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Remediation of heavy metals lead, cobalt and copper from industrail wastewater by phytoremediation

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Abstract: *To fulfil human beings requirement number of industries increases day by day which play important role in development of country but also causes environment pollution. Effluent of many industries contain heavy metals and other contaminants. Industrial effluent usually used for agriculture purposes without treatment. Plants take these heavy metals from industrial water and accumulate it in roots and Arial parts which become the part of animal and human body through food chain causes various diseases. In this research work plants were grown using wastewater of industrial effluents. Three sample of wastewater were made of various concentration level of lead, copper and cobalt. Typha latifoliate was grown in controlled environment. Three sample of wastewater were used. Soil used in pots was of known concentration of heavy metals. Using x-ray fluorescence spectrometry was used to find concentration of contaminants in soil before and after plantation and atomic absorption spectrometry was used to find concentration of heavy metals in industrial effluent. Wastewater of various concentration level was obtained by adding domestic water having no heavy metals. Extraction percentage performed by plants in various lawn was found by analysis of soil before and after the maturity of plants. soil which was irrigated by fully contaminated wastewater was remediated by 10%. Soil in which plants were irrigated by diluted wastewater was remediated by 15 and 21% respectively for copper and cobalt. Plants matured in seventy-five days in winter season.*

Keywords*: Heavy metals; industrial effluent; various concentration of contaminants; phytoremediation.*

I. INTRODUCTION

Heavy metals found naturally and artificially. Artificially contributors of heavy metals to environment are industries, agriculture, volcanic explosion, gasoline formation, sludge of sewage and extraction of Zinc and Copper (Cristaldi, Oliveri, Hea, & Zuccarello, 2017; Hernberg, 2000; Kabata-pendias, 2004; Oosten & Maggio, 2014; Pacyna, Pacyna, Steenhuisen, & Wilson, 2006; Sreeram & Ramasami, 2003; Tchounwou, Yedjou, Patlolla, & Sutton, 2014). Heavy metals are mutagenic, carcinogenic, disturb metabolism, causes kidney failure, ammonia, fatigue, dizziness, short term memory, renal failure, cardiovascular diseases, coordination problems, lung, throat, stomach cancer, neurotoxic, hepatoxic, immunotoxin, rapid hair fall, kidney ,brain damage, severe anemia , intestinal irritation, disturbs cellular processes such as ATP synthesis, oxidative phosphorylation ((Awofolu, 2005; Khan, Ahmad, & Rahman, 2007; Pabis et al., 2018; Salem & Elfouly, n.d.; Tripathi et al., 2007). (Peng et al., 2018) used co-cropping to improve efficiency of phytoremediation using (Trifolium repens, Artemisia selengensis, Houttuynia cordata and Medicago sativa) on purifying wastewater contaminated by Vanadium, Chromium, Cadmium and Lead. The results exposed that reasonable cropping pattern could expressively increase the efficiency of phytoremediation for wastewater. Phytoremediation use both woody (Salix species, Populus species), Herb (Thalspi Caerulescens, Brassica Juncea). Herb and woody species have ability to extract contaminants at root zone and transfer them to aerial parts of plants or stabilize them in root zone (Tahir, 2015). Plant species, soil nature, bioavailability, contaminants type play important role in efficiency of phytoremediation (Sreelal & Jayanthi, 2017). In phytoremediation two type of plants are used known as hyper accumulator and low accumulator plants. Hyper accumulator have ability and tolerance to more metals accumulation but having less biomass production (Oosten & Maggio, 2014). Plants extraction efficiency for contaminants also depend on biomass production of the pants, plants with high biomass production extract and accumulate more contaminants in roots and aerial parts (Labelle et al., 2005; Rajakaruna, Tompkins, & Pavicevic, 2006; Sharma & Pandey, 2014) plants with high biomass need number of harvesting, composting of biomass, biomass transportation. So, use of such plants increase the overall cost for phytoremediation. (Lasat, 1999) show that phytoremediation is economical and environmentally friendly compared to conventional techniques used for soil remediation from pollutants such as soil washing using solubilizing agents in water, electrochemical separation, vitrification of polluted soil, excavation and confrontation of the soil in landfill. Various research work show that engineered plant can improve efficiency of phytoremediation (Campos, Merino, Casado, Pacios, & Gómez, 2008; Kawahigashi, 2009). Arundo donax L. was used for remediation of soil contaminated by cadmium during hydroponics experiments and in in soil experiment. Bioaccumulation factor and translocation factor were greater in case of hydroponics experiments (Sabeen et al., 2013). Effect of chemically aided soil on phytoremediation using Typha latifolia and vetiver (Chrysopogon zizanioides) was studied by (Ko & Akoto, 2018). In this research work three type soil was used each containing sixteen sample differ by ethylene di-aminete- traacetic acid (EDTA), aluminum sulfate [$Al_2(SO_4)_3$], and unchanged soil. Using tetramethylammonium (TMA) and dodecyl trimethylammonium

