Phytoremediation of Bacopa Monnieri in Lead-Contaminated Battery Effluent

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Abstract— The ability of Bacopa monnieri to serve as a phytoremediation plant in the removal of lead(Pb), heavy metal from the battery effluent was taken under consideration for the study. Lead was assessed in water & chelating agent and the analysis report of plant root and shoot values were used to determine bio concentration factor and translocation factor. The concentrations of metal accumulated in plant were lower than the specified values of hyper accumulator, thus the Bacopa monnieri taken under consideration was an accumulator. But its accumulation capacity of lead in root and shoot shown is higher value, which implies the plant forms larger bio-mass on water surface and its tendency to uptake lead to higher and translocation factor will determine the sustainability of the plant.

Key words: Bacopa Monnieri, Battery Effluent

I. INTRODUCTION

Heavy metals discharge into ponds, and lakes have increased in recent days. These heavy metals are the main contributors for water pollution in many areas [1,2,3].Heavy metals like Pb and Al are not biodegradable and presence of such metals in water lead to bio-accumulation in living organisms, causing health problems in flora and fauna[4,6,7].

It's effect on human beings should also be taken into consideration. If it is done, appropriate treatment of heavy metals in waste water is of almost importance[7, 9].

The technologies for treatment of heavy metals are Reverse-Osmosis, flotation, Ion-exchange, adsorption, oxidation with O3 and H2O2, etc…, But these techniques are losing their shine due to the introduction of a biological technique like phytoremediation. The main advantage of phytoremediations that it is a low cost method [6,8,10].

This technique is based on ability of plants to absorb and accumulate metal contaminant in their tissues. The bio removal process using aquatic plants contains two uptake processes. Biosorption which is an initial, fast, reversible, metal binding process and bio accumulation, a slow, irreversible, ion sequestration step[3,10].

The aquatic plants can be either of floating type (or) submerged type plants. The floating plants will absorb (or)accumulate contaminants by it's roots, while submerged plants accumulate metals by their whole body[5].

Selection of aquatic plant was based on consideration such as high growth rate and tolerance on exposure to high elements concentration [2].

Lead accumulation by plants has been extensively investigated using Bacopa monnieri as a model plant. Bacopa monnieri, commonly called as "Vallarai Keerai'' is a fast growing plant,which adapts earily to various aquatic conditions and plays an important role in extraction and accumulation of lead from surface waters.

II. METHODS

A. Preservation Of Samples And Collection Of Effluent:

Plants were collected from the pond and taken in an air-tight Polyethylene covers. The samples were allowed to grow in the laboratory conditions. For 2 weeks to check the sustainability of the plants .The samples were made to grow in polyethylene bottles filled. With lab water and sand in the ratio(1:1). After 2 weeks, the plants show normal growth which means that they can live distance apart from their existed area. The effluent was collected from a Battery industry and given for analysis of lead. It was found that lead concentration in the effluent was 17ppm read by Atomic Absorption Spectrophotometer(AAS). It was then diluted to 5ppm,10ppm,15ppm.Using distilled water after dilution, the lead concentration was once again checked by Atomic Absorption Spectrophotometer AAS.

B. Chemical Analysis:

The samples were made to grow two sets of container. One set of container with the direct effluent and the other set of container with effluent and chelating agent, EDTA. EDTA is abbreviated for Ethylene Diammine Tetra Acetic Acid, a synthetic chelating agent. The samples were analyzed at an interval of 10 days for lead uptake. The lead contamination in root and shoot were found individually. The root/shoot was completely powdered using mortar and pestle .About 1g of the powder was taken and 10ml each of concentrated HNO3, HCl and H2SO4 were added. The mixture was kept in oven at 800C for 4h.It was then filtered and the clear filtrate was given for analysis. The lead concentration in shoot, root, soil and effluent were found by atomic absorption spectroscopy AAS. The same procedure was repeated for other sample at a definite time interval of 10days.

C. Data Analysis:

After the analyses the report was obtained and by using that report the table was generated in order to get the clear observation that how effective the plant undergone up taking the lead contaminant with respect to the period of time. By using that values obtained the important factors are estimated namely translocation factor and bioconcentration factor, the biological parameter which ensures the stability of the plant towards the effluent concentration. Tables of different concentration were obtained of 5,10&15 ppm of Pb. Translocation factor which is a ratio of concentration of lead in plant,shoot and leaves to that of lead in root was also evaluated. While the Bio-concentration factor which is a ratio of the measure of concentration of Pb in plant to that of concentration of Pb in the effluent after the process time was also evaluated.

