RESEARCH PLAN PROPOSAL

"An Innovative And Cost Effective Phyto- Remediation Technique For Removal of Heavy Metals From The Textile Polluted Soil And Water Of Bagru Region"

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INTRODUCTION

Environmental pollution affects the quality of pedosphere, hydrosphere, atmosphere, lithosphere and biosphere. Land and water are precious natural resources on which rely the sustainability of agriculture and the civilization of mankind. Unfortunately, they have been subjected to maximum exploitation and severely degraded or polluted due to anthropogenic activities. The pollution includes point sources such as emission, effluents and solid discharge from industries. Vehicle exhaustion and metals from smelting and mining, and nonpoint sources such as soluble salts (natural and artificial), use of insecticides/pesticides, disposal of industrial and municipal wastes in agriculture, and excessive use of fertilizers (McGrath et al.,2001;)[1]. Each source of contamination has its own damaging effects to plants, animals, and ultimately to human health. But those that add heavy metals to soils and waters are of serious concern due to there persistence in the environment and carcinogenicity to human beings. They cannot be destroyed biologically but are only transformed from one oxidation state or organic complex to another (Garbius and Alkorta 2001; Gisbert et.al., 2003).[2-3] . Heavy metals in the polluted environment include As, Cu, Cd, Pb, Cr, Ni, Hg and Zn. The presence of any metal may vary from site to site, depending upon the source of individual pollutant.

The textile industries use large volumes of water in their operations and therefore discharge into the environment without treatment. These textile industries used natural and synthetic dyes. Natural and synthetic dyes contain heavy metals and other pollutants which pollute water and soil.

The area of study is a Bagru village located near by Jaipur. Bagru is known for natural dyes and hand block printing. A survey shows that in Bagru dying cluster units are using rice-husk, wheat- husk for dying the cloth.

But the study contradicts above observation. Practically Bagru is not an eco-friendly industrial area as they are using certain synthetic vat dyes as mordents which are toxic in nature and contain heavy metals. For example $FeSO_4$, $CuSO_4$, chromium etc. thus it is necessary to investigate the physiochemical parameters of waste water and soil of this area and to apply some eco-friendly treatment process to remove heavy metals.

Different approaches have been developed to mitigate/reclaim the heavy metal pollutant soils and waters including the landfill/damping sides. These may be broadly classified into physicochemical and biological approaches.

The physicochemical approach includes excavation and burial of the soil at a hazardous waste side, fixation/inactivation (chemical processing of the soil to immobilize the metals), leaching by using acid solution or proprietary leachants to desorbs and leach the metals from soil followed by the return of clean soil residue to the site (salt et.al., 1995)[4], ion exchange, reverse osmosis and microfiltration (Raskin et.al., 1996)[5]. the physicochemical approaches are generally costly and have side effects (Raskin et.al.,1997)[6] .

Biological approaches of remediation include: (1) use of microorganisms to detoxify the metals by valance transformation, extracellular chemical precipitation or volatilization, and (2) use of special types of plants to decontaminate soil or water by inactivating metals in the rhizosphere or translocating them in the aerial parts. This approach is called **phytoremediation**, which is considered as a new and highly promising technology for the reclamation of polluted sites and cheaper than physicochemical approaches (Garbisu and Alkorta, 2001; McGrath et.al., 2001; Raskin et.al., 1997). It is an emerging eco-friendly technology than can be applied to organic and inorganic pollutants present in soil, water and air (salt et.al. 1998)[7].

Types of Phytoremediation :-

Depending on the mechanism of remediation, various types are as follows:-

1. phytoextraction
2. phytofilltration
3. phytostabilization
4. phytovolatization
5. phytodegradation

Phytoextraction involves the use of plants to remove contaminants from soil. The metal ion accumulated in the aerial parts that can be removed to dispose or burnt to recover metals. Phytofiltration involves the plant roots or seedling for removal of metals from aqueous wastes. In phytostabilzation, the plant roots absorbs the pollutants from the soil and keep them in the rhizosphese rendering them harmless by preventing them from laching. Phytovolatization involves the use of plants to volatilize pollutants from there foliage such as Se and Hg. Phytodegradation means the use of plants and associated micro-organisms to degrade organic pollutants (Garbisu and Alkorta, 2001)[2] . Some plants may have one function whereas others can involve two or more functions of phytoremediation.

