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Risk Assessment of some Heavy Metals onTomato (*Solanum lycopersicum*L.)

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سم الله الرحمن الرحيم

(وَقُلِ اعمْلَوُا فَسَيرَىَ اللهُ عمَلَكَمُ وَرَسُوُلهُ وَالْمُؤْمِنُونَ)

صدق الله العظيم

الاية (105)سورة التوبة

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Dedication

To all my Family Especially my Parents

Abstract

In recent decades, serious contamination of soils by heavy metals has been reported,which in turn transmitted to humans through the food chain. It is therefore a matter of urgency to develop a new and efficient technology for removing contaminants from soil. Another aspect to this problem is that environmental pollution decreases the biological quality of soil, which is why pesticides and fertilizers are being used in ever-larger quantities. The environmentally friendly solutions to these problems are phytoremediation, which is a technology that cleanses the soil of heavy metals, a process that helps to protect crops using natural plant compounds.

A greenhouse experiment was conducted to determine the effect of some heavy metals such as Zn and Pb (individual and mixture) on *Solanum lycopersicum* L. (Tomato): on the seed germination, root/shoot growth (plant were grown for 30 days before transferring to experimental pots) and uptake of these metals and determined their concentration in different plant parts by Atomic Absorption Spectrophotometer at the end of this study. The selected metals were dosed at various concentrations ranging from 5, 10, 20 and 50 ppmin addition distilled water for control, to Irrigate plant. Data were statistically analyzed. Result shown that, the seed germination of *Solanum lycopersicum* L. (Tomato) was found significantly affected by these metals,where it was decreased with increase of concentration this heavy metals. Root and shoot growth of *Solanum lycopersicum* L. (Tomato) were found not significantly affected by these metals, concentration of both Zn and Pb in different parts of plant increased with increase the concentration of these metals in treatments,whereZn concentration was: Shoot > Root >Fruit but Pb concentration was: Root > Shoot > Fruit.

It was also noted that the presence of Zn with Pb decrease their uptake, where concentration in different plant parts was decrease at Pb in the mixture for in Pb individual, unlike Zn concentration was close at the mixture and an individual.

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Chapter 1

Introduction

Introduction

1.1-Overture:

Many countries in the world faced with the problem of soil contaminations, especially with heavy metals pollution (Luo and Teng, 2006; Brus *et al*., 2009). Pollution of the natural environment due to the anthropogenic activity particularly by heavy metals is a man-made problem. (Marchiol *et al*., 2004; Gruca *et al*., 2006). The increased industrialization,mining melting of metallic ferrous ores, smelting, burning of fossil fuels, electroplating, agriculture, fertilizers, pesticides, sewage sludge, municipal waste and other anthropogenic activities. All these sources of pollution could concentrated various heavy metals and their into the soil and water environment (Xiong, 1998; Peng *et al*., 2006).For example Zn comes from tire wear and galvanized parts such as fuel tanks (Falahi-Ardakani,1984).While the Brake wear is the most important source for Cu and Pb emissions. Pb comes also from exhaust gas and worn metal alloys in the engine (Winther and Slento, 2010). In addition these metals may enter the food chain because Plants uptake essential and non-essential elements from soils in response to concentration gradients induced by selective uptake of ions by roots, or by diffusion of elements in the soil (Peralta-Videa *etal*., 2009), where the level of accumulation of elements differs between and within plant species (Mcgrath *et al*.,2002), and therefore harm the human body through various ways such as ingestion or absorption through the skin (Life Extention, 2003).

For instance , Pb, one of the more persistent metals, was estimated to have a soil retention time of about 150–5000 years and was reported to maintain high concentration for as long as 150 years after sludge application to the soil(Yang *et al*., 2005).

The toxic effect of heavy metal is related to their extremely high concentrations in the cells of the living organisms. This concentration could cause disturbances in cell membranefunctioning in the photosynthetic, mitochondrialelectron transportand in the inactivationof many enzymes in the basic cell metabolism regulation, which as the result leads to diminishing energy balance and disturbances in cell mineral nutrition (Gondek and Filipek-Mazur, 2003). All these possible risks and potential hazards that may be caused by heavy metals pollution led to the importance for many countries to search for way, to prevent contamination of the soil and food in the first place (Gruca *et al*., 2006).

Some of the species now being studied--or already in use--are mustards, alfalfa, vines, bamboo, cord grass, tomato and sunflowers. Some trees, including willows and poplars, also make good phytoremediators. The plant material may be used for non-food purposes; alternatively, it can be ashed followed by recycling of the metals or as disposal in a landfill (Bennett *et al*., 2003; Angel and Linacre, 2005).In the present study we chosen tomato because of its renowned ability in phytoremediation and addition to its economic importance in Libya.

1.2- Aims of Study:

The current study has been carried out in order to achieve several goals among which are the following:

1- Study the impact some of heavy metals (Zn, Pb) on germination and growth of tomato (*Solanum lycopersicum* L.).

2- Investigate the accumulation process of pollutants (heavy metals) in the different parts of the plants (fruit ,shoot and root) in order to determine their levels and their specific site .This study so important as it comes at time when the regulation and monitoring of food quality is very weak , and there was a lack of such studies.

3- Finding the degree of pollution that may have human health risks from consuming contaminated food.

4- The cleanup of most of the contaminated sites is mandatory in order to reclaim the area and to minimize the entry of toxic elements into the food chain.

Chapter 2

Literature Review

2-Literature Review

2.1- Effect of Heavy Metals on Seed Germination.

The term heavy metals refers to metals and metalloids having densities greater than $5g/cm^3$ and is usually associated with pollution and toxicity although some of these elements (essential metals) are required by organisms at low concentrations such as Cr, Cu, Fe, Mn, Mo and Zn (Adriano, 2001).

Some other elements nonessential elements such as Cd, Co, Hg, Se, Pb, V and W (Horne, 2000; Blaylock and Huang, 2000) they are toxic even at low concentrations, and the most common heavy metal contaminants are: Cadmium (Cd), Chromium (Cr), Copper (Cu), Mercury (Hg), Lead (Pb), Nickel (Ni) and Zinc (Zn) (USEPA, 1997; Lasat, 2002).

(Tuna *et al*., 2002) carried out their study to determine the effects of heavy metals (Ni, Fe, Pb, Co, Cd, Hg, Al, Zn and Cu) on pollen germination and pollen tube length in the tobacco plant (*Nicotiana tabacum* L. cv. Karabaular). The results showed that enhanced concentrations of heavy metals, except Fe, decreased the pollen germination rates and the pollen tube lengths. With Fe concentrations, on the other hand, first a positive, and then a negative relation was determined between the pollen characteristics examined. The most toxic effect on pollen germination was seen with the applications of Cu, Ni and Hg; on pollen tube length. The toxic effects of Co, Al and Fe were found to be low on both of the pollen characteristics. As a result, all the heavy metals examined prevented pollen germination and tube growth in the tobacco plant, but their toxicity levels varied.

(Jaja and Odoemena, 2004) this study on the germination of two tomato seeds varieties (NHLe 158-3 and ROMA VF) were investigated using five levels (0% 0.001% 0.01% 0.1% 1%) of lead acetate, cupric carbonate and ferric chloride respectively. The results showed that the aggregate germination percentage (AGP) as well as the coefficient of germination velocity (CGV) decreased with increase in the levels of metallic compounds on the two tomato varieties. The decreases in AGP and CGV were significant when compared with that of the control. Lead acetate and copper chloride salts indicated higher inhibitory tendencies to the germination of the tomato varieties than the Ferric chloride. The study showed that NHLe 158- 3 variety is more tolerant to metallic pollutants than the Roma VF variety.

(Munzuroglu and Zengin, 2006) in their study on the effect of cadmium on barley. It was found that cadmium has inhibited seed germination. In general, increase in cadmium concentration caused a greater inhibition of germination. While (Shafiq *et al*., 2008) determined effect of lead and cadmium on seed germination of (*Leucaena leucocephala*). Seed were grown under laboratory conditions at 25, 50, 75 and 100 ppm of metal ions of lead and cadmium. Increasing the concentration of lead to 75 ppm, significantly decreased seed germination as compared to control .Seed germination significantly decreased at 50 ppm treatment of cadmium as compared to control.

(Aydinalp and Marinova, 2009) observed effects of Cd^{+2}, Cr^{+6}, Cu^{+2}, Ni^{+2}, and Zn^{+2} on seed germination of Alfalfa Plant(*Medicago sativa*). The doses of 0, 5, 10, 20, and 40 ppm were used. The seed germination was significantly affected by Cd^{+2} and Cr^{+6} at 10 ppm, as well as by Cu^{+2} and Ni^{+2} at 20 ppm and higher concentrations. Zn^{+2} did not affect seed germination.

(Pirselova, 2011)compared effects of heavy metals on seed germination of five selected species of agricultural crops barley (*Hordeum vulgare* cv. Garant), corn (*Zea mays* cv. Quintal), pea (*Pisum sativum* cv. Olivнn), soybean (*Glycine max* cv. Korada), Beans (*Vicia faba* cvs. and Piestansky) were monitored. Observed dosage of lead (500 mg/l) had little effect on seed germination, cadmium (300 mg/l) significantly affected seed germination of pea and barley, while arsenic (100 mg/l) caused total inhibition of seed germination in all tested plant species.

(Hatamzadeh *et al*., 2012) doing study to evaluate effect of ferric chloride, cupric carbonate and lead acetate on the seed germination of (*Festuca rubra* ssp.). Commutate (Chewings fescue), a turfsgrass species. Seeds were subjected separately to five levels (0, 0.001, 0.01, 0.1, and 1% w/v) of the metal salts. Results showed that the germination percentage (GP) and coefficient rate of germination (CRG) decreased significantly with increasing metal concentrations. However, no germination occurred at 1% concentrations of both lead and ferric salts. Approximately 50% seed germination was observed in thesame concentration of cupric salt. Our results exhibited that lead had more inhibitory effect on seed germination of Chewings fescue than ferric or cupric salts.

(Abraham *et al*., 2013) conducted this study to determine the effect of cadmium, Lead, and copper on seed germination of (*Arachis hypogeae* L.). Seeds were germinated under laboratory condition. Every part of cadmium, Lead, and copper showed significantly decreased on seed germination of (*Arachis hypogeae* L.) as compare to control. Increasing concentration of Cd at 75 and 100 mg/L affected the groundnut seed germination comparedwith control. Lead treatment at 75 and 100 mg/L significantly reduced seed germination of groundnut as compared with control. Copper treatment at100 mg/L also condensed seed germination of (*Arachishypogeae* L.)

compared with control. Cadmium produced more significant effect on seed germination of (*Arachis hypogeae* L.) than lead and copper.

2.2- Uptake and Effect of Heavy Metals on Plant Growth. Heavy metals cause toxicity and environmental impact; although toxicity is entirely dependent on several factors mainly on the particular element, speciation, concentration and environmental conditions (Fulekar, 2005).

Zinc: Is essential for cell physiological processes, and in most living organisms it is the second most abundant transition metal after Fe and is the only metal present in all enzyme classes, (dehydrogenases, proteinases, peptidases) (Vallee and Auld, 1990; Barak and Helmke, 1993). Zinc is also essential for plants. When present at high concentrations, Zn can be toxic, and plants affected may show symptoms similar to those found in other heavy metal toxicities, such as those of Cd or Pb (Foy *et al*., 1978) The mechanisms controlling Zn homeostasis in plants are still not fully known (Hacisalihoglu *et al*., 2004;Broadley *et al*., 2007; Kramer *et al*., 2007).Lead:It has no known functions in biological systemsand found at low levels in Earth’s crust, mainly as lead sulfide (IARC, 2006). However, the widespread occurrence of lead in the environment is largely the result of human activity. It is a toxic metal whose widespread use has caused extensive environmental contamination and health problems in many parts of the world. It is a cumulative toxicant that affects multiple body systems, including the neurological, haematological, gastrointestinal, cardiovascular and renalsystems. Children are particularly vulnerable to the neurotoxic effects of lead, and even relatively low levels of exposure can cause serious and, in some cases, irreversible neurological damage (IPCS, 1995; Fewtrell *et al*.,2003).Lead exposure is estimated to account for 0.6% of the global burden of disease, with the highest burden in developing regions (WHO, 2009).

Recent reductions in the use of lead in petrol (gasoline), paint, plumbing and solder have resulted in substantial reductions in lead levels in the blood (Fewtrell *et al.*, 2003) However, significant sources of exposure to lead still remain, particularly in developing countries. Further efforts are required to continue to reduce the use and releases of lead and to reduce environmental and occupational exposures, particularly for children and women of child-bearing age.

(Jaja and Odoemena, 2004) from thru their study about the early seedling growth of two tomato seed varieties (NHLe 158-3 and ROMA VF) were investigated using five levels (0% 0.001% 0.01% 0.1% 1%) of lead acetate, cupric carbonate and ferric chloride respectively. The results showed that the growth parameters tested was not significantly different in both Roma VF and NHLe 158-3 variety when compared with that of the control.

(Munzuroglu and Zengin, 2006) doing study about effect of cadmium on barley. Showed important inhibitory effects on roots and coleoptile growth after germination .In general, increase in cadmium concentration caused a greater inhibition of root and coleoptile growth. The adverse effect of cadmium on root and coleoptile growth was more pronounced than that on germination. While testa was pierced by radicle (an indication of germination), no root or coleoptile development was observed above at concentration of 3-9.5 mM $CdCl_2.H_2O$. Low concentrations of cadmium have inhibited the root growth more than it did on coleoptile growth.

(Jadia and Fulekar, 2008*)* on their study on sunflower plant indicated that heavy metal uptake by Sunflower plant was very fast-growing with a high biomass which may be used for phytoremediation (uptake) of toxic metals (Cu, Zn, Pb, Hg, As, Cd, Ni) from soil in heavily contaminated areas.

(Shafiq *et al.*, 2008) from thru their study about effect of lead and cadmium on seedling and growth of (*Leucaena leucocephala*). The study showed that seedling both lead and cadmium treatments showed toxic effects on various growth indices of (*L. leucocephala*). Seedling and root growth was significantly reduced at 50 ppm treatment of lead. Root length significantly decreased at 50 ppm treatment of cadmium as compared to control. The seedling dry weight also significantly reduced at 25 ppm treatment of lead and cadmium. Cadmium treatment at 100 ppm showed comparatively pronounced effects in (*L. Leucocephala*) seedlings as compared to lead. The results of the study suggest that due to better metal tolerance indices there is a possibility of growing (*L. leucocephala*)in areas contaminated with lead and cadmium.

(Aydinalp and Marinova, 2009) have reflected on the effects of Cd^{+2}, Cr^{+6}, Cu^{+2}, Ni^{+2}, and Zn^{+2} on Alfalfa Plant (*Medicago sativa*). The doses applied were 0, 5, 10, 20, and 40 ppm were used. Results showed plant growth was significantly affected by Cd^{+2} and Cr^{+6} at 10 ppm, as well as by Cu^{+2} and Ni^{+2} at 20 ppm and higher concentrations. Meanwhile,the dose of 5 ppm of Cr^{+6}, Cu^{+2}, Ni^{+2}, and Zn^{+2} increased the shoot size by 13.0%, 59.0%,35.0%, and 6.6%, respectively. Zn^{+2} were only promotedthe shoot growth at the dosesof 20 and 40 ppm.

(John *et al*., 2009) in another study on the plant growth, were the uptake of heavy metals were determined for (*Brassica juncea* L.). In response to cadmium and lead stress. The plant exhibited a decline in growth, chlorophyll content and carotenoids with Cd and Pb but Cd was found to be more detrimental than Pb treatment in (*B. juncea*). The protein content was decreased by Cd (900 μM) to 95% and 44% by Pb (1500 μM) at the flowering stage. Proline showed increase at lower concentrations of Cd and Pb but at higher concentrations it showed decrease. More accumulation of Cd and Pb was observed in roots than shoots in (*B. juncea*). Cd was found to be more accumulated than Pb but higher concentrations of Pb hampers the Cd absorption.

(Shekar *et al*., 2011) reported that lower concentration of heavy metal mercury on (*Lycopersicon esculentum* Mill.) at different stages of its growth and development. Treatment showed enhanced percentage of plant height, root length, early flowering more pollen viability increase in totalchlorophyll content. Different yield components such as number of fruits / plant, fruit weight and fruit girth were under taken. The higherconcentration of heavy metal mercury treatments showed inhibitory effect in general.

(Pirselova, 2011) Compared effects of heavy metals on five selected species of agricultural crops barley (*Hordeum vulgare* cv. Garant), corn

(*Zea mays* cv. Quintal), pea (*Pisum sativum* cv. Olivнn), soybean (*Glycine max* cv. Korada), and beans (*Vicia faba* cvs. Astar and Piestansky) were monitored. He focused his attention to general and commonly used stress indicators such as weight and length of roots and shoots. Each of these characteristics was dependent on the tested plant species and tested heavy metals. Plants grow in soilcontaminated with heavy metals showed several symptoms of metal toxicity (chlorosis, necrosis of leaf tips, blackening of roots). In general, the highest tolerance to tested metal ions was observed in both varieties of bean, and the lowest sensitivity was observed in soybean plants. The highest degree of toxicity was shown to have tested doses of cadmium and arsenic, the lowest the doses of lead. In general, the lowest tolerance indexes were determined based on the decrease in fresh weight of roots.

(Hatamzadeh *et al*., 2012) doing study to evaluate effect of ferric chloride, cupric carbonate and lead acetate on seedling growth of

(*Festuca rubra* ssp.) Commutate (*Chewingsfescue*), a turfsgrass species. Seedling were subjected separately to five levels (0, 0.001, 0.01, 0.1, and 1% w/v) of the metal salts. Results showed that root length was more affected bymetals than shoot length. Both dry and fresh weights of seedlings decreased with increased salt load. An exception was 0.001% ferric salt which significantly enhanced dry weight. Also, among metal solutions, copper had nosignificant effect on fresh weight in comparison to thecontrol. Our results exhibited that lead had more inhibitory effect on growth parameters of (*Chewings fescue*) than ferric or cupric salts.

2.3- Accumulation of Heavy Metals in the Different Parts of the Plants (Fruit, Shoot and Root) in order to Determine their Levels and their Specific Site thus Human Health Risks from Consuming Contaminated Food.

Heavy metals unlike organic compounds, they cannot be degraded but can be biologically accumulation in the living organisms so accumulation of heavy metals in crops grown in metal-polluted soil may easily cause damage effect on human health through food chain (Singh and Agrawal, 2007; Fu *et al*., 2008). So the removal of these pollutants is necessary for the survival and maintenance of ecosystem.

(Ouariti *et al*., 1997) from thru their study about the effects of Cd on growth, mineral content and nitrate reductase (EC. 1.6.6.1) activity of 17-day-old bean (*Phaseolus vulgaris* L. cv. Morgane) and tomato (*Lycopersicon esculentum* Mill. cv. Ibiza F_1) plants treated for 7 days with nutrient solutions containing 0 to 50 µM $CdCl_2$ were studied. Accumulation of Cd in the roots exceeds by far that of shoots, with the greatest Cd accumulation occurring in tomato plants. Increasing Cd supply resulted in a decrease of the Ca^{2+}, K^{+}, NO^{-3} and reduced nitrogen contents of the tissues compared to control plants. Nitrate reductase activity from roots and leaves of Cd treated plants was reduced more in bean than in tomato. Cd-induced decrease in nitrate reductase activity was accompanied by a similar decrease in tissue NO^{-3} concentrations. Therefore,thisdecreaseisinterpreted as being indirect, i.e. the consequence of reduced NO^{-3} uptake and translocation in the plants.

(Sekara *et al*., 2004) observed maximum levels of Cd and Pb content in leaves.Species suited for phytoremediation were selected. Within the red beet, field pumpkin,chicory, common bean, white cabbage, alfalfa and parsnip. The red beet was characterized by the highest cadmium concentration ratio (shoots/roots). The red beet and common parsnip were characterized by the highest lead concentration ratios (shoots/roots).

(Ariyakanon and Winaipanich, 2006) in another study was used to monitor efficiency of copper removal from soil by (*Brassica juncea* L. Czern) and (*Bidens alba* L. DC. var *radiate*). Their results showed that the maximum concentrations of copper of (*Brassicajuncea* L.) and (*Bidens alba* L. DC. var *radiate*)were 3,771 and 879 mg/kg (dry weight) in experimental pots with 150 mg Cu/kg soil. The statistical analysis indicated that copper accumulations between shoots and roots of (*Brassica juncea* L.Czern) were not significantly different when Cu was added at 0 and 50 mg.

However, in the experimental pots amended with 100, 150 and 200 mg Cu/kg, copper concentration in the roots was greater than those in theshoots. For (*Bidens alba* L. DC. var *radiate*), copper accumulation was higher in the roots than in the shoots in every composition. The highestaccumulation efficiency of (*Brassica juncea* L. Czern) and (*Bidens alba* L. DC. var *radiata*) was 1.61% and 0.14% in the pot with 150 mg Cu/kg soil.

(Singh *et al*., 2008)from thru their study about uptake of cadmium by (*Medicago sativa*) (alfalfa, var. CoI)reported that the growth of alfalfa plants was affected at higherconcentration i.e. at 20 and 50 μg ml-1; whereas the lower concentration of cadmium was uptake without any effects on growth of plant. The cadmium content in plant tissues wasquantified using AtomicAbsorption Spectroscopy. The result shows that most of the cadmium uptake 12360 μg gm-1 was located in roots, while 1920 μg gm-1 was translocated to shoots when exposed to 50 μg ml-1 concentration of cadmium. The phytoremediation of cadmium using alfalfa plant in hydroponic solution shows that, during the period of the experiment (i.e. 21 days), the plant was found to have potential to uptake 80- 85% of cadmium.

(Opeolu *et al*., 2009) doing study on Phytotoxic effects of Pb as $Pb(NO_3)_2$ on tomato(*Lycopersicon esculentum*)plantedon

contaminatedsoil was assessed in terms of growth, yield and Vitamin Ccontent at various concentrations (300, 600 and 1800 ppm). The residual Pb was also determined in the soil used for plant cultivation and in the experimental plant tissues. Results showed that plant performance significantly reduced with increasing concentrations of Pb contamination. Residual Pb was detected in the tomato roots, shoots and fruits. Results also showed that Vitamin C content of the tomato was not affected by various concentrations of the Pb contaminants. Pb contamination has adverse effects on tomato production but not on Vitamin C content.

(Angelova *et al*., 2010) observed impact of organic soil additives (peat, compost and vermicompost) on the quantity of mobile forms of Pb, Zn, Cd and Cu and uptake of these elements by potato *(Solanum tuberosum* L.*)* plants was carried out. The application of soil amendments favours plant growth and development. Development and fruit yield demonstrated a stimulating effect with all amendments and this effect was best expressed after 10% compost addition. Organic amendments led to an increase of starch yield, absolute dry substance and quantity and to a decrease of reducing sugars in potatoes. Peat compost and vermicompost application led to effective immobilization of Pb,Cu, Zn and Cdphytoaccessible forms in soil.Organic amendments led to decreased heavy metal contentin potato peel and tubers, and this decrease was best expressed with 10%

compost and 10% vermicompost (separately). Organic amendments were especially effective for reduction of cadmium content in potato tubers.

Chapter 3

Materials and Methods

3-Material and Method

3.1- Collected of Soil Sample and Measured Physical-Chemical Properties for Soil Sample.