- Bio concentration factor

$$= \frac{\text{Pb concentration in root/shoot}}{\text{Pb concentration in Effluent}}$$

- Translocation factor

$$= \frac{\text{Pb concentration in shoot}}{\text{Pb concentration in root}}$$

III. Results and Discussions

A. Effect Of 5ppm Concentration:

The absorption of the lead contaminant by EDTA roots is generally lower than the absorption with direct effluent in the initial stages. During 70th day, the EDTA roots nearly equals the absorption of lead contaminant by the direct plants. After that i.e.after 70thday,the absorption by EDTA plants was triggered. At the end of 100th day, the absorption by EDTA plants was higher than the normal plants used. This insists the usage of EDTA.The absorption of lead by EDTA plants is lower in initial stages and when the time passes, the absorption is also factor than normal plants. This results even when high concentration of lead (i.e..,10ppm&15ppm)are used.

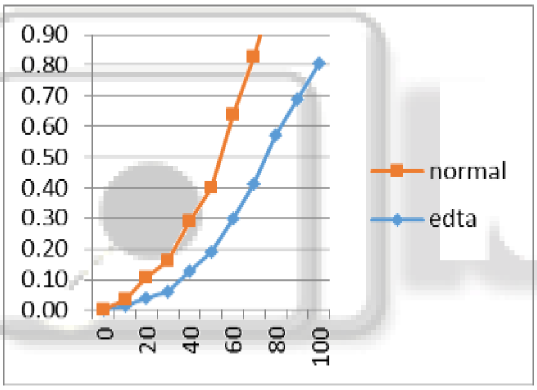

Fig. 1: Root (days vs ppm)

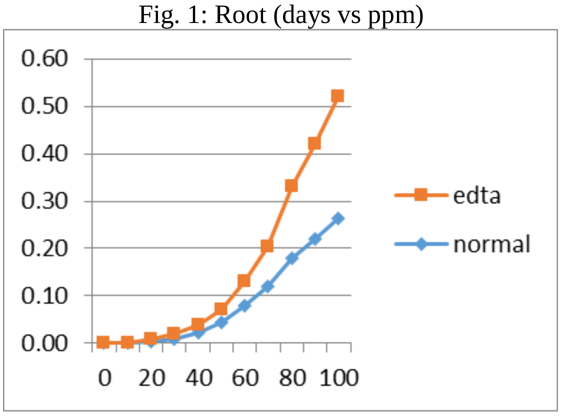

Fig. 2: Shoot (days vs ppm)

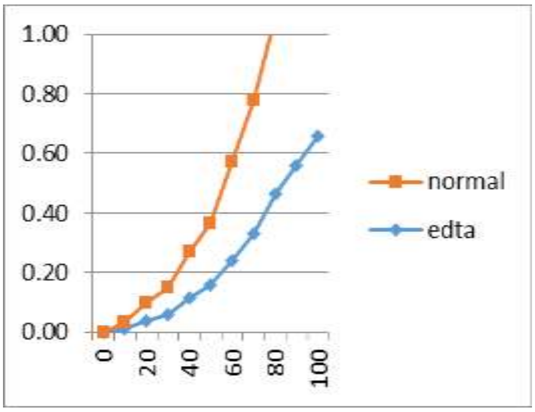

Fig. 3: Soil (days vs ppm)

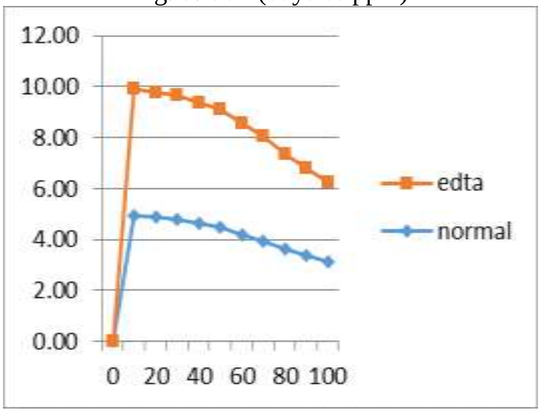

Fig. 4: Effluent(days vs ppm)

B. Effect Of 10ppm Concentration:

The translocation of lead contaminants is a faster process only in hyperaccumulator type of plants .Because of the presence of larger vacuoles,these type of plants can store excess heavy metals in their shoot system .In our model plants,(Bacopa monnieri),the translocation of lead contaminant is a very slow process. Since it is not a hyper accumulator type. The best examples of hyperaccumulator are sunflower, onion, etc. The translocation of lead contaminant is very fewer throughtout the process time, the model plant stores excess lead in its root system and its transfusion to shoot system is rare. The translocation of lead contaminant in shoot system is higher in normal plants than the EDTA plants. At the end of process time(i.e at the 100thday) the translocation of lead in shoot by normal plants equals the EDTA plants. The translocation was trigged only at the end of process time(i.e,,90th,100thday).

