Hanaa Mohammed

بسم اللّه الرحمن الرحيم

مركز الشبكات وتكنولوجيا المعلومات

قسم التوثيق الإلكتروني

Safaa Mahmoud

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم باللّه العظيم أن المادة التي تم توثيقها وتسجيلها

علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

REDUCTION OF THE RISK POLLUTION USING ORGANIC AND INORGANIC ADDITION ON TOMATO CROP IRRIGATED BY INDUSTRIAL WASTEWATER

By

RANA HOSNY HASSAN ABOU-NOUFAL
B.Sc. Agric. Coop. Sci., Agric. Higher Institute for Agric. Coop., 1995
M.Sc. Agric. Sci., (Agriculture and Desert Areas Affected by Salinity) Fac. Agric., Ain Shams Univ., 2015

A Thesis Submitted in Partial Fulfillment

Of

The Requirements for the Degree of

DOCTOR OF PHILOSOPHY

in

AGRICULTURAL SCIENCES
(Agriculture and Desert Areas Affected by Salinity)

Arid Lands Agricultural Graduate and Research Institute
Faculty of Agricultural
Ain Shams University

2022

REDUCTION OF THE RISK POLLUTION USING ORGANIC AND INORGANIC ADDITION ON TOMATO CROP IRRIGATED BY INDUSTRIAL WASTEWATER

By

RANA HOSNY HASSAN ABOU-NOUFAL

B.Sc. Agric. Coop. Sci., Agric. Higher Institute for Agric. Coop., 1995
M.Sc. Agric. Sci., (Agriculture and Desert Areas Affected by Salinity) Fac. Agric., Ain Shams Univ., 2016

Under the supervision of:

Dr. Mohaumed Zaky EL-Shinawy
Prof. of vegetable crops, Faculty of Agriculture, Ain Shams University.

Dr. Eman Aly Diab
Assistant Prof. of Environmental Pollution, Plant Ecology and rang Dept., Desert research center, Cairo, Egypt.

CONTENTS

LIST OF TABLES

ABSTRACT

Rana Hosny Hassan Abou-Noufal, Reduction of the Risk Pollution Using Organic and Inorganic Addition on Tomato Crop Irrigated by Industrial Wastewater. Unpublished Ph.D. Thesis, Department of Arid Lands Agricultural Graduate and Research Institute, Faculty of Agricultural, Ain Shams University

An experiment was conducted for two successive seasons of 2017 and 2018 to investigate the deleterious effect of irrigating tomato plant with untreated industrial waste water and the possible ameliorating effects of compost and potassium silicate on the yield. Compost was applied during soil preparation at rates of 0, 10, 20, and 30 m^3/fed. Potassium silicate was sprayed on the plants three times during the seasons at 20, 40 and 60 days after transplanting in concentrations of 0, 3, 4 and 5 cm^3/l. Treatments were arranged as potassium silicate was in the main plot while compost treatment was in the sub main and with 3 replicates for each treatment. Results revealed that vegetative growth and fruit yield of treated plants were increased by increasing compost and potassium silicate rates compared by the control treatment. Plant length, number of leaves and number of branches increased as the application rate of compost and potassium silicate increased. Zinc, Pb, Cd and Mn 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. 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¸ Cd¸ Zn ¸ Pb ¸ Ni and Yield .

ACKNOWLEDGEMENT

Special thanks to **Prof. Dr. Mohamed Zaky EL-Shinawy**, professor of Vegetable Crops, Faculty of Agriculture, Ain Shams University, for his help, valuable advices, and kind help during the preparation of this thesis.

Deep gratitude and thanks are also due to **Dr. Eman, Diab,** Associate professor of Environmental Pollution, Plant Ecology and rang Dept., Desert research center, Cairo, Egypt, for his kind supervision, advice, valuable assistance, during the preparation of this thesis.

I would like to express my sincere, special thanks and appreciation to **Dr. Mohamed Hashim,** Emeritus Professor of Vegetable Crops, Faculty of Agriculture, Ain Shams University, for his supervision, great support.

Special thanks also to **Prof. Dr. Hani Gamal Abdel-Gawad**, professor of Vegetable Crops, Faculty of Agriculture, Ain Shams University, for his help, valuable advices, and kind help.

Great special thanks to **Alaa El-Din Salah Tantawy,** professor of Vegetable Crops,Research Department, National Research Center, Dokki, Giza, Egypt for being my motivation and supportive continually to achieving this thesis. So, I dedicated this thesis.