Soil sample were collected at a depth of (0-20 cm) from agriculture land located at Boatni area in Benghazi .Stones and the remain of plant tissues were carefully removed from the soil prior to drying process which been carried out under laboratory conditions. Soil were collected and put into plastic bags and transported to the botany department laboratory for treatment. The soil samples were air dried and sieved with 2 mm mesh using a mechanical sieves and the soil texture were identified using the texture triangle Fig.(1) (Appendix 1). Before planting the tomato plant in November 2013, the chemical properties of the soil were taken to determine as follow:

Soil pH: The measurement of the soil pH were carried out using 1:1 weight suspensions of soil and distilled water (Miller and Kissel, 2010). Measurements of the soil pH then were made after 10 minutes equilibration time using (pH meter-TRACER-LaMotte) as shown in Fig.(2) (Appendix 1).The meter was calibrated with buffer solutions of (pH=4), (pH=7), (pH=10) and the reading were taken and noted.

Moisture Content (MC %): The water content was determined by drying a known quantity of wet soil in weighed pre-dried ceramic crucible at 105°C for 24 hours (Jadia and Fulekar, 2008). The crucible was placed in desiccators until cooled and re-weighed for the moisture content calculation according to following formula:

Moisture content % = $\frac{}{}$ ×100

W=Weight of wet soil

d =Weight of dry soil

Organic Matter (OM %): The loss on ignition (LOI) methods of (Dean, 1974) is the method applied on this study and it is widely used. The samples were placed in the furnace at 500°C for 24 hour as shown in Fig.(3) (Appendix 1) then the crucible was placed in desiccators until cooled and re-weighed for the organic content determination and determine the heavy metal Concentration (Zn and Pb) in the soil sample by single beam flame atomic Absorption Spectrophotometer as shown in Fig.(4) (Appendix 1).

3.2-Preparation the Solutions from Heavy Metals Salts.

Were prepared solutions at different concentrations (5, 10, 20and 50ppm) from heavy metals salts and were used in irrigation thru this study (germination and growth period).

3.2.1- Preparation Stock Solution.

Prepared stock solution (1000 ppm), Zn from zinc chloride $ZnCl_2$ and Pb from lead nitrate $Pb((No_3)_2$.

e. g. make a 1000 ppm standard of Zn using the salt $ZnCl_2$

MW of salt =136.30g

At. Wt. of Zn = 65.39

1g Zn in relation to MW of salt = 136.30 / 65.39 = 2.084g.

Hence, weigh out 2.084g $ZnCl_2$ and dissolve in 1 liter volume to make a 1000 ppm Zn standard (Lloyd, 2000).

3.2.2- Preparation Different Concentration (5, 10, 20 and 50ppm) from Stock Solution.

Dilution Formula: C1V1 = C2V2 (Lloyd, 2000).

C1= concentration before the dilution.

V1=volume before dilution.

C2= concentration after the dilution.

V2= volume after dilution.

The tomato is the edible, often red fruit of the plant *Solanum lycopersicum* L., commonly known as a tomato plant. The species originated in the South AmericanAndes (Peralta and Spooner, 2007). Its use as a food originated in Mexico(Peralta and Spooner, 2007), and spread throughout the world following the Spanish colonization of the Americas. Its many varieties are now widely grown, sometimes in greenhouses in cooler climates (Robinson and Kolavalli, 2010).

Scientific Classification of Tomato:

Kingdom: Plantae - Plants

SubKingdom: Tracheobionta – Vascular plants

Superdivision: Spermatophyta – Seed plants

Division: Magnoliophyta _ Flowering plants

Class: Magnoliopsida _ Dicotyledons

Subclass: Asteridae

Order: Solanales

Family: Solanaceae

Genus: Solanum

Species: *Solanum lycopersicum* L.

Tomato plant typically grow to 1–3 meters (3–10 ft) in height and have a weak stem that often sprawls over the ground and vines over other plants (Relf *et al.*, 2009).

Most tomato plants have compound leaves, and are called regular leaf (RL) plants, but some cultivars have simple leaves known as potato leaf (PL). The leaves are odd pinnate, petioles, with a serrated margin; both the stem and leaves are densely glandular-hairy (Relf *et al.*, 2009).

Their flowers, appearing on the apical meristem, have the anthers fused along the edges, forming a column surrounding the pistil's style. Flowers in domestic cultivars tend to be self-fertilizing. The flowers are 1–2 cm (0.4–0.8 in) across, yellow, with five pointed lobes on the corolla; they are borne in a cyme of 3 to 12 together (Relf *et al.*, 2009).

Tomato fruit is classified as a berry. As a true fruit, it develops from the ovary of the plant after fertilization, its flesh comprising the pericarp walls. The fruit contains hollow spaces full of seeds and moisture, called locular cavities. These vary, among cultivated species, according to type. Some smaller varieties have two cavities, globe-shaped varieties typically have three to five, beefsteak tomatoes have a great number of smaller cavities, while paste tomatoes have very few, very small cavities (Relf *et al.*, 2009).

For propagation, the seeds need to come from a mature fruit, and be dried or fermented before germination (Relf *et al.*, 2009).

3.3- The Seeds Germination.

The criterion used for seed germination test was taken as emergence of 2mm radicle at the time of observation (Odoemena, 1988).The sterilized Seeds oftomato (*Solanum lycopersicum*L.). Obtained them from local market were selected to be similar in shape and size. Germinated in Sterilized Petri dishes of approximately 9cm in diameter, each containing 2 Whatman No. 1 filter papers were used as sowing container and media. Three replicates were used per treatment and 20 seed in every Petri dish for three days in the dark at 25°C by addition heavy metals solutions(Zn, Pb) individual and mixed per concentration from the four concentrations (5, 10, 20, and 50 ppm) as well as used the distilled water (control) respectively as shown in Fig.(5) (Appendix 1). The investigation was carried out in the laboratory conditions. Seed germination was estimated through the germination percentage.

3.4- Plant Growth.

The experiment was conducted in a greenhouse. Tomato's seedling their age one month were planted in individual pots (the experimental pot used were plastic with a 25 cm upper diameter, 20 cm lower diameter and 30 cm height) their number were 52 pots dispersed to four replicates per treatment and irrigated by heavy metals solutions(Zn, Pb) individual and mixed per concentration from the four concentrations (5, 10, 20, and 50 ppm) as well as used the distilled water (control) respectively twice in the week and were measured the shoot length by using a meter every week until the maturity time (17 weeks) as shown in Fig. (6-1) and (6-2) (Appendix 1).

At the end of the study period until mature of plant used in this study and were collected the tomato fruit every plant of alone, different parameters were measured as following :

1- Length of plant, root and shoot (cm) using a meter.

2- Fresh weight of plant, root and shoot (g) by using analytical balance as shown in Fig. (7) (Appendix 1).

3- Dry weight that root and shoot were covered with aluminum foil and then placed in oven at 65°C for 72 hours. After that, their dry weight was determined (g) (Antonious andSnyder, 2007).

3.5- Heavy Metals Analysis.

3.5.1- Plant Digestion Procedure.

Plant was harvested after 17 weeks of plantation. Each plant was washed with tap water and with distilled water then wiped with clean tissue paper. The main parts of the plant were separate into root, shoot and fruit. The root and shoot were dried in oven at 65°C for 48 hours but fruits werecut into small pieces and were left for two days on filter paper in laboratory to dry, then were put in the oven at 65°C for 48 hours according to the method of (Antonious and Snyder, 2007). The dried samples were ground into fine powder using pestle and mortar. About one gram of each dry sample was weight out using a fine analytical balance and transferred into a prepared digestion tube. 10 ml of concentration of nitric acid (HNO_3) was added and the mixture was allowed to stand overnight, and then heated for 4 hours at 125°C on a hot plate. After cooling, the samples were filtered through filter paper No. 1 into a 50 ml volumetric flask, and made up to the mark and distilled water as shown in Fig. (8) (Appendix 1).

3.5.2- Soil Digestion Procedure.

Soil sample was oven – dried at 105°C to a constant weight and sieved to a size of 2 mm. To one gram of dried and homogenized soil was weighted into a beaker and 10ml of concentration nitric acid (HNO_3) was added and mixture was allowed to stand overnight, and then heated for 4 hour at 125°C on a hot plate in a similar way as the of the plant. Finally, the digest was cooled and filtered through filter paper No.1 into a 50 ml volumetric flask, and then madeup to the mark with distilledwater.Znand

Pb in this solution were determined by single beam Flame Atomic Absorption Spectrophotometer.

3.6- Statistical Analysis.

The data obtained were analyzed by using one-way ANOVA (SPSS program version 11.0 for Windows) were used for the statistical analysis of the result.

Chapter 4

Results and Discussion

4-Results and Discussion

4.1-Results

4.1.1- **Physical -Chemical Properties of the Soil Sample.**

A- Soil Particle Size.

Table (1) shows the percentages (%)of sand, silt and clay in the soil sample. The results indicate that the nature of the soil texture is silty clay.

Table (1): Percentage Sand, Silt and Clay for Soil Sample.

Location	**C. Sand (%)**	**F. Sand (%)**	**Silt (%)**	**Clay (%)**	**Texture**
Boatni	23.02	10.80	30.60	35.58	Silty Clay

B- Soil pH, Moisture Content (MC %), Organic Matter (OM %) and Heavy Metal concentration for Soil Sample.

Table (2) shows soil pH, moisture content (%), organic matter (%) and concentration of heavy metals (Zn and Pb ppm) for soil sample. The results obtained reflect on the alkaline nature of the soil the PH was found to be 7.83, and also on the fertility of soil were the percentages (%)of organic content found to be 8.42 % while the moisture content was 16.02 % . The concentration of Zinc (Zn) and Lead (Pb) were very low and found to be 0.92 ppm and 0.17 ppm for both of them respectively.

Table (2) Some Physical -Chemical Properties for Soil Sample before Planting Tomato.

Characteristic	**Soil Sample**
PH	7.83
MC (%)	16.02
OM (%)	8.42
Zn (ppm)	0.92
Pb (ppm)	0.17

4.1.2- Seeds Germination for*Solanum lycopersicum* L. (Tomato) at Different Treatments.

A- Percentage of Seeds Germination for *Solanum lycopersicum* L. (Tomato) Treated withZn (5, 10, 20 and 50 ppm) and Distilled Water (Control).

Table (1-a) (Appendix 2) shows percentage of seeds germination treated withZn (5, 10, 20 and 50 ppm) and with the distilled water (control) after one day. The highest average of seeds germination were reordered 90% at the control , while for the other treatment were decreased gradually to become 80% at 5 ppm, 72% at 10 ppm, 65% at 20 ppm and the lowest average for seeds germination percentage was 63% at 50 ppm. There were significant difference found among the treatments compared with the control at ($P<0.05$) Fig. (1-a).

Table (1-b) (Appendix 2) shows percentage of seeds germination treated withZn (5, 10, 20 and 50 ppm) and with the distilled water (control) after two days. The average for seeds germination percentage increasing at all treatmentsfrom the previous day to become highest average for seeds germination percentage 100% at the control while, thepercentage decreasing gradually to 85% at 5 ppm, 78 % at 10 ppm then 73% at 20 ppm and the lowest average for seeds germination percentage was 73% at 50 ppm .There were significant difference found among the treatments compared with the control at ($P=0.001$) Fig. (1-b).

Table (1-c) (Appendix 2) shows percentage of seeds germination treated with Zn (5, 10, 20 and 50 ppm) andwith the distilled water (control) after three days. The average for seeds germination percentage increasing at all treatments from the previous day except control because it was 100% after two days. Increasing average for seeds germination percentage at 5ppm and 10 ppm to equate with the control 100%, and decreasing the average for seeds germination percentage gradually to become 88% at 20 ppm and the lowest average for seeds germination percentage was 85% at 50 ppm. There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (1-c).

(a)

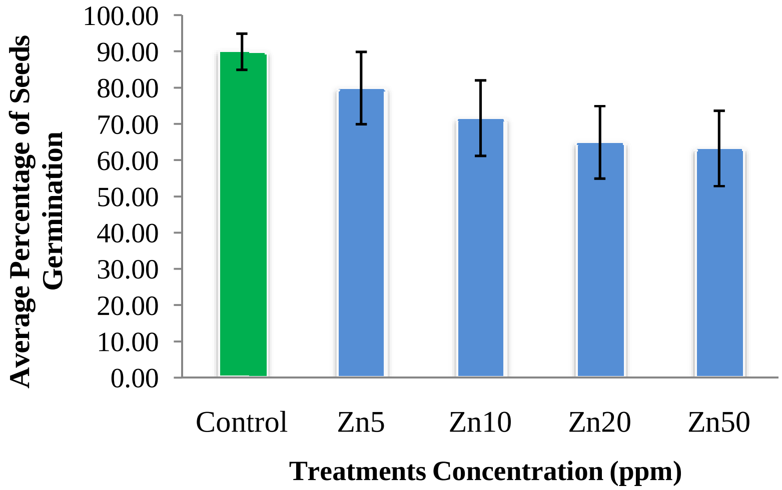

Fig. (1): Percentage (%) of Seeds Germination for *Solanum lycopersicum* L. (Tomato) treated with Zn (5, 10, 20 and 50 ppm) and Distilled Water (Control). (a) after One Day.

(b)

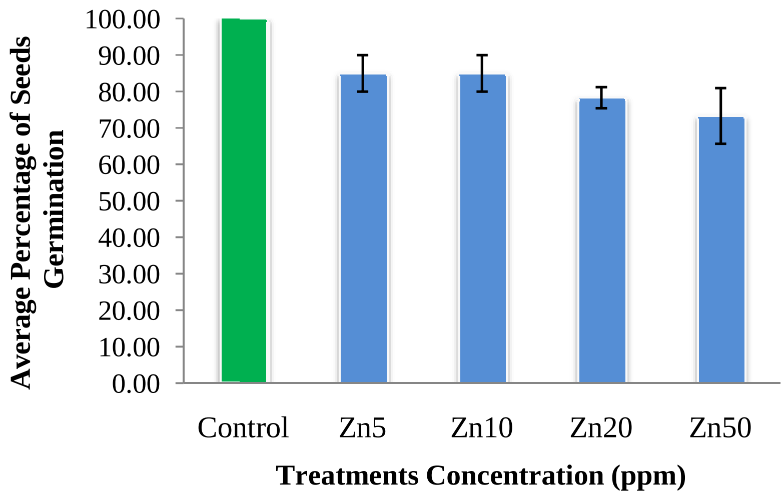

Fig. (1): Percentage (%) of Seeds Germination for *Solanum lycopersicum* L. (Tomato) treated with Zn (5, 10, 20 and 50 ppm) and Distilled Water (Control). (b) after Two Days.

(c)

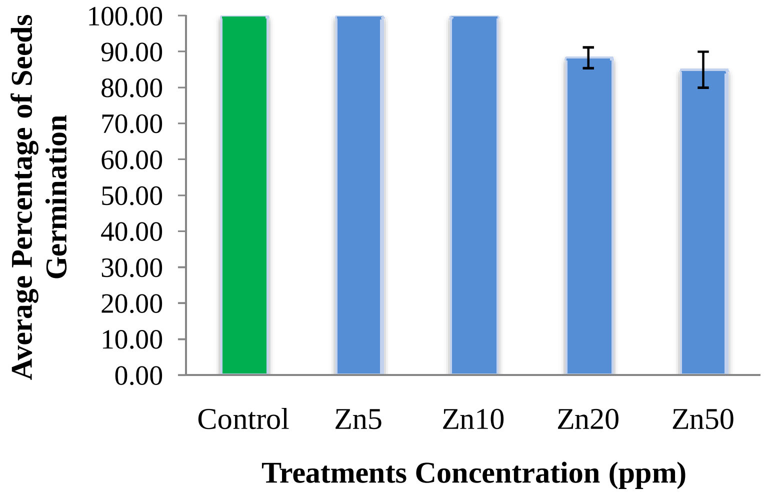

Fig. (1): Percentage (%) of Seeds Germination for *Solanum lycopersicum* L. (Tomato) treated with Zn (5, 10, 20 and 50 ppm) and Distilled Water (Control). (c) after Three Days.

B- Percentage of Seeds Germination for *Solanum lycopersicum* L. (Tomato) Treated withPb (5, 10, 20 and 50 ppm) and Distilled Water (Control).

Table (2-a) (Appendix 2) shows percentage of seeds germination treated withPb (5, 10, 20 and 50 ppm) and with the distilled water (control) after one day. The highest average of seeds germination were reordered 90% at the control, while for the other treatment were decreased gradually to become 78% at 5 ppm, 70% at 10 ppm, 62% at 20 ppm and the lowest average for seeds germination percentage was 52% at 50 ppm .There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (2-a).

Table (2-b) (Appendix 2) shows percentage of seeds germination treated with Pb (5, 10, 20 and 50 ppm) and with the distilled water (control) after two days. The average of seeds germination percentage increasing at all treatments from the previous day to become highest average for seeds germination percentage 100% at the control, and decreasing the average for seeds germination percentage to 83% at 5 ppm, then 82% at 10 and 76 at 20 ppm, and the lowest average for seeds germination percentage was 67% at 50 ppm .There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (2-b).

Table (2-c) (Appendix 2) shows percentage of seeds germination treated withPb (5, 10, 20 and 50 ppm) and with the distilled water (control) after three days. The average for seeds germination percentage increasing at all treatments from the previous day except control because it was 100% after two days. Increasing average for seeds germination percentage at 5ppm to equate with the control 100%, and decreasing the average for seedsgermination percentage gradually to become 98% at 10 ppm, then 86% at

20 ppm and the lowest average for seeds germination percentage was 77% at 50 ppm.There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig.(2-c).

(a)

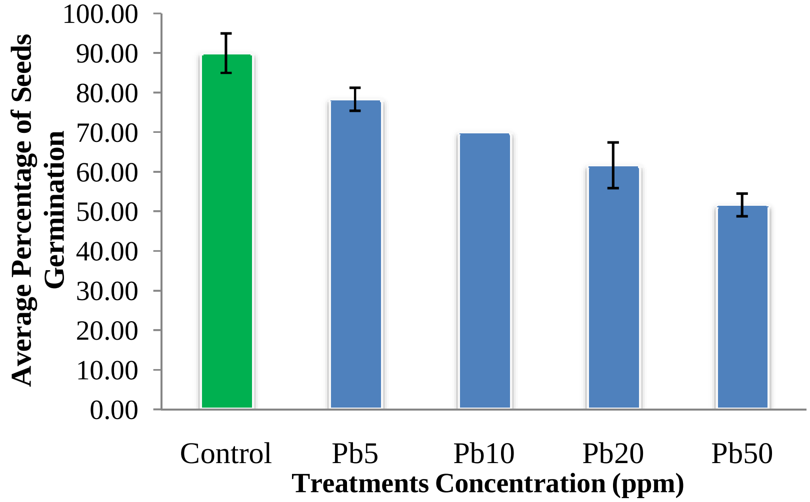

Fig. (2): Percentage (%) of Seeds Germination for *Solanum lycopersicum* L. (Tomato) treated with Pb (5, 10, 20 and 50 ppm) and Distilled Water (Control). (a) after One Day.

(b)

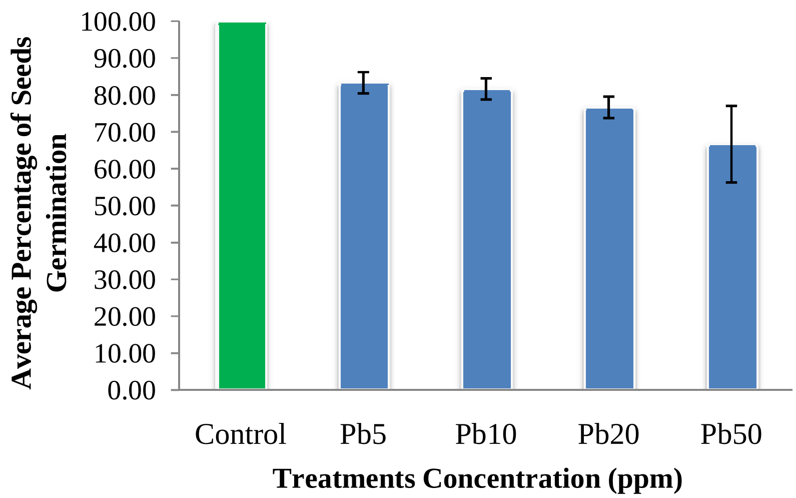

Fig. (2): Percentage (%) of Seeds Germination for *Solanum lycopersicum* L. (Tomato) treated with Pb (5, 10, 20 and 50 ppm) and Distilled Water (Control). (b) after Two Days.

(c)

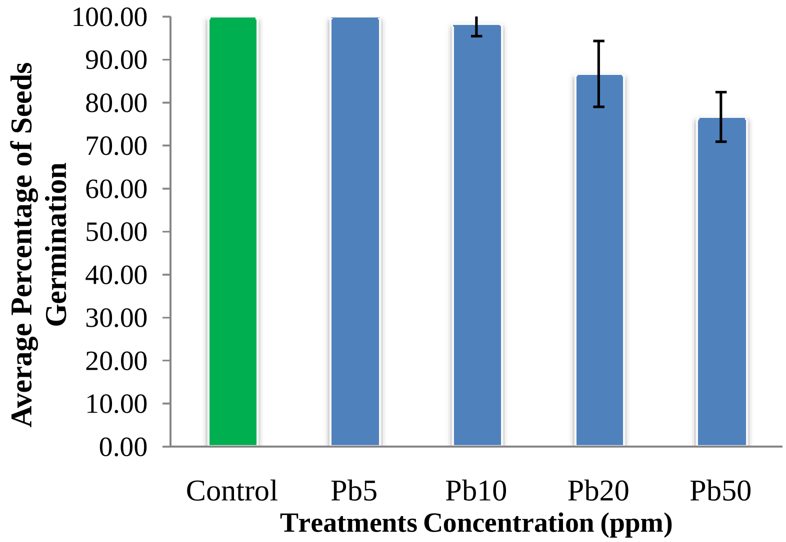

Fig. (2): Percentage (%) of Seeds Germination for *Solanum lycopersicum* L. (Tomato) treated with Pb (5, 10, 20 and 50 ppm) and Distilled Water (Control). (c) after Three Days.

C- Percentage of Seeds Germination for *Solanum lycopersicum* L. (Tomato) Treated withMixture (Zn+Pb)(5, 10, 20 and 50 ppm) and Distilled Water (Control).

Table (3-a) (Appendix 2) shows percentage of seeds germination treated withmixture (Zn+Pb) (5, 10, 20 and 50 ppm) and with the distilled water (control) after one day. The highest average of seeds germination were reordered 90% at the control, while for the other treatment were decreased gradually to become 80% at 5 ppm, 70% at 10 ppm, 65% at 20 ppm and the lowest seeds germination percentage was found to be 56% at 50 ppm. There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (3-a)

Table (3-b) (Appendix 2) shows percentage of seeds germination treated withmixture (Zn+Pb) (5, 10, 20 and 50 ppm) and with the distilled water (control) after two days. The average for seeds germination percentage increasing at all treatments from the previous day to become highest average for seeds germination percentage100% at the control, and decreasing the average for seeds germination percentage to 84% at 5 ppm, then 78% at 10, 75% at 20 ppm and the lowest average for seeds germination percentage was 71% at 50 ppm .There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (3-b).