The extreme level of metal tolerance in vascular plants is called hyper-accumulation. Hyper-accumulators are defined as higher plants species whose shoots contain- 100 mg Cd/kg, 1000 mg Ni, Pb and Cu Kg^{-1} or 10,000mg Zn and Mn Kg^{-1} (dry weight) when grown in metal-rich soils (Baker and Brooks, 1989; Baker et.al.,2000)[8-9].

Plant Species Used for Phytoremediation

Several aquatic species and xerophytic plants have been used for phytoremediation of heavy metals. These include sharp dock (polygonum amphibium L.), duckweed (Lemna minor L.), water hyacinth (eichhornia crassipes), water lettuce (P.Stratiotes), water dropwort[oenathe javanica (BL) DC], calamus (Lepironia articulate), pennywort (hydrocotyle umbellate L.), (Prasad and freitas, 2003). The roots of Indian mustard are found to be effective in the removal of Cd, Cr, Cu, Ni, Pb and Zn. (zaranyika and ndapwadza, 1995, wang et al 2002 prasad and freitas,2003). Radish(raphanus sativus L.) and two varieties of wheat (T>aestivum L.,var.UP2338 and var PBW373), also used to Cu metal. Vetiver and phragmites xerophytic plants are used to remove Cu.

Review of Literature

The potential of some crop plants from brassicaceae for phytoremediation has been extensively studied (Baker et.al., 1994b; Brown et.al.,1995b; Dushenkove et.al.,1995; Huang and Cunningham, 1996; Ebbs and Kochian, 1997; Ebbs et.al.,1997)[10-15] and it was demonstrated that some efficient shoot accumulators of the genus brassica contained up to 3.5% on a dry weight basis of heavy metals (Nanda-Kumar et.al.,1995)[12] .

Whiting et.al. (2000)[16] found that the plants from T. carerulescens population that accumulated Cd also showed increased root biomass and root length after allocation into Cd- enriched soil, whereas plants from the population that did not accumulate Cd showed no such increase.

Uneo et.al. (2004a)[17] studied the interaction between Zn and Cd in T. caerulescens in solution culture and in pot soil. Results from long term (4 weeks) and short term (1 week) solution culture experiments indicate that Cd accumulation in the shoot was not affected by the supply of a 4-10-fold excess of Zn, whereas the Cd concentration of the roots decreased with increasing Zn concentrations in the solution.

Uneo et.al. (2004b)[18] investigated the uptake of Cd and Zn by T. caerulescens (the Ganges ecotype) from enriched soil with different insoluble and soluble sources of Cd and Zn. The data show that there was no significant differences in the shoot Cd concentration between the treatments with soluble or insoluble Cd compounds, even though Cd concentration in the soil solution was in the order of $CdSO_4$ >> $CdCO_3$ >CdS.

The solubility of heavy metals in the polluted soils can be increased by using organic and inorganic agents thus enhancing the phytoextraction capabilities of many plant spices such as applied enhancement materials include ethylene diamine tetraacetic acid (EDTA), citric acid, elemental sulfur or ammonium sulfate. Increases greater than 100 folds in Pb concentration in the biomass of crops were reported when EDTA was applied to the contaminated soils(Cunningham and Berti, 2000)[19]. Uranium, Cd, and Zn concentrations in plant biomass were increased by the application of citric acid, elemental sulfur or ammonium sulfate, respectively(Schmidt, 2003)[20] .

The efficiency of copper removal from soil by (Naiyanan et.al) [20] it was found that copper accumulation was higher in the roots than in the shoots in every composition.

(Turan et.al.)[21] to investigate the effects of addition of different concentration of EDTA on heavy metal availability in soils contaminated with 50 mg/Kg Cd, 50 mg/Kg Cu, 50 mg/KgPb and 50 mg/Kg Zn by using canola and Indian mustard plants. The results indicated that EDTA application increased heavy metal availability and uptake by plants.

