Studies on the effect of cadmium chloride with super phosphate on *Capsicum annuum* L. and *Acora calamus* L.

Suresh Kumar J*, R. Nirmala and M. Krishnaveni

PG and Research Department of Botany, Government Arts College, Thiruvalluvar University

Thiruvannamalai, Tamil Nadu, India

*Corresponding author:jayninebiotech@gmail.com

Abstract

Heavy metals such as cadmium chloride, lead, mercury, chromium, cobalt etc. may cause many problems to plants, animals and the health of human beings. In this research, the effect of cadmium chloride on seed germination percentage, biomass and biochemical compounds of *Capsicum annuum* L. and *Acora calamus* L. were investigated. The experiments were carried out by pot cultures and during the period of four weeks. The samples were collected after 28th day and used for morphological and biochemical studies. The results of this study indicated that cadmium chloride with super phosphate had very low toxic effects on seed germination than cadmium chloride treated seeds.

Keywords: *Capsicum annuum*, *Acora calamus*, pollutants

Introduction

Inorganic pollutants occur as natural elements in the earth’s crust or atmosphere and human activities such as mining, industry, agriculture and military activities promote their release into the environment, leading to toxicity (Fargasova, 1994) heavy metals may enter the human body through food, water, air or absorption through the skin (Life Extention, 2003). Heavy metals interferes with several metabolic processes, causing toxicity to the plants as exhibited by reduced seed germination, root and shoots growth and phytomass, chlorosis, photosynthetic impairing, stunting and finally plant death (Gardea-Torresday et al., 2004; Roy et al., 2005). Unlike organic compounds, metals cannot be degraded (Salt et al., 1995) and their cleanup requires their immobilization and toxicity reduction or removal. Currently, conventional remediation methods of heavy metal contaminated soils include electro-kinetic treatment, chemical oxidation or reduction, leaching, solidification, vitrification, excavation and offsite treatment. But a majority of these technologies are costly to implement and cause further disturbance to the already damaged environment (Bio-Wise, 2003).

Phytoremediation using trees provides a potential opportunity to extract or stabilize metals. Phytoextraction (uptake) involves the use of high yielding plants that readily transport targeted metals from soil to vegetation, allowing removal of metals by harvesting the plants, without damaging the soil or requiring its disposal to landfill (EPA, 1996). Some of them are dangerous to health or to the environment (Eg. Mercury, Cadmium, Lead, Chromium) (Michael Hogan, 2010). Certain elements are actually necessary for humans in minute amounts (Co, Cu, Cr, Mn, Ni) while others are carcinogenic or toxic, affecting, among others, the central nervous system (Mn, Hg, Pb, Ar), the kidneys or...
liver (mercury, lead, cadmium, copper) or skin, bones, or
teeth (nickel, cadmium, copper, chromium) (Ron
Zevenhoven, 2001). The objectives of this study is to
determine the effects of cadmium chloride with
phosphate combination on seed germination, plant
growth, biomass and examine their uptake by Capsicum
annuum L. and Acorus calamus L. plants.

Materials and Methods

The present study was carried out to analyse the
effect of CdCl\textsubscript{2} on seed germination percentage, biomass
and biochemical compounds of Capsicum annuum and
Acorus calamus. The experiments were carried out by
pot cultures. Experiments were carried out during the 28
days. Healthy seeds especially uniform size, colour and
weight were choosen for the experiments. Capsicum
annuum L. and Acorus calamus L. plants were grown in
pots in untreated soil (control) and in soil to which
cadmium chloride had been applied 10 mg/kg of soil and
in soil 10 mg of cadmium chloride with 50 mg of super
phosphate. Plastic mugs were used as pots. Each pots
contained 3 kg of soil and in another type along with
cadmium chloride 50 mg of super phosphate is used,
which was thoroughly mixed with the soil. Ten seeds
were sowed in each pot. All parts were watered in twice
a day. Three sets of replicates were maintained for the
entire work. After first and second week, the seeds were
uprooted and used for the experimental studies. Plant
samples were collected after 28\textsuperscript{th} day and used for
morphological and biochemical studies. Three plants
from each replicates of a pot were analysed for its
various parameters and the average was calculated.
These mean values of the replicated were tabulated.

Morphological parameters

The morphological parameters such as length of
root and shoot, number of rootlets, dry weight of
plantlets were determined for every sample.

Dry matter production (g/plant\textsuperscript{-1}): To estimate the dry
weight, root and shoot portions were separated and dried
at 80°C for 48 hrs in a hot air oven and then weighed
using digital balance.

Results

Effect of heavy metals on seed germination

The present research demonstrated a
concentration dependent inhibition of the seed
germination with regards to 10 mg/kg of cadmium
chloride and 10 mg/kg of cadmium chloride with 50 mg
super phosphate (Table 1). The results of this study
indicated that cadmium chloride levels had very low
toxic effects on seed germination while cadmium
chloride with super phosphate at the same doses
increased seed germination.

Effect of heavy metals on root growth

Presence of super phosphate with heavy metal
concentration in the soil media caused root length
decrease with stunt growth of roots (Table 1 & 2). The
dose of 10 mg/kg of cadmium chloride promoted the root
growth of the plants as compared to the root growth of
the plants treated with soil consisting of heavy metal
with super phosphate but not as compared to control
plants.

