94.72	81.03	83.72	11.27	12.06
5 cm^3 / L		101.52	99.24	86.19	89.13	11.87	12.85
L.S.D at 5% level		2.13	1.98	2.93	3.16	0.62	0.44
Compost							
0 m^3 / fed.		85.96	83.78	65.32	70.36	9.28	10.61
10 m^3 / fed.		88.58	86.77	73.90	76.56	10.21	10.70
20 m^3 / fed.		91.85	90.06	79.96	82.69	11.49	12.45
30 m^3 / fed.		95.85	93.33	86.92	89.91	12.73	13.81
L.S.D at 5% level		1.44	1.32	3.34	3.57	0.59	0.63
Interaction							
0 cm^3 / L	0 m^3 Compost / fed.	70.45	68.54	54.23	57.32	8.12	9.65
	10 m^3 Compost / fed.	74.23	72.56	61.56	64.22	9.65	10.65
	20 m^3 Compost / fed.	80.22	78.76	70.44	73.41	10.22	11.22
	30 m^3 Compost / fed.	85.33	83.54	80.81	84.45	11.45	12.55
3 cm^3 / L	0 m^3 Compost / fed.	81.97	79.43	62.68	65.71	9.34	10.11
	10 m^3 Compost / fed.	84.45	82.66	71.65	74.29	9.98	10.85
	20 m^3 Compost / fed.	86.49	84.56	78.56	81.11	11.43	12.38
	30 m^3 Compost / fed.	92.59	90.11	84.66	87.23	12.22	13.32
4 cm^3 / L	0 m^3 Compost / fed.	93.23	91.22	73.84	76.11	9.67	10.92
	10 m^3 Compost / fed.	95.55	93.71	78.44	81.43	10.20	10.01
	20 m^3 Compost / fed.	98.45	96.65	82.43	85.66	11.89	12.92
	30 m^3 Compost / fed.	99.94	97.33	89.42	91.71	13.33	14.41
5 cm^3 / L	0 m^3 Compost / fed.	98.21	96.11	79.56	82.32	10.11	11.76
	10 m^3 Compost / fed.	100.01	98.17	83.98	86.33	10.99	10.99
	20 m^3 Compost / fed.	102.22	100.30	88.42	91.67	12.45	13.67
	30 m^3 Compost / fed.	105.56	102.37	92.82	96.28	13.93	14.98
L.S.D at 5% level		2.01	1.91	2.53	2.76	1.32	1.68

Data in **Table 5** indicate that potassium silicate spraying increased significantly SPAD reading and total yield per plant as the concentration of the application increased in both growing seasons.

As for the effect of compost adding, compost application showed a gradual positive effect on SPAD reading and total yield per plant with the highest effect recorded with the highest rate of application (30 m^3/fed.) **Table 5**.

The interaction effect of potassium silicate and compost showed an added effect of both treatments on all measured parameters. The highest concentration of potassium silicate with the highest rate of compost gave the highest SPAD reading and total yield per plant.

Data in **Table 6** indicated that Zn and Mn contents responded negatively and significantly to the increment in potassium silicate application rates **Table 6**.

Also, increasing compost application rate significantly decreased the contents of Zn and Mn in the tissue of the plants with the highest negative effect recorded with the highest rate of application (30 m^3/fed.) in two seasons of study **Table 6**.

Data in **Table 6** showed Zn and Mn contents responded negatively and significantly to the interaction effect of the treatments showing the highest effect with the treatment 5 cm^3 potassium silicate associated with 30 m^3 compost application compared to control.