(DTMA) improved bentonites (T-Bents and D-Bents) as amendments was studied for Stabilization of Cu, Zn, Cd, Hg, Cr and As in soil (Yu et al., 2017). Various research work show that engineered plant can improve efficiency of phytoremediation (Campos et al., 2008; Kawahigashi, 2009). Arundo donax L. was used for remediation of soil contaminated by cadmium during hydroponics experiments and in in soil experiment. Bioaccumulation factor and translocation factor were greater in case of hydroponics experiments (Sabeen et al., 2013) Effect of chemically aided soil on phytoremediation using Typha latifolia and vetiver (Chrysopogon zizanioides) was studied by (Ko & Akoto, 2018). In this research work three type soil was used each containing sixteen sample differ by ethylene di-aminete- traacetic acid (EDTA), aluminum sulfate [Al2(SO4)3], and unchanged soil. Using tetramethylammonium (TMA) and dodecyl trimethylammonium (DTMA) improved bentonites (T-Bents and D-Bents) as amendments was studied for Stabilization of Cu, Zn, Cd, Hg, Cr and As in soil (Yu et al., 2017).

II. Sample collection

Best result of laboratory is function of sample therefore sample was collected using all necessary precautions to get result more accurate. Little error in sample making tends to error in whole results, as sample is representation of whole quantity used in research work. Quantity of sample should be which can be easily handled.
The selection of sampling point's location and the samples collection was carried out by following general principles.

- Sample was collected near effluent of industrial zone where effluent was well mixed by free falling from pipe carrying industrial wastewater.
- All suspended material was removed such as wood particles, papers and plastic etc. All those particles whose diameter is one-quarter inch is known as large particles; it effects the overall result of sample.
- The collection of proper samples was made as easy as possible such that sampling points was eagerly reachable, proper equipment were at hand, safety precautions were followed.

following above principal, a sample point location was selected just outside the industrial area. Sample of waste water was collected from effluent of Industrial Estate at two points shown in Figure 2; where effluent was well mixed, accessible and sample handle easily. Sample is collected in water cane which was then mixed to form composite sample.

III. Materials and Methodology

Materials used were pots, soil, plants, industrial wastewater, shed covered by plastic, water canes to collect sample, water tank to make composite sample. Overall methodology is shown in Figure 1.