Effect of heavy metals on shoot growth

The effects of heavy metals and heavy metal with
super phosphate on the shoot growth are different from
their effects on root growth (Table 1 & 2). The shoot
length was found slightly reduced than the control

*Capsicum* sp. and *Acorus calamus* plants in pot consisting of super phosphate and cadmium chloride.

**Effect of heavy metals on biochemical content**

Out of this experiment super phosphate with heavy metal supplemented plants gave higher profile in

### Table 1. Effect of cadmium chloride and super phosphate on the growth of *Capsicum annuum* L.

<table>
<thead>
<tr>
<th>Parts Length (cm)</th>
<th>7th day</th>
<th>14th day</th>
<th>21st day</th>
<th>28th day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>10% CdCl</td>
<td>10% CdCl + Super phosphate</td>
<td>Control</td>
<td>10% CdCl</td>
</tr>
<tr>
<td>Roots</td>
<td>22</td>
<td>12</td>
<td>15</td>
<td>35</td>
</tr>
<tr>
<td>Rootlets</td>
<td>28</td>
<td>24</td>
<td>22</td>
<td>45</td>
</tr>
<tr>
<td>Stem</td>
<td>98</td>
<td>53</td>
<td>76</td>
<td>130</td>
</tr>
<tr>
<td>Leaves</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Leaf length</td>
<td>20</td>
<td>16</td>
<td>18</td>
<td>52</td>
</tr>
<tr>
<td>Whole plant height</td>
<td>120</td>
<td>65</td>
<td>91</td>
<td>165</td>
</tr>
</tbody>
</table>

### Table 2. Effect of cadmium chloride and super phosphate on the growth of *Acorus calamus* L.

<table>
<thead>
<tr>
<th>Parts Length (cm)</th>
<th>7th day</th>
<th>14th day</th>
<th>21st day</th>
<th>28th day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>10% CdCl</td>
<td>10% CdCl + Super phosphate</td>
<td>Control</td>
<td>10% CdCl</td>
</tr>
<tr>
<td>Roots</td>
<td>73</td>
<td>48</td>
<td>65</td>
<td>130</td>
</tr>
<tr>
<td>Rootlets</td>
<td>32</td>
<td>18</td>
<td>24</td>
<td>66</td>
</tr>
<tr>
<td>Leaves</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Leaf length</td>
<td>98</td>
<td>62</td>
<td>73</td>
<td>188</td>
</tr>
<tr>
<td>Whole plant height</td>
<td>220</td>
<td>216</td>
<td>208</td>
<td>350</td>
</tr>
</tbody>
</table>

### Table 3. Effect of cadmium chloride and super phosphate on biochemical content of *C. annuum* and *A. calamus*

<table>
<thead>
<tr>
<th>In different conditions</th>
<th>Amino acid readings at 525 nm</th>
<th>Starch readings at 620 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Capsicum annuum</em></td>
<td><em>Acorus calamus</em></td>
</tr>
<tr>
<td>Control</td>
<td>0.12</td>
<td>0.10</td>
</tr>
<tr>
<td>10% cadmium chloride</td>
<td>0.06</td>
<td>0.01</td>
</tr>
<tr>
<td>10% cadmium chloride + Super phosphate</td>
<td>0.10</td>
<td>0.06</td>
</tr>
</tbody>
</table>

biochemical content then control plants (Table 3).

**Discussion:** Plants use photosynthetic energy to extracts according to nutritional requirements (Kramer and ions from the soil and concentrate them in their biomass, Chardonnens, 2001). Zn is relatively mobile in soils and

www.currentsciencejournal.info
contaminated plants as it is in soils. This metal is necessary as a minor nutrient and it is known that plants have special zinc transporters to absorb this metal (Zhu et al., 1999). However, an excessive accumulation of this element in living tissues leads to toxicity symptoms (Shen et al., 2002). An ultrastructural study using transmission electron microscopy revealed the retention of unchelated Pb mainly in cell wall of roots, particularly around intercellular spaces (Wenger et al., 2003). Cadmium also is considered to be mobile in soils but is present in much smaller concentrations than Zn (Zhu et al., 1999). Moreover, many studies have demonstrated that Cd taken up by plants accumulates at higher concentrations in the roots than in the leaves (Boominathan and Doran, 2003).

Alloway (1995) mentioned that alyssum species which are naturally adapted to serpentine soils can accumulated over 2% Ni. The uptake by some plants has been confirmed for Cd (up to 0.2% Cd in shoot dry biomass) but the presence of phosphate fertilizer in the soil induce the uptake of cadmium chloride upto greater extend then present normally Organic matter in soil could effectively increase the activity of metals in soil and improve metal mobility and distribution in soil. The application of natural fertilizer (compost and vermicompost) in soils has helped in increase in metal mobility through the formation of soluble metal-organic complexes (Yang et al., 2005). In addition, exudation of organic compounds by plant roots, such as organic acids, influence ion solubility and uptake (Klassen et al., 2000) through their effects on microbial activity, rhizosphere physical properties and root-growth dynamics (Yang et al., 2005). The higher concentrations uptake of heavy metals (Cu, Zn, Fe, Al and Mn) by alfalfa (Medicago sativa) was reported by Rebah et al. (2002).

Conclusion

The present work concluded the effectiveness of cadmium chloride 10 mg/kg and 10 mg/kg of cadmium chloride with 50 mg super phosphate on Capsicum sp. and Acorus calamus. The results of this study indicated that cadmium chloride had very low toxic effects on seed germination, shoot length, root length and biochemical profile but this toxicity level also reduced by the addition of super phosphate with cadmium chloride.

References


