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Impact of Toxic Heavy metal contaminated soil on an ornamental plant *Tagetes erecta* L.

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Abstract

Phytoremediation is a cost-effective, aesthetically pleasing, and long-term solution for contaminated environments. The report makes recommendations about the mobility, bioavailability, and reaction of plants to heavy metals in the soil. An investigation into the phytotoxicity of heavy metals like zink (Zn) and lead (Pb) on the growth of Tagetes erecta L. was carried out in a shaded area of college campus. The chosen metals were independently dosed in soil at different concentrations: 240 mg/l for Zink (Zn) and lead (Pb). The findings showed that, in comparison to control, the total length of the plant reduces as the concentration of heavy metals in the soil increases.

Key word : Heavy metal, Phytoremediation, Ornamental plant, *Tagetes erecta* L., Accumulation.

Heavy metal-contaminated soils are a major source of issues for the environment and human health, necessitating the development of practical technological solutions. Heavy metal contamination is a major environmental issue around the world. Because they are difficult to convert into non-toxic forms, these toxicants belong to a special class of substances. The release of wastewater and garbage from anthropogenic sources has led to a reasonable increase in heavy metal soil pollution during the past few decades[15]. Even at very low concentrations, metals like Pb, Hg, Cd, Zn, Ar, and Cr are poisonous to life and serve no biological purpose[33]. Soil pollution is a major issue in many industrialized countries. This is particularly true in densely populated areas where property is heavily utilized and, as a result, a contaminated site cannot be easily cleared. Numerous factors can contribute to soil contamination such as heavy metals including Cd, Cr, Cu, Ni, Pb, and Zn in sediments and soils in order to assess the level of pollution in both terrestrial and aquatic settings. Various combinations of concentrated acids, such as hydroflouric acid (HF), hydrochloric acid (HCl), nitric acid (HNO_3), perchloric acid ($HClO_4$), and sulfuric acid (H_2SO_4), are utilized for this purpose in different digesting procedures[9]. The chemical reactivity of metal

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ions with membrane systems, enzymes, and structural proteins of cells is generally the cause of their toxicity to mammalian systems. The organs that acquire the greatest quantities of the metal in vivo are often the target organs of a given metal toxicity. This frequently depends on the metal's chemical makeup, including its volatility, lipid solubility, and Valency state, as well as the exposure route. Similar electron characteristics are shared by metals like Zn^{2+}, Cd^{2+}, and Cu^{2+}, but they differ in terms of their chemical makeup, ion radius, and affinity for biological ligands.

It follows that their physiological impacts must also be different. This study examined how different Pb, Cu, Zn, and Cd concentrations affected the water relations in marigold. For the preparation of the manuscript relevant literature[1-41] has been consulted.

Preparation of plant sample :

The prepared soil samples were utilized to fill the pots. There were made 30.48 cm in diameter and 45.72 cm height earthen pots. To prevent leaching, plastic bags were used to line these pots. Five kg of prepared soil, the same calculated amount, were put into each pot. A phytoremediation investigation was carried out on potted decorative plants. *Tagetes erecta*, an attractive plant that grows annually, was chosen for the experiment. It is a widely distributed plant that grows quickly and is readily available. This species can tolerate lead and zinc, two heavy metals.

Estimation of Total Sugar: Nelson-Somogyi *method*[26] *:*

Plant extract was made with 80% ethanol. 1ml of 1N H_2SO_4 was added to 1ml of alcoholic aliquot, and the combination was hydrolyzed for thirty minutes at 49 ^oC in a water bath. After adding two to three drops of methyl red indicator, 1N NaOH was added drop by drop to neutralize the reaction (color changed from pink to yellow). After adding 1 ml of Nelson Somogyi's reagent to it, the test tube was placed in a bath of boiling water for 20 minutes. The test tube was allowed to cool before 1 ml of arsenomolybdate was added, and 20 ml of distilled water was needed to complete the volume. 540 nm was the O.D. found. The same process was used to prepare Blank. The benchmark utilized was glucose (Fig. 1).

Estimation of Reducing sugar: Nelson-Somogyi *method*[26] *:*

Plant extract was made with 80% ethanol. To 1ml of this alcoholic extract, 1ml Nelson Somogyi's reagent was added and kept in boiling waterbath for 20min. The test tube was allowed to cool before 1 ml of arsenomolybdate was added, and 20 ml of distilled water was needed to complete the volume. At 540 nm, the optical density was recorded. The same process was used to prepare Blank. The standard utilized was glucose (Fig. 2)

Estimation of Starch: Chinoy, J. J.[13] *:*

The sample was prepared using an 80% ethanol extraction. The residue left over after all rounds of centrifugation and homogenization was combined and used as a sample to measure the starch concentration. In order to gelatinize the residue, it was dissolved in 20 ml of 0.7% KOH and heated for 40 minutes. After letting it cool, a centrifuge was used.

Supernatant was employed in additional examination. After adding 1 ml of the supernatant (aliquot), 0.5 ml of 20% acetic acid, 1 ml of the citrate buffer (0.05 M, pH 5.0), and 1 ml of I_2KI, the mixture was incubated for 10 minutes at room temperature. At 600 nm, the optical density was observed. The same process was used to prepare Blank. The standard ingredient was starch.

Table-1 shows that marigold (*Tagetes erecta*) plant growth varies with heavy metal concentrations. The merigold plant was shown to grow well at the starting concentrations of the corresponding heavy metals.The analysis of variance (ANOVA) test was also used to evaluate for significant toxicity.