Table 5. Effect of foliar application of potassium silicate, compost adding and their interaction on SPAD readings and total yield of tomato plants in 2017 and 2018 seasons

Treatments		Seasons		Seasons	
		2017	2018	2017	2018
Potassium silicate		**SPAD readings**		**Total yield/plant (g)**	
0 cm^3 / L		38.44	39.41	2145.18	2258.11
3 cm^3 / L		41.39	42.65	2421.58	2470.37
4 cm^3 / L		45.83	46.83	2798.49	2897.84
5 cm^3 / L		48.20	49.13	3073.94	3155.67
L.S.D at 5% level		1.33	1.42	23.57	29.39
Compost					
0 m^3 / fed.		38.40	39.47	2214.46	2258.74
10 m^3 / fed.		41.02	41.73	2441.76	2554.98
20 m^3 / fed.		45.10	46.10	2716.40	2807.81
30 m^3 / fed.		49.72	50.73	3066.65	3144.87
L.S.D at 5% level		1.50	1.64	27.58	34.32
Interaction					
0 cm^3 / L	0 m^3 Compost / fed.	30.82	31.45	1654.32	1756.21
	10 m^3 Compost / fed.	33.67	34.54	1956.64	2107.72
	20 m^3 Compost / fed.	41.88	42.91	2285.43	2378.53
	30 m^3 Compost / fed.	47.41	48.76	2684.34	2790.63
3 cm^3 / L	0 m^3 Compost / fed.	35.15	36.55	1967.87	1854.79
	10 m^3 Compost / fed.	38.83	39.27	2269.91	2372.89
	20 m^3 Compost / fed.	43.54	44.72	2554.11	2672.31
	30 m^3 Compost / fed.	49.48	50.09	2895.34	2981.51
4 cm^3 / L	0 m^3 Compost / fed.	42.36	43.56	2493.34	2572.44
	10 m^3 Compost / fed.	43.89	44.78	2656.53	2773.61
	20 m^3 Compost / fed.	46.72	47.44	2848.71	2961.68
	30 m^3 Compost / fed.	50.63	51.56	3195.39	3283.63
5 cm^3 / L	0 m^3 Compost / fed.	45.25	46.34	2742.32	2851.52
	10 m^3 Compost / fed.	47.67	48.34	2884.52	2965.72
	20 m^3 Compost / fed.	48.54	49.34	3177.38	3281.74
	30 m^3 Compost / fed.	51.34	52.52	3491.56	3523.71
L.S.D at 5% level		2.67	2.51	33.67	45.42

Table 6. Effect of foliar application of potassium silicate, compost adding and their interaction on Zn and Mn content of tomato plants in 2017 and 2018 seasons

Treatments		Seasons		Seasons	
		2017	2018	2017	2018
Potassium silicate		Zncontent		Mn content	
0 cm^3 / L		40.73	43.46	11.30	12.02
3 cm^3 / L		37.21	39.72	11.04	11.62
4 cm^3 / L		33.18	35.72	10.50	11.00
5 cm^3 / L		27.99	30.74	10.02	10.62
L.S.D at 5% level		2.11	2.91	0.85	0.91
Compost					
0 m^3 / fed.		40.73	45.84	11.31	12.09
10 m^3 / fed.		36.16	38.97	11.03	11.76
20 m^3 / fed.		32.54	35.41	10.64	11.32
30 m^3 / fed.		27.22	29.41	10.02	10.08
L.S.D at 5% level		3.23	3.71	0.88	0.90
Interaction					
0 cm^3 / L	0 m^3 Compost / fed.	50.78	53.11	11.89	12.93
	10 m^3 Compost / fed.	41.43	44.09	11.41	12.50
	20 m^3 Compost / fed.	38.29	41.33	11.15	11.85
	30 m^3 Compost / fed.	32.44	35.32	10.71	10.83
3 cm^3 / L	0 m^3 Compost / fed.	45.75	48.24	11.65	12.41
	10 m^3 Compost / fed.	39.59	42.12	11.42	12.11
	20 m^3 Compost / fed.	34.39	37.91	10.81	11.62
	30 m^3 Compost / fed.	29.12	30.61	10.30	10.36
4 cm^3 / L	0 m^3 Compost / fed.	42.47	45.35	10.91	11.62
	10 m^3 Compost / fed.	33.56	36.29	10.77	11.39
	20 m^3 Compost / fed.	30.27	33.03	10.50	11.07
	30 m^3 Compost / fed.	26.13	28.22	9.71	9.94
5 cm^3 / L	0 m^3 Compost / fed.	33.45	36.67	10.80	11.41
	10 m^3 Compost / fed.	30.09	33.41	10.52	11.12
	20 m^3 Compost / fed.	27.22	29.40	10.13	10.74
	30 m^3 Compost / fed.	21.21	23.51	9.37	9.22
L.S.D at 5% level		5.56	5.23	1.02	1.11

