BIOACCUMULATION OF HEAVY METAL IN SOIL AND DIFFERENT PLANT PARTS OF ALBIZIA PROCERA (ROXB.) SEEDLING

PREETI PANDEY* AND A. K. TRIPATHI
Ecology and Environment Division, Forest Research Institute, P. O. New Forest, Dehradun, Uttarakhand (India) - 248 006
E-mail: preeti.fri@gmail.com

INTRODUCTION
Environment Pollution is one of the severe problems worlds facing today. Heavy metals are major environmental pollutant, which are discharged into the atmosphere from the burning of fossil fuels, release of industrial wastes and use of agrochemicals. Heavy metals, like As, Cd, Co, Cu, Ni, Zn, and Cr are phytotoxic either at all concentrations or above certain threshold levels. Toxic metals are biologically magnified through the food chain. They infect the environment by affecting soil properties and its fertility, biomass and crop yields and ultimately human health. In recent years interest has been focused on the study of plants as promising candidate for pollutant uptake and biological indicators of heavy metals in ecosystems. Heavy metals are significant environmental pollutants and many of them are toxic even at very low concentrations. Pollution of the biosphere with toxic metals has accelerated dramatically since the beginning of the industrial revolution. The use of plants has been a common practice for biomonitoring. They have also been used frequently to remove suspended solids, heavy metals, toxic organics etc. Living plants can be compared to solar driven pumps which can extract and concentrate several elements from their environment. From soil, plants have the ability to accumulate heavy metals which are essential for their growth and development. Hyperaccumulator plants possess an ability to take up abnormally high amounts of heavy metals in their shoots Chaney et al., (1997) and Shen et al., (1997). Metal hyper accumulator was first used by Brooks et al., (1977) to describe some “strong hyperaccumulators” of nickel in 1977. It was defined as those plants containing > 1,000 pg g⁻¹(0.1%) metal in dry materials. The main objective of the work is to find out the accumulation limit of A. procera after treatments.

MATERIALS AND METHODS
Species was selected on the basis of survey in different sites/locations, which are highly affected by industrial effluents. A. procera seeds procured from Forest Research Institute, Dehradun, (Uttarakhand), India, were selected for uniformity of colour and size, soaked overnight in distilled water containing Bayesville. In this analysis the plants were sown from the seeds planted directly in the media filled pots, after germination the seedlings were transferred in to the root trainer. The species were placed in the natural condition of central nursery of Forest Research Institute (FRI), Dehradun. After 3 weeks the plants were grown in polythene bags filled with sand, soil and farm land manure (1:1:1) and were watered daily (for one year).

Heavy metal treatments consisted of CdCl₂, As₂O₃ and Pb (C₂H₃O₂)₂·3H₂O with three different concentrations of 1mg/L, 5mg/L, 10mg/L. Three replicates were kept for each treatment along with control. Treatments were given to plant’s root environment by watering the plant with doses of three different concentrations of 1mg/L, 5mg/L, and 10mg/L of each heavy metal. After the completion of the doses plants were separated from polythene bags and divided into different plant parts (root, shoot and leaf) and these parts were analyzed for Heavy metals. Heavy metals in soil, root, shoot and leaf of plant species were analyzed by digestion of powdered sample. The digested material was diluted and filtered and then filtrate was analyzed on an inductively coupled plasma mass spectroscopy (ICP-MS).
Bioconcentration factor: The Bioconcentration Factor (BCF) of metals was used to determine the quantity of heavy metals that is absorbed by the plant from the soil. This is an index of the ability of the plant to accumulate a particular metal with respect to its concentration in the soil (Ghosh and Singh, 2005) and is calculated using the formula:

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\text{BCF} = \frac{\text{Metal concentration in plant tissue (whole plant/portal)}}{\text{Initial concentration of metal in substrate (soil)}}
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The higher the BCF value the more suitable is the plant for phytoextraction (Blaylock et al., 1997). BCF Values > 2 were regarded as high values.

Statistical analysis
The mean of metal concentration was calculated and subjected to analysis of variance (ANOVA) using randomized block design and least significant different methods (RBD) on the “SPSS for windows” program after analysis of the homogeneity of variance according to scheffe test

RESULTS AND DISCUSSION

Heavy metal content
Metals (Cd, As and Pb) were not observed in the control plants at all exposure times. Heavy metal contents in soil, root, shoot and leaf of A. procera are shown in Table 1. The metal concentration significantly increased when the concentration were increased (p<0.001). for Cd samples of 1, 5 and 10mg/L, the 10 mg/L Cd sample contents showed higher concentration in leafs (0.077mg/g) lower in soil (0.069mg/g), while for 5mg/L Cd samples, maximum concentration was found in shoot(0.038mg/g) and minimum was in root (0.032mg/g). After treatment minimum concentration was found in 1mg/L Cd samples, which was higher in soil (0.0069mg/g) and lower in leaf (0.0044mg/g).

For As samples maximum concentration was found in 10mg/L treatment that was 0.045mg/g in soil then in root (0.0412mg/g) and minimum in leafs (0.038mg/g). For 5mg/L treatment higher concentration was found in root (0.141mg/g) and minimum in soil, while for 1mg/g maximum As concentration was found in shoot (0.0236mg/g) and minimum in root (0.0065mg/g). (p<0.001) (Table 1).

For Pb samples concentrations maximum concentration was found in 10mg/L treatment that was 0.0697mg/g in soil then in root and minimum in leafs (0.0441mg/g). For 5mg/L treatment, higher concentration was found in soil (0.0445mg/g) then in root and minimum in leafs (0.0095mg/g), while in 1mg/g maximum Pb concentration was found in soil (0.0168mg/g) and minimum in leaf (0.0081mg/g). (Table 1). The interactions between metals, treