International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 3, 2025
https://www.theaspd.com/ijes.php

An Impact of Lead Induced Toxicity on Growth Parameters and Chlorophyll Content of Tomato Plant (Pusa Ruby): A Pot Study

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Abstract-
The toxic effect of lead on Pb accumulation from soil on tomato plant (Pusa ruby): growth parameters (shoot length, root length, fresh weight, and dry weight), chlorophyll content and lead content in plants with different concentration of lead: control, 0.05mg/L, 0.1mg/L, 0.15mg/L, 0.2mg/L). Elevated lead concentrations, particularly 0.2mg/L Pb, had a detrimental effect on the germination rate and the uptake of elements by roots, shoots, and leaves. Germination rate decreases as the lead concentration increases in the soil, at concentration of 0.2mg/L the germination ratio is about 1:10 which is around negligible. Plants exposed to increased Pb concentrations may display a diversity of detrimental symptoms, decrease in the germination rate, reduction in growth parameters (shoot length, root length, fresh weight and dry weight) blackening of the roots, dwarfism in plant height, growth retardation, and other symptoms. as well as the chlorophyll content (chlorophyll a, and a+b) and the tissue water content also decreases. Lead content on plant parts (root, shoot and leaf) increases as the lead concentration increases from control to very high concentration. We concluded that increased the lead concentration in the plants, the plants went through the various detrimental toxicity to avoid these toxicity and negative effect on plants we should use mitigation strategies on lead.
Key words: *Lead (Pb), Tomato plant, Toxicity, Detrimental impacts.*

INTRODUCTION:

Since ancient times, lead has been understood and utilized. As a result, there has been a rise in lead exposure, primarily due to the element's increasing contamination of the environment (Dharmendra K. Gupta *et al.* 2020). A significant contaminant in aquatic and terrestrial environments is lead. Since lead is more soluble and harmful in soil, it is a dangerous trace element. The main reason why lead pollution occur , aside from the natural deteriorating process, are automobile exhaust emissions, industrial chimneys that use lead, storage battery effluents, industry, mining and smelting of lead ores, Plated with metal and ending processes, fertilizers, insecticides, and additions in gasoline and pigments (Akinci *et al.*, 2010). 0.002% of the Earth's crust is made up of lead, a heavy metal that is extremely toxic and non - dis-integrative. According to the the Agency for Environmental Protection (EPA), children inhabited that has total lead content equal to or greater than 400 parts per million (ppm) in a play area or, based on soil samples, an average of 1200 parts per million in the remaining yard constitutes a soil lead hazard (Collin *et al.*, 2022). Even at low quantities, lead is poisonous to living things and serves no biological purpose, While lead is not a necessary component, certain types of plants grow in lead-contaminated areas and acquire lead in various sections of their bodies. The first organ to come into contact with the different elements of the rhizosphere is the root (Fahr et al. 2013). Lead (Pb) may readily be absorbed by plants and build up on the soil's surface, where it can cause a variety of harmful symptoms. Pb has a major impact on the growth and development of plants, All morphological, physiological and biochemical processes are severely impacted if Pb levels beyond that critical limit (Zulfiqar *et al.*2019). Lead has an adverse effect on a number of biological processes in plants, In response to lead stress, Reactive oxygen species (ROS) are produced at high levels by plants. This results to oxidative damage, which increases the oxidation of general lipids, permeability of membranes, chloroplast decline, and hydrolysis of protein and DNA (Afzaal *et al.* 2020). There is research gap in the past studies of lead nitrate on the plant studies, effect on the germination and growth parameters of plants and its further studies (chlorophyll content, water content and the presence of lead in the plant parts by taking different concentration of lead).

