Evaluation of Phytoremediation Potential of *Lantana camara* for Heavy Metals in an Industrially Polluted Area in Bhopal, India

Ashwini A. Waoo, Swati Khare, Sujata Ganguly

Abstract— **Soil contamination from industrial effluents and mining activities is a widespread concern all over the world. Generally soil act as the buffer zone between atmosphere and underground water, thus soil contamination creates a serious threat to soil and to the surrounding biosphere. This research program is aimed to make an in-depth investigation about the remediation of contaminated sites from various metal contaminants using specific plants. This study concentrates on the evaluation of phytoremediation potential of Lantana camara for the surroundings of industrial area of Bhopal, which is heavily affected by heavy metal pollution. The aim of our research was to identify some interesting accumulators which may associate an important biomass production with an effective absorption and translocation of heavy metals. The present study is focused on the ability of the native plant to accumulate and tolerate high concentrations of heavy metals on heavy metal supplemented M S medium in tissue culture, which are often associated in polluted areas.**

***Index Terms*— Bhopal, Heavy Metal, Pollution, Phytoremediation, Tissue Culture.**

I. INTRODUCTION

Soil is a vital environment where rock, air and water exists in interface. Soil pollution can be defined as long term presence of radioactive materials, toxic compounds like heavy metals, salts and chemicals or disease causing agents, which have hazardous effects on plant and animal health. Soil pollution was mainly results in the deterioration of the quality, texture, mineral and chemical content of the soil or which overall disturbs the biological balance of the ecosystem.

The most common chemicals involved are pesticides, petroleum hydrocarbons, lead and other heavy metals. Their occurrence is depends on the degree of industrialization and quantities of chemical usage. Contaminated soil should not be used for agriculture or as for underground water source. Because there was leeching of chemicals into the food, water and it was extremely harmful for human health. Heavy metals such as lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and nickel (Ni), includes a group of inorganic chemical hazards at contaminated sites. Soils contamination occurred by the accumulation of heavy metals by emissions from the rapidly expanding industrial areas. Introduction of invasive species for phytoremediation purposes in Bhopal may affect the local flora. Therefore, identification and selection of locally available plant species for phytoremediation research and implementation is one of the challenges that need to be met and a pre-requisite for successful phytoremediation research (Erakhrumen, 2007).

The potential of phytoremediation technology based on proper selection of native plant species, having hyperaccumulator capabilities, which have the ability to grow on poor quality of soil in case of texture, structure, age, and fertility of contaminated soil with high concentration of toxic heavy metals (Pulford and Watson, 2003). Phytoremediation of different types of contaminants requires different general plant characteristics for optimum effectiveness Careful selection of plant and plant species is very critical, first, to ensure that the plant is appropriate for the climatic and soil parameters at the site, and second, for effectiveness of the phytoremediation of the pollutant at hand.

On the basis of majority of occurrence in the contaminated area *Lantana camara* was selected as a plant to carry out study on phytoremediation potential.

Lantana camara plant is found mostly in the South India, in Tamilnadu (Kuppandapalayam), in America, in Africa, mostly native to subtropical and tropical America, but a few taxa were indigenous to tropical Asia and Africa, and also found in Himachal Pradesh, Jammu-Kashmir, and Uttar Pradesh.

100 genera and 2000 species of Verbanaceae family, *Lantana* is a genus of 150 species that were very popular as popular ornamental garden plant. Among of 150 species of *Lantana camara* is one of them, Butterflies are said to love *Lantana camara* flowers after blooming, young flowers are in yellow colour and old are in red colour. The plant is serious weed in the hilly terracing and also in the plains of the country weeds were known to be inhibit growth of neighboring vegetation due to release of phyto toxins.

Lantana camara is rarely found in natural or semi-natural areas of forest as it is unable to compete with taller trees due to its lack of tolerance for shade and instead grows at the forest edge. *Lantana camara* can survive in a wide range of climates, including drought, soil types, heat, humidity and salt. It is also relatively fire tolerant and can quickly establish itself in recently burnt areas of forest.