Table-1. Accumulation of Pb an Zn in *Tagetes erecta* L.

Parameters	Control	Pb 240 mg/l	Zn 240 mg/l
Total sugar (mg/gm)	9.31±0.01	7.42±0.02	3.21±0.01
Reducing Sugar (mg/gm)	3.52±0.02	2.04±0.03	1.15±0.02
Starch (mg/gm)	14.23±0.04	13.58±0.05	10.08±0.03

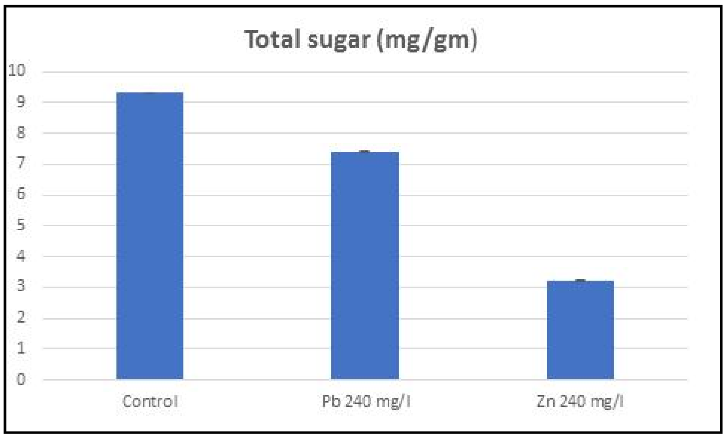

Fig. 1. Total sugar content in *Tagetes erecta*

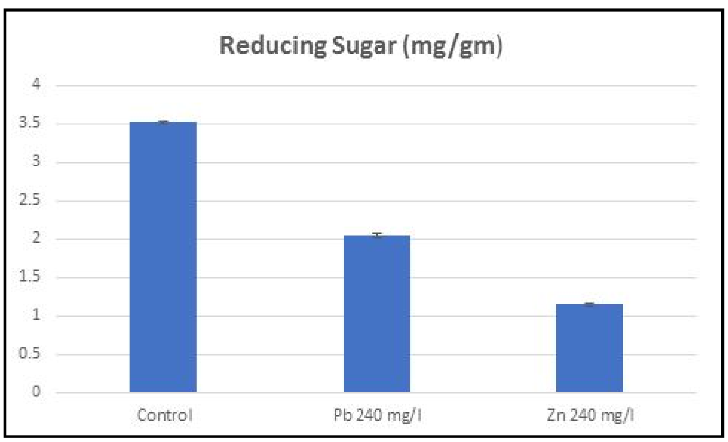

Fig. 2. Total reducing sugar contents in *Tagetes erecta*

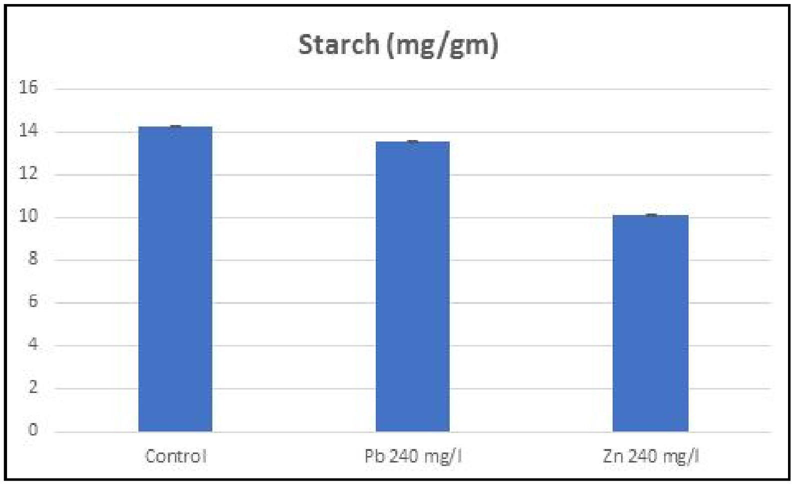

Fig. 3. Starch contents in *Tagetes erecta*

This Research aims at three major phytoconstituent total sugar, reducing sugar and starch in *Tagetes erecta* L. In control condition total Sugar (9.31±0.01), Reducing sugar (3.52±0.02) and Starch (14.23±0.04). while the treatment of pb and Zn (240 mg/l) showing the decreasing amount of these phytoconstituent. These Result is due to the accumulation of heavy metal (Zn an Pb) in *Tagetes erecta* L.

Heavy metals are crucial for plant growth and development since they are found in numerous enzymes and proteins. However, it has been shown that rising levels of heavy metals have caused the appearance of poisoning symptoms, such as stunting plant growth[20]. Heavy Metals like zinc (Zn), manganese (Mn), and copper (Cu), lead (Pb) is a very toxic heavy metal that disrupts several plant physiological systems and has no biological role.

Additionally, it accelerates the generation of reactive oxygen species (ROS), which damages lipid membranes and damages chlorophyll and photosynthetic activities, ultimately inhibiting the plant's ability to develop[24].

The study suggests that due to Zn and Pb accumulation in Tagetes erecta L., there was very less negative effect on its growth parameters Biochemical parameters were affected upto certain extent, but the plant showed a very good capability to accumulate Zn and Pb. So *Tagetes erecta* L. can be effectively used for the phytoremediation of the soils contaminated with Zinc and Lead.

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