Data in **Table 7** indicated that Pb, Ni and Cd contents responded negatively and significantly to the increment in potassium silicate application rates **Table 7**.

Also, increasing compost application rate significantly decreased the contents of Pb, Ni and Cd in the tissue of the plants in two seasons of study **Table 7**.

Data in **Table 7** showed Pb, Ni and Cd contents responded negatively and significantly to the interaction effect of the treatments showing the highest effect with the treatment 5 cm^3 potassium silicate associated with 30 m^3 compost application compared to control.

Table 7. Effect of foliar application of potassium silicate, compost adding and their interaction on Pb, Ni and Cd contents of tomato plants in 2017 and 2018 seasons

Treatments		Seasons		Seasons		Seasons	
		2017	2018	2017	2018	2017	2018
Potassium silicate		Pbcontent		Ni content (ppm)		Cd content (ppm)	
0 cm^3 / L		31.13	33.82	8.31	8.53	8.81	7.78
3 cm^3 / L		25.61	27.84	6.20	5.98	6.51	5.50
4 cm^3 / L		18.95	21.54	4.06	3.45	4.85	4.10
5 cm^3 / L		12.26	18.09	3.03	2.81	3.84	2.95
L.S.D at 5% level		2.39	2.92	0.53	0.47	1.45	1.11
Compost							
0 m^3 / fed.		28.76	30.77	7.58	6.59	8.65	7.53
10 m^3 / fed.		24.54	27.17	6.05	5.43	6.95	5.99
20 m^3 / fed.		21.24	24.13	4.42	4.63	4.72	3.25
30 m^3 / fed.		16.40	19.21	3.55	4.12	3.70	3.07
L.S.D at 5% level		3.01	3.22	0.43	0.51	1.22	1.19
Interaction							
0 cm^3 / L	0 m^3 Compost / fed.	40.16	42.21	12.42	11.56	12.45	11.21
	10 m^3 Compost / fed.	32.05	34.31	9.33	8.32	10.22	9.11
	20 m^3 Compost / fed.	29.20	32.32	6.54	7.67	7.11	6.23
	30 m^3 Compost / fed.	23.10	26.43	4.94	6.56	5.45	4.56
3 cm^3 / L	0 m^3 Compost / fed.	31.92	33.61	8.61	7.45	9.56	8.45
	10 m^3 Compost / fed.	28.20	30.12	7.52	6.84	7.78	6.81
	20 m^3 Compost / fed.	23.10	25.42	5.11	5.11	4.94	3.75
	30 m^3 Compost / fed.	19.20	22.22	3.55	4.52	3.74	2.99
4 cm^3 / L	0 m^3 Compost / fed.	23.52	25.91	5.73	4.22	7.34	6.33
	10 m^3 Compost / fed.	20.60	23.34	4.32	3.65	5.33	4.56
	20 m^3 Compost / fed.	18.55	21.46	3.21	3.01	3.82	2.79
	30 m^3 Compost / fed.	13.11	15.43	2.99	2.90	2.92	2.71
5 cm^3 / L	0 m^3 Compost / fed.	19.42	21.34	3.57	3.11	5.23	4.11
	10 m^3 Compost / fed.	17.30	20.92	3.01	2.89	4.45	3.45
	20 m^3 Compost / fed.	14.12	17.33	2.82	2.71	3.01	2.21
	30 m^3 Compost / fed.	10.20	12.76	2.72	2.51	2.67	2.03
L.S.D at 5% level		5.19	6.34	1.03	0.9	1.02	0.86