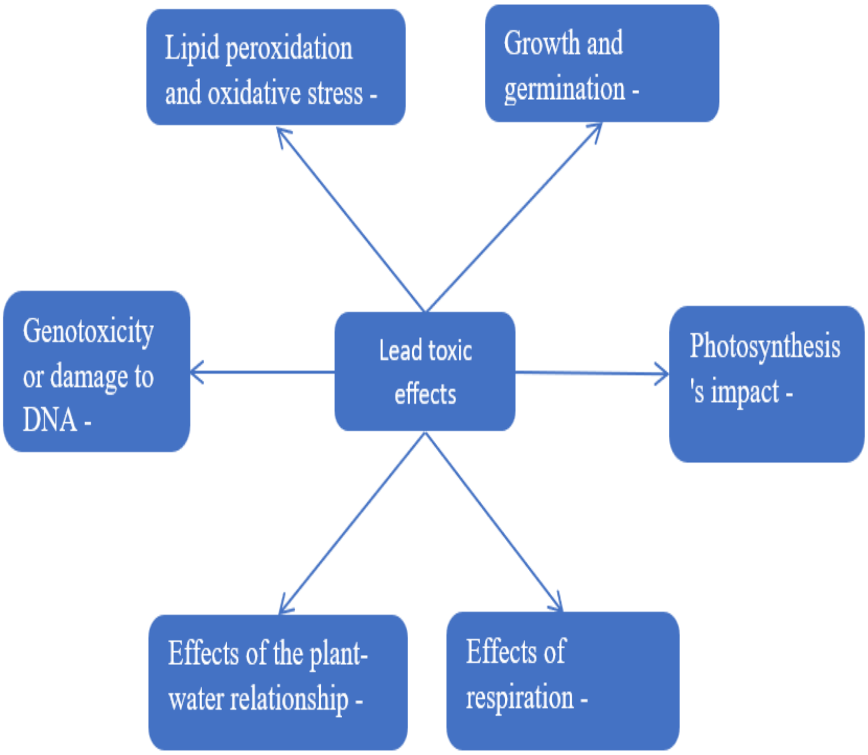

Figure 1. Effect of lead toxicity in plants (Source: Aaliya Ashraf *et al.,* 2021).

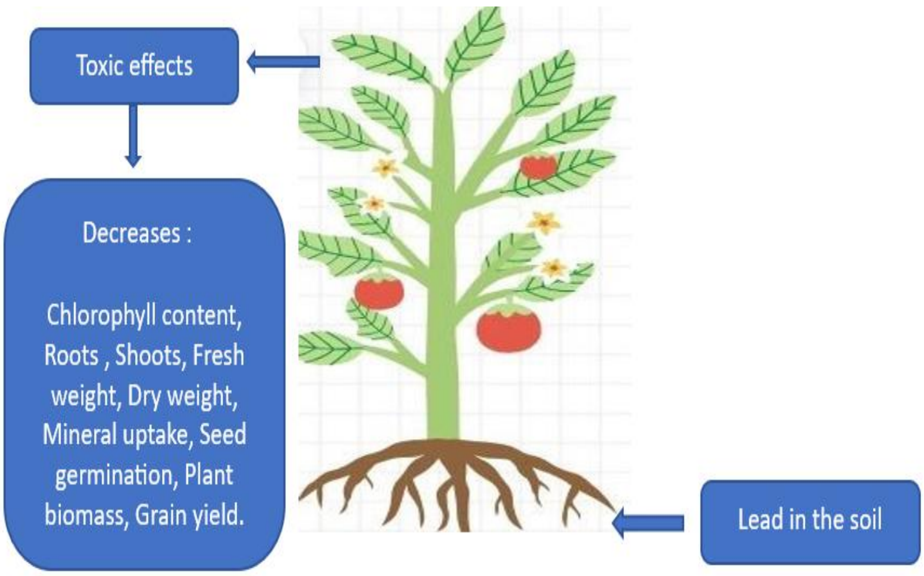

Figure 2. Toxic effects of lead in plant (Source: Usman Zulfiqar *et al.,* 2019).

Tomato is an edible berry of the plant that grow in all climate zones and are an excellent source of vitamins, minerals, and lycopene, With beyond five million hectares acquired in China, the United States of America, India, Turkey, and Egypt as the top five producers, respectively, it is the most significant fresh market vegetable farmed worldwide (Sartipnia *et al.*, 2013). Tomatoes are an excellent source of minerals and phytochemicals, including lycopene, potassium, iron, folic acid, vitamin C, flavonoids, ferulic acid, chlorogenic and other antioxidants, and these nutrients carry out a number of physiological tasks, such as preventing constipation, lowering high blood pressure, promoting blood circulation, preserving bodily fluids and lipid profiles, eliminating bodily pollutants, and preserving bone mass and strength (Ali et al., 2021; Collins et al., 2022). Some research reported the numerous pharmacological effects of tomato, such as anticancer, anti-inflammatory, anti-diabetic, anti-allergic, antioxidant potentials (Collins et al., 2022). The objective of this study were to investigate the lead toxicity of distinct concentration (Control, 0.05mg/L, 0.1mg/L, 0.15mg/L, 0.2mg/L) of lead on tomato plants- (a) to check the growth parameters (shoot length, root length, fresh weight and dry weight, (b) to check the chlorophyll content, (c) to check the lead content in tomato plant parts.