Table (3-c) (Appendix 2) shows percentage of seeds germination treated withmixture (Zn+Pb) (5, 10, 20 and 50 ppm) and with the distilled water (control) after three days. The average for seeds germination percentage increasing at all treatments from the previous day except control because it was 100% after two days. Increasing average for seeds germination percentage at 5ppm to equate with the control 100%, and decreasing the average for seeds germination percentagegradually to become 97%at

10 ppm, 87% at 20 ppm and the lowest average for seeds germination percentage was 79% at 50 ppm. There were highly significant difference found among the treatments compared with the control at ($P<0.001$)Fig.(3-c).

(a)

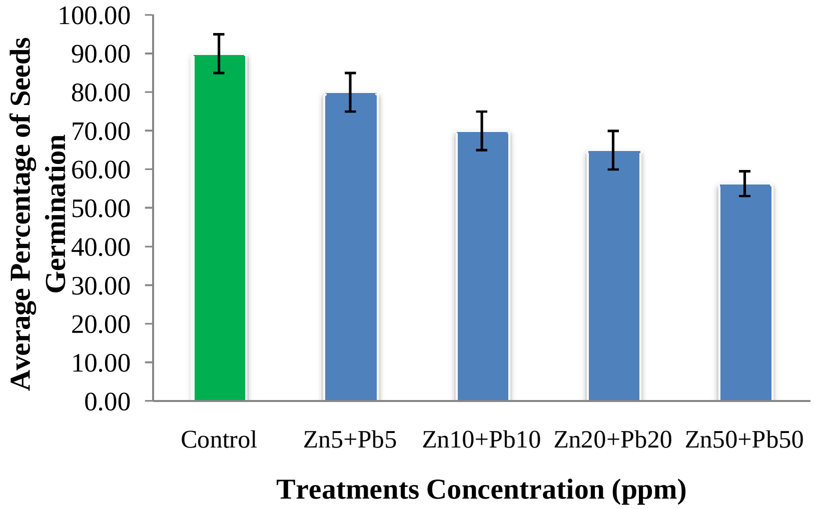

Fig. (3): percentage (%) Seeds Germination for *Solanum lycopersicum* L. (Tomato) treated withmixture (Zn+Pb) (5, 10, 20 and 50 ppm) and Distilled Water (Control). (a) after One Day.

(b)

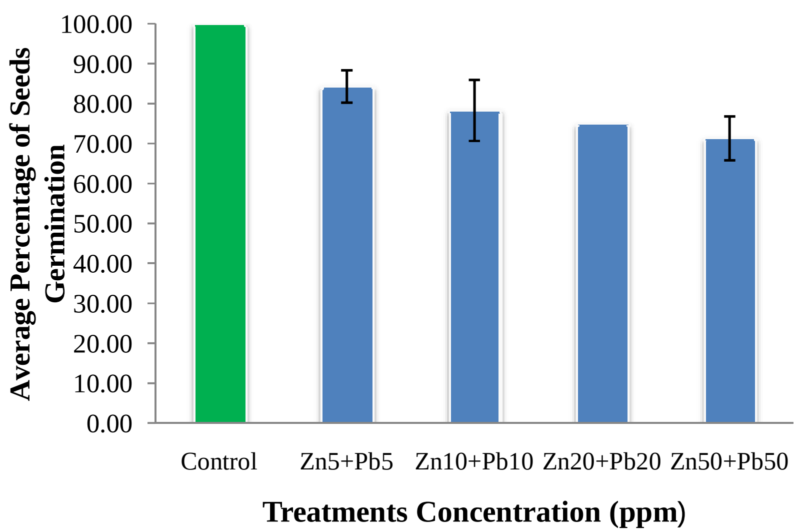

Fig. (3): percentage (%) Seeds Germination for *Solanum lycopersicum* L. (Tomato) treated withmixture (Zn+Pb) (5, 10, 20 and 50 ppm) and Distilled Water (Control). (b) after Two Days.

(c)

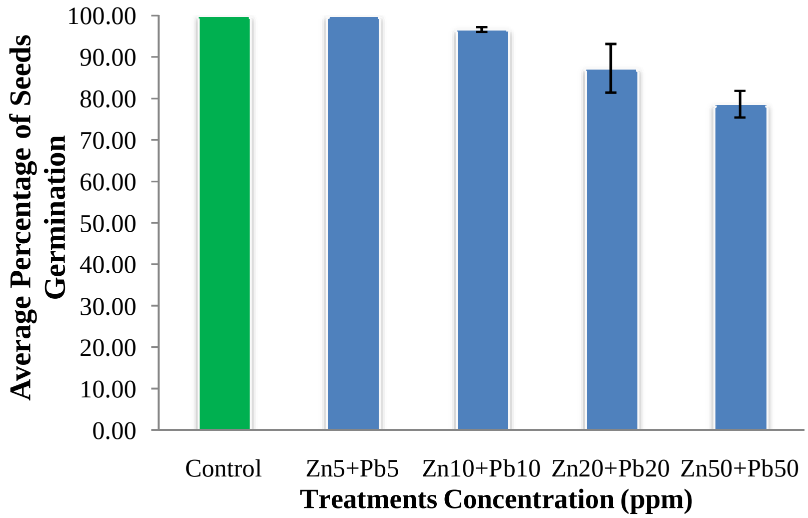

Fig. (3): percentage (%) Seeds Germination for *Solanum lycopersicum* L. (Tomato) treated withmixture (Zn+Pb) (5, 10, 20 and 50 ppm) and Distilled Water (Control). (c) after Three Days.

4.1.3- Growth of *Solanum lycopersicum* L. (Tomato) at Different Treatments.

4.1.3.1-Weekly Shoot Length for*Solanum lycopersicum* L. (Tomato) during growth period.

A- Weekly Shoot Length for*Solanum lycopersicum* L. (Tomato) Treated withZn (5, 10, 20 and 50 ppm).

Table (4-a) (Appendix 2) shows the average length of the shoot of plant treated with 5 ppm Zn on weekly basis at the beginning of the experiment was 12 cm, and there was a clear increase in the average length of the shoot of plant every week until the tenth week of the study period, was the highest average length of shoots of the plant 63.25 cm, then stop the plant from the increase in length. There were highly significant difference among them at ($P<0.001$) Fig. (4-a).

Table (4-b) (Appendix 2) shows the average length of the shoot of plant treated with 10 ppm Zn on weekly basis at the beginning it was 13.25 cm, and there was a clear increase in the average length of the shoot of plant every week until the tenth week of the study period, was the highest average length of shoots of the plant 65 cm, then stop the plant from the increase in length. There was highly significant difference among them at ($P<0.001$) Fig. (4-b).

Table (4-c) (Appendix 2) shows the average length of the shoot of plant treated with 20 ppm Zn on weekly basis at the beginning it was 12cm, and there was a clear increase in the average length of the shoot of plant every week until the tenth week of the study period, was the highest average length of shoots of the plant 67 cm, then stop the plant from the increase in length. There were highly significant difference among themat

(P<0.001) Fig. (4-c).

Table(4-d)(Appendix2)shows the average length of the shoot of plant treated with50 ppm Zn on weekly basis at the beginning it was 11cm, and there was a clear increase in the average length of the shoot of plant every week until the tenth week of the study period, was the highest average length of shoots of the plant 65.5 cm, then stop the plant from the increase in length. There were highly significant difference among them at (P<0.001)Fig.(4-d).

(a)

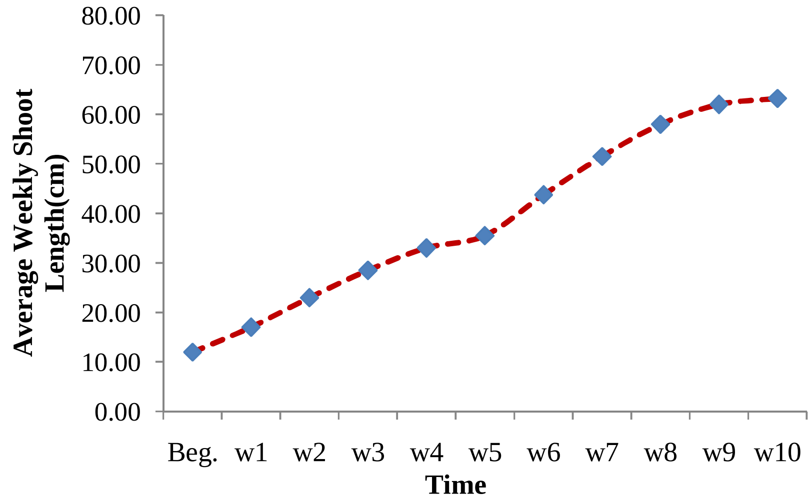

Fig. (4): Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) treated with Zn During Growth Period. (Beg. = Beginning, W1= First week, W2= Second week,...). (a) 5 ppm.

(b)

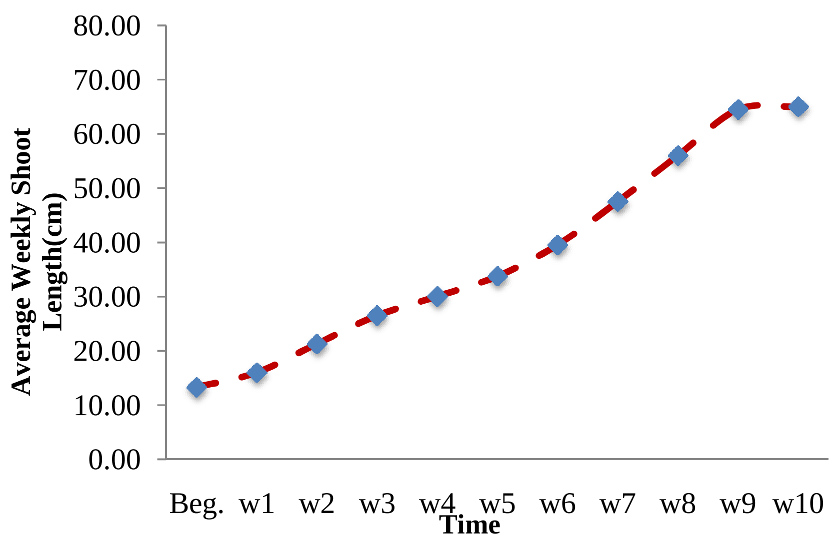

Fig. (4): Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) treated with Zn During Growth Period. (Beg. = Beginning, W1= First week, W2= Second week,..)(b) 10 ppm.

(c)

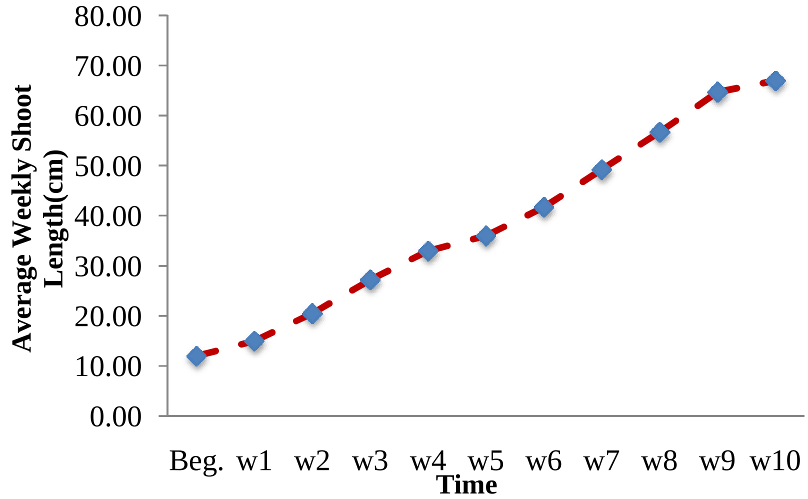

Fig. (4): Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) treated with Zn During Growth Period. (Beg. = Beginning, W1= First week, W2= Second week,..). (c) 20 ppm.

(d)

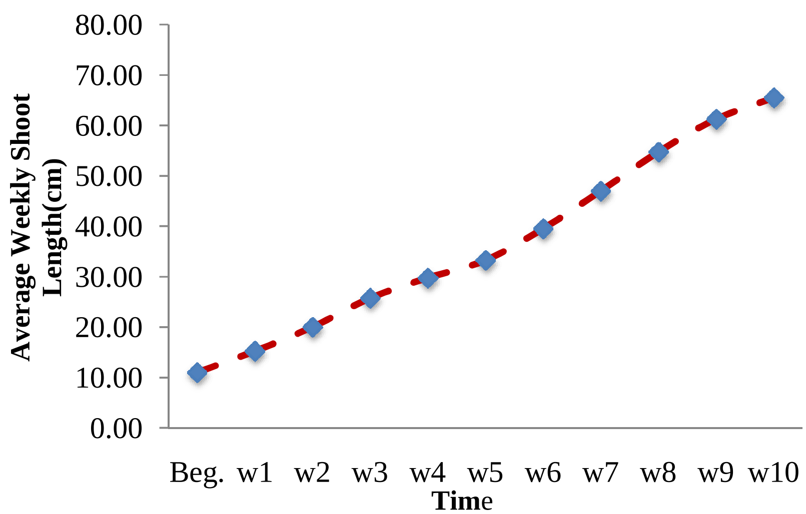

Fig. (4): Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) treated with Zn During Growth Period. (Beg. = Beginning, W1= First week, W2= Second week,..). (d) 50 ppm.

B- Weekly Shoot Length for*Solanum lycopersicum* L. (Tomato) Treated withPb (5, 10, 20 and 50 ppm).

Table (5-a) (Appendix 2) shows the average length of the shoot of plant treated with 5 ppm Pb on weekly basis at thebeginning was 13 cm, and there was a clear increase in the average length of the shoot of plant every week until the tenth week of the study period, was the highest average length of shoots of the plant 64.50 cm, then stop the plant from the increase in length. There were highly significant difference among them at ($P<0.001$) Fig. (5-a).

Table (5-b) (Appendix 2) shows the average length of the shoot of plant treated with 10 ppm Pb on weekly basis at thebeginning it was 13.25 cm, and there was a clear increase in the average length of the shoot of plant every week until the tenth week of the study period, was the highest average length of shoots of the plant 59.25 cm, then stop the plant from the increase in length. There were highly significant difference among them at ($P<0.001$) Fig. (5-b).

Table (5-c) (Appendix 2) shows the average length of the shoot of plant treated with 20 ppm Pb on weekly basis at thebeginning it was 12.50cm, and there was a clear increase in the average length of the shoot of plant every week until the tenth week of the study period, was the highest average length of shoots of the plant 64.25 cm, then stop the plant from the increase in length. There were highly significant difference among them at ($P<0.001$) Fig. (5-c).

Table (5-d) (Appendix 2) shows the average length of the shoot of plant treated with 50 ppm Pb on weekly basis at thebeginning it was 11.75cm, and there was a clear increase in the average length of the shoot of plant every week until the tenth week of the study period, was the highest average length of shoots of the plant 64.50 cm, then stop the plant from the increase in length. There were highly significant difference among them at ($P<0.001$) Fig. (5-d).

(a)

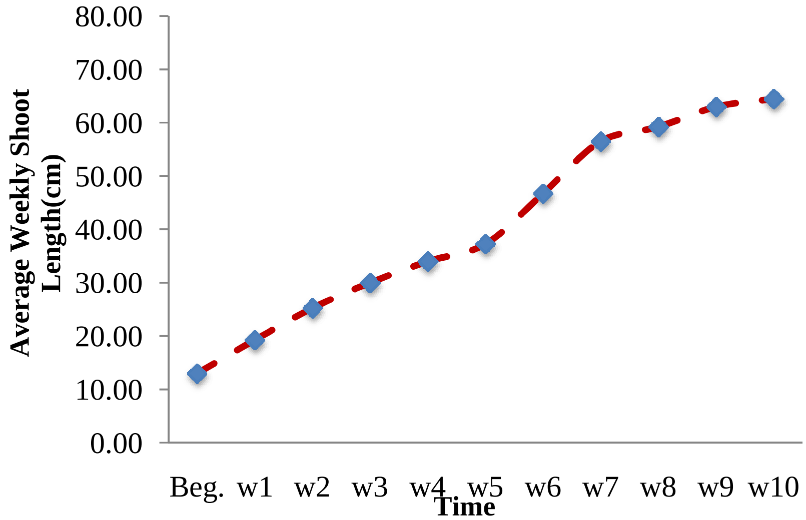

Fig. (5) Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) treated with Pb During Growth Period. (Beg. = Beginning, W1= First week, W2= Second week,..). (a) 5 ppm.

(b)

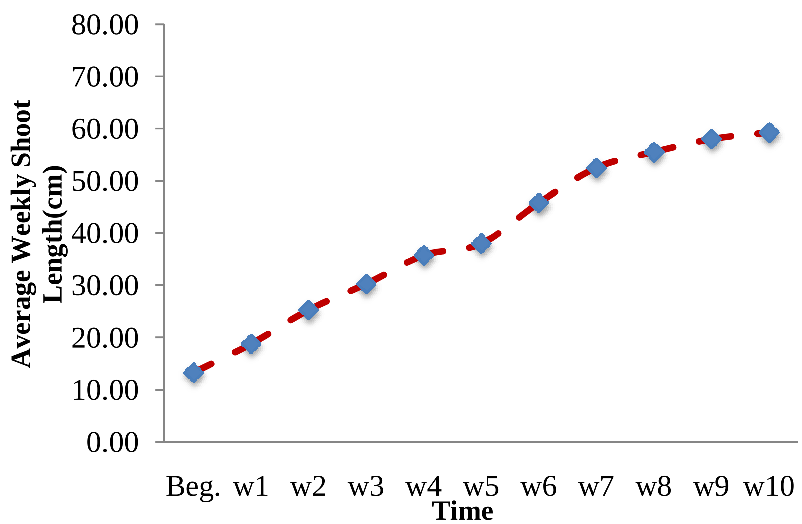

Fig. (5) Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) treated with Pb During Growth Period. (Beg. = Beginning, W1= First week, W2= Second week,..). (b) 10 ppm.

(c)

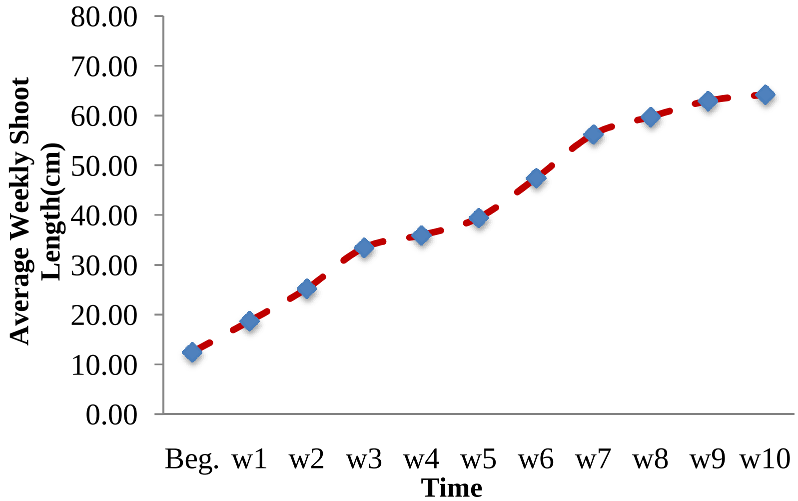

Fig. (5) Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) treated with Pb During Growth Period. (Beg. = Beginning, W1= First week, W2= Second week,..). (c) 20 ppm.

(d)

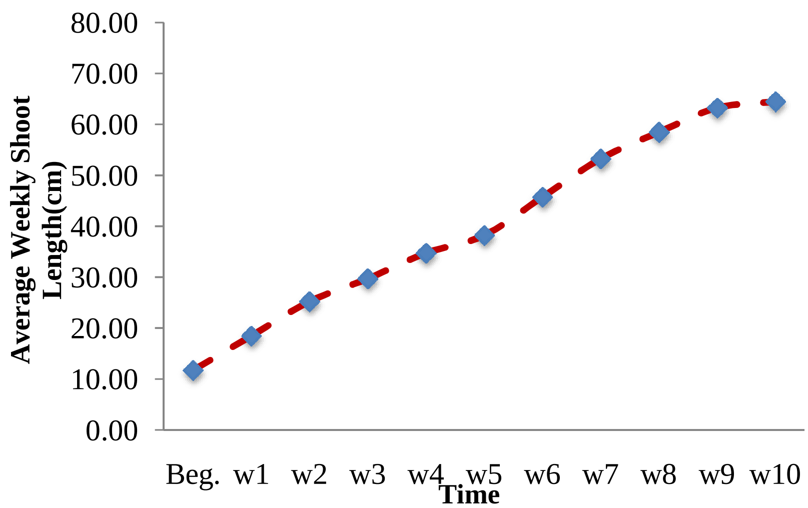

Fig. (5) Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) treated with Pb During Growth Period. (Beg. = Beginning, W1= First week, W2= Second week,..). (d) 50 ppm.

C- Weekly Shoot Length for*Solanum lycopersicum* L. (Tomato) Treated withof Mixture (Zn+Pb) (5, 10, 20 and 50 ppm).

Table (6-a) (Appendix 2) shows the average length of the shoot of plant treated with 5 ppm mixture (Zn+Pb) on weekly basis at thebeginning it was 13 cm, and there was a clear increase in the average length of the shoot of plant every week until the tenth week of the study period, was the highest average length of shoots of the plant 59.75 cm, then stop the plant from the increase in length. There were highly significant difference among them at ($P<0.001$) Fig. (6-a).

Table (6-b) (Appendix 2) shows the average length of the shoot of plant treated with 10 ppm mixture (Zn+Pb) on weekly basis at the beginning it was 11.50 cm, and there was a clear increase in the average length of the shoot of plant every week until the tenth week of the study period, was the highest average length of shoots of the plant 64.75 cm, then stop the plant from the increase in length. There were highly significant difference among them at ($P<0.001$) Fig. (6-b).

Table (6-c) (Appendix 2) shows the average length of the shoot of plant treated with 20 ppm mixture (Zn+Pb) on weekly basis at the beginning it was 12.25cm, and there was a clear increase in the average length of the shoot of plant every week until the tenth week of the study period, was the highest average length of shoots of the plant 64.50 cm, then stop the plant from the increase in length. There were highly significant difference among them at ($P<0.001$) Fig. (6-c).

Table (6-d) (Appendix 2) shows the average length of the shoot of plant treated with 50 ppm mixture (Zn+Pb) on weekly basis at the beginning it was 11.50cm, and there was a clear increase in the average length of the shoot of plant every week until the tenth week of the study period, was the highest average length of shoots of the plant 67.00 cm, then stop the plant from the increase in length. There was highly significant difference among them at ($P<0.001$) Fig. (6-d).

