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Original Article

Phytoaccumulation of Mercuric Chloride Polluted Soil Using Tomato Plants.
(Lycopersicon esculentum Mill.)

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Abstract

The present work was made to study the phytoaccumulation of Mercuric chloride polluted soil using tomato plants. Plants response to very high concentration of toxic heavy metals by employing two basis strategies. (I) Exclusion, accumulating and sequestration of metals. In the exclusion strategy, plants maintain metals at relatively low concentrations within plants by avoiding excessive metal uptake and Transport. (II) In second strategy plants have an extremely high capacity to take up metals by roots and translocation and store them in the shoot and leaves. The tomato plants with high metal uptake and accumulating capacity have been termed hyper accumulator species. The plants test the heavy metal accumulation ability of tomato. Mercuric chloride was given to tomato (Lycopersicon esculentum Mill.) plants grown in pot culture experiments by soil drenching method. The accumulation and uptake of Mercuric chloride was tested from root, stem and leaves of treated plants. The results showed higher concentration of Mercuric chloride (150 mg kg⁻¹ soil) resulted in maximum accumulation in root, stem and leaves of tomato plants, while the lower concentrations of Mercuric chloride (10 mg kg⁻¹ soil) in the soil did not show any significant effect.

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Keyword : Mercuric chloride, Phytoaccumulation, Tomato plants, Heavy metal, and Pollution.

Introduction

Mercuric chloride being a highly toxic metal pollutant of soils, inhibit root shoot growth and yield production, affects nutrient uptake and homeostasis, and is frequently accumulation by agriculturally important crops and then enters the food chain with a significant potential to impair animals and human health (di Toppi and Gabrielli.,1999). The reduction of biomass by Mercuric chloride toxicity could be the direct consequence of the inhibition of chlorophyll synthesis and photosynthesis (Padmaja et al., 1990). Excessive amount of cadmium may cause decreased uptake of nutrient elements, inhibition of various enzyme activities, induction of oxidative stress including alteration in enzymes of the antioxidant defense system (Sandalio et al., 2001).

The sensitivity of plants to heavy metal depends on an interrelated network of physiological and molecular mechanisms such as (I) uptake and accumulation of metals through binding to extracellular exudates and cell wall constituents. (II) Efflux of heavy metals from cytoplasm to extracellular compartments including vacuoles. (III) Complexation of heavy metal ions inside the cell by various substance , for example ,organic acids , amino acids , phytochelatins ,and metallothioneins.(IV) accumulation of osmolytes and osmoprotectants and induction of antioxidative enzyme (V) activation or modification of plant metabolism to allow adequate functioning of metabolic pathways and rapid repair of damaged cell structure (Cho et al.,2003).

Mercuric chloride

Mercuric chloride is extremely toxic to plants even at low levels. It passes from soil to plants and further through food chain to animals and to man. It forms a major constituent of many industrial discharges which affects the growth and productivity of the crop plants.

Tomato plants

Tomato is one of the food plants.

a. It grows in different kinds of soil and in different seasons.
b. It is one of the fast growing plants.
c. Tomato plants one of hyper accumulator plants in Mercuric chloride contaminated soil.

Materials and methods

In the present investigation has been carried out to find out the effect of Mercuric chloride a heavy metal pollutant on growth, biochemicals and phytoaccumulation of tomato plants. (Lycopersicon esculentum Mill.)

Seed collection

The Lycopersicon esculentum (Mill.) seeds were collected
from Tamil Nadu Agricultural University. (TNAU) Coimbatore, seeds with uniform size were chosen for this experiment.

The seeds were sterilized with 0.1 percent mercuric chloride solution and washed thoroughly with tap water and then distilled water.

**Preparation of metal solution**

Different concentrations of Mercuric chloride (25, 50, 75, 100 and 125 mg kg\(^{-1}\) soil) were prepared and used for this experiment.

**Pot culture experiments**

The tomato seeds were grown in pots. The untreated soil was control and in soil to which Mercuric chloride has been applied (25, 50, 75, 100, and 125 mg kg\(^{-1}\) soil) is considered as treatments. The inner surface of pots was bind with a polythene sheet. Each pot contained 3 kg of air dried soil. The different concentration of metal (Mercuric chloride) was mixed with the soil. Ten seeds were sown in each pot for all treatments. All pots were watered to field capacity daily. In each treatment including the control was replicated three times.

**Sampling**

The plant samples collected at fifteen days interval, up to harvest stage viz., 15, 30, 45 and 60\(^{th}\) day for the measurement of various morphological growth parameters. The biochemical, enzymes, nutrients and phytoaccumulation of Mercuric chloride content of the tomato plants were estimated at all the four sampling periods. Six plants from each replicate of a pot were analyzed for its various parameters and the average was calculated. These mean values were used for statistical analysis.

**Experimental result and Discussion**

**Uptake and phytoaccumulation of Mercuric chloride on tomato root**

Mercuric chloride content of root in tomato plants is recorded in Table 1. Maximum Mercuric chloride content of tomato root (0.42, 0.64, 0.89, and 1.36. µg g\(^{-1}\)) was observed at 150 mg kg\(^{-1}\). Minimum Mercuric chloride level in the soil. The minimum Mercuric chloride content of tomato root (0.18, 0.24, 0.52, and 0.85 µg g\(^{-1}\)) was observed in 10 mg kg\(^{-1}\) soil.