MATERIALS AND METHODS

i. Plant material and treatments

Tomato seeds were collected and authenticate from the IARI - Indian Agricultural Research Institute of India, and the variety of tomato collected for the research is (PUSA RUBY) (as it is perfect for the spring, summer, winter, and fall seasons). Tomato was chosen for this study because of its easy-to-measure parameters for examination, quick development cycle, sensitivity to external changes, and widespread usage. This experiment is greenhouse pot experiment five pots used for the experiment, the pots were filled with the ratio of 3 : 1 with garden soil and manure, and the pots were filled with the five different concentration of lead nitrate (Control, 0.05mg/L, 0.1mg/L, 0.15mg/L, 0.2mg/L). control is taken in the experimental setup for the comparison, The concentration of lead were chosen based on the earlier experiment Hirpa Abduro Ogo et al., 2022). The pots were arranged in equal distance. Tomato seeds were surface sterlized and double distilled water (ddH_2O) waas used for the soaking of tomato seeds for overnight. After the soaking process seeds were sowing into the experimentals pots for the easy germination, the seedling should be uniformly. Distilled water (dH_2O) was used for the irrigation of pots on every alternative days.

ii. Growth parameters

Growth parameters: Root length, Shoot length, fresh weight and dry weight, for the measurement of these parameters the plants were randomly selected from the control group as well as from all the other concentration groups. To get rid of soil particles, the plants were removed and given a thorough wash. Both the root and shoot lengths were measured from the bottom to the longest root branch and from the bottom to the tallest leaf tip, respectively. Each plant's roots and shoots were removed at the root-shoot junction and evaluated with a digital balance to determine the plant fresh weight (PFW). In the meantime, the roots and shoots were oven-dried for 72 hours at 70 °C to determine the plant dry weight (PDW) (Fahr et al. 2013, Nuamzanei *et al.,* 2024)).

iii. Chlorophyll content

Chlorophyll was measured from the third and fourth leaves. Leaf material- Crushed in a a pestle and mortar, adding 0.5g of $MgCO_3$ powder and 20 millilitres of 80% acetone, and then frozen for 4 hours at 40 degrees Celsius. Centrifuged for 5 minutes at 500 rpm and the absorbance were measured using a spectrophotometer. Using a spectrophotometer, the solution's color attenuation was measured at wavelengths of 645 and 663 nm compared to the solvent, and the chlorophyll content calculated according to the formula of (Kamble *et al.* 2015).
Formula:
Chl a= 11.75×A662.6 – 2.35×A645.6
Chl b=18.61×A645.6 – 3.96× A662.6
Where, A is absorbance.

RESULTS AND DISCUSSION

- Effect of lead nitrate on growth parameters (shoot length, root length, fresh weight, dry weight).

Increased lead concentration tempered the growth parameters (shoot lenght, root length, fresh weight and dry weight) in the tomato plant. This research concluded that as the lead concentration increases from (control to 0.05mg/L, 0.1mg/L, 0.15mg/L, 0.2mg/L) the shoot length and root length decreases as we had studied in previous research also, which stunted the growth of the plants and also decreases the uptake of nutrients from the soil (Usman Zulfiqar *et al.,* 2019). Plant fresh weight and dry weight also decreases as the concentration of lead nitrate increases which results into shrivels of the plant (leaves dry and wrinkled). (Figure 3. sowed the graphical representation of the result.