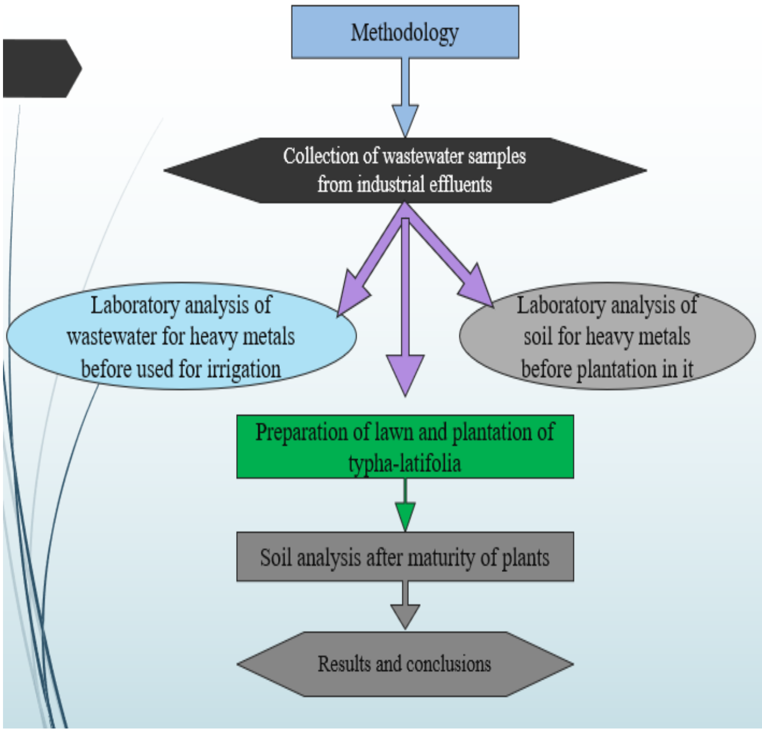

Figure 1: Over all methodology

Three lawns were made each lawn contain three flower pots shown in Figure 3. Shed was provided to protect from surrounding environment interference such as extra contaminants or rain water shown in Figure 4. Concentration of heavy metals in soil before and after maturity of plants were found using X-ray Fluorescence spectrometry shown in Figure 5. Concentration of heavy metals in industrial wastewater was determined by using atomic absorption spectrometry shown in Figure 6. Waste water of different concentration level of heavy metals was made by adding domestic water in industrial wastewater in known amount. Three lawns were made labeled as Lawn X, Lawn Y and Lawn Z. Lawn X and Lawn Y were irrigated by industrial wastewater which were diluted by domestic wastewater. Lawn Z was irrigated by undiluted wastewater. In this research work amount of heavy metals extracted by plant was determined by soil analysis before and after plantation in it. Soil used in pots shown in Figure 7 of known concentration of heavy metals and wastewater used for irrigation also of known amount of heavy metals were used for plant growth. On daily basis wastewater of different concentration level in known amount were provided to X, Y and Z lawn for seventy-five days. After maturity plants are removed from pot carefully such that no soil wasted in which plantation were completed shown in Figure 8. After mixing soil in each flower pot separately in X, Y and Z were analyzed in laboratory using X-ray Fluorescence spectrometry. Amount of concentration removed from soil was calculated by following formula.

Heavy metals in soil = C_s

Heavy metals in wastewater used for irrigation = C_w

Heavy metals extracted by plants= C_E

Heavy metals in soil after plants growth C_2=Cs + Cw - CE

Total dosage in of heavy metals in soil C_1 = Cs + Cw

% Extraction by plants= $\frac{C1-C2}{C1} \times 100 = \frac{CE}{C_1} \times 10$**……………………. (1)**

Figure 2: Sample collection

Figure 3 plantation

Figure 4 Shed to protect from rain

Figure 5: X-ray Fluorescence Spectrometry

Figure 6: Atomic absorption spectrometry

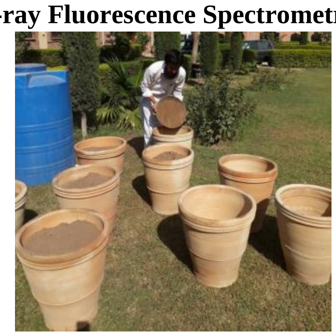

Figure 7: Lawn preparation

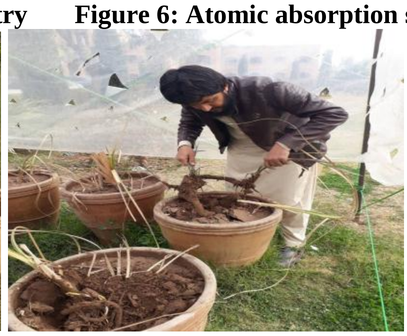

Figure 8: Plants harvesting

3.1. Results

After maturity of plants, plants were removed from soil in each pot. Soil of each flower pot was analyzed for heavy metals using X-ray fluorescence spectrometry Using Formula 1 to calculate the amount of heavy metals remediated from soil it was found that heavy metal lead was totally extracted by plant provided in form of waste water of different concentration level. In case of soil which was irrigated by fully contaminated wastewater copper was remediated by 15%. Copper while cobalt was remediated by 21%. Plants was grown for 75.

IV. FOOTNOTES

To know the efficiency of various plants species to extract heavy metals is very important because phytoremediation is environmentally friendly process to remediate contaminants from soil and water, as soil and water is getting polluted due to increase in population and industries. Following recommendations are made for future studies:

- More contamination levels.
- Effects of Seasonal Variations
- Different species

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