Thanks, are also extended to **the staff members** of the Department of Arid Lands Agricultural graduate studies and Research Institute, Faculty of Agriculture, Ain Shams University for their encouragement and help during this work.

Thanks, are also extended to **the staff members** of the Environmental Pollution, Plant Ecology and rang Dept., Desert research center, Cairo, Egypt for their encouragement and help during this work.

Finally, deeply kind regards to my daughter **Basmala Hashim**, for showing me the value of hard work, discipline, commitment, likewise for my brothers as whom taught me to pursue my dreams with optimism.

INTRODUCTION

Egypt was classified as an arid land with a very little amount of rain fall mainly in the north coast and having the river Nile as the main source of irrigation water. Officials revealed that with the ongoing agricultural expansion and climate changes, Egypt was 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 the first cannot be degraded by microorganisms and last in the soil for longer time. Some researchers used soil amendments to change the mobility and bioavailabilty of such heavy metals **(Bolan *et al.* 2014 and 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 at investigating the effect of compost and potassium silicate application, as a soil amendment, on the growth and production of tomato crop grown in soils irrigated with untreated industrial waste water.

REVIEW

2.1-Effect of irrigation by industrial sewage water

2.1.1- Vegetative growth.

Oancea *et al* (2005), working on tomato plants, showed that both growth and photosynthetic pigments are affected by the presence of heavy metals.**Qaryouti *et al* (2015)** indicated that the application of Raw Waste Water from Food Industry improve cucumber and tomato performance and soil fertility.

Marwari and Khan (2012) show that with the increase use of textile wastewater treatment the root and shoot length, root and shoot dry weight and total dry weight were reduced too.

El-Sherif*el al(2015)* evaluate the impact of calcium sulphate or potassium silicate on Moringa dry-leaf powder either alone or combined as double or triple treatments. They found that the increment values of total plant length, number of leaves and branches per plant; total plant fresh weight and shoot dry weight, parameters with the maximum values of final plant, respectively. The half doses overwhelmed other double treatments in the percentage increase values of such plant growth characters of tomato and achieved the highest values.

Daifi*et al*. (2015),In this study, we tested the effect of purified industrial wastewater discharged from CMCP of Kenitra city on the growth of tomato plant (*Lycopersiconesculentum*). After testing the agronomical parameters we found that the highest fresh weight is observed in plants irrigated with drinking water and those irrigated with unpurified wastewater have shown the lowest fresh weight. Also the growth of tomato plants irrigated with drinking water were higher than plants treated with purified wastewater, followed by plants treated with percentages of 25, 75 and finally with unpurified wastewater.

Uzma *et al*. (2016),the present study was conducted to determinethe effect of industrial wastewater on the germinationand seedling growth of some commonly grown vegetablesin Pakistan. Wastewater samples were collectedfrom two different industries in Peshawar, Pakistan, and their effect on different growth parameters of four vegetables including Hibiscus esculentus, *Lactuca sativa*, *Cucumis sativus*, and *Cucumis melo* was investigated. The obtained results revealed that wastewater from marble industry did not affect seed germination except a minor inhibition in H. esculentus. Effluents from match alam factory stimulated seed germination in C. melo and C. sativus but had no effect on seed germination in the other two vegetables. Wastewater increased root and shoot length in H. esculentus, L. sativa and C. melo, but decreased it in C. sativus. Similarly, differential effects ofwastewater were observed on fresh and dry biomass of seedlings in all vegetables. It can be concluded that wastewater may have different effects on different crops, depending upon the nature of wastewater and sensitivity of a plant species to wastewater.

2.1.2- Concentration of heavy metals in leaves.

Hashem *et al* (2013),mention that the effect of irrigation with industrial wastewater on three crop plants: turnip, tomato and lettuce. Industrial wastewater contain significant amounts of heavy metals (Cd, Ni and Co) which resulted in a significant decrease in leaf area.

Khan*et al* (2011),conducted a comparative study to show the effect of tube well (TW) and waste water (WW) with or without basal dose of NP and K on the yield and heavy metal uptake of tomato. The overall results showed that leaves accumulated higher concentration (with exception of Cu) of heavy metals studied compared to fruit. The concentration of Cr, Fe, Mn Pb and Zn in leaves was above the permissible limits when irrigated with waste water while waste water supplemented with fertilizers showed reduction in heavy metals uptake. The concentration of Fe and Pb was above the permissible limits in fruits indicating toxicity.