(a)

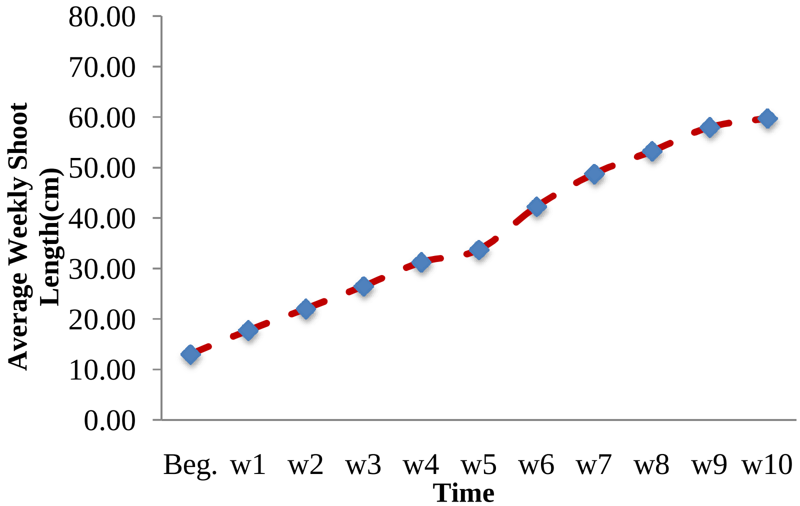

Fig. (6): Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) treated with Mixture (Zn+ Pb) During Growth Period. (Beg. = Beginning, W1= First week, W2= Second week,……..).(a) 5 ppm.

(b)

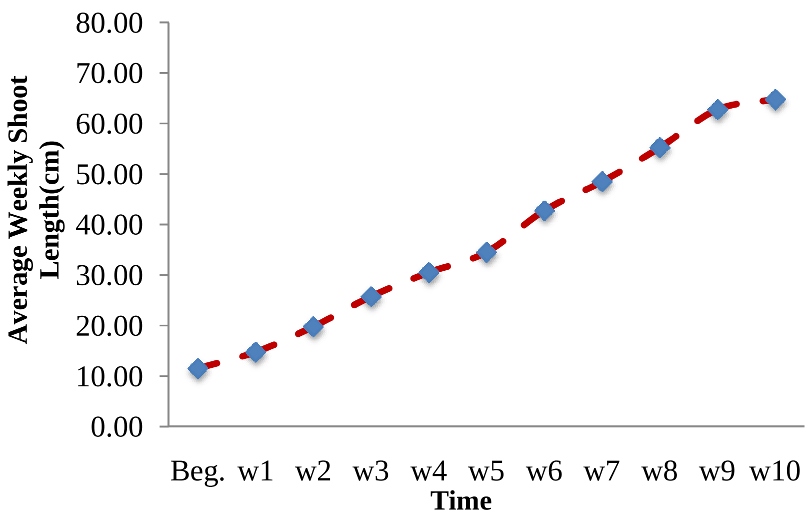

Fig. (6): Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) treated with Mixture (Zn+ Pb) During Growth Period. (Beg. = Beginning, W1= First week, W2= Second week,……..).(b) 10 ppm.

(c)

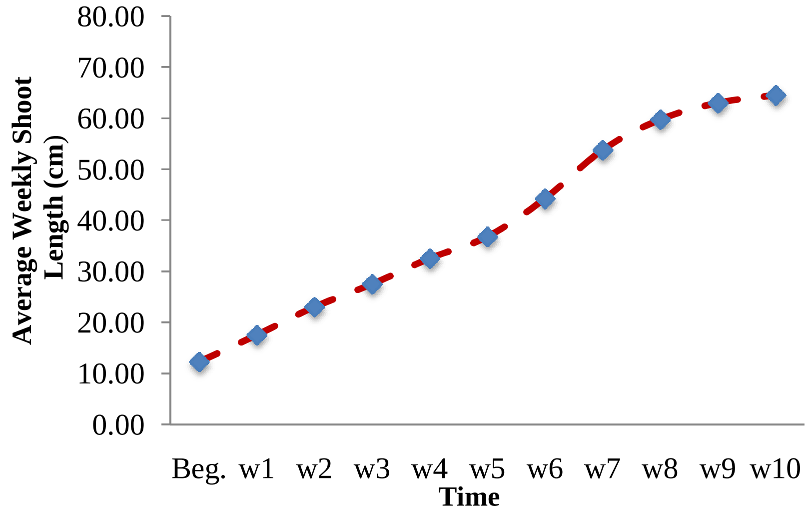

Fig. (6): Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) treated with Mixture (Zn+ Pb) During Growth Period. (Beg. = Beginning, W1= First week, W2= Second week,……..). (c) 20 ppm

(d)

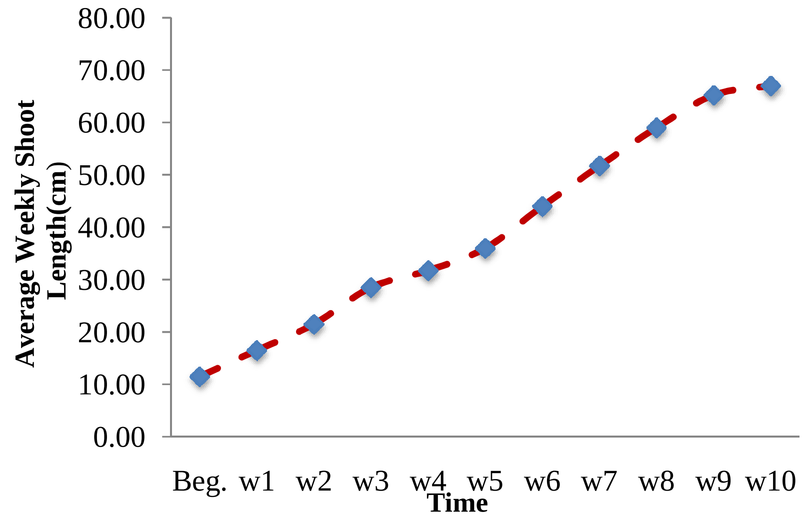

Fig. (6): Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) treated with Mixture (Zn+ Pb) During Growth Period. (Beg. = Beginning, W1= First week, W2= Second week,……..). (d) 50 ppm.

D- Weekly Shoot Length for*Solanum lycopersicum* L. (Tomato) at the Distilled Water (Control).

Table (7) (Appendix 2) shows the average length of the shoot of plant at the distilled water (Control) On weekly basis at the beginning it was 11.00 cm, and there was a clear increase in the average length of the shoot of plant every week until the tenth week of the study period, was the highest average length of shoots of the plant 62.75 cm then stop the plant from the increase in length. There were highly significant difference among them at ($P<0.001$) Fig. (7).

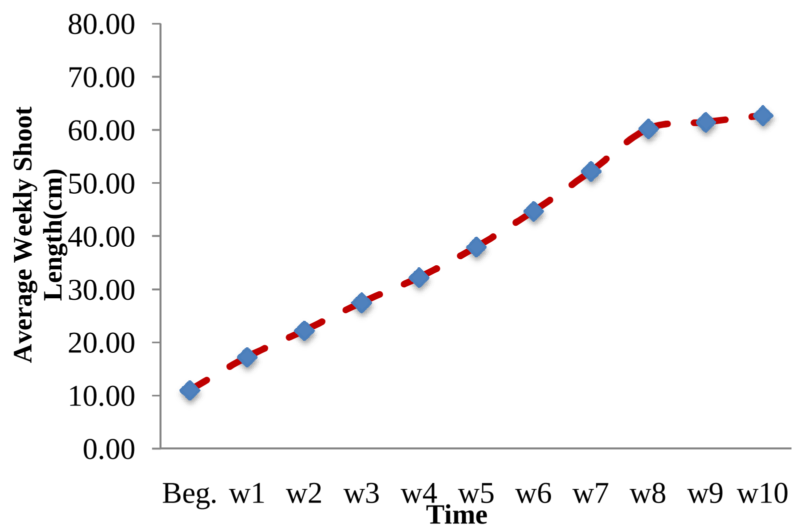

Fig. (7): Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) at the Distilled Water (Control) During Growth Period. (Beg.= Beginning, W1= First week, W2= Second week,……..).

4.1.3.2-Length of Shoot and Root for*Solanum lycopersicum* L. (Tomato) at Different Treatments at the end of the study period (until mature of plant).

A- Length of Shoot and Root for*Solanum lycopersicum* L. (Tomato) Treated withZn (5, 10, 20 and 50 ppm) and the Distilled Water (Control).

Table (8-a) (Appendix 2) shows the average length of the shoot of plant treated with Zn (5, 10, 20 and 50 ppm) and Control the ranging from 62.75 cm at the control to 63.25 cm at 5 ppm, 66.50 at 10 ppm, 67.00 cm at 20 ppm and 63.00 cm at 50 ppm. There were not significant difference found among the treatments compared with the control at ($P>0.05$).

Table (8-b) (Appendix 2) shows the average length of the root of plant treated with Zn (5, 10, 20 and 50 ppm) and Control the ranging from 38.75 cm at the control to 53.75 cm at 5 ppm, 50.75 cm at 10 ppm, 53.25 cm at 20 ppm and 46.75 cm at 50 ppm. There were not significant difference found among the treatments compared with the control at ($P>0.05$).

B-Length of Shoot and Root for*Solanum lycopersicum* L. (Tomato) Treated withPb (5, 10, 20 and 50 ppm) and the Distilled Water (Control).

Table (9-a) (Appendix 2) shows the average length of the shoot of plant treated with Pb (5, 10, 20 and 50 ppm) and Control the ranging from 62.75 cm at the control to 64.50 cm at 5 ppm, 59.25 at 10 ppm, 64.25 cm at 20 ppm and 64.50 cm at 50 ppm. There were not significant difference found among the treatments compared with the control at ($P>0.05$).

Table (9-b) (Appendix 2) shows the average length of the root of plant treated with Pb (5, 10, 20 and 50 ppm) and Control the ranging from 38.75 cm at the control to 52.50 cm at 5 ppm, 53.75 cm at 10 ppm, 42.00 cm at 20 ppm and 49.75 cm at 50 ppm. There were not significant difference found among the treatments compared with the control at ($P>0.05$).

C- Length of Shoot and Root for*Solanum lycopersicum* L. (Tomato) Treated withMixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Water (Control).

Table (10-a) (Appendix 2) shows the average length of the shoot of plant treated with mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and Control the ranging from 62.75 cm at the control to, 59.75 cm at 5 ppm, 64.75 at 10 ppm, 64.50 cm at 20 ppm and 67.00 cm at 50 ppm. There were not significant difference found among the treatments compared with the control at ($P>0.05$).

Table (10-b) (Appendix 2) shows the average length of the root of plant treated with mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and Control the ranging from 38.75 cm at the control to 46.75 cm at 5 ppm, 39.75 cm at 10 ppm, 47.50 cm at 20 ppm then 40.00 cm at 50ppm. There were not significant difference found among the treatments compared with the control at ($P>0.05$).

4.1.3.3-Fresh Weight of Shoot and Root (g) for*Solanum lycopersicum* L. (Tomato) at Different Treatments at the end of the study period (until mature of plant).

A-Fresh Weight of Shoot and Root (g) for*Solanum lycopersicum* L. (Tomato) Treated withZn (5, 10, 20 and 50 ppm) and the Distilled Water (Control).

Table (11-a) (Appendix 2) shows the average fresh weight of shoot of the plant treated with Zn (5, 10, 20 and 50 ppm) and Control where were close values 54.25 g at the control, 52.00 g at 5 ppm, 57.25 g at 10 ppm, 50.50 g at 20 ppm and 56.75 g at 50 ppm. There were not significant difference found among the treatments compared with the control at ($P>0.05$).

Table (11-b) (Appendix 2) shows the average fresh weight of root of the plant treated with Zn (5, 10, 20 and 50 ppm) and Control where were close values 12.00 g at the control, 13.00 g at 5 ppm, 15.50 g at 10 ppm, 13.50 g at 20 ppm and 12.75 g at 50 ppm. There were not significant difference found among the treatments compared with the control at ($P>0.05$).

B-Fresh Weight of Shoot and Root (g) for*Solanum lycopersicum* L. (Tomato) Treated withPb (5, 10, 20 and 50 ppm) and the Distilled Water (Control).

Table (12-a) (Appendix 2) shows the average fresh weight of shoot of the plant treated with Pb (5, 10, 20 and 50 ppm) and Control where were close values 54.25 g at the control, 53.75 g at 5 ppm, 58.00 g at 10 ppm, 51.75 g at 20 ppm and 39.00 g at 50 ppm. There were not significant difference found among the treatments compared with the control at ($P>0.05$).

Table (12-b) (Appendix 2) shows the average fresh weight of root of the plant treated with Pb (5, 10, 20 and 50 ppm) and Control where were close values 12.00 g at the control, 15.50 g at 5 ppm, 14.00 g at 10 ppm, 16.00 g at 20 ppm and 11.75 g at 50 ppm. There were not significant differencefound among the treatments compared with the control at (P>0.05).

C-Fresh Weight of Shoot and Root (g) for*Solanum lycopersicum* L. (Tomato) Treated withMixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Water (Control).

Table (13-a) (Appendix 2) shows the average fresh weight of shoot of the plant treated with mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and Control where were close values 54.25 g at the control, 45.25 g at 5 ppm, 66.75 g at 10 ppm, 60.00 g at 20 ppm and 58.00 g at 50 ppm. There were not significant differencefound among the treatments compared with the control at (P>0.05).

Table (13-b) (Appendix 2) shows the average fresh weight of root of the plant treated with mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and Control where were close values 12.00 g at the control, 11.00 g at 5 ppm, 14.25 g at 10 ppm, 12.75 g at 20 ppm, 13.25 g at 50 ppm and. There were not significant differencefound among the treatments compared with the control at (P>0.05).

4.1.3.4-Dry Weight of Shoot and Root (g) for*Solanum lycopersicum* L. (Tomato) at Different Treatments at the end of the study period (until mature of plant).

A-Dry Weight of Shoot and Root (g) for*Solanum lycopersicum* L. (Tomato) Treated withZn (5, 10, 20 and 50 ppm) and the Distilled Water (Control).

Table (14-a) (Appendix 2) shows the average dry weight of shoot of the plant treated with Zn (5, 10, 20 and 50 ppm) and Control where were close values 12.25 g at the control, 11.00 g at 5 ppm, 12.75 g at 10 ppm, 11.50 g at 20 ppm and 11.50 g at 50 ppm. There were not significant differencefound among the treatments compared with the control at (P>0.05).

Table (14-b) (Appendix 2) shows the average dry weight of root of the plant treated with Zn (5, 10, 20 and 50 ppm) and Control where were close values 2.03 g at the control, 2.33 g at 5 ppm, 3.23 g at 10 ppm, 2.13 g at 20 ppm and 2.15 g at 50 ppm. There were not significant differencefound among the treatments compared with the control at (P>0.05).

B-Dry Weight of Shoot and Root (g) for*Solanum lycopersicum* L. (Tomato) Treated withPb (5, 10, 20 and 50 ppm) and the Distilled Water (Control).

Table (15-a) (Appendix 2) shows the average dry weight of shoot of the plant treated with Pb (5, 10, 20 and 50 ppm) and Control where were close values 12.25 g at the control, 11.25 g at 5 ppm,12.00 g at 10 ppm, 11.25 g at 20 ppm and 9.50 g at 50 ppm. There were not significant differencefound among the treatments compared with the control at (P>0.05).

Table (15-b) (Appendix 2) shows the average dry weight of root of the plant treated with Pb (5, 10, 20 and 50 ppm) and Control where were close values 2.03 g at the control, 2.83 g at 5 ppm, 2.20 g at 10 ppm, 3.58 g at 20 ppm and 2.05 g at 50 ppm. There were not significant differencefound among the treatments compared with the control at ($P>0.05$).

C- Dry Weight of Shoot and Root (g) for*Solanum lycopersicum* L. (Tomato) Treated withMixture (Zn+Pb) (5, 10, 20 and 50 ppm) and Distilled Water (Control).

Table (16-a) (Appendix 2) shows the average dry weight of shoot of the plant treated with mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and Control where were close values 12.25 g at the control, 9.75 g at 5 ppm, 12.50 g at 10 ppm, 12.00 g at 20 ppm and 10.75 g at 50 ppm. There were not significant differencefound among the treatments compared with the control at ($P>0.05$).

Table (16-b) (Appendix 2) shows the average dry weight of root of the plant treated with mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and Control where were close values 2.03 g at the control, 1.88 g at 5 ppm, 2.30 g at 10 ppm, 2.93 g at 20 ppm and 2.33 g at 50 ppm. There was not significant differencefound among the treatments compared with the control at ($P>0.05$).

4.1.4- Concentration of Zn and Pb (ppm) in Different Parts (Root, Shoot and Fruit) of *Solanum lycopersicum* L. (Tomato) at Different Treatments.

A- Concentration of Zn (ppm) in Root, Shoot and Fruit Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water (Control).

Table (17-a) (Appendix 2) shows the average Zn concentration (ppm) in the root where was the lowest value at the control 0.93 ppm, then gradually increased its value, becoming 1.12 ppm at 5 ppm, 1.43 ppm at 10 ppm, 1.67 ppm at 20 ppm and 2.26 ppm at 50 ppm. There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (8-a).

Table (17-b)(Appendix 2) shows the average Zn concentration (ppm) in the shoot where was the lowest value at the control 11.64 ppm, then gradually increased its value, becoming 12.36 ppm at 5 ppm, 13.59 ppm at 10 ppm, 16.95 ppm at 20 ppm and 17.49 ppm at 50 ppm. There was highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (8-b).

Table (17-c) (Appendix 2) shows the average Zn concentration (ppm) in the fruit where was the lowest value at the control 0.40 ppm, then gradually increased its value, becoming 0.55 ppm at 5 ppm, 0.62 ppm at 10 ppm, 0.64 ppm at 20 ppm and 0.73 ppm at 50 ppm. There was highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (8-c).

(a)

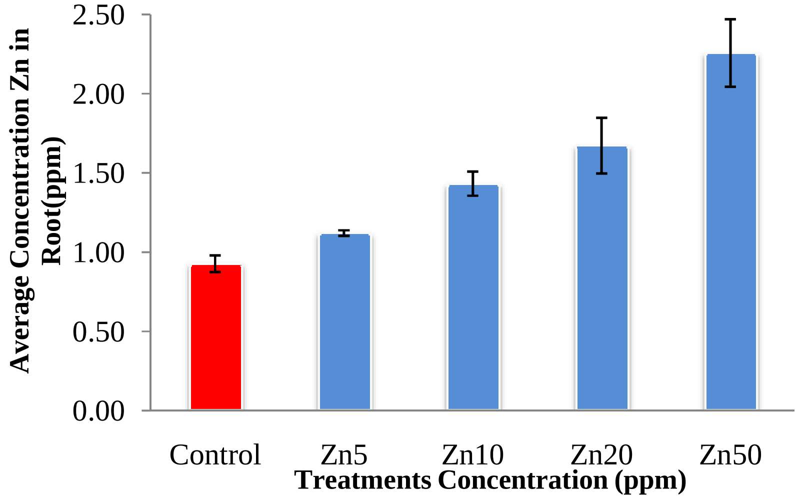

Fig. (8): Average Concentration of Zn (ppm) in the Parts of *Solanum lycopersicum* L. (Tomato) treated with Zn (5, 10, 20 and 50 ppm) and Distilled Water (Control). (a) Root.

(b)

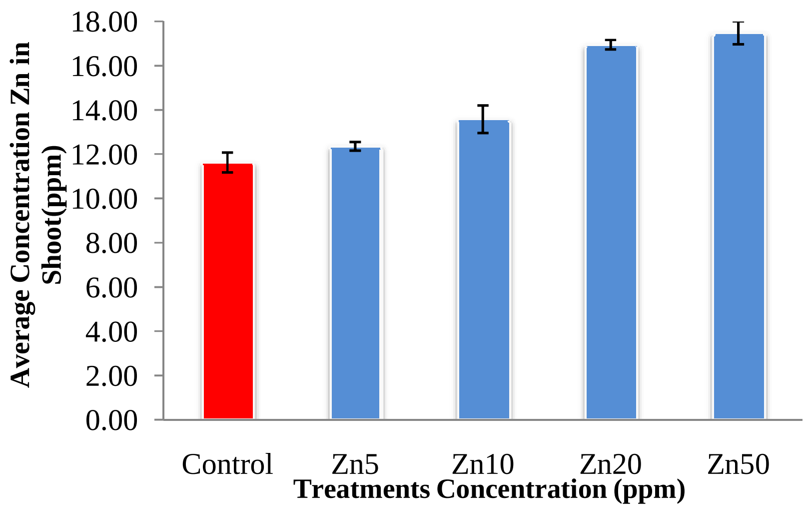

Fig. (8): Average Concentration of Zn (ppm) in the Parts of *Solanum lycopersicum* L. (Tomato) treated with Zn (5, 10, 20 and 50 ppm) and Distilled Water (Control). (b) Shoot.

(c)

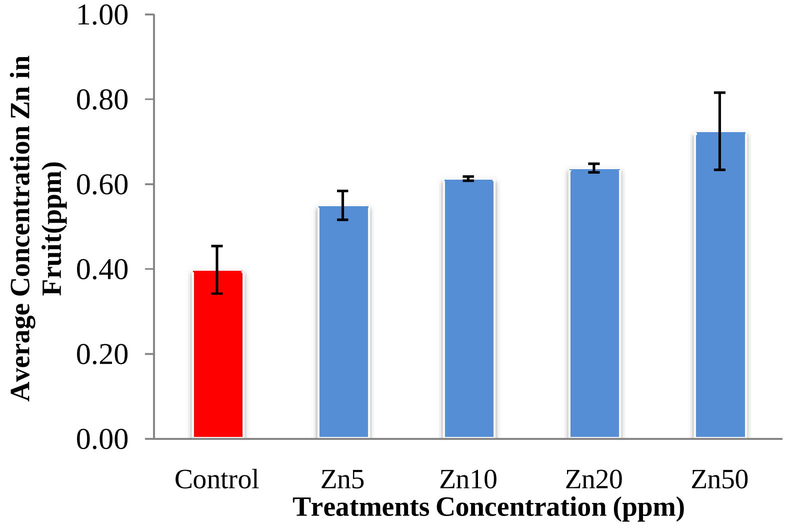

Fig. (8): Average Concentration of Zn (ppm) in the Parts of *Solanum lycopersicum* L. (Tomato) treated with Zn (5, 10, 20 and 50 ppm) and Distilled Water (Control). (c) Fruit.

B- Concentration of Pb (ppm) in Root, Shoot and Fruit Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water (Control).

Table (18-a) (Appendix 2)shows the average Pb concentration (ppm) in the rootwhere was the lowest value at the control 0.10 ppm, then gradually increased its value, becoming 0.30 ppm at 5 ppm, 0.54 ppm at 10 ppm, 1.13ppm at 20 ppm and 2.50 ppm at 50 ppm. There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (9-a).

Table (18-b) (Appendix 2) shows the average Pb concentration (ppm) in the shootwhere was the lowest value at the control 0.01 ppm, then gradually increased its value, becoming 0.09 ppm at 5 ppm, 0.41 ppm at 10 ppm, 0.46 ppm at 20 ppm and 0.49 ppm at 50 ppm. There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (9-b).

Table (18-c) (Appendix 2) shows the average Pb concentration (ppm) in the fruitwhere was the lowest value when the control 0.0005 ppm, then gradually increased its value, becoming 0.0021 ppm at 5 ppm, 0.0023 ppm at 10 ppm, 0.0026 ppm at 20 ppm and 0.0031 ppm at 50 ppm. There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (9-c).