The plant named *Lantana camara* linn. Family- Verbanaceae is commonly known as wild sage or red sage and lantana weed. It is a large scrambling evergreen, strong smelling

Manuscript received November 09, 2014.

Ashwini A. Waoo, Department of Botany, Barktullah University, Govt M.V.M., Bhopal, India.

Swati Khare, Department of Biotechnology, Barktullah University, Institute for Excellence in Higher Education (IEHE), Bhopal, India

Sujata Ganguly, Department of Botany, Barktullah University, Govt M.V.M., Bhopal, India.

shrub with stout prickles, its leaves were opposite and scabrid on both sides. Lantana Flowers were small, generally orange but often vary in colors from white to dark red, which are prominently capitates in heads; bracts conspicuous and persistent. Lantana fruits were small, 5 mm diameter, drupaceous and shining, blue, greenish, blackish, with two nutlets in it. Its seeds were germinated easily throughout central and south India in most dry stony hills and black

Lantana camara is a small perennial shrub which can grow to around 2m in height and forms dense thickets in a variety of habitats. Due to extensive selective breeding throughout the 17th and 18th Century for use as an ornamental plant there are now many forms of *Lantana camara* present throughout the world.

Lantana camara has small tubular shaped flowers which each have four petals and are arranged in clusters at the end of stems. Flowers have variety of colours including white red, pink yellow, and orange which differ according to age, location, and maturity. After pollination occurs the colour of the flowers change (typically from yellow to orange or red), this is believed to be a signal to pollinators that the pre-change colour contains a reward as well as being sexually viable, therefore increasing pollination efficiency can be seen in *Lantana camara.*

The leaves are simple, arranged oppositely on the stem and have a strong odour when crushed. The fruit of *Lantana camara* is berry-like and turns a deep purple colour when mature. Both vegetative (asexual) and seed reproduction takes place in it. Up to 12,000 fruits can be produced by each plant which is then eaten by birds and other animals which can spread the seeds over large distances, facilitating the spread of *Lantana camara*.

Plants growing on heavy metal contaminated soils have developed the ability to accumulate huge amounts of the local metals in their tissues without exhibiting symptoms of toxicity (Prasad and Freitas, 2003) and the ability of a plant to hyper accumulate any one metal may interfered with ability to accumulate other metals (Prasad and Freitas, 2003). These plant species accumulates significant amount of the some heavy metals (Prabha et al., 2007). Thus, these plant species can be effectively used for phytoremediation of heavy metal contaminated soil. Present research deals with the phyto extraction of *Lantana camara*.

II. Study Area

The study was conducted in Govindpura Industrial Area, Bhopal city which is located between Latitude: 23°16′00″ N and Longitude: 77°24′00″ E Elevation above sea level: 487 m = 1597 ft. It is located in the central part of India, and at just north of the upper limit of the Vindhya mountain ranges, located on the Malwa plateau. Bhopal represents humid subtropical climate, with a humid monsoon season, cool, dry winters, and a hot summer. The average temperature is being around 30 °C and highs regularly exceed 40 °C. The average temperature is around 25 °C (77 °F) and the humidity is quite high. The monsoon generally starts in late June and ends in late September. The Govindpura industrial area has 1044 small- and medium-scale industries involved in various kinds of production activities.

III. Heavy Metal Analysis from *Lantana camara*

This section accounts for heavy metal analysis of *Lantana camara* to find out their heavy metal accumulation capability and phytoremediational potential. Concentration of heavy metals such as Lead, Chromium, Cadmium and Nickel was analyzed by atomic absorption spectrophotometer. Various plant organs such as leaves and shoot were analyzed for heavy metal concentration.

Phytoremediation is one of best suitable, cost effective and ecofriendly tool for removal of heavy metals from the contaminated sites. The potential of phytoremediation techniques using hyperaccumulators resulted in concerns related to invasiveness and disruption of local or native ecosystems (Angle et al., 2001), as the introduction of extra-terrestrial plants may change the ecosystem function. Thus, an alternate option is to identify native hyper accumulator plants from polluted regions and use them for soil remediation in same region (Gonzalez and Chavez, 2006). The native plant species that dominated the contaminated area were assessed for their phytoremediation efficiency.