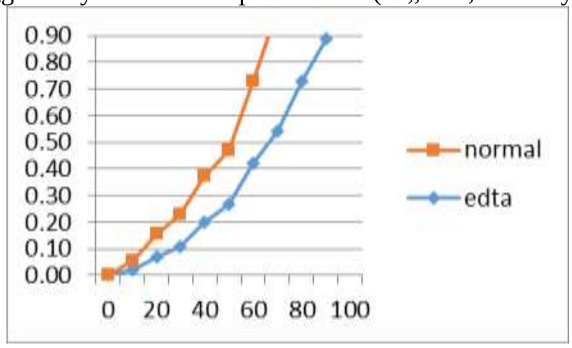

Fig. 5: Root (days vs ppm)

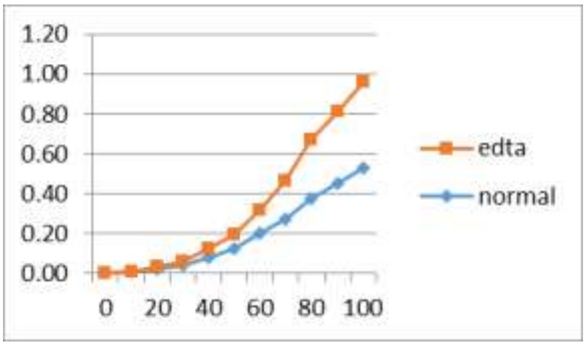

Fig. 6: Shoot 10ppm (days vs ppm)

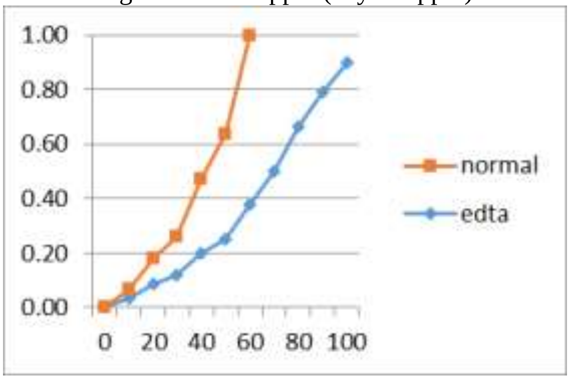

Fig. 7: Soil (days vs ppm)

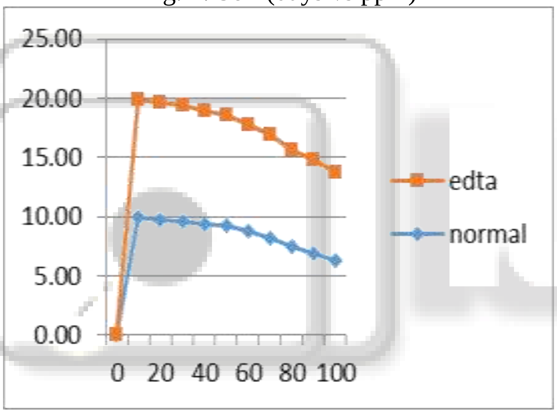

Fig. 8: Effluent (days vs ppm)

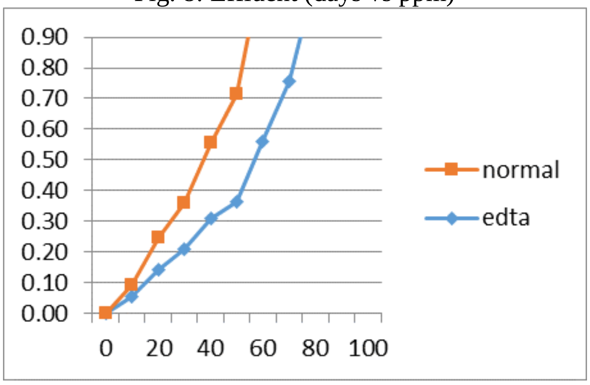

Fig. 9: Root 15 (days vs ppm)