(a)

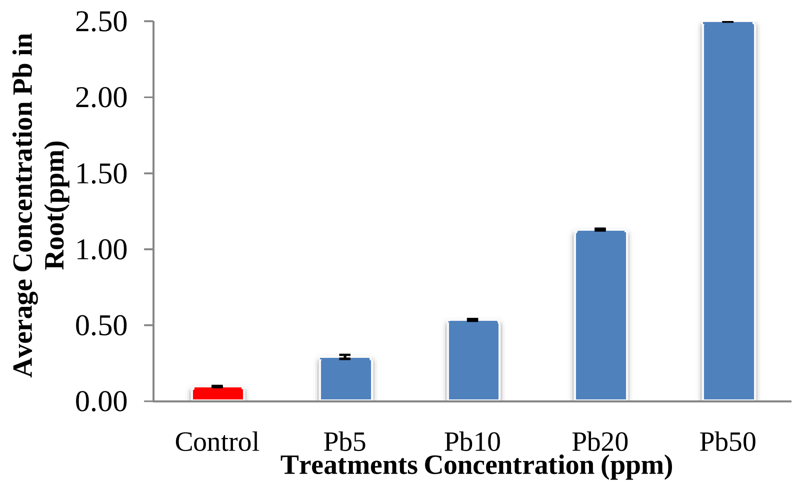

Fig. (9):Average Concentration of Pb (ppm) in the Parts of *Solanum lycopersicum* L. (Tomato) treated with Pb (5, 10, 20 and 50 ppm) and Distilled Water(Control).(a) Root.

(b)

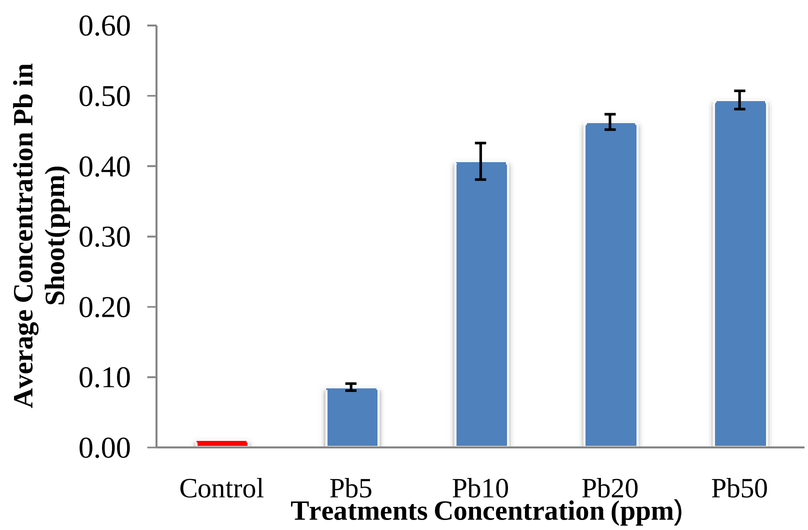

Fig. (9):Average Concentration of Pb (ppm) in the Parts of *Solanum lycopersicum* L. (Tomato) treated with Pb (5, 10, 20 and 50 ppm) and Distilled Water(Control). (b) Shoot.

(c)

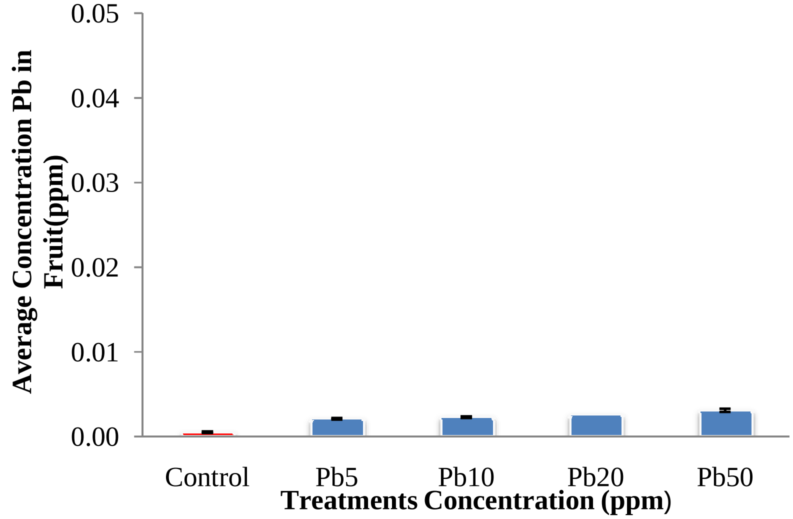

Fig. (9):Average Concentration of Pb (ppm) in the Parts of *Solanum lycopersicum* L. (Tomato) treated with Pb (5, 10, 20 and 50 ppm) and Distilled Water(Control). (c) Fruit.

C- Concentration of Zn and Pb (ppm) in Root, Shoot and Fruit Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and Distilled Water (Control).

Table (19-a) (Appendix 2) shows the average Zn (mi) concentration (ppm) in the rootwhere was the lowest value at the control 0.93 ppm, then gradually increased its value, becoming 1.18 ppm at 5 ppm, 1.48 ppm at 10 ppm, 1.60 ppm at 20 ppm and 1.83 ppm at 50 ppm. There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (10-a).

Table (19-b) (Appendix 2)shows the average Pb (mi) concentration (ppm) in the rootwhere was the lowest value when the control 0.10 ppm, then gradually increased its value, becoming 0.17 ppm at 5 ppm, 0.20 ppm at 10 ppm, 0.37ppm at 20 ppm and 0.80 ppm at 50 ppm. There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (10-b).

(a)

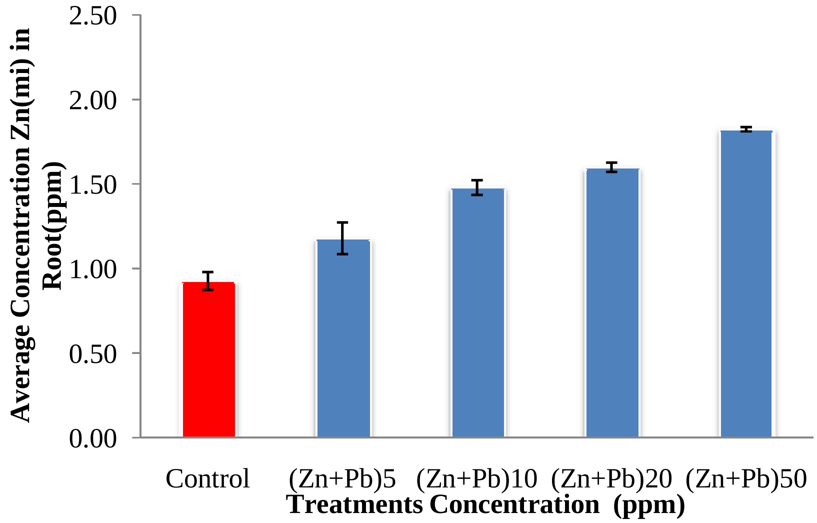

Fig.(10): Average Concentration of Zn(mi) and Pb(mi) (ppm) in Root of *Solanum lycopersicum* L. (Tomato) treated withMixture (Zn+Pb) and the Control.(a) Concentration of Zn (mi).

(b)

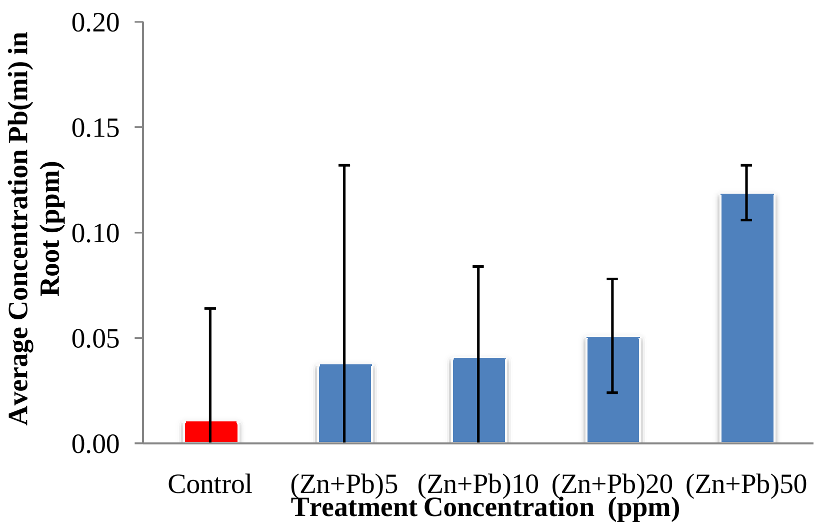

Fig.(10): Average Concentration of Zn(mi) and Pb(mi) (ppm) in Root of *Solanum lycopersicum* L. (Tomato) treated withMixture (Zn+Pb) and the Control. (b) Concentration of Pb (mi).

Table (20-a) (Appendix 2) shows the average Zn (mi) concentration (ppm) in the shootwhere was the lowest value when the control 11.64 ppm, then gradually increased its value, becoming 12.40 ppm at 5 ppm, 13.60 ppm at 10 ppm, 16.90 ppm at 20 ppm and 17.50 ppm at 50 ppm. There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (11-a).

Table (20-b) (Appendix 2) shows the average Pb (mi) concentration (ppm) in the shootwhere was the lowest value when the control 0.01 ppm, then gradually increased its value, becoming 0.04 ppm at 5 ppm, 0.04 ppm at 10 ppm, 0.05 ppm at 20 ppm and 0.12 ppm at 50 ppm. There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (11-b).

(a)

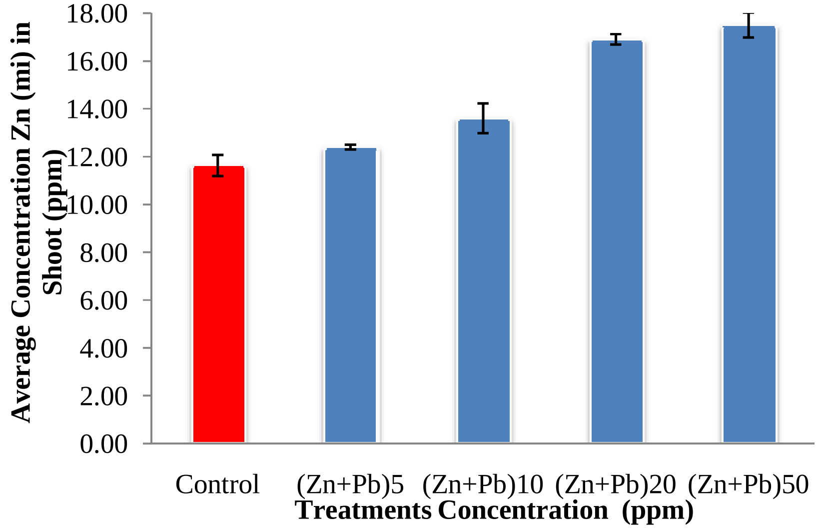

Fig. (11): Average Concentration of Zn (mi) and Pb (mi) (ppm) in Shoot of *Solanum lycopersicum* L. (Tomato) treated with Mixture (Zn+Pb) and the Control. (a) Concentration of Zn (mi).

(b)

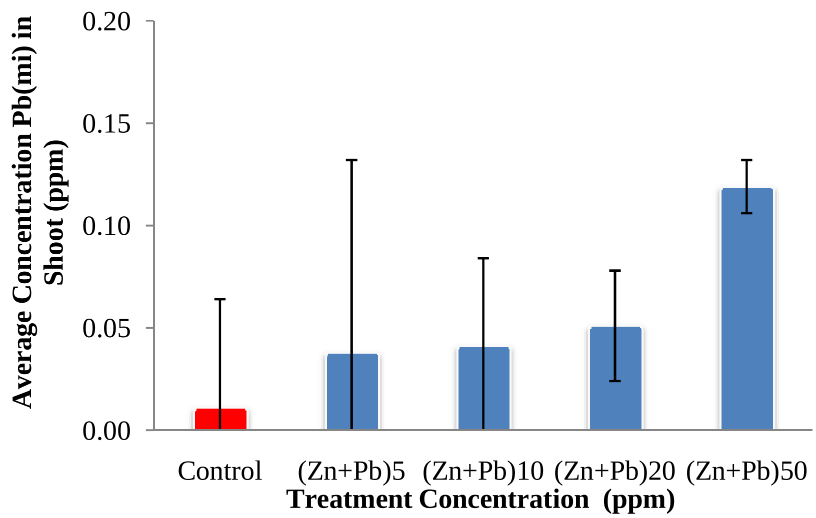

Fig. (11): Average Concentration of Zn (mi) and Pb (mi) (ppm) in Shoot of *Solanum lycopersicum* L. (Tomato) treatedwith Mixture (Zn+Pb) and the Control. (b) Concentration of Pb (mi).

Table (21-a) (Appendix 2) shows the average Zn (mi) concentration (ppm) in the fruitwhere was the lowest value when the control 0.40 ppm, then gradually increased its value, becoming 0.58 ppm at 5 ppm, 0.63 ppm at 10 ppm, 0.66 ppm at 20 ppm and 0.73 ppm at 50 ppm. There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (12-a).

Table (21-b) (Appendix 2) shows the average Pb (mi) concentration (ppm) in the fruitwhere was the lowest value when the control 0.0005 ppm, then gradually increased its value, becoming 0.0016 ppm at 5 ppm, 0.0019 ppm at 10 ppm, 0.0025 ppm at 20 ppm and 0.0028 ppm at 50 ppm. There were highly significant difference found among the treatments compared with the control at ($P<0.001$) Fig. (12-b).

(a)

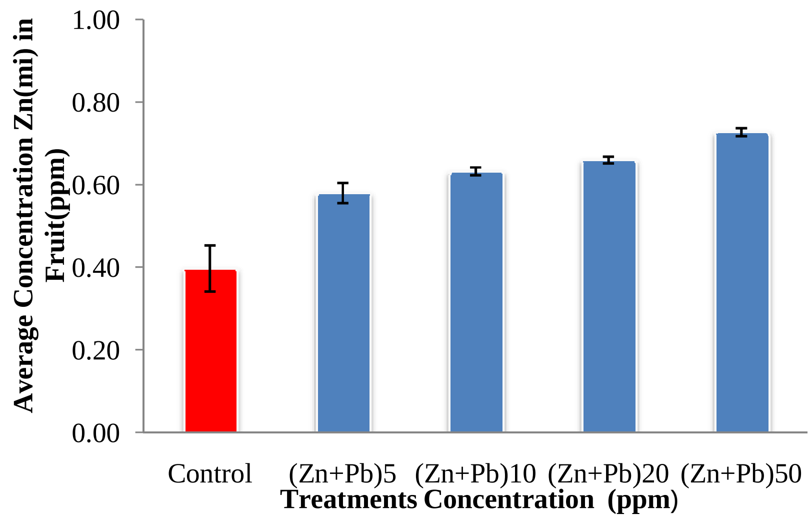

Fig.(12): Average Concentration of Zn(mi) and Pb(mi) (ppm) in Fruit of *Solanum lycopersicum* L. (Tomato) treated withMixture (Zn+Pb) and the Control.(a) Concentration of Zn (mi).

(b)

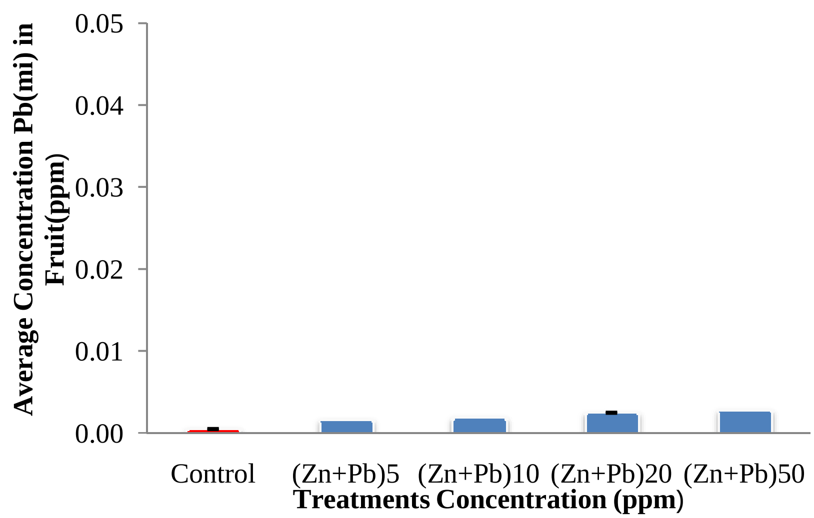

Fig.(12): Average Concentration of Zn(mi) and Pb(mi) (ppm) in Fruit of *Solanum lycopersicum* L. (Tomato) treated withMixture (Zn+Pb) and the Control. (b) Concentration of Pb (mi).

4.2- Discussion

In order to make the discussion of the results clear and simple, the different effectobserved in the study were discussed in the following pattern:-

4.2.1-The Effect of Seeds Germination.

As been mentioned before there were clear pattern of decreasing percentage of seeds germination with increased concentrations of Zn and Pb reflecting on the direct effect of the high metal concentration on the seeds germination of the tomato plant. This finding is in agreement with the result observed by Jaja and Odoemena, (2004) where similar pattern of decreasing percentage of seeds germination were observed with increased concentration of lead used in the form of lead acetateapplied on two tomato varieties (NHLe 158-3 and ROMA VF).

The decreases in percentage of seed germination in the samples treated with Zn was significantly decreased at 20 and 50 ppm compared with their control, this was very clear after the third day of the treatment as shown in (table (1-c) (Appendix 2)),where 88% at 20 ppm and 85% at 50 ppm,Whilethe decreases in percentage of seed germination treated with Pb was significantly at 10, 20 and 50 ppm when compared with their control, also this is more clear after the third day as shown in (table (2-c) (Appendix 2)), where 98% at 10 ppm, 86% at 20 ppm and 77% at 50 ppm, and finally the decreases in percentage of seed germinationtreated with mixture (Zn+Pb) was significantly at 10,20 and 50 ppm when compared with their control, also this was very clear after the third day of the treatment as shown in (table (3-c) (Appendix 2)), where 97% at 10 ppm, 87% at 20 ppm and 79% at 50 ppm. While the treatments with Zn, Pb and mixture

(Zn+Pb) at 5 ppm, and Zn at10 ppm the result were found to be equal with the control as shown in (table (1-c), (2-c) and (3-c) (Appendix 2)). In other words,the decrease in the seed germination of the tomato caused by the increased amount of metallic compounds indicates that at a lower concentration, the contaminants posed little or no harm on the seed viability, but at a higher level, germination is retarded. This is in line with earlier reports by Levitt (1980).

From the above result it is clear thatPb and mixture (Zn+Pb) were the most influential on the percentage of seed germination compared with Zn. This finding were found to be similar to the result observed by Pirselova, (2011) who found that when compared effects of heavy metals on seed germination of five selected species of agricultural crops barley (*Hordeum vulgare* cv. Garant), corn (*Zea mays* cv. Quintal), pea (*Pisum sativum* cv. Olivнn), soybean (*Glycine max* cv. Korada), Beans (*Vicia faba* cvs. and Piestansky). Seed germination dependent on the tested plant species and tested heavy metals.

4.2.2- The Effect on Plant Growth.

General and commonly used stress indicators such as weight and length of roots and shoots. Each of these characteristics was dependent on the tested plant species and tested heavy metals (Pirselova, 2011).

The shoot length with all treatments to had increased gradually from the first week and until the tenth week, which is the period of the experiment but the increase was not significantly when compared with the control. It was also noted that the shoot for all plants stopped the increasing in length at the tenth week.

Table (8-a) and (8-b) (Appendix 2) show shoots and roots length for the samples treated with Zn (5, 10, 20 and 50 ppm) while, table (9-a) and (9-b)(Appendix 2) show the samples treated with Pb (5, 10, 20 and 50 ppm) and table (10-a) and (10-b)(Appendix 2) show shoots and roots length for the samples treated with mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and all with the control.

Table (11-a) and (11-b) (Appendix 2) show fresh weight of shoots and roots in the samples treated with Zn (5, 10, 20 and 50 ppm), while table (12-a) and (12-b) (Appendix 2) show the samples treated with Pb (5, 10, 20 and 50 ppm)and table (13-a) and (13-b) (Appendix 2) show fresh weight of shoots and roots for the samples treated with mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and all with the control.

Table (14-a) and (14-b) (Appendix 2) show dry weight of shoots and roots in the samples treated with Zn (5, 10, 20 and 50 ppm), table (15-a) and (15-b) (Appendix 2) show dry weight of shoots and roots in the samples treated with Pb (5, 10, 20 and 50 ppm) and table (16-a) and (16-b) (Appendix 2) show the samples treated with mixture of (Zn+Pb) (5, 10, 20 and 50 ppm) and all with the control.It was noted that all concentrations of Zn, Pb and mixture (Zn, Pb) until 50 ppm, were found not to be significantly different when compared with their control. This finding were consistent with result was observed by Jaja and Odoemena, (2004) from thru their study about the early seedling growth of two tomato seed varieties (NHLe 158-3 and ROMA VF) were investigated using five levels (0% 0.001% 0.01% 0.1% 1%) of lead acetate, cupric carbonate and ferric chloride respectively. The results showed that the growth parameters tested was not significantly different in both Roma VF and NHLe 158-3 variety when compared with that of the control.

From growth parameters previous, the tomato plant growth was not effected in presence zinc and lead until 50 ppm, where concentrations are considered fairly low but increasing in concentration of heavy metals more than that, effect clearly on tomato growth, this finding were consistent with result was observed byOpeolu ***et al***., (2009)from thru their study about thePhytotoxic effects of Pb as $Pb(NO_3)_2$ on tomato (*Lycopersicon esculentum*) planted on contaminated soil was assessed in terms of growth at various concentrations (300, 600 and 1800 ppm). Results showed that plant performance significantly reduced with increasing concentrations of Pb contamination.

The results in this study showed also concentration Zn and Pb in different plant parts (root, shoot and fruit) for plant at all treatments. Similar results were reported by Opeolu *etal*., (2009)from their study about thePhytotoxic effects of Pb as $Pb(NO_3)_2$ on tomato (*Lycopersicon esculentum*) planted on contaminated soil was assessed in terms of growth at various concentrations (300, 600 and 1800 ppm). Results showed Pb was present in the tomato roots, shoots and fruits. Where increased concentration of both zinc and lead in different plant parts with the increase in the concentration of treatments.

Table (17-a), (17-b) and (17-c) (Appendix 2) show concentration of Zn in root, shoot and fruit in the samples treated with Zn(5, 10, 20 and 50 ppm) were highly significantly different when compared with their control.

Table (18-a), (18-b) and (18-c) (Appendix 2) show concentration of Pb in root, shoot and fruit in the samples treated with Pb (5, 10, 20 and 50 ppm) were highly significantly different when compared with their control.

Table (19-a) and (19-b) (Appendix 2) show concentration of Zn and Pb in root in the samples treated with mixture (Zn+Pb) (5, 10, 20 and 50 ppm) were highly significantly different when compared with their control.

Table (20-a) and (20-b) (Appendix 2) show concentration of Zn and Pb in shoot in the samples treated with mixture (Zn+Pb) (5, 10, 20 and 50 ppm) were highly significantly different when compared with their control.

Table (21-a) and (21-b) (Appendix 2) show concentration of Zn and Pb in fruit in the samples treated with mixture (Zn+Pb) (5, 10, 20 and 50 ppm) were highly significantly different when compared with their control.

