Short Communication (NS-2)

PHYTOREMEDIATION OF INORGANICS IN INDUSTRIAL AND URBAN CONTAMINATED SOILS

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ABSTRACT

Heavy metals are important environmental pollutants and their toxicity is a problem of increasing significant for ecological, evolutionary, nutritional and environmental reasons. Phyto extraction is the best approach to remove the contaminations from soil. In order to evaluate Phytoremediation and green house study was designed and implemented to examine the fate of Nickel (Ni) and Cadmium (Cd) in soil and plant tissues

Key Words: Heavy metals, Soil, Cadmium, Nickel, Phytoremediation

INTRODUCTION

Phytoremediation is an innovative and most ideal alternative technology that utilized the natural properties of plants for removing pollutants from the environment, restoring contaminated sites and preventing further pollution. Most of the conventional remedial technologies are expensive and inhibit soil sterility. This subsequently causes negative impacts on the ecosystem. Phytoremediation is a cost effective, environmental friendly aesthetically pleasing approach most suitable for developing countries. Therefore; these types of studies are highly needed for serious efforts to exploit the natural capacity of green plants to degrade complex compounds. Survey of plants of a particular place and their assessment of ability to reduce pollution is required. Trees can be listed and their pollution reducing capacity can be ascertained. Accordingly they can be recommended for plantation in and around industrial areas and urban localities to provide scientific basis to solve real practical problems related with environmental cleanup.

Nickel (Ni) and Cadmium (Cd) are not essential for plant growth and development, are regarded primary as pollutant metals and may reach potentially toxic levels in soils. Nickel and Cadmium can be readily taken up and accumulated by plants depending on soil conditions.

The objective of this study was to investigate how cadmium and Nickel influence each other, especially with green plant, in terms of Phytotoxicity, plant uptake and Phytoremediation.
MATERIAL AND METHODS

Seeds of Indian mustard (*Brassica juncea* L.) were sown in commercial potting mixture and then grown for 10 days in pots. Seedlings of similar height and fresh weight, were selected and transplanted to a soil column. The soil, sandy loam was collected from an agricultural site of Mandideep, Commercial area of Bhopal City. The soil was passed through a 0.4 cm. sieve, air dried and then artificially contaminated with 100 mg of Cadmium and 100mg Nickel per Kilogram of soil, separately and in combination. Contaminated soils were allowed to equilibrate for 7 days at field moisture levels before the introduction of test plants uncontaminated soil was used as a control.7

Experimental Design: Soil columns were constructed for 15 cm. diameter and 100cm lengths of PVC pipe. Each coil was filled to a depth of 70 cm. with unsieved and uncontaminated soil, followed by 20 cm of contaminated soil on top. The bottom of each column had layers of plastic mesh netting to prevent the loss of tailing into the leachate.

Three seedlings of similar height and fresh weight were transplanted into each column. The plants were placed in a green house with natural light, temperature and humidity to mimic as closely as possible the conditions in the field. The plants were fertilized daily with Hoagland's solution for 4 weeks and then every two days until harvest. The plants were grown for 150 days.

Plants and Soil Analysis: Randomly selected columns were pulled out of the green house for destructive analysis. Plants were harvested by gently removing them from soil. Prior to analysis, plants were washed with water to remove soil deposits for determining the amount of Cadmium and Nickel in the plants, roots and shoots were further separated with scissors and then dried in an Oven at 70°C for three days.

The three digested samples each of soil and plants were analyzed for Cd and Ni by atomic spectrophotometer (Flame AAS; Analyst 100 spectrophotometer perkin Elmer, USA). The magnification coefficient which is the concentration of heavy metals in the plant parts in relation to the concentration in soil samples was calculated. This was done by dividing the concentration in the plant parts by concentration of heavy metals in the soil samples. This indeed shows the rate of uptake of the heavy metals by the plants. The results on Atomic Absorption Spectrophotometer were converted to actual concentration of the metal in the samples.