Parashar and Prasad (2013),study the effect of irrigation by sewage on heavy metal contamination of Spinach, Cabbage, Beetroot, Reddish, Okra, Tomato, and Cucumber. They conclude that the use of treated and untreated wastewater for irrigation has increased the contamination of Cd, Pb in edible portion of vegetables causing potential health risk in the long term from this practice. The study also points to the fact that adherence to standards for heavy metal contamination of soil and irrigation water does not ensure safe food. Pb and Cd were found more in untreated sites as compared to treated site.

Fatoba, *et al.*(2012). investigate the effects of industrial waste effluents on the fruits of Tomato (*Lycopersconesculentum)*and Okra (*Abelmoschus esculentus*) irrigated with wastes from Global Soaps and Detergents, Ilorin were to assess the safety of their consumption. The used wastes were collected before their discharge into the water bodies. Top soils were collected from unpolluted environment homogenously mixed together and stocked into plastic pots perforated at their bases. The collected wastes and soils were subjected to heavy metal: Pb; Zn; Cu; Cd; Fe and Hg determination with the aid of Atomic Absorption Spectrophotometer. The pH of the wastes and soil were determined electrometrically. .... Seeds of tomato and okra were sown differently into these pots and the prepared waste water was used to irrigate these plants twice a week and the stands per pot were reduced to 2. The fruits produced by these plants were appropriately digested and subjected to Pb, Zn, Fe, Cd, Cu and Hg determination with the aid of Atomic Absorption Spectrophotometer. It was found that only the okra and tomato plants irrigated with only borehole water (Control), 1% and 5% GSD and 1% DCF wastewater fruited. The pH of the soil However, the presence and accumulation of Pb, Hg and Cd in the fruits raised with GSD waste water pose a serious threat to life. It is therefore possible to recommend

these wastes for the raising of okra and tomato at very low concentration less than 1% for GSD and less 10% for DCF to avoid accumulation of Pb, Cd and Hg.

Sultana *et al*.(2016)assessment the effect of industrial wastewater on the yield and trace element contents of red amaranth was carried out by this study. Thirty wastewater samples were collected from five major environment-polluting industries namely pharmaceuticals, dyeing, leather, food, and plastic industries at three different locations. The results concludes that the wastewater samples of pharmaceuticals, dyeing, leather and plastic industries were more polluted than the wastewater of food industries. Vegetables grown in industrial areas contain trace elements viz. Cr, Ni and Cu which would be health hazardous for consumer.

2.1.3-Total fruit yield- Total yield

Hashem *et al* (2013),investigated that the effect of irrigation with industrial wastewater containing amounts of heavy metals (Cd, Ni and Co) resulted in a significant decrease total crop yield in tomato plant.

2.1.4- Concentration of heavy metals in fruit.

Hashem *et al*. (2013)showed that industrial wastewater contain significant amounts of heavy metals (Cd, Ni and Co) which their amounts exceed the maximum recommended concentrations according to FAO guide lines for trace metals in irrigation water.The effect of industrial factories on contaminating water with toxic metals and the impact of irrigation using industrial wastewater on growth and photosynthetic pigments content of some vegetable crop plants differ in their edible part; fruits in the case of tomato, leaves in the case of lettuce and roots in the case of turnip plants.

2.1.5- Fruit quality

Hashem *et al*. (2013)found a marked reduction in photosynthetic pigment content and damage to cell membranes, as indicated by increased electrolyte leakage and a lower membrane stability index. Significant increases in the activities of antioxidant enzymes and in the glutathione, proline, soluble sugar and total amino nitrogen content in response to irrigation with wastewater may be defense mechanisms induced in response to the heavy metal stress.

MacFarlane and Burchett, (2001) pointed that a significant decreases in amounts of photopigments were found in *Avicennia marina* treated with Cu and Zn at concentrations lower than those inducing visible toxicity; thus, photosynthetic pigments may be sensitive biological indicators of Cu and Zn stress in this plant.

Marwari and Khan (2012) In his study on Tomato (*Lycopersiconesculentum*) treated with 20 and 30% textile wastewater. Findings of the study revealed that

chlorophyll content was most severely affected with the increase in metal concentration. Total chlorophyll content showed a reduction of 72.44% while carbohydrate, protein and nitrogen content showed a reduction of 46.83, 71.65 and 71.65% respectively. After crop harvesting, the fruit samples of the plants treated with highest concentration of textile waste water contained 2.570 mg g(-1)d.wt. of Zn, 0.800 mg g(-1) d.wt. Cu, 1.520 mg g(-1) d.wt. Cr and 2.010 mg g(-1) d.wt. Pb.