Of previous results also note concentration of Zn was the highest in shootthen root and lowest in the fruit, but concentration of Pb was the highest in rootthen shoot and lowest in the fruit.

Zn accumulation was: Shoot > Root > Fruit

Pb accumulation was: root > shoot > Fruit

Similar results were reported byOuaritio*et al*., (1997) from their study about the effects of Cd on the growth, bean (*Phaseolus vulgaris* L. cv. Morgane) and tomato (*Lycopersicon esculentum* Mill. cv. Ibiza F_1) plants treated for 7 days with nutrient solutions containing 0 to 50 μM $CdCl_2$ were accumulated in the roots exceeded by far that of shoots, with the greatest Cd accumulation occurring in tomato plants. Both Pb and Cd are notessential elements(Horne, 2000; Blaylock and Huang, 2000) and their concentrationwas found to be the highest in rootsthen shoots, unlike Zn which is an essential element (Adriano, 2001) so it was their concentration the highest in the shoot.

As plants constitute the foundation of the food chain, some concerns have been raised about the possibility of toxic concentrations of some elements been accumulated in the plants and transported from to higher strata of the food chain, especially human,for examplelead is well known neurotoxins that can be consumed via sea food, vegetables and rice (Peralta-Videa *et al*., 2009).

Also, the average Zn concentration in different plant parts were convergent at both Znindividual and at Zn in mixture but Pb concentration in different plant parts were less at mixture. Consequently, we can say that the presence of Zn with Pb reduces uptake Pb by plant, thus reduces its concentration in different plant partsSimilar results were reported byPirselova, (2011).

Finally, we can say the environmental problems with heavy metals because are that they as elements the most of them have toxic effects on living organisms when exceeding a certain concentration. Furthermore, some heavy metals are being subjected to bioaccumulation and may pose a risk to human health when transferred to the food chain. Soils, whether in urban or agricultural areas represent a major sink for metals released into the environment from a wide variety of anthropogenic sources (Nriagu, 1991).

Conclusion

From the results obtained in this study, It can be concluded there were clear effect specially at high concentration and in particular in seed germination . The main conclusion of the study can summarised as follow:-

1-The presence of Zn and Pb at a concentration ranging from 5 to 50 ppm, whether separate or in mixture have , reduced germination of the seeds of *Solanum lycopersicum* L. (tomato), compared with the seeds germinated in control, it is known that plants are sensitive at this stage.

2-The presence of Zn and Pb at concentration ranging from 5 to 50 ppm, seems not affect the growth of *Solanum lycopersicum* L. (tomato), compared with the plants grown in control. Where concentrations are considered fairly low compared to what came in StudyOpeolu et al., (2009).

3-The presence of Zn and Pb concentrations that were low in fruits compared to its concentration in the roots and shoots, but they are able to the accumulation in the human body through the food chain, so we need to more monitoring of food quality, to preserve human health. Especially with increased pollution with heavy metals in the environment.

REFERENCES

Abraham, K., Sridevi, R., Suresh, B. and Damodharam, T. (2013) "Effectof Heavy Metals (Cd, Pb, Cu) on Seed Germination of *Arachis hypogeae*.L.". *Plan. Sci. Res. Asiaz J.*, 3(1):10-12, available at: (http://www.pelagiaresearchlibrary.com).

Adriano, D. C. (2001)"TraceElements in Terrestrial Environments; Biochemistry, Bioavailability and Risks of Metals". *Springer-Verlag, N. Y.*

Angel, J. S. and Linacre, N. A. (2005)"Metal Phytoextraction-A Survey ofPotential Risks". *Inter. Phyto. J.*, (7):241-254.

Angelova, V., Ivanova, R., Pevicharova, G. and Ivanov, K. (2010) "Effectof Organic Amendments on Heavy Metals Uptake by Potato Plants". *W.Cong. Soi. Sci.*,: 84-87.

Antonious, G. and Snyder, J. (2007) "Accumulation of Heavy Metals in Plants and Potential Phytoremediation of Lead by Potato,*Solanum tuberosum*L.". *Environ. Sci. Health, J. Par.A*, 42: 811–816.

Ariyakanon, N. and Winaipanich, B. (2006) "Phytoremediation of Copper Contaminated Soil by *Brassica juncea* L. Czern and *Bidens alba* L. DC. var.*radiata*". *Sci. Res. J.*, 31(1): 49-56.

Aydinalp, C. and Marinova, S. (2009) "The Effects of Heavy Metals on Seed Germination and Plant Growth on AlfaAlfa Plant (*Medicago sativa* L.)".*Agr. Sci. Bulgar. J.*,15 (4): 347-350.

Barak, P. and Helmke, P. (1993) "The Chemistry of Zinc in Soil and Plants" (Ed. Robson,A.D.).*Kluwer.Aca.Publ*.,:1–13.

Bennett, L. E., Burkhead, J. L., Hale, K. L., Terry, N., Pilon, M. and Pilon-Smits, E. A. H. (2003) "Analysis of Transgenic Indian Mustard Plants for Phytoremediation of Metalscontaminated Mine Tailings". *Environ. Qual. J.*, 32: 432-440.

Blaylock, M. J. and Huang, J. W. (2000) "Phytoextraction of Metals. In: Phytoremediation of Toxic Metals Using Plants to Clean up the Environment" (Eds: Raskin, I. and Ensley, B. D.). *Wiley, N. Y.*,:53-70.

Broadley, M. R., White, P. J., Hammond, J. P., Zelko, I. and Lux, A. (2007) "Zinc in Plants". *New Phyt.*, 173: 677–702.

Brus, D., Li, Z. B., Temminghoffd, E. J. M., Song, J., Koopmans, G. F., Luo, Y. M. and Japenga, J. (2009) "Predictions of Spatially Averaged Cadmium Contents in Rice Grains in the Fuyang Valley, P.R. China". *Environ. Qual. J.*, 38: 1126-1136.

Dean, W. E. J. (1974) "Determination of Carbonate and Organic Matter in Calcareous Sediments and Sedimentary Rock by Loss on Ignition". *Sedime. Pet.*, (44): 242-248.

Falahi-Ardakani, A. (1984) "Contamination of Environment with Heavy Metals Emitted from Automotives". *Ecotoxicol. Environ. Saf.* , 8: 152–161.

Fewtrell, L., Kaufmann, R. and Pruss-Ustun, A. (2003) "World Health Organization Environmental Burden of Disease Series". *Lead: Ass. Environ. Bur. Dise. at Nation. & Loc. Lev., Gene.,* (2), available at: (http://www.who.int/quantifying_ehimpacts/publications/en/leadebd2.pdf).

Foy, C. D., Chaney, R. L. and White, M. C. (1978) "The Physiology of Metal Toxicity in Plants". *Ann. Rev. Plant Phys.*, 29: 511–566.

Fu, J., Zhou, Q., Liu, J., Liu, W., Wang, T., Zhang, Q. and Jiang, G. (2008) "High Levels of Heavy Metals in Rice *Oryza sativa* L. from a Typical E-Waste Recycling area in Southeast China and its Potential Risk to Human Health". *Chemosph.*, 71: 1269-1275.

Fulekar, M. H. (2005) "Environmental Biotechnology". *Oxford & IBH Publishing Co. Pvt. Ltd.*

Gondek, K. and Filipek-Mazur, B. (2003) "Biomass Yields of Shoots and Roots of Plants Cultivated in Soil Amended by Vermicomposts Based on Tannery Sludge and Content of Heavy Metals in Plant Issues". *Soi. Environ.*, 49(9): 402-409.

Gruca-Krolikowska, S., Waclawek, W. and Metale, W. S. (2006) "Chemia Dydaktyka Ekologia Metrologia". *Inter. Mol. Sci. J.*,11:41–55.

Hacisalihoglu, G., Hart, J. J., Vallejos, C. E. and Kochian, L. V. (2004) "The Role of Shoot-Localized Processes in the Mechanism of Zn Efficiency in Common Bean". *Pla.*, 218: 704–711.

Hatamzadeh, A., Sharaf, A. R. N., Vafaei, M. H., Salehi, M. and Ahmadi, G. (2012) "Effect of Some Heavy Metals (Fe, Cu and Pb) on Seed Germination and Incipient Seedling Growth of *Festuca rubra* ssp. Commutate Chewings fescue L.". *Inter. Agr.& Crop Sci. J.*, 4 (15):1068-1073, available at: (http://www.ijagcs.com).

Horne, A. J. (2000) "Phytoremediation by Constructed Wetlands. In: Phytoremediation of Contaminated Soil and Water" (Eds: Terry, N. and Banuelos, G.). *Boca Raton, Lewis.*, :13-40.

IARC (2006) "Monographs for the Evaluation of Carcinogenic Risks to Humans. (International Agency for Research on Cancer)". *Summ. & eva.: Inor. & org. lead com.*, 87, available at: (http://www.inchem.org/documents/iarc/vol87/volume87.pdf).

IPCS (1995) "World Health Organization, (International Programme on Chemical Safety) Environmental Health Criteria". *Inor. lead, Gene.*, 165, available at:(http://www.inchem.org/documents/ehc/ehc/ehc165.htm).

Jadia, C. D. and Fulekar, M. H. (2008)"Phytoremediation: The Application of Vermicompost to Remove Zinc, Cadmium, Copper, Nickel and Lead by Sunflower Plant". *Environ. Engin. & Managem. J.*, 7(5):547-55, available at: (http://www.omicron.ch.tuiasi.ro/EEMJ/).

Jaja, E. T. and Odoemena, C.S.I. (2004) "Effect of Pb, Cu and Fe Compounds on the Germination and Early Seedling Growth of Tomato Varieties". *Appl. Sci. Environ. J.*,8 (2): 50-53, available at: (http://www.bioline.org.br/ja).

John, R., Ahmad, P., Gadgil, K. and Sharma, S. (2009)"Heavy Metal Toxicity: Effect on Plant Growth, Biochemical Parameters and Metal Accumulation by *Brassica juncea* L.". *Inter. Pla. Prod. J.*, 3(3): 65-76, available at: (http://www.ijpp.info).

Kramer, U., Talke, I. N. and Hanikenne, M. (2007) "Transition Metal Transport". *FEBS Lett.*, 581: 2263–2272.

Lasat, M. M. (2002) "Phytoextraction of Toxic Metals: A Review of Biological Mechanisms". *Environ. Qual. J.,* 31: 109-120.

Levitt, J (1980) "Responses of Plants of Environmental Stresses. Water, Radiation, Salt and other Stresses". *Wiley N.Y.*,: 489-530.

Life Extention, (2003) "Heavy Metal Toxicity". Available at: (http://www.lef.org/protocols/prtcl-156.shtml).

Lloyd, D. D. (2000) "Parts Per Million Conversions".*Chem. Dept, Univer. of The West Indi.*

Luo, Y. M. and Teng, Y. (2006) "Status of Soil Pollution-Caused Degradation and Countermeasures in China (in Chinese)". *Soi. J.*, 38:505-508.

Marchiol, L., Assolari, S., Sacco, P. and Zerbi, G. (2004) "Phytoextraction of Heavy Metals by Canola *Brassica napus* L. and Radish *Raphanus sativus* L. Grown on Multicontaminated Soil". *Environ. Pollut.*, 132: 21–27.

Mcgrath, S. P.,ZhaoF. J. and Lombi, E. (2002) "Phytoremediationof Metals, Metalloids and Radionuclides". *Adv. Agric.*, 75:1–56.

Miller, R. O. and Kissel, D.E. (2010) "Comparison of Soil pH Methods on Soils of North America". *Soi. Sci. Soci. Amer. J.*, 74:212-215.

Munzuroglu, O. and Zengin, F. K. (2006) "Effect of Cadmium on Germination, Coleoptile and Root Growth of Barley Seeds in the Presence of Gibberellic Acid and Kinetin". *Environ. Bio. J.*, 27 (4): 671-677.

Nriagu, J.O. (1991)"Human Influence on the Global Cycling of the Metals" (Ed: Farmer, J. G.). *CEP consultants Ltd., Edinbur., UK*., 1: 1-5.

Odoemena, C. S. (1988) "Breaking of Seed Coat Dormancy in a Medicinal Plant *Tetrapleura tetraptera* L. ". *Agr. Sci. J.*, 111 (2): 393 – 394.

Opeolu, B. O., Adenuga, O. O., Ndakidemi, P. A. and Olujimi, O. O. (2009) "Assessment of Phyto-Toxicity Potential of Lead on Tomato *Lycopersicon esculentum* L. Planted on Contaminated Soil". *Int. Phy. Sci. J.*, 5 (2): 068-073, available at: (http://www.academicjournals.org/IJPS).

Ouaritio, O., Gouia, H. and Ghorbal, M. H. (1997) "Responses of Bean and Tomato Plants to Cadmium: Growth, Mineral Nutrition, and Nitrate Reduction". *Plan. phys. & biochem.*,35 (5): 347-354.

Peng, K., Li, X., Luo, C. and Shen, Z. (2006) "Vegetation Composition and Heavy Metal Uptake by Wild Plants at Three Contaminated Sites in Xiangxi Area, China". *Environ. Sci. & Health J.*Par. A, 40: 65-76.

Peralta, I. E. and Spooner, D. M. (2007) " History, Origin and Early Cultivation of Tomato (Solanaceae)". *Enfield, NH: Sci. Publ.*, 20: 1-27.

Peralta-Videaa, J. R., Martha, L. L., Mahesh, N., Geoffrey, S. and Gardea-Torresdeya, J.(2009)"The Biochemistry of Environmental Heavy Metal Uptake by Plants: Implications for the Food Chain"*Inter. Biochem.& Cell Biol. J.* 41: 1665–1677.

Pirselova, B. (2011) "Monitoring the Sensitivity of Selected Crops to Lead, Cadmium and Arsenic". *Str. Phys. & Bio. J.*, 7 (4): 31-38.

Relf, D., McDaniel, A. and Morse, R. (2009). "Tomatoes ". *Virgi. Cooper. Exten.Public.*,: 381-426.

Robinson, J. Z. E. and Kolavalli, S. L. (2010)"The Case of Tomato in Ghana – Marketing". (International Food Policy Research Institute - IFPRI). available at: (http://www.ifpri.org).

Sekara, A., Poniedzialek, M., Ciura, J. and Jedrszczyk, E. (2004) "Cadmium and Lead Accumulation and Distribution in the Organs of Nine Crops: Implications for Phytoremediation". *Polish Environ. Stud. J.*, 14(4): 509-516.

Shafiq, M., Zafar, I. M. and Athar, M. (2008) "Effect of Lead and Cadmium on Germination and Seedling Growth of *Leucaena leucocephala* L.". *Appl. Sci. Environ. J.*, 12 (2):61-66, available at: (http://www.bioline.org.br/ja).

Shekar CH. CH., Sammaiah, D., Shasthree, T. and Reddy, K. J. (2011) "Effect of Mercury on Tomato Growth and Yield Attribute". *Inter. Pharma & Bio Sci. J.*, 2:358-364, available at: (http://www.ijpbs.net).

Singh, R. P. and Agrawal, M. (2007) "Effects of Sewage Sludge Amendment on Heavy Metal Accumulation and Consequent Responses of *Beta vulgaris* L. plants". *Chemosph.*, 67: 2229–2240.

Tuna, A. L., Burun, B., Yokafi, I. and Coban, E. (2002) "The Effects of Heavy Metals on Pollen Germination and Pollen Tube Length in the Tobacco Plant". *Turk . Bio. J.*, 26 : 109-113.

USEPA, (1997) "CleaningUp the Nation's Waste Sites: Markets and Technology Trends (United States Environmental Protection Agency)". *EPA/542/R-96/005: Office of Solid Waste and Emergency Response Washington, DC.*

Vallee, B. L. and Auld, D. S. (1990) "Zinc Coordination, Function, and Structure of Zinc Enzymes and other Proteins". *Biochem.*, 929: 5647–5659.

WHO (2009) "Global health risks: Mortality and burden of disease attributable to selected major risks, (World Health Organization)".*Gene.*, available at: (http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisk report_full.pdf).

Winther, M. and Slento, E. (2010)"In Heavy Metal Emissions for Danish Road Transport; National Environmental Research Institute", *Aarhus Univer.: Aarhus, Denma.*, : 99-104.

Xiong, Z. T. (1998) "Lead Uptake and Effects on Seed Germination and Plant Growth in a Pb Hyperaccumulator *Brassica pekinensis* Rupr.". *Bull. Environ. Contam. Toxicol*., 6: 258-291.

Yang, X., Feng, Y., He, Z. and Stoffella, P. J. (2005) "Molecular Mechanisms of Heavy Metals Hyperaccumulation and Phytoremediation". *Trace Elem. Med. Bio. J.*, 18: 339–353.

Appendix 1

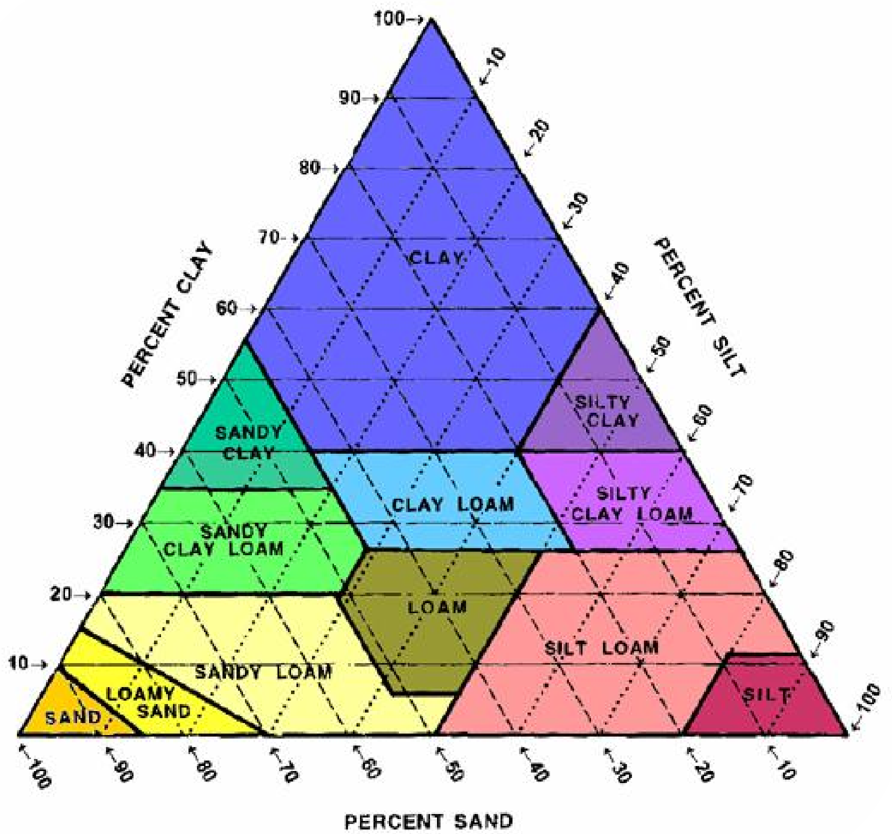

Figure (1): Soil Textural Triangle

Figure (2): pH Meter.

Figure (3): Oven

Figure (4): Atomic Absorption Spectrometer.

Figure (5): Germination ofTomato Seeds in Petri Dishes.

Figure (6-1): Tomato Plant Before they Mature.

Figure (6-2): Tomato Plant After they Mature.

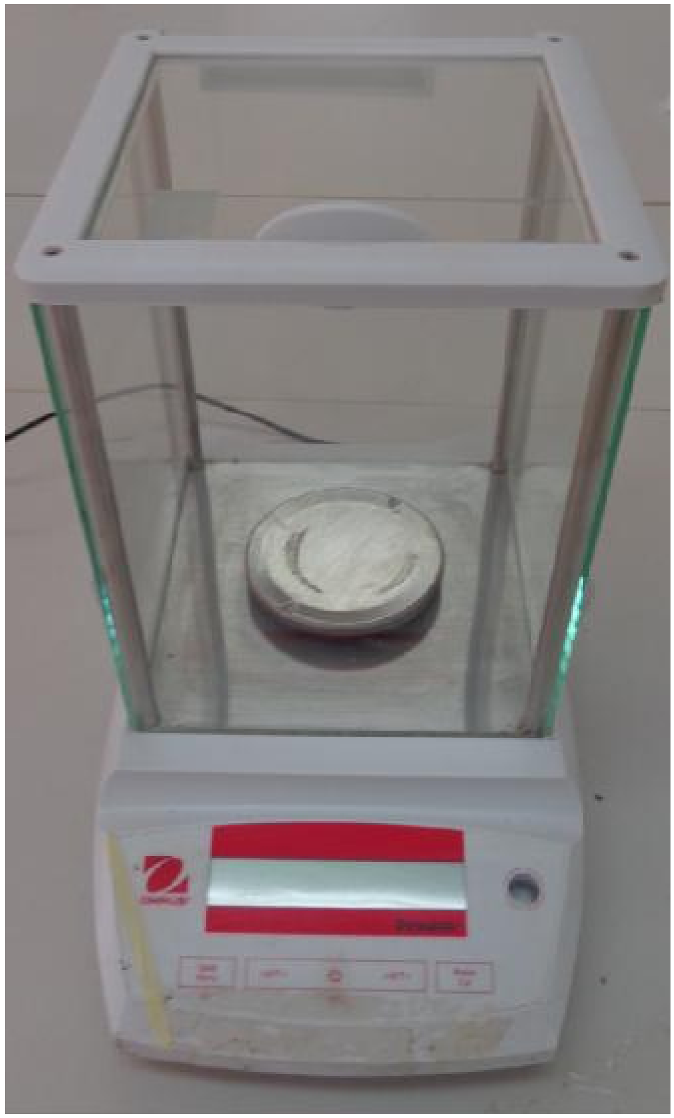

Figure (7): Analytical Balance.

Figure (8): Plant Digestion Procedure.

Appendix 2

Table (1): Average and Std. for Seeds Germination Percentage for *Solanum lycopersicum* L. (Tomato) Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water (Control)During Three Days .(a) after One Day.

(a)

Concentration (ppm)	Fre.	Average %S.G.	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	3	90.00	5.00	77.58	102.42	0.030^{*}	A>B B>C C>D D>E
Zn5	3	80.00	10.00	55.16	104.84		
Zn10	3	71.67	1041	45.81	97.52		
Zn20	3	65.00	10.00	40.16	89.84		
Zn50	3	63.33	10.41	37.48	89.19		

Table (1): Average and Std. for Seeds Germination Percentage for *Solanum lycopersicum* L. (Tomato) Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water (Control)During Three Days .(b) after TwoDays.

(b)

Concentration (ppm)	Fre.	Average %S.G.	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	3	100.00	0.00	100.00	100.00	0.001^{**}	A>B A>C D>E
Zn5	3	85.00	5.00	72.58	97.42		
Zn10	3	85.00	5.00	72.58	97.42		
Zn20	3	78.33	2.89	71.16	85.50		
Zn50	3	73.33	7.64	54.36	92.31		

Table (1): Average and Std. for Seeds Germination Percentage for *Solanum lycopersicum* L. (Tomato) Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water (Control)During Three Days .(c) after Three Days.