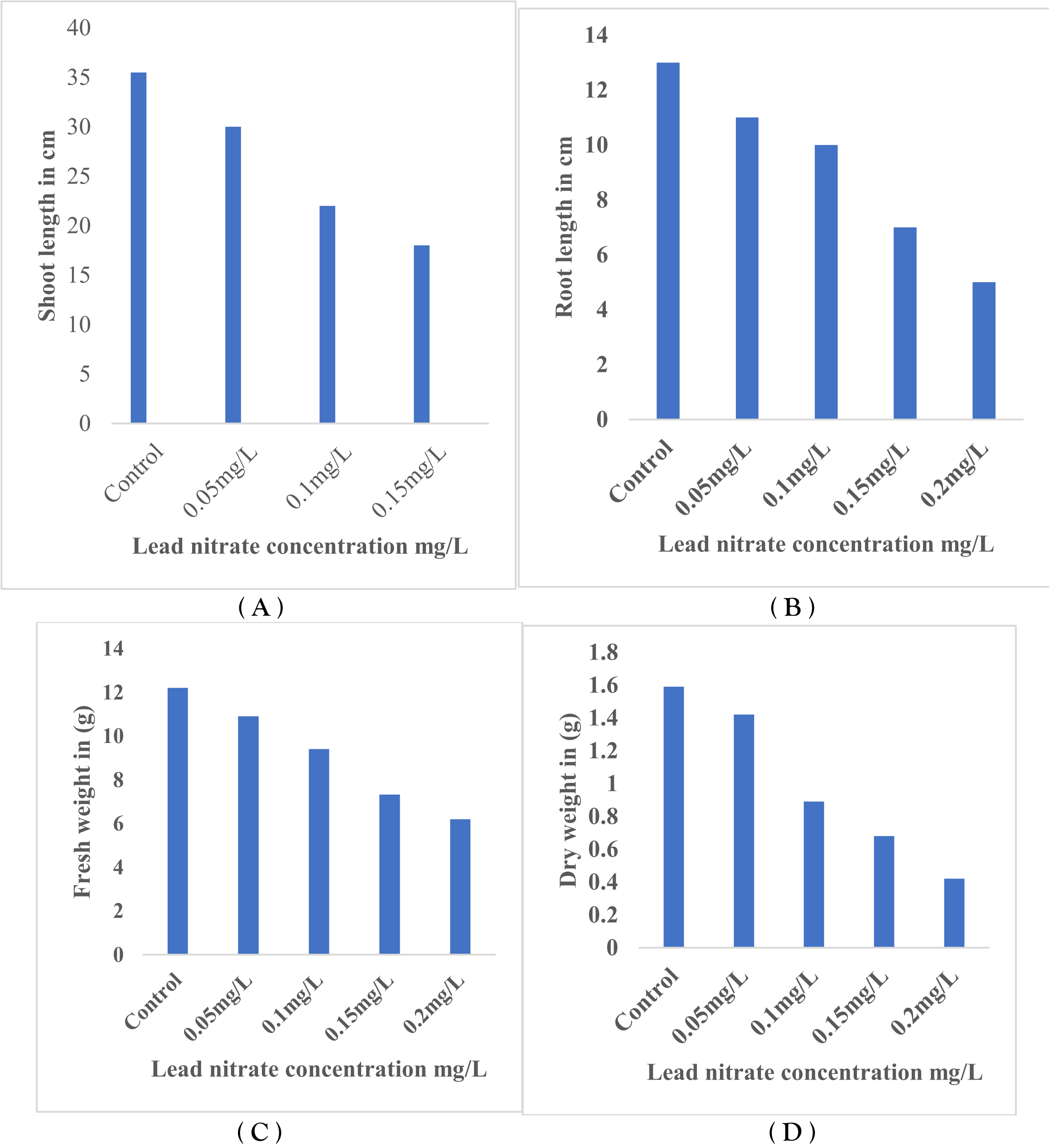

Figure 3. (A) Shoot length, (B) Root length, (C) Fresh weight, (D) Dry weight of tomato plant with different concentration of lead nitrate.

- Effect of lead nitrate on chlorophyll content

As the lead concentration increases the chlorophyll content affect negatively chlorophyll a , chlorophyll b and chlorophyll a + b. chlorophyll a, b and a + b were fold greater in higher concentration then in control (0.05mg/L, 0.1mg/L, 0.15mg/L, 0.2mg/L), The reduction in sunlight harvesting for photosynthesis is indicated by the decrease in the amount of chlorophyll in the tomato plants treated with PE - MP. Graph implicate the Chlorophyll content in (g).

Table 2. Chlorophyll content of tomato plant with different concentration of Lead nitrate.

S.NO	LEAD NITRATE CONCENTRATION	CHLOROPHYLL CONTENT
1.	Control	1.292
2.	0.05mg/L	1.133
3.	0.1mg/L	0.981

4.	0.15mg/L	0.721
5.	0.2mg/L	0.549

CONCLUSION

This present study investigated the effect of lead nitrate on the growth and development of tomato plant and on chlorophyll content. The results revealed the presence lead nitrate inside tomato roots suggesting that they can potentially accumulate into the food chain. The toxic effect of Microplastic decrease in the shoot length which stunted the growth of tomato plant, as well as decreases in the root length of the plant. Fresh weight and dry weight also decreases when the concentration of lead nitrate increases from control to 0.2mg/L. chlorophyll content decreases as compared to control. The reduction in sunlight harvesting for photosynthesis is indicated by the decrease in the amount of chlorophyll in the tomato plants treated with lead nitrate. This research concluded the toxicity of lead nitrate on growth parameters and chlorophyll content of tomato plant.
The current investigation's generalizability is limited due to the use of a single plant species. The impact of lead nitrate on plants might exhibit significant variation depending on the specific lead composition and different plant species.

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