The experiment was conducted by Sutthirak et.al 2007 [22] to investigate the ability of vetiver grass to uptake heavy metals from industrial wastewater. The result shows that the three vetiver ecotypes absorbed Fe>Mn>Zn>Cu>Pb, and they concentrated these metals more in roots than in shoots.

Exhaustive literature survey shows that no such type of work on phytoremediation has been done on the bagru region. This region is known for using national dyes and is considered as eco-friendly region. But extensive use of mordents to fix up these vat dyes on clothes causes contamination of soil and water of the cluster units and near by agricultural land. Thus, the present study is undertaken to assess native hyper accumulator plants grown in Bagru region and near by areas.

Motivation/Justification and Relevance

Bagru is known for hand block printing. Various printing and textile units are located in this region. These units are called as clusters.They are well known for using natural dyes and thus considered as eco-friendly. But the study shows that these units are using some synthetic dyes and mordents as colour fixer. These mordents employs heavy metals, thus polluting the land and water of this area. Therefore, a Phytoremediation which is a greener and cost effective technique is required for the removal of heavy metals from that region.

Thus, the aim of present study is to identify native accumulator plants grown in Bagru area and to assess their uptake capacity of heavy metals at different pH and to optimize the condition for the remediation of heavy metals present in the soil and water of this particular area.

Also, Phytoextraction technique is-

1. more economically viable using the same tools and supplies as agriculture.
2. less disruptive to the environment and does not involve waiting for new plant communities to recolonise the site.
3. Disposal sites are not needed.
4. more likely to be accepted by the public as it is more aesthetical.
5. cost-effective and eco-friendly technique.

Objective

1. To analyze physico-chemical parameters of waste water :-

   pH, EC, TDS, TSS, TS, nitrates, Phosphates, BOD, COD.

2. To analyze physico-chemical parameters of contaminated soil :-

   pH , EC, % orgainic carbon, Available nitrogen, Available phosphorus.

3. To estimate concentrations of copper and chromium in water and soil samples

4. To carry out phytoextraction of the above mention metal ions.

Plan of Work and Methodology:-

1. Sampling Design:-

- Selection of Area:- Textile cluster units of bagru region is selected. The region is located at a distance of 30 Km from Jaipur- Ajmer road. Bagru is known for natural dyes and hand block printing.

- Selection of sample – Two types of sample will be taken of soil and water near about 20 samples. each of soil and water will be taken -10 samples pre monsoons and 10 samples post-monsoons.
- Grabs sampling will be done.

2. Experimental techniquesand the instrumentation employed :

- Physico-chemical analysis of water and soil

Water analysis techniques:-
pH - pH Meter
EC- Conductivity meter
TDS- oven dried method
TSS- fiteration method
Nitates- U.V. spectrophotometer
Phosphate- U.V. spectrophotometer
BOD- Titration method
COD- open reflection method

- Soil analysis techniques:-

pH - pH Meter
EC- Conductivity meter
% organic carbon- titration method
Available Nitrogen- Kelplus Nitrogen Estimation System
Available phosphorus- U.V. spectrophotometer

- Metal estimation - Atomic Absorption spectrophotometer

3. Removal of heavy metals:-

Phytoextraction technique-

Plant species used for phytoextraction may be one of the following plants:-

Brassica Juncea, Triticum Aestivum and Xerophytic plant, depending on the optimum action of the plant.

The metal ions (Cu, Cr) will be estimated titrimetrically using EDTA, before and after phyto-remediation. The effect of the following variable will be studied:-

- Temperature
- pH
- Time
- Concentration of biomass

Place of Work and Facilities Available:-

Most of the analytical work will be done in central instrumentation lab and research lab present at the IIS University. For the estimation of heavy metal by AAS, the facility from external source will be employed like pollution control board might be taken.

Limitation And Alternative Plan of The Study :-

For the present work, three plant species will be taken. Out of which one will be Xerophytic plant. If in case, Xerophytic plants does not grown well in time and give the results, the vetiver grass will be taken for the study.

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