2.2-Effect of potassium silicate

2.2.1- Vegetative growth

Romero-Aranda *et al*. (2006), concluded that Si improves the water storage within plant tissues, which allows a higher growth rate that, in turn, contributes to salt dilution into the plant, mitigating salt toxicity effects.

Salim *et al* (2014) conducted an experiment to study the effect of foliar spray with potassium nitrate, potassium silicate, potassium chloride and mono potassium phosphate at the rates1000 ppm and 2000 ppm on growth, yield parameters and some biochemical constituents of potato plant(*Solanum tuberosum* L.). The results indicated that the higher rate of potassium silicate and potassium nitrate were more effective than the rest treatments on enhancing the vegetative growth parameters and yield components. In general, all potassium treatments have strongly stimulating effect on mineral nutrients (N, P, K, Mg, Zn, Mn and Fe) and protein concentration of potato leaves in both seasons.

2.2.2- Concentration of heavy metals in leaves

Marodin*et al*. (2014),mention that calcium and potassium silicates increased the Si levels on the leaves linearly with the increase of the doses, while sodium silicate reduced the levels in larger doses.

2.2.3-Chlorophyll content

Rana *et.al.* mention that the positive and significantly effects of potassium silicate was also obvious on total chlorophyll content.

Emrich *et.al.*study the evaluate effect of leaf application of different doses of potassium silicate, on the levels of chlorophyll a, b and total in leaves of tomato cultivated.The increase of potassium silicate doses stimulated the concentration of chlorophyll a, b and total chlorophyll.

Shedeed *et al*. (2018) conducted a field experiment using three treatments of silicon applications in order to evaluate and study the effect of foliar potassium silicate application and agro-mineral silicate (vermiculite) in soil as supplemental for Si in decreasing heavy elements accumulation in cowpea plants (shoots and roots) and their concentration in the soil. The obtained results showed that the studied treatments had a

significant positive effect on Si (beneficial element) and some micronutrients (Fe, Zn and Mn). On the other hand, there was a reduction effect on some heavy elements (Cu, Ni, Pb, Cd and V) in plant and soil by using the silicate treatments as compared with control. In addition, the different silicon applications affected significantly the studied growth parameters and yield of cowpea plants.

2.2.4-Total fruit yield.

Marodin *et al.*(2014),pointed out that Silicon fertilization increases the productivity of tomato plants with possible economic return on the use of this input.

Zbigniew (2014), determine the effect of root application of colloidal silicon as well as of three types of growing media of different silica content and varying ability to release ortho silicate monomers (rock wool, sand, straw) on yield and chemical composition of greenhouse tomato. Tomato plants fertigated with the nutrient solution enriched with silicon showed significantly higher total fruit yield (15.98 kg/plant-1) compare to plant grown in control treatments. In the studies not found significant differences in total and marketable yield as well as in mean fruit weight between plants grown in rock wool and straw mediums. The total fruit yield of tomato plants grown in sand was lower compared to rock wool-grown plants. The fruit of tomato grown in sand was shown to have more dry matter (5.52%), total sugars (2.58% FR.W.) and potassium (4.19% DW) compared to rock wool culture as well as significantly the highest amount of silicon. The leaves of tomato fertilized with the silicon-enriched nutrient solution contained more silicon as well as less manganese and zinc compared to control plants.

Josuéet al.(2014) found that thebenefits of silicon (Si) on tomato plants. This element has structural and metabolic functions in the physiology of plants, generating benefits that may result in increased productivity of various plant species.

2.2.5- Concentration of heavy metals in fruits

Shedeed *et al*. (2018).A field experiment was conducted using three treatments of silicon applications in order to evaluate and study the effect of foliar potassium silicate application and agro-mineral silicate (vermiculite) in soil as supplemental for Si in decreasing heavy elements accumulation in cowpea plants (shoots and roots) and their concentration in the soil. The obtained results showed that the studied treatments had a significant positive effect on Si (beneficial element) and some micronutrients (Fe, Zn and Mn). On the other hand, there was a reduction effect on some heavy elements (Cu, Ni, Pb, Cd and V) in plant and soil by using the silicate treatments as compared with control. In addition, the different silicon applications affected significantly the studied growth parameters and yield of cowpea plants

2.2.6- Fruit quality.