4 Discussion

Heavy metals have been reported to cause deteriorating effects on different plant growth aspects resulting in reduction in plant production and quality. Cd, Ni and Pb are such example of those heavy metals exist in agricultural soils because of misuse of agrochemicals and/or pollution from other sources such as irrigation of raw untreated sewage effluent. In this study, the deteriorating effect of heavy metal polluted irrigation water has been observed leading to the lowest growth and production of tomato plants as well as the highest contents of heavy metals in plant tissue. Such accumulation has been observed earlier in many crops (Nagajyoti et al 2010). In this study, compost application reduced the harmful effect of heavy metals existed in irrigation water. This can be due to changing the physicochemical property of soils and reacting with heavy metals (Bolan et al 2014, Liu et al 2009). The beneficial effect of compost application in reducing the harmful effects of heavy metals has been reported earlier by Huang et al (2016). On the other hand, potassium silicate showed also an ameliorating effect on plant growth and production as revealed from our data. These positive effects are mainly due to the presence of Si. These beneficial effects have been explained on the basis that Si increase plant resistance to some heavy metals such as Cd by inhibiting Cd uptake in roots and the enhancement of light-use-efficiency in leaves (Nwugo and Huerta 2008 a&b). Silicon has been reported to have a beneficial effect on growth and yield for various horticultural plant species such as bean, cucumber (Zhu et al 2004), tomato (Romero- Aranda et al 2006) and Zucchini squash (Savvas et al 2015).

Because of the different mode of action for compost and potassium silicate against heavy metals, the interaction of the two treatments was additive and its combination resulted in enhancing the effect of each other which reflected on higher plant growth and production.

5 Conclusion

It can be concluded that the treatment with compost and potassium silicate, as well as the interaction between them, reduced the harmful effect of irrigation with untreated industrial wastewater, as well as increased the vegetative growth and yield of the tomato plants under study.

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نمو وإنتاج محصول الطماطم المروية بمياه الصرف الصناعي غير المعالجة ومعالجتها بإستخدام سيليكات البوتاسيوم وسماد الكمبوست النباتي

[83]

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الموجـــــــز

تم إجراء تجربة في موسمين متتاليين في عامي 2017 و 2018 لدراسة التأثير الضار لري نباتات الطماطم بمياه الصرف الصناعي غير المعالجة والتأثيرات المحتملة لمعاملة الكمبوست النباتي وسيليكات البوتاسيوم على نمو وإنتاج النباتات المزروعة. تم زرع شتلات نباتات الطماطم هجين 186 في عمر اربعة من الأوراق الحقيقية وتم ريها بمياه الصرف الصناعي غير المعالج. تم استخدام الكومبوست أثناء تحضير التربة بمعدلات 0.0 (كنترول) ، 10 ، 20 ، و30 م^3/فدان. تم رش سيليكات البوتاسيوم على النباتات ثلاث مرات خلال المواسم عند 20 و 40 و 60 يومًا بعد الزرعة بتركيزات 0.0 (كنترول)، 3 ، 4 و 5 سم 3 / لتر. تم وضع معاملة سيليكات البوتاسيوم في القطع الرئيسية بينما كانت معاملة السماد في القطع الفرعية، فى أربع مكررات لكل معاملة. أظهرت النتائج أن النمو الخضري ومحصول الثمار من النباتات المعاملة قد تأثرت بشكل إيجابي من خلال كل من معاملاتسماد الكمبوست وسيليكات البوتاسيوم وتفاعلاتها. وفي الوقت نفسه، تأثرت بشكل كبير محتويات المعادن الثقيلة في الأنسجة النباتية بهذه المعاملات . ويمكن أن نستنتج أن تطبيقات سيليكات البوتاسيوم والكمبوست يمكن أن تخفف من الآثار الضارة للمعادن الثقيلة في التربة.