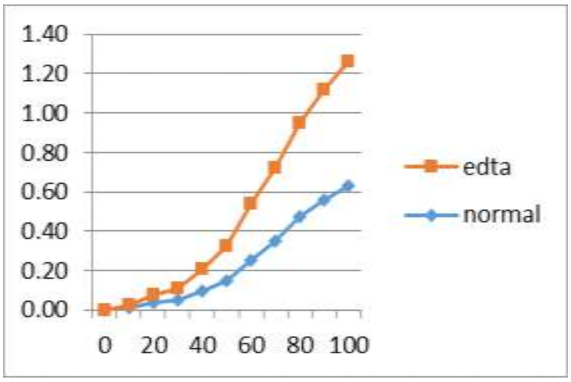

Fig. 10: Shoot 15 (days vs ppm)

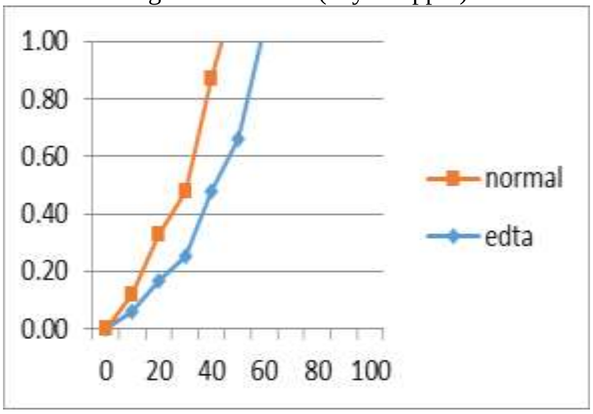

Fig. 11: Soil 15 (days vs ppm)

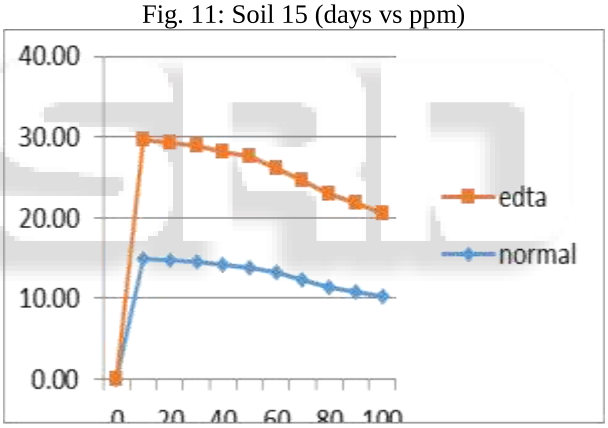

Fig. 12: Effluent 15 (days vs ppm)

The lead contaminants in the waste water effluent usually decreases since its our concern to reduce the heavy metal(Pb) using biological creature. The absorption of lead by soil increases day by day. Since the minerals in soil absorb lead from the effluent. But the lead absorption by soil is lower in case of EDTA plants. The lead absorption by soil is slightly higher in case of normal plants. The lead absorption by the soil is slower in the initial stages. As time passes, the uptake of lead by soil was also trigerred. But using EDTA plants, the lead absorption by soil can be decreased. This is how we can save the fertility of soil by using EDTA plants. In normal plants, the lead absorption by soil is a slower process in the initial stages. Similarly when the time passes, the absorption rate also increases.

Our major aim is to reduce the heavy metal(Pb) contaminant in the waste WATER EFFLUENT RELEASED BY industries using green plants. This is how we can eliminate the absorption of lead by soil and water. In substitute, the green plants will take this heavy metals(Pb) for its metabolism but the lifespan gets reduced. The lead composition in the effluent decreases as the day passes out.

The lead in effluent decreases slightly faster in the initial stages incase of normal plants. As time passes, EDTA plants will over take the normal plants in the final stages of our process time. The lead in effluent decreases to a greater extent incase of EDTA plants between 90th to 100th day. Analysis done at 90th day indicates that the lead in both the cases is approximately equal. EDTA as such chelating agent causes its effect only at the later stages of process time.

IV. CONCLUSION

In this study,Bacopa monnieri has been found to accumulate metals in both its root and shoot in a high degree and also to be capable of transferring the metals absorbed into the shoot to give higher translocation factors.But the addition of EDTA tends to enhance the phytoremediation potential of the plant is also observed from this study.It is therefore concluded from this study that the plant being a large biomass on the water course not consumed by animals could serve as an effective phytoremediation plant.

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