IV. Extraction of Heavy Metals from Leaves of *Lantana* camara

The study of accumulation of heavy metals namely Cd, Ni, Cr and Pb in the leaves of *Lantana camara* was done. Table 1 shows the mean values of metal accumulation of leaves in relation to the different external concentrations of toxic metals. Toxic metal concentrations ranges were found similar to that of shoots of *Lantana camara*. The highest accumulation of Lead 262.2 mg/kg was shown in the leaves and the lowest accumulation was found to be of Nickel 34.77 mg/kg. Figure 1 shows the graphical representation of Leaves of *Lantana camara*.

Table 1: Heavy Metal Extraction from Leaves *of Lantana camara*

Leaves	*Chromium (mg/kg)*	*Lead (mg/kg)*	*Cadmium (mg/kg)*	*Nickel (mg/kg)*
PL-5 Lantana	242.7	262.2	49.4	34.77

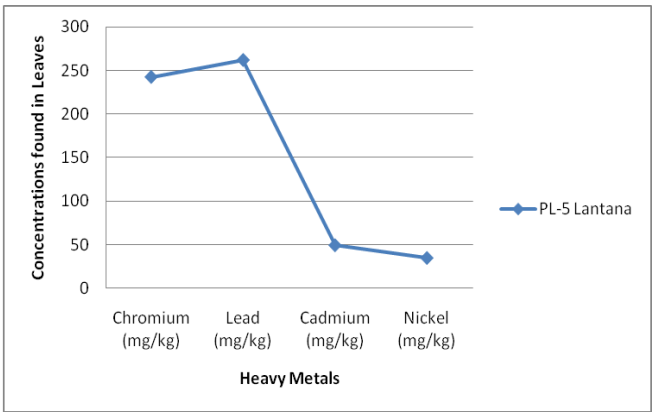

Figure 1: Concentration of Heavy Metals in Leaves of *Lantana camara*

The Cd, Ni, Cr and Pb accumulation by *Lantana camara* was studied in the shoots. Figure 2 shows the mean values of heavy metal accumulated in the shoots. In *Lantana camara* significantly higher metal concentrations were found in the shoots, it had revealed that better translocation of heavy metals in the upper part of plants.

Table 2: Heavy Metal Extraction from Shoots of *Lantana camara*

Shoots	*Chromium (mg/kg)*	*Lead (mg/kg)*	*Cadmium (mg/kg)*	*Nickel (mg/kg)*
PB -5 Lantana	72.3	88.4	28.76	22.76

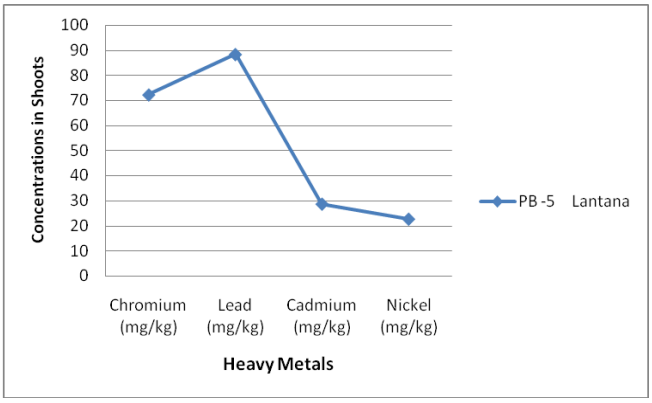

Figure 2: Concentration of Heavy Metals in Shoots of *Lantana camara*

Toxic metal concentrations were found in the shoots as follows: Pb > Cr > Cd > Ni. *Lantana camara* had shown the highest accumulation of lead in the shoots 88.4 mg/kg as shown in Table 2 and Figure 2 is the graphical representation of heavy metal concentrations in shoots of *Lantana camara*.

V. Result and Discussion

The normal heavy metal contents of terrestrial plants growing in uncontaminated soils were found to be in range of 50 mg/kg for Pb, 0.5-2 mg/kg for Cr, 0.01-1 mg/kg for Cd, and 1-5 mg/kg for Ni.