**Uptake and accumulation of Mercuric chloride on tomato stem**

Mercuric chloride content of stem in tomato plants is recorded in Table 2. Maximum Mercuric chloride content of tomato stem (0.25, 0.40, 0.75, and 1.14 µg g\(^{-1}\)) was observed at 150 mg kg\(^{-1}\). Minimum Mercuric chloride content of tomato stem (0.10, 0.20, 0.46, and 0.61. µg g\(^{-1}\)) was observed in 10 mgkg\(^{-1}\) soil.

**Uptake and accumulation of Mercuric chloride on tomato leaves**

Mercuric chloride content of leaves in tomato plants is recorded in 15, 30, 45 and 60 Maximum Mercuric chloride content of tomato leaves (0.20, 0.37, 0.62, and 1.95. µg g\(^{-1}\)) was observed at 150 mg kg\(^{-1}\). Minimum Mercuric chloride content of tomato leaves (0.08, 0.11, 0.25, and 0.48 µg g\(^{-1}\)) was observed in 10 mg kg\(^{-1}\) soil.
Table 2: Uptake and accumulation of Mercuric chloride (µg g⁻¹) on 30th DAS Plant parts (Lycopersicon esculentum Mill.)

<table>
<thead>
<tr>
<th>Mercuric chloride added in the soil (mg kg⁻¹)</th>
<th>Root (µg g⁻¹)</th>
<th>Stem (µg g⁻¹)</th>
<th>Leaves (µg g⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>0.31 ±0.01</td>
<td>0.27 ±0.01</td>
<td>0.13 ±0.05</td>
</tr>
<tr>
<td>50</td>
<td>0.38 ±0.01</td>
<td>0.31 ±0.01</td>
<td>0.18 ±0.05</td>
</tr>
<tr>
<td>75</td>
<td>0.40 ±0.01</td>
<td>0.35 ±0.01</td>
<td>0.24 ±0.01</td>
</tr>
<tr>
<td>100</td>
<td>0.47 ±0.02</td>
<td>0.38 ±0.01</td>
<td>0.29 ±0.01</td>
</tr>
<tr>
<td>125</td>
<td>0.51 ±0.02</td>
<td>0.43 ±0.01</td>
<td>0.32 ±0.01</td>
</tr>
</tbody>
</table>

Table 3 : Uptake and accumulation of Mercuric chloride (µg g⁻¹) on 45th DAS Plant parts. (Lycopersicon esculentum Mill.)

<table>
<thead>
<tr>
<th>Mercuric chloride added in the soil (mg kg⁻¹)</th>
<th>Root (µg g⁻¹)</th>
<th>Stem (µg g⁻¹)</th>
<th>Leaves (µg g⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>0.58 ±0.02</td>
<td>0.49 ±0.02</td>
<td>0.32 ±0.01</td>
</tr>
<tr>
<td>50</td>
<td>0.63 ±0.02</td>
<td>0.56 ±0.02</td>
<td>0.38 ±0.01</td>
</tr>
<tr>
<td>75</td>
<td>0.71 ±0.03</td>
<td>0.65 ±0.02</td>
<td>0.43 ±0.01</td>
</tr>
<tr>
<td>100</td>
<td>0.78 ±0.03</td>
<td>0.69 ±0.03</td>
<td>0.49 ±0.01</td>
</tr>
<tr>
<td>125</td>
<td>0.81 ±0.03</td>
<td>0.72 ±0.03</td>
<td>0.54 ±0.02</td>
</tr>
</tbody>
</table>

Table 4 : Uptake and accumulation of Mercuric chloride (µg g⁻¹) on 60th DAS Plant parts. (Lycopersicon esculentum Mill.)

<table>
<thead>
<tr>
<th>Mercuric chloride added in the soil (mg kg⁻¹)</th>
<th>Root (µg g⁻¹)</th>
<th>Stem (µg g⁻¹)</th>
<th>Leaves (µg g⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>0.93 ±0.04</td>
<td>0.73 ±0.03</td>
<td>0.55 ±0.02</td>
</tr>
<tr>
<td>50</td>
<td>0.99 ±0.04</td>
<td>0.79 ±0.03</td>
<td>0.59 ±0.02</td>
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<tr>
<td>75</td>
<td>1.17 ±0.05</td>
<td>0.81 ±0.03</td>
<td>0.67 ±0.03</td>
</tr>
<tr>
<td>100</td>
<td>1.22 ±0.05</td>
<td>0.85 ±0.03</td>
<td>0.79 ±0.03</td>
</tr>
<tr>
<td>125</td>
<td>1.29 ±0.05</td>
<td>0.94 ±0.04</td>
<td>0.81 ±0.03</td>
</tr>
</tbody>
</table>

Reference
15. Sandal,L.M.,dalu,r.h.,Gomez,m.,romero-puertas ,M.C.,del Rio,l.a.,2001.cadmium-induced changes in the growth.

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