RESULTS AND DISCUSSION

Phytotoxicity: The growth of the plants in the contaminated soil with Cd (100mg/kg) and Cd + Ni (100mg Cd/kg + 100mg Ni/Kg) was greatly inhibited, compared to plants grown in uncontaminated soil (Table 1). After 75 days, the roots of control plants and Ni exposed plant extended well into the bottom of column, whereas, the fine root structure of the Cd - exposed plants and Cd + Ni exposed plants did not. After a further 75 days, the roots of control plants were almost unchanged but the roots of exposed plants ended into the bottom of the column. Therefore, Cd is the only factor to inhibit the growth of *B.juncea* in the Cd + Ni soil columns. (Table 2). There have been various reports on the effect of heavy metals on root
and shoot growth of various plant sps. Decreased root and stem length of *Oryza sativa* L. by Cadmium inhibition of root growth of *pinus*, *pinaster* seedlings. Stem length decreased in *B. juncea* seedlings exposed to zink.

Table 1: Root and shoot size and mass of *B. juncea* plants exposed to Cd and Ni at 100mg/Kg at the growth stage of 35 days.

<table>
<thead>
<tr>
<th>Metal</th>
<th>Root length (mm)</th>
<th>Shoot length (mm)</th>
<th>Root Mass (Mg/plant)</th>
<th>Shoot Mass (Mg/plant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>39.9 ± 8</td>
<td>41.3 ± 8.0</td>
<td>4.7 ± 1.6</td>
<td>13.4 ± 3.2</td>
</tr>
<tr>
<td>Cadmium</td>
<td>39.2 ± 10</td>
<td>38.6 ± 7.9</td>
<td>3.9 ± 1.0</td>
<td>12.3 ± 7.2</td>
</tr>
<tr>
<td>Nickel</td>
<td>40.6 ± 9</td>
<td>39.6 ± 7.5</td>
<td>4.3 ± 0.5</td>
<td>13.5 ± 0.05</td>
</tr>
</tbody>
</table>

Table 2: Percentage (%) of heavy metals (Ni and Cd) removed from plant parts (ug/g)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Plants sps</th>
<th>Plants parts</th>
<th>Cadmium (Cd) After 75 Days</th>
<th>After 150 Days</th>
<th>Nickel (Ni) After 75 Days</th>
<th>After 150 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>B. Juncea</td>
<td>Roots</td>
<td>125.05 ± 0.05</td>
<td>242.30 ± 0.25</td>
<td>72.25 ± 0.25</td>
<td>102.25 ± 0.25</td>
</tr>
<tr>
<td>2.</td>
<td>G. Juncea</td>
<td>Shoots (Stem)</td>
<td>7.51 ± 0.00</td>
<td>7.05 ± 0.05</td>
<td>2.34 ± 0.00</td>
<td>14.10 ± 0.01</td>
</tr>
<tr>
<td>3.</td>
<td>B. Juncea</td>
<td>Foliage</td>
<td>0.00 ± 0.00</td>
<td>5.20 ± 0.05</td>
<td>0.0 ± 0.00</td>
<td>2.36 ± 0.21</td>
</tr>
</tbody>
</table>

Contaminant uptake by plants: The roots are the primary site for absorption of water and minerals including heavy metals. The roots will thus contain more heavy metal load than the shoot and acts as a source of storage organ. Table 3 shows the relationship of the concentration of heavy metals in the root with the concentration in the soil. The trend of concentrations of heavy metals in plants being higher than that of the soil has been observed in several studies. Cd-accumulation is generally higher in roots than in shoots. At 150 days, after transplantation, *B. juncea* grown in the soil contaminated with Cd had accumulated substantial amounts of Cd in their roots and shoots than the Ni.

Table 3: Relationship of heavy metal in root tissues with the concentration in the soil, showing multiplication factor.

<table>
<thead>
<tr>
<th>Plants sps.</th>
<th>Cadmium</th>
<th>Nickel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>2.43 ± 0.02</td>
<td>36.74 ± 0.03</td>
</tr>
<tr>
<td>Root</td>
<td>25.38 ± 0.05</td>
<td>47.35 ± 0.05</td>
</tr>
<tr>
<td>Magnification Coefficient</td>
<td>10.45</td>
<td>1.29</td>
</tr>
</tbody>
</table>
CONCLUSION

Therefore our findings suggest that *B. juncea* phytoremediates heavy metals through taking up. In several studies plant have been used successfully to recover metals from contaminated soil. Since soil particles alone will not effectively prevent mobility of contaminants, stabilization or adsorption on organic matter such as the well developed roots of the plant is responsible for the majority of contaminant retardation in the planted soil. Therefore, use of plants, to remove pollutant is an inexpensive and easy technique.

REFERENCES