The present study showed that concentrations of Cr, Pb, Cd and Ni metal in the studied native plant species were higher than the normal plant, and thereby indicating that these plants had a strong ability to tolerate and accumulate these heavy metals. It was found that, leaves of both studied native plant species accumulated more Cr concentration than those of shoots.

VI. Conclusion

For exploring the potential of phytoremediation technology, and evaluating the phytoremediation potential of *Lantana camara*, this study was carried out. Heavy metal concentration in Lantana camara was analyzed using AAS and it is one of the most important factors to determine the success of phytoremediation. In the present study, it was found that heavy metal concentrations in investigated plant species was exceeding the normal values showing the higher accumulation in native plants like *Lantana camara* existing in that particular area. Further, the methodology was undertaken to develop a novel phytoremediation system of *Lantana camara* plants to remove major toxicants in the form of heavy metals such as Pb, Cd, Ni and Cr. In future the growth performance, metal uptake *Lantana camara* plants will be in pipeline.

Acknowledgement

I would like to thanks to my supervisor and co-supervisor for their valuable guidance and also thankful to Dr. Shagufta Khan, Director, Growtips Biotech Training Institute, Bhopal for her support in my research work. I would like to thanks to Dr. Aabha Gargava, Pricipal, Govt. M.V.M. Bhopal to provide me resources in M.V.M. college.

References

[1] Majeti Narasimha Vara Prasad, Helena Maria de Oliveira Freitas, "Metal hyperaccumulation in plants - Biodiversity prospecting forphytoremediation technology",Electronic Journal of Biotechnology ISSN: 0717-3458 Vol.6 No.3, Issue of December 15, 2003

[2] Angle, J.S., R. L.Chaney, A.J.M. Baker, Y-M. Li, Reeves, V. Volk, R. Roseberg, E. Brewer, S. Burke, and J. P. Nelkin. 2001, Developing Commercial Phytoremediation Technologies: Practical Considerations. South African J. of Science. 97: 619-623.

[3] Prabha K. Padmavathiamma & Loretta Y. Li, Phytoremediation Technology: Hyper-accumulation Metals in Plants, Springer Science + Business Media B.V. May 2007

[4] Pulford I.D. and Watson C., (2003), Phytoremediation of heavy metal contaminated land by trees, Environment international 29, pp 529 – 540.

[5] Ashwini A. Waoo, Dr. Swati Khare, Dr. Sujata Ganguli, "In-vitro Culture of *Lantana camara* from Nodal and Shoot-tip Explants in Phytoremediation Studies", Current Trends in Technology & Sciences (http://www.ctts.in), ISSN 2279 0535, [Volume No.: II Issue No. : I - Jan. 2013] [Page No: 183-186] [2013]

[6] Erakhrumen, Andrew Agbontalor, Phytoremediation: An Environmentally Sound Technology for Pollution Prevention, Control and Remediation in Developing Countries, Department of Forest Resources Management, University of Ibadan, Ibadan, Nigeria. May, 2007

[7] González–Chávez, M. C.; J. Vangronsveld, J. Colpaert, C. Leyval. 2006. Arbuscular mycorrhizal fungi and heavy metals: Tolerance mechanisms and potential use in bioremediation, pp. 211–234. In: PRASAD, M.N.V.; SAJWAN, K. S.; NAIDU, R. (eds.). Trace Elements in the Environment. Biogeochemistry, Biotechnology, and Bioremediation. CRC Press. Boca Raton, Florida, USA.

Mrs. Ashwini A. Waoo ,Research Scholar, Government Motilal Vighyan Mahavidhyalaya, Barkatullah Universiry, Bhopal, (M. P.),India

Dr. Swati Khare, Professor of Botany Department of Biotechnology, Institute for Excellence in Higher Education (IEHE), Bhopal, (M.P.), India

Dr. Sujata Ganguly, Professor of Botany Department of Botany, Government Motilal Vighyan Mahavidhyalaya, Bhopal, (M.P.), India