(c)

Concentration (ppm)	Fre.	Average %S.G.	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	3	100.00	0.00	100.00	100.00	0.000^{***}	A>D B>D C>D D>E
Zn5	3	100.00	0.00	100.00	100.00		
Zn10	3	100.00	0.00	100.00	100.00		
Zn20	3	88.33	2.89	81.16	95.50		
Zn50	3	85.00	5.00	72.58	97.42		

(Fre.= Frequency, Average %S.G.= Average for Seeds Germination Percentage, *Significant at 5%, ** Significant at 1% , ***Highly Significant at 0.1% , A= Control, B= Zn5, C= Zn10, D= Zn20 and E= Zn50ppm).

Table (2): Average and Std. for Seeds Germination Percentage for *Solanum lycopersicum* L. (Tomato) Treated with Pb (5, 10, 20 and 50 ppm) and the Distilled Water (Control)During Three days .(a) after One Day.

(a)

Concentration (ppm)	Fre.	Average %S.G.	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	3	90.00	5.00	77.58	102.42	0.000^{***}	A>B B>C C>D D>E
Pb5	3	78.33	2.89	71.16	85.50		
Pb10	3	70.00	0.00	70.00	70.00		
Pb20	3	61.67	5.77	47.32	76.01		
Pb50	3	51.67	2.89	44.50	58.84		

Table (2): Average and Std. for Seeds Germination Percentage for *Solanum lycopersicum* L. (Tomato) Treated with Pb (5, 10, 20 and 50 ppm) and the Distilled Water (Control)During Three days .(b) after Two days

(b)

Concentration (ppm)	Fre.	Average %S.G.	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	3	100.00	0.00	100.00	100.00	0.000^{***}	A>B B>C C>D D>E
Pb5	3	83.33	2.89	76.16	90.50		
Pb10	3	81.67	2.89	74.50	88.84		
Pb20	3	76.67	2.89	69.50	83.84		
Pb50	3	66.67	10.41	40.81	92.52		

Table (2): Average and Std. for Seeds Germination Percentage for *Solanum lycopersicum* L. (Tomato) Treated with Pb (5, 10, 20 and 50 ppm) and the Distilled Water (Control)During Three days . (c) after Three Days.

(c)

Concentration (ppm)	**Fre.**	**Average %S.G.**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Control	3	100.00	0.00	100.00	100.00	0.000^{***}	A>C B>C C>D D>E
Pb5	3	100.00	0.00	100.00	100.00		
Pb10	3	98.33	2.89	91.16	105.50		
Pb20	3	86.67	7.64	67.69	105.46		
Pb50	3	76.67	5.77	62.32	91.01		

(Fre.= Frequency, Average %S.G.= Average for Seeds Germination Percentage, ***Highly Significant at 0.1% , A= Control, B= Pb5, C= Pb10, D= Pb20 and E= Pb50ppm).

Table (3): Average and Std. for Seeds Germination Percentage for *Solanum lycopersicum* L. (Tomato) Treated with Mixture (Zn+ Pb) (5, 10, 20 and 50 ppm) and the Distilled Water(Control)During Three Days.(a) after One Day.

(a)

Concentration (ppm)	Fre.	Average %S.G.	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	3	90.00	5.00	77.58	102.42	0.000***	A>B B>C C>D D>E
Zn+Pb(5)	3	80.00	5.00	67.58	92.42		
Zn+Pb(10)	3	70.00	5.00	57.58	82.42		
Zn+Pb(20)	3	65.00	5.00	52.58	77.42		
Zn+Pb(50)	3	56.33	3.21	48.35	32.64		

Table (3): Average and Std. for Seeds Germination Percentage for *Solanum lycopersicum* L. (Tomato) Treated with Mixture (Zn+ Pb) (5, 10, 20 and 50 ppm) and the Distilled Water(Control)During Three Days.(b) after Two Days.

(b)

Concentration (ppm)	Fre.	Average %S.G.	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	3	100.00	0.00	100.00	100.00	0.000***	A>B B>C C>D D>E
Zn+Pb(5)	3	84.33	4.04	74.29	94.37		
Zn+Pb(10)	3	78.33	7.64	59.36	97.31		
Zn+Pb(20)	3	75.00	0.00	75.00	75.00		
Zn+Pb(50)	3	71.33	5.51	57.56	85.01		

Table (3): Average and Std. for Seeds Germination Percentage for *Solanum lycopersicum* L. (Tomato) Treated with Mixture (Zn+ Pb) (5, 10, 20 and 50 ppm) and the Distilled Water(Control)During Three Days. (c) after Three Days.

(c)

Concentration (ppm)	Fre.	Average %S.G.	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	3	100.00	0.00	100.00	100.00		A>C
Zn+Pb(5)	3	100.00	0.00	100.00	100.00		B>C
Zn+Pb(10)	3	96.67	0.58	95.23	98.10	0.000^{***}	C>D
Zn+Pb(20)	3	87.33	5.86	72.78	101.01		D>E
Zn+Pb(50)	3	78.67	3.21	70.68	86.65		

(Fre.= Frequency, Average %S.G.= Average for Seeds Germination Percentage ,***Highly Significant at 0.1% , A= Control, B=(Zn+Pb)5, C= (Zn+Pb)10, D= (Zn+Pb)20 and E=(Zn+Pb)50 ppm).

Table (4): Average and Std. for Weekly Shoot Length(cm)for*Solanum lycopersicum* L. (Tomato) Treated with Zn (5, 10, 20 and 50 ppm) During Growth Period. (a) 5 ppm.

(a)

Time	Fre.	Average W.S.L. (cm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Beg.	4	12.00	1.63	9.40	14.60	0.000^{***}	W10> W 9 W9> W8 W8>W7 W7>W6 W6>W5 W5>W4 W4>W3 W3>W2 W2>W1 W1>Beg.
W1	4	17.00	1.83	14.09	19.91		
W2	4	23.00	3.46	17.49	28.51		
W3	4	28.50	2.65	24.29	32.71		
W4	4	33.00	2.94	28.32	37.68		
W5	4	35.50	3.00	30.73	40.27		
W6	4	43.75	4.03	37.34	50.16		
W7	4	51.50	4.93	43.65	59.35		
W8	4	58.00	4.55	50.77	65.23		
W9	4	62.00	5.29	53.58	70.42		
W10	4	63.25	5.25	54.89	71.61		

Table (4): Average and Std. for Weekly Shoot Length(cm)for*Solanum lycopersicum* L. (Tomato) Treated with Zn (5, 10, 20 and 50 ppm) During Growth Period. (b) 10 ppm.

(b)

Time	**Fre.**	**Average W.S.L. (cm)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Beg.	4	13.25	0.96	11.73	14.77	0.000^{***}	W10> W9 W9>W8 W8> W7 W7> W6 W6> W5 W5> W4 W4> W3 W3>W2 W2>W1 W1>Beg.
W1	4	16.00	0.82	14.70	17.30		
W2	4	21.25	1.89	18.24	24.26		
W3	4	26.50	3.11	21.55	31.45		
W4	4	30.00	2.71	25.69	34.31		
W5	4	33.75	3.59	28.03	39.47		
W6	4	39.50	4.36	32.56	46.44		
W7	4	47.50	3.79	41.48	53.52		
W8	4	56.00	2.71	51.69	60.31		
W9	4	64.50	3.87	58.34	70.66		
W10	4	65.00	4.55	57.77	72.23		

Table (4): Average and Std. for Weekly Shoot Length(cm)for*Solanum lycopersicum* L. (Tomato) Treated with Zn (5, 10, 20 and 50 ppm) During Growth Period. (c) 20 ppm.

(c)

Time	**Fre.**	**Average W.S.L. (cm)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Beg.	4	12.00	1.41	9.75	14.25	0.000^{***}	W10>W9 W9>W8 W8>W7 W7>W6 W6>W5 W5>W4 W4>W3 W3>W2 W2>W1 W1>Beg.
W1	4	15.00	0.82	13.70	16.30		
W2	4	20.50	1.73	17.74	23.26		
W3	4	27.25	1.71	24.53	29.97		
W4	4	33.00	0.00	33.00	33.00		
W5	4	36.00	0.00	36.00	36.00		
W6	4	41.75	2.50	37.77	45.73		
W7	4	49.25	1.50	46.86	51.64		
W8	4	56.75	2.75	52.37	61.13		
W9	4	64.75	5.12	56.60	72.90		
W10	4	67.00	5.94	57.54	76.46		

Table (4): Average and Std. for Weekly Shoot Length(cm)for*Solanum lycopersicum* L. (Tomato) Treated with Zn (5, 10, 20 and 50 ppm) During Growth Period. (d) 50 ppm.

(d)

Time	Fre.	Average W.S.L. (cm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Beg.	4	11.00	2.16	7.56	14.44	0.000***	W10>W9 W9>W8 W8>W7 W7>W6 W6>W5 W5>W4 W4>W3 W3>W2 W2>W1 W1>Beg.
W1	4	15.25	0.96	13.73	16.77		
W2	4	20.00	1.83	17.09	22.91		
W3	4	25.75	1.50	23.36	28.14		
W4	4	29.75	1.71	27.03	32.47		
W5	4	33.25	2.06	29.97	36.53		
W6	4	39.50	2.65	35.29	43.71		
W7	4	47.00	2.94	42.32	51.68		
W8	4	54.75	4.99	46.81	62.69		
W9	4	61.25	6.29	51.24	71.26		
W10	4	65.50	9.68	50.10	80.90		

(Fre.= Frequency, Average W.S.L. (cm)=Average Weekly Shoot Length(cm),Beg.= Beginning, ***Highly Significant at 0.1% , W1= First week, W2= Second week,……..).

Table (5): Average and Std. for Weekly Shoot Length (cm) for*Solanum lycopersicum* L. (Tomato) Treated with Pb (5, 10, 20 and 50 ppm)During Growth Period. (a) 5 ppm.

(a)

Time	**Fre.**	**Average W.S.L. (cm)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Beg.	4	13.00	0.82	11.70	14.30	0.000^{***}	W10>W9 W9> W8 W8>W7 W7>W6 W6>W5 W5>W4 W4>W3 W3>W2 W2>W1 W1>Beg.
W1	4	19.25	1.50	16.86	21.64		
W2	4	25.25	3.50	19.68	30.82		
W3	4	30.00	4.62	22.65	37.35		
W4	4	34.00	4.69	26.54	41.46		
W5	4	37.25	3.50	31.68	42.82		
W6	4	46.75	3.95	40.47	53.03		
W7	4	56.50	4.80	48.87	64.13		
W8	4	59.25	5.91	49.85	68.65		
W9	4	63.00	7.39	51.23	74.77		
W10	4	64.50	7.51	52.56	76.44		

Table (5): Average and Std. for Weekly Shoot Length (cm) for*Solanum lycopersicum* L(Tomato) Treated with Pb (5, 10, 20 and 50 ppm)During Growth Period. (b) 10 ppm.

(b)

Time	**Fre.**	**Average W.S.L. (cm)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Beg.	4	13.25	1.89	10.24	16.26	0.000^{***}	W10>W9 W9> W8 W8>W7 W7>W6 W6>W5 W5>W4 W4>W3 W3>W2 W2>W1 W1>Beg.
W1	4	18.75	2.22	15.22	22.28		
W2	4	25.25	2.99	20.50	30.00		
W3	4	30.25	2.87	25.68	34.82		
W4	4	35.75	1.71	33.03	38.47		
W5	4	38.00	1.41	35.75	40.25		
W6	4	45.75	2.99	41.00	50.50		
W7	4	52.50	1.73	49.74	55.26		
W8	4	55.50	1.29	53.45	57.55		
W9	4	58.00	2.83	53.50	62.50		
W10	4	59.25	2.87	54.68	63.82		

Table (5): Average and Std. for Weekly Shoot Length (cm) for*Solanum lycopersicum* L. (Tomato) Treated with Pb (5, 10, 20 and 50 ppm)During Growth Period. (c) 20 ppm.

(c)

Time	Fre.	Average W.S.L. (cm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Beg.	4	12.50	2.08	9.19	15.81	0.000***	W10>W9 W9> W8 W8>W7 W7>W6 W6>W5 W5>W4 W4>W3 W3>W2 W2>W1 W1>Beg.
W1	4	18.75	1.71	16.03	21.47		
W2	4	25.25	2.63	21.07	29.43		
W3	4	33.50	1.73	30.74	36.26		
W4	4	36.00	1.41	33.75	38.25		
W5	4	39.50	2.65	35.29	43.71		
W6	4	47.50	4.65	40.09	54.91		
W7	4	56.25	5.62	47.31	65.19		
W8	4	59.75	7.41	47.96	71.54		
W9	4	63.00	8.21	49.94	76.06		
W10	4	64.25	8.38	50.91	77.59		

Table (5): Average and Std. for Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) Treated with Pb (5, 10, 20 and 50 ppm)During Growth Period. (d) 50 ppm.

(d)

Time	Fre.	Average W.S.L. (cm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Beg.	4	11.75	1.89	8.74	14.76	0.000^{***}	W10>W9 W9> W8 W8>W7 W7>W6 W6>W5 W5>W4 W4>W3 W3>W2 W2>W1 W1>Beg.
W1	4	18.50	2.38	14.71	22.29		
W2	4	25.25	1.50	22.86	27.64		
W3	4	29.75	1.26	27.75	31.75		
W4	4	34.75	3.30	29.49	40.01		
W5	4	38.25	3.86	32.10	44.40		
W6	4	45.75	3.10	40.82	50.68		
W7	4	53.25	2.22	49.72	56.78		
W8	4	58.50	2.89	53.91	63.09		
W9	4	63.25	5.38	54.69	71.81		
W10	4	64.50	5.45	55.83	73.17		

(Fre.= Frequency, Average W.S.L.(cm)=Average Weekly Shoot Length(cm),Beg.= Beginning, ***Highly Significant at 0.1% , W1= First week, W2= Second week,……..).

Table (6): Average and Std. for Weekly Shoot Length (cm) for*Solanum lycopersicum* L. (Tomato) Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm)During Growth Period. (a) 5 ppm.

(a)

Time	Fre.	Average W.S.L. (cm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Beg.	4	13.00	1.41	10.75	15.25	0.000***	W10>W9 W9> W8 W8>W7 W7>W6 W6>W5 W5>W4 W4>W3 W3>W2 W2>W1 W1>Beg.
W1	4	17.75	1.50	15.36	20.14		
W2	4	22.00	2.45	18.10	25.90		
W3	4	26.50	3.70	20.62	32.38		
W4	4	31.25	4.72	23.74	38.76		
W5	4	33.75	5.06	25.70	41.80		
W6	4	42.25	2.63	38.07	46.43		
W7	4	48.75	2.87	44.18	53.32		
W8	4	53.25	2.22	49.72	56.78		
W9	4	58.00	0.82	56.70	59.30		
W10	4	59.75	0.96	58.23	61.27		

Table (6): Average and Std. for Weekly Shoot Length (cm) for*Solanum lycopersicum* L. (Tomato) Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm)During Growth Period. (b) 10 ppm.

(b)

Time	Fre.	Average W.S.L. (cm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Beg.	4	11.50	1.00	9.91	13.09	0.000***	W10>W9 W9> W8 W8>W7 W7>W6 W6>W5 W5>W4 W4>W3 W3>W2 W2>W1 W1>Beg.
W1	4	14.75	0.50	13.95	15.55		
W2	4	19.75	0.96	18.23	21.27		
W3	4	25.75	2.63	21.57	29.93		
W4	4	30.50	4.36	23.56	37.44		
W5	4	34.50	5.51	25.74	43.26		
W6	4	42.75	5.56	33.90	51.60		
W7	4	48.50	6.14	38.73	58.27		
W8	4	55.25	5.19	46.99	63.51		
W9	4	62.75	1.71	60.03	65.47		
W10	4	64.75	2.50	60.77	68.73		

Table (6): Average and Std. for Weekly Shoot Length (cm) for *Solanum lycopersicum* L. (Tomato) Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) During Growth Period. (c) 20 ppm.

(c)

Time	Fre.	Average W.S.L. (cm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Beg.	4	12.25	0.96	10.73	13.77	0.000***	W10>W9 W9> W8 W8>W7 W7>W6 W6>W5 W5>W4 W4>W3 W3>W2 W2>W1 W1>Beg.
W1	4	17.50	1.29	15.45	19.55		
W2	4	23.00	1.83	20.09	25.91		
W3	4	27.50	3.11	22.55	32.45		
W4	4	32.50	4.04	26.07	38.93		
W5	4	36.75	5.32	28.29	45.21		
W6	4	44.25	3.77	38.24	50.26		
W7	4	53.75	6.55	43.33	64.17		
W8	4	59.75	7.14	48.40	71.10		
W9	4	63.00	6.68	52.37	73.63		
W10	4	64.50	7.05	53.29	75.71		

Table (6): Average and Std. for Weekly Shoot Length (cm) for*Solanum lycopersicum* L. (Tomato) Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) During Growth Period. (d) 50 ppm.

(d)

Time	**Fre.**	**Average W.S.L. (cm)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Beg.	4	11.50	1.73	8.74	14.26	0.000^{***}	W10>W9 W9> W8 W8>W7 W7>W6 W6>W5 W5>W4 W4>W3 W3>W2 W2>W1 W1>Beg.
W1	4	16.50	0.58	15.58	17.42		
W2	4	21.50	1.29	19.45	23.55		
W3	4	28.50	1.91	25.45	31.55		
W4	4	31.75	2.22	28.22	35.28		
W5	4	36.00	1.63	33.40	38.60		
W6	4	44.00	2.94	39.32	48.68		
W7	4	51.75	4.72	44.24	59.26		
W8	4	59.00	5.72	49.91	68.09		
W9	4	65.25	9.46	50.19	80.31		
W10	4	67.00	9.90	51.25	82.75		

(Fre.= Frequency, Average W.S.L. (cm)=Average Weekly Shoot Length(cm), Beg.= Beginning, ***Highly Significant at 0.1% , W1= First week, W2= Second week,……..).

Table (7): Average and Std. for Weekly Shoot Length(cm)for*Solanum lycopersicum* L. (Tomato) at the Distilled Water (Control)During Growth Period.

Time	**Fre.**	**Average W.S.L. (cm)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Beg.	4	11.00	1.15	9.16	12.84	0.000***	W10>W9 W9> W8 W8>W7 W7>W6 W6>W5 W5>W4 W4>W3 W3>W2 W2>W1 W1>Beg.
W1	4	17.25	0.96	15.73	18.77		
W2	4	22.25	0.96	20.73	23.77		
W3	4	27.50	0.58	26.58	28.42		
W4	4	32.25	0.96	30.73	33.77		
W5	4	38.00	0.82	36.70	39.30		
W6	4	44.75	0.96	43.23	46.27		
W7	4	52.25	1.26	50.25	54.25		
W8	4	60.25	5.38	51.69	68.81		
W9	4	61.50	2.52	57.50	65.50		
W10	4	62.75	2.50	58.77	66.73		

(Fre.= Frequency, Average W.S.L. (cm)=Average Weekly Shoot Length(cm), Beg.= Beginning, ***Highly Significant at 0.1% , W1= First week, W2= Second week,……..).

Table (8): Average and Std. for Length of Shoot and Root (cm) of *Solanum lycopersicum* L. (Tomato)Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water(Control) after 17 Weeks from the Planting (Until Mature of Plant).(a) Shoot Length.

(a)

Concentration (ppm)	**Fre.**	**Average Shoot Length (cm)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Control	4	62.75	2.50	58.77	66.72	0.589	Not Sig.
Zn5	4	63.25	2.25	54.89	71.60		
Zn10	4	66.50	3.69	60.61	72.38		
Zn20	4	67.00	5.94	57.54	76.45		
Zn50	4	63.00	5.94	53.54	72.45		

Table (8): Average and Std. for Length of Shoot and Root (cm) of *Solanum lycopersicum* L. (Tomato)Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water(Control) after 17 Weeks from the Planting (Until Mature of Plant). (b) Root Length.

(b)

Concentration (ppm)	**Fre.**	**Average Root Length (cm)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Control	4	38.75	6.29	28.74	48.76	0.260	Not Sig.
Zn5	4	53.75	14.93	29.99	77.51		
Zn10	4	50.75	10.72	33.69	67.81		
Zn20	4	53.25	7.89	40.70	65.80		
Zn50	4	46.75	9.00	32.44	61.06		

(Fre.= Frequency, Not Sig.= Not Significant).

Table (9): Average and Std. for Length ofShoot and Root (cm) of *Solanum lycopersicum* L. (Tomato)Treated withPb (5, 10, 20 and 50 ppm) and the Distilled Water(Control) after 17 Weeks from the Planting (Until Mature of Plant).(a) Shoot Length.

(a)

Concentration (ppm)	Fre.	Average Shoot Length (cm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	62.75	2.50	58.77	66.73	0.675	Not Sig.
Pb5	4	64.50	7.51	52.56	76.44		
Pb10	4	59.25	2.87	54.68	63.82		
Pb20	4	64.25	8.38	50.91	77.59		
Pb50	4	64.50	5.45	55.83	73.17		

Table (9): Average and Std. for Length ofShoot and Root (cm) of *Solanum lycopersicum* L. (Tomato)Treated withPb (5, 10, 20 and 50 ppm) and the Distilled Water(Control) after 17 Weeks from the Planting (Until Mature of Plant).(b) Root Length.

(b)

Concentration (ppm)	Fre.	Average Root Length (cm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	38.75	6.29	28.74	48.76	0.193	Not Sig.
Pb5	4	52.50	2.38	48.71	56.29		
Pb10	4	53.75	8.26	40.60	66.90		
Pb20	4	42.00	12.75	21.71	62.29		
Pb50	4	49.75	15.11	25.71	73.79		

(Fre.= Frequency, Not Sig.= Not Significant).

Table (10): Average and Std. for Length of Shoot and Root (cm) of *Solanum lycopersicum* L. (Tomato) Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Wate(Control) after 17 Weeks from the Planting (Until Mature of Plant).(a) Shoot Length.

(a)

Concentration (ppm)	Fre.	Average Shoot Length (cm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	62.75	2.50	58.77	66.73	0.486	Not Sig.
Zn5+Pb5	4	59.75	0.96	58.23	61.27		
Zn10+Pb10	4	64.75	2.50	60.77	68.73		
Zn20+Pb20	4	64.50	7.05	53.29	75.71		
Zn50+Pb50	4	67.00	9.90	51.25	82.75		

Table (10): Average and Std. for Length of Shoot and Root (cm) of *Solanum lycopersicum* L. (Tomato) Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Wate(Control) after 17 Weeks from the Planting (Until Mature of Plant). (b) Root Length.

(b)

Concentration (ppm)	Fre.	Average Root Length (cm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	38.75	6.29	28.74	48.76	0.463	Not Sig.
Zn5+Pb5	4	46.75	10.44	30.14	63.36		
Zn10+Pb10	4	39.75	4.11	33.21	46.29		
Zn20+Pb20	4	47.50	9.57	32.27	62.73		
Zn50+Pb50	4	40.00	10.80	22.81	57.19		

(Fre.= Frequency, Not Sig.= Not Significant).

Table (11): Average and Std. for Fresh Weight of Shoot and Root (g)of *Solanum lycopersicum* L. (Tomato)Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water (Control)after 17 Weeks from the Planting (Until Mature of Plant).(a) Fresh Weight of Shoot.

(a)

Concentration (ppm)	**Fre.**	**Average F.W.S. (g)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Control	4	54.25	10.37	37.75	70.75	0.916	Not Sig.
Zn5	4	52.00	7.44	40.16	63.84		
Zn10	4	57.25	19.10	26.85	87.65		
Zn20	4	50.50	13.92	38.36	72.64		
Zn50	4	56.75	4.35	49.83	63.67		

Table (11): Average and Std. for Fresh Weight of Shoot and Root (g)of *Solanum lycopersicum* L. (Tomato)Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water (Control)after 17 Weeks from the Planting (Until Mature of Plant).(b) Fresh Weight of Root.

(b)

Concentration (ppm)	**Fre.**	**Average F.W.R. (g)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Control	4	12.00	2.16	8.56	15.44	0.476	Not Sig.
Zn5	4	13.00	3.16	7.97	18.03		
Zn10	4	15.50	4.20	8.81	22.19		
Zn20	4	13.50	2.08	10.19	16.81		
Zn50	4	12.75	0.96	11.23	14.27		

(Fre.= Frequency, Average F.W.S.(g) =Average Fresh Weight of Shoot (g), Average F.W.R. (g) =Average Fresh Weight of Root (g), Not Sig.= Not Significant).

Table (12): Average and Std. for Fresh Weight of Shoot and Root (g) of *Solanum lycopersicum* L. (Tomato)Treated with Pb (5, 10, 20 and 50 ppm) and the Distilled Water(Control) after 17 Weeks from the Planting (until mature of plant).(a) Fresh Weight of Shoot.

(a)

Concentration (ppm)	**Fre.**	**Average F.W.S. (g)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Control	4	54.25	10.37	37.75	70.75	0.288	Not Sig.
Pb5	4	53.75	7.50	41.82	65.68		
Pb10	4	58.00	9.49	42.90	73.10		
Pb20	4	51.75	11.87	32.86	70.64		
Pb50	4	39.00	19.25	8.36	69.64		

Table (12): Average and Std. for Fresh Weight of Shoot and Root (g) of *Solanum lycopersicum* L. (Tomato)Treated with Pb (5, 10, 20 and 50 ppm) and the Distilled Water(Control) after 17 Weeks from the Planting (until mature of plant). (b) Fresh Weight of Root.

(b)

Concentration (ppm)	**Fre.**	**Average F.W.R. (g)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Control	4	12.00	2.16	8.56	15.44	0.267	Not Sig.
Pb5	4	15.50	2.75	13.37	20.13		
Pb10	4	14.00	4.32	7.13	20.87		
Pb20	4	16.00	2.83	11.50	20.50		
Pb50	4	11.75	0.58	10.58	12.42		

(Fre.= Frequency, Average F.W.S. (g) =Average Fresh Weight of Shoot(g), Average F.W.R. (g) =Average Fresh Weight of Root (g), Not Sig.= Not Significant).

Table (13): Average and Std. for Fresh Weight of Shoot and Root (g) of *Solanum lycopersicum* L. (Tomato)Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Water(Control) after 17 Weeks from the Planting (Until Mature of Plant).(a) Fresh Weight of Shoot.

(a)

Concentration (ppm)	Fre.	Average F.W.S. (g)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	54.25	10.37	37.75	70.75	0.119	Not Sig.
Zn5+Pb5	4	45.25	9.07	30.82	59.68		
Zn10+Pb10	4	66.75	12.53	46.82	86.68		
Zn20+Pb20	4	60.00	6.78	49.21	70.79		
Zn50+Pb50	4	58.00	13.34	36.77	79.23		

Table (13): Average and Std. for Fresh Weight of Shoot and Root (g) of *Solanum lycopersicum* L. (Tomato)Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Water(Control) after 17 Weeks from the Planting (Until Mature of Plant). (b) Fresh Weight of Root.

(b)

Concentration (ppm)	Fre.	Average F.W.R. (g)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	12.00	2.16	8.56	15.44	0.801	Not Sig.
Zn5+Pb5	4	11.00	1.41	8.75	13.25		
Zn10+Pb10	4	14.25	3.77	8.24	20.26		
Zn20+Pb20	4	12.75	1.50	10.36	15.14		
Zn50+Pb50	4	13.25	7.18	1.82	24.68		

(Fre.= Frequency, Average F.W.S. (g) =Average Fresh Weight of Shoot (g), Average F.W.R. (g) =Average Fresh Weight of Root (g), Not Sig.= Not Significant).

Table (14): Average and Std. for Dry Weight of Shoot and Root (g) of *Solanum lycopersicum* L. (Tomato) Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water(Control)after 17 Weeks from the Planting (Until Mature of Plant).(a) Dry Weight of Shoot.

(a)

Concentration (ppm)	Fre.	Average D.W.S. (g)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	12.25	1.71	9.53	14.97	0.858	Not Sig.
Zn5	4	11.00	2.45	7.10	14.90		
Zn10	4	12.75	4.35	5.83	19.67		
Zn20	4	11.50	0.58	10.58	12.42		
Zn50	4	11.50	1.29	9.45	13.55		

Table (14): Average and Std. for Dry Weight of Shoot and Root (g) of *Solanum lycopersicum* L. (Tomato) Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water(Control)after 17 Weeks from the Planting (Until Mature of Plant).(b) Dry Weight of Root.

(b)

Concentration (ppm)	Fre.	Average D.W.R. (g)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	2.03	0.33	1.50	2.55	0.085	Not Sig.
Zn5	4	2.33	0.85	0.98	3.67		
Zn10	4	2.23	0.74	2.05	4.40		
Zn20	4	2.13	0.71	1.00	3.25		
Zn50	4	2.15	0.17	1.87	3.43		

(Fre.= Frequency, Average D.W.S. (g) =Average Dry Weight of Shoot (g), Average D.W.R. (g) =Average Dry Weight of Root (g), Not Sig.= Not Significant).

Table (15): Average and Std. for Dry Weight of Shoot and Root (g) of *Solanum lycopersicum* L. (Tomato)Treated with Pb (5, 10, 20 and 50 ppm) and the Distilled Water (Control)after 17 Weeks from the Planting (Until Mature of Plant).(a) Dry Weight of Shoot.

(a)

Concentration (ppm)	Fre.	Average D.W.S. (g)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	12.25	1.71	9.53	14.97	0.622	Not Sig.
Pb5	4	11.25	2.22	7.72	14.78		
Pb10	4	12.00	4.24	5.25	18.75		
Pb20	4	11.25	1.71	8.53	13.97		
Pb50	4	9.50	2.38	5.71	13.29		

Table (15): Average and Std. for Dry Weight of Shoot and Root (g) of *Solanum lycopersicum* L. (Tomato)Treated with Pb (5, 10, 20 and 50 ppm) and the Distilled Water (Control)after 17 Weeks from the Planting (Until Mature of Plant). (b) Dry Weight of Root.

(b)

Concentration (ppm)	Fre.	Average D.W.R. (g)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	2.03	0.33	1.50	2.55	0.074	Not Sig.
Pb5	4	2.83	0.35	2.27	3.38		
Pb10	4	2.20	0.62	1.22	3.18		
Pb20	4	3.58	1.65	0.95	6.20		
Pb50	4	2.05	0.06	1.96	2.14		

(Fre.= Frequency, Average D.W.S. (g) =Average Dry Weight of Shoot (g), Average D.W.R. (g) =Average Dry Weight of Root (g), Not Sig.= Not Significant).

Table (16): Average and Std. for Dry Weight of Shoot and Root (g) of *Solanum lycopersicum* L. (Tomato)Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Water (Control)after 17 Weeks from the Planting (Until Mature of Plant).(a) Dry Weight of Shoot .

(a)

Concentration (ppm)	Fre.	Average D.W.S. (g)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	12.25	1.71	9.53	14.97	0.503	Not Sig.
Zn5+Pb5	4	9.75	1.26	7.75	11.75		
Zn10+Pb10	4	12.50	3.11	7.55	17.45		
Zn20+Pb20	4	12.00	3.16	6.97	17.03		
Zn50+Pb50	4	10.75	2.63	6.57	14.93		

Table (16): Average and Std. for Dry Weight of Shoot and Root (g) of *Solanum lycopersicum* L. (Tomato)Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Water (Control)after 17 Weeks from the Planting (Until Mature of Plant). (b) Dry Weight of Root .

(b)

Concentration (ppm)	Fre.	Average D.W.R. (g)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	2.03	0.33	1.50	2.55	0.435	Not Sig.
Zn5+Pb5	4	1.88	0.32	1.37	2.38		
Zn10+Pb10	4	2.30	0.48	1.54	3.06		
Zn20+Pb20	4	2.93	1.11	1.17	4.68		
Zn50+Pb50	4	2.33	1.25	0.34	4.31		

(Fre.= Frequency, Average D.W.S. (g) =Average Dry Weight of Shoot (g), Average D.W.R. (g) =Average Dry Weight of Root (g), Not Sig.= Not Significant).

Table (17): Average and Std. of Concentration of Zn (ppm) in the Parts of *Solanum lycopersicum* L. (Tomato) Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water(Control).(a) Root.

(a)

Concentration (ppm)	Fre.	Average Zn Con.R. (ppm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	0.93	0.05	0.84	1.01	0.000^{***}	E>D D>C C>B B>A
Zn5	4	1.12	0.02	1.09	1.15		
Zn10	4	1.43	0.08	1.31	1.55		
Zn20	4	1.67	0.18	1.39	1.95		
Zn50	4	2.26	0.21	1.92	2.60		

Table (17): Average and Std. of Concentration of Zn (ppm) in the Parts of *Solanum lycopersicum* L. (Tomato) Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water(Control). (b) Shoot.

(b)

Concentration (ppm)	Fre.	Average Zn Con.S. (ppm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	11.64	0.44	10.93	12.34	0.000^{***}	E>D D>C C>B B>A
Zn5	4	12.36	0.20	12.05	12.68		
Zn10	4	13.59	0.62	12.61	14.57		
Zn20	4	16.95	0.22	16.61	17.30		
Zn50	4	17.49	0.52	16.67	18.31		

Table (17): Average and Std. of Concentration of Zn (ppm) in the Parts of *Solanum lycopersicum* L. (Tomato) Treated with Zn (5, 10, 20 and 50 ppm) and the Distilled Water(Control). (c) Fruit.

(c)

Concentration (ppm)	**Fre.**	**Average Zn Con.F. ppm**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Control	4	0.40	0.06	0.31	0.49	0.000^{***}	E>D D>C C>B B>A
Zn5	4	0.55	0.03	0.50	0.60		
Zn10	4	0.61	0.01	0.61	0.62		
Zn20	4	0.64	0.01	0.62	0.65		
Zn50	4	0.73	0.09	0.58	0.87		

(Fre.= Frequency, Average Zn Con. R.(ppm) = Average Zn Concentration in Root (ppm), Average Zn Con. S.(ppm)= Average Zn Concentration in Shoot (ppm), Average Zn Con. F. (ppm)= Average Zn Concentration in Fruit, ***Highly Significant at 0.1% , A= Control, B= Zn5, C= Zn10, D= Zn20 and E= Zn50 ppm).

Table (18): Average and Std. of Concentration of Pb (ppm) in the Parts of *Solanum lycopersicum* L. (Tomato) Treated with Pb (5, 10, 20 and 50 ppm) and the Distilled Water(Control). (a) Root.

(a)

Concentration (ppm)	**Fre.**	**Average Pb Con.R. (ppm)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Control	4	0.10	0.00	0.09	0.10		E>D D>C C>B B>A
Pb5	4	0.29	0.01	0.27	0.31		
Pb10	4	0.54	0.01	0.53	0.54	0.000***	
Pb20	4	1.13	0.01	1.12	1.14		
Pb50	4	2.50	0.00	2.50	2.51		

Table (18): Average and Std. of Concentration of Pb (ppm) in the Parts of *Solanum lycopersicum* L. (Tomato) Treated with Pb (5, 10, 20 and 50 ppm) and the Distilled Water(Control). (b) Shoot.

(b)

Concentration (ppm)	**Fre.**	**Average Pb Con.S. (ppm)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Control	4	0.01	0.00	0.01	0.01		E>D D>C C>B B>A
Pb5	4	0.09	0.01	0.08	0.09		
Pb10	4	0.41	0.03	0.37	0.45	0.000***	
Pb20	4	0.46	0.01	0.45	0.48		
Pb50	4	0.49	0.01	0.47	0.51		

Table (18): Average and Std. of Concentration of Pb (ppm) in the Parts of *Solanum lycopersicum* L. (Tomato) Treated with Pb (5, 10, 20 and 50 ppm) and the Distilled Water(Control). (c) Fruit.

(c)

Concentration (ppm)	Fre.	Average Pb Con.F. (ppm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	0.0005	0.0001	0.0004	0.0006	0.000***	E>D D>C C>B B>A
Pb5	4	0.0021	0.0001	0.0020	0.0022		
Pb10	4	0.0023	0.0001	0.0021	0.0025		
Pb20	4	0.0026	0.0000	0.0025	0.0027		
Pb50	4	0.0031	0.0002	0.0028	0.0033		

(Fre.= Frequency, Average Pb Con. R.(ppm)= Average Pb Concentration in Root (ppm), Average Pb Con. S.(ppm)= Average Pb Concentration in Shoot (ppm), Average Pb Con.F. (ppm)= Average Pb Concentration in Fruit (ppm), ***Highly Significant at 0.1% , A= Control, B= Zn5, C= Zn10, D= Zn20 and E= Zn50ppm).

Table (19):Average and Std. of Concentration of Zn(mi) and Pb(mi) (ppm) in the Root of *Solanum lycopersicum* L. (Tomato)Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Water(Control).(a) Concentration of Zn(mi) (ppm) in Root.

(a)

Concentration (ppm)	Fre.	Average Zn(mi) Con.R. (ppm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	0.93	0.05	0.84	1.01		E>D
(Zn+Pb)5	4	1.18	0.09	1.03	1.33		D>C
(Zn+Pb)10	4	1.48	0.04	1.41	1.55	0.000^{***}	C>B
(Zn+Pb)20	4	1.60	0.03	1.56	1.64		B>A
(Zn+Pb)50	4	1.83	0.01	1.80	1.85		

Table (19):Average and Std. of Concentration of Zn(mi) and Pb(mi) (ppm) in the Root of *Solanum lycopersicum* L. (Tomato)Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Water(Control). (b) Concentration of Pb(mi) (ppm) in Root.

(b)

Concentration (ppm)	Fre.	Average Pb(mi) Con.R. (ppm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	0.10	0.00	0.09	0.10		E>D
(Zn+Pb)5	4	0.17	0.00	0.16	0.17		D>C
(Zn+Pb)10	4	0.20	0.01	0.19	0.22	0.000^{***}	C>B
(Zn+Pb)20	4	0.37	0.01	0.36	0.38		B>A
(Zn+Pb)50	4	0.80	0.01	0.78	0.81		

(Fre.= Frequency, Average Zn(mi) Con. R. (ppm)= Average Zn(mi) Concentration in Root (ppm), Average Pb(mi) Con. R.(ppm)= Average Pb(mi) Concentration in Root (ppm), ***Highly Significant at 0.1% , A= Control, B=(Zn+Pb)5, C=(Zn+Pb)10, D= (Zn+Pb)20 and E= (Zn+Pb)50 ppm).

Table (20): Average and Std. of Concentration of Zn(mi) and Pb(mi) (ppm) in the Shoot of *Solanum lycopersicum* L. (Tomato)Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Water(Control).(a) Concentration of Zn(mi) (ppm) in Shoot.

(a)

Concentration (ppm)	Fre.	Average Zn Con.S. (ppm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	11.64	0.44	10.93	12.34	0.000^{***}	E>D D>C C>B B>A
(Zn+Pb)5	4	12.40	0.10	12.39	12.43		
(Zn+Pb)10	4	13.60	0.62	13.56	13.60		
(Zn+Pb)20	4	16.90	0.22	16.88	16.90		
(Zn+Pb)50	4	17.50	0.52	17.47	17.50		

Table (20): Average and Std. of Concentration of Zn(mi) and Pb(mi) (ppm) in the Shoot of *Solanum lycopersicum* L. (Tomato)Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Water(Control).(b) Concentration of Pb(mi) (ppm) in Shoot.

(b)

Concentration (ppm)	Fre.	Average Pb(mi) Con.S. (ppm)	Std. Deviation	%95Confidence Interval for Mean		Statistical Inference	
				Lower Bound	Upper Bound	ANOVA	L.S.D
Control	4	0.01	0.00	0.01	0.01	0.000^{***}	E>D D>C C>B B>A
(Zn+Pb)5	4	0.04	0.00	0.04	0.04		
(Zn+Pb)10	4	0.04	0.00	0.04	0.04		
(Zn+Pb)20	4	0.05	0.00	0.05	0.05		
(Zn+Pb)50	4	0.12	0.01	0.11	0.13		

(Fre.= Frequency, Average Zn(mi) Con. S.(ppm)= Average Zn(mi) Concentration in Shoot (ppm), Average Pb(mi) Con. S.(ppm)= Average Pb(mi) Concentration in Shoot (ppm), ***Highly Significant at 0.1% , A= Control, B=(Zn+Pb)5, C=(Zn+Pb)10, D= (Zn+Pb)20 and E= (Zn+Pb)50 ppm).

Table (21): Average and Std. of Concentration of Zn(mi) and Pb(mi) (ppm) in the Fruit of *Solanum lycopersicum* L. (Tomato)Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Water(Control).(a) Concentration of Zn(mi) (ppm) in Fruit.

(a)

Concentration (ppm)	**Fre.**	**Average Zn(mi) Con.F. (ppm)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Control	4	0.40	0.06	0.31	0.49	0.000^{***}	E>D D>C C>B B>A
(Zn+Pb)5	4	0.58	0.02	0.54	0.62		
(Zn+Pb)10	4	0.63	0.01	0.62	0.65		
(Zn+Pb)20	4	0.66	0.01	0.65	0.67		
(Zn+Pb)50	4	0.73	0.01	0.71	0.74		

Table (21): Average and Std. of Concentration of Zn(mi) and Pb(mi) (ppm) in the Fruit of *Solanum lycopersicum* L. (Tomato)Treated with Mixture (Zn+Pb) (5, 10, 20 and 50 ppm) and the Distilled Water(Control).(b) Concentration of Pb(mi) (ppm) in Fruit.

(b)

Concentration (ppm)	**Fre.**	**Average Pb(mi) Con.F. (ppm)**	**Std. Deviation**	**%95Confidence Interval for Mean**		**Statistical Inference**	
				Lower Bound	**Upper Bound**	**ANOVA**	**L.S.D**
Control	4	0.0005	0.0001	0.0004	0.0006	0.000^{***}	E>D D>C C>B B>A
(Zn+Pb)5	4	0.0016	0.0000	0.0016	0.0017		
(Zn+Pb)10	4	0.0019	0.0000	0.0019	0.0019		
(Zn+Pb)20	4	0.0025	0.0001	0.0024	0.0027		
(Zn+Pb)50	4	0.0028	0.0000	0.0027	0.0028		

(Fre.= Frequency, Average Zn(mi) Con. F. (ppm)= Average Zn(mi) Concentration in Fruit (ppm), Average Pb(mi) Con. F. (ppm)= Average Pb(mi) Concentration in Fruit (ppm), ***Highly Significant at 0.1% , A= Control, B=(Zn+Pb)5, C=(Zn+Pb)10, D= (Zn+Pb)20 and E= (Zn+Pb)50 ppm.

الملخص

تتناول هذه الدراسة تأثير بعض العناصر الثقيلة (الزنك و الرصاص) على إنبات ونمو نبات الطماطم، وذلك باستعمال محاليل كل من الزنك والرصاص عند تركيزات (5، 10، 20، 50 ملجم /ل) حيث استعملت محاليل كلاً من الزنك و الرصاص مره بشكل منفرد و مرة أخرى في صورة خليط من الزنك والرصاص ، بالإضافة للماء المقطر منزوع الأملاح كشاهد ، لري البذور حتى الإنبات والنباتات حتى النضج (النباتات في هذه الدراسة نمت لمدة شهر قبل نقلها لأصص الدراسة بعد ذلك استغرقت 17 أسبوع حتى النضج).

من خلال تحليل النتائج المتحصل عليها إحصائياً تبين أن وجود الزنك والرصاص يقلل من إنبات بذورالطماطم،فكلما زاد تركيز الزنك والرصاص يقل معه إنبات البذور؛ أي أنها علاقة عكسية، بينت الدراسة أيضاً أن تأثير الرصاص منفرداً وخليط الرصاص مع الزنك كان اكبر من تأثير الزنك منفرداً على إنبات البذور.

أما نمو النبات فلم يلاحظ أي تأثير يذكر لهذه العناصر على نمو النبات من حيث الطول والوزن الرطب والجاف للمجموع الجذري والخضري للنبات، وذلك حتى التركيز 50 ملجم /ل .

تشير النتائج المتحصل عليها أيضاً إلى أن تركيز الزنك و الرصاص في الأجزاء المختلفة لنبات الطماطم (الجذور والسيقان والثمار) يزداد مع زيادة تركيز هذه العناصر في المعاملات من 5 الى 50 ملجم / ل،فبالتالي كان أعلى تركيز للزنك في أجزاء النبات عند معاملتها بالزنك (50ملجم / ل) حيث وصلت إلى 17.49 ملجم / كجم في الساق و 2.26 ملجم / كجم في الجذر بينما أقل تركيز وجد للزنك كان في الثمار حيث كانت0.73 ملجم / كجم ، هذه القيم تعتبر مرتفعة عند مقارنتها بالشاهد حيث كان تركيز الزنك فيها 11.64 ملجم / كجم في الساق و0.93 ملجم / كجم في الجذر وأقل تركيز كان في الثمار 0.40 ملجم / كجم.

أما الرصاص فقد كان أعلى تركيز له في الجذور ثم اقل منه في السيقان وأقل تركيز للرصاص سجل أيضاً في الثمار، سجلت أيضاً أعلى تركيزات للرصاص في أجزاء النبات المختلفة عند معاملتها بالرصاص (50ملجم /ل) فكانت 2.50 ملجم / كجم في الجذر و 0.49 ملجم / كجم في الساق وأقل تركيز في الثمار حيث كان 0.0031 ملجم / كجم ، هذه التركيزات تعتبر أيضاً مرتفعة عند مقارنتها بالنباتات المعاملة بالماء المقطر كشاهد حيث كان تركيز الرصاص فيها 0.10 ملجم / كجم في الجذر و0.01 ملجم / كجم في الساق وأقل تركيز كان في الثمار 0.0005 ملجم / كجم.

اوضحت النتائج أيضاً أن وجود الزنك مع الرصاص يقلل من امتصاص النبات للرصاص، حيث وجد أن تركيز الرصاص يقل في أجزاء النبات المختلفة في وجود الزنك حيث كانت تراكيز الرصاص في أجزاء النبات المختلفة عند معاملتها بخليط الزنك والرصاص(50 ملجم / ل) كالتالي 0.80 ملجم / كجم في الجذر و0.12 ملجم / كجم في الساق وأقل تركيز كان في الثمار 0.0028 ملجم / كجم.

جامعة بنغازي - كلية العلوم

قسم النبات

تقييم مخاطر بعض المعادن الثقيلة على نبات الطماطم

مقدمة من

حنان عوض علي الاوجلي

اشراف

د. محمد سالم حمودة

مشرف مساعد

أ. د. محمد الدراوي العايب

قدمتهذهالرسالةاستكمالألمتطلباتالحصولعلىدرجةالإجازةالعالية (الماجستير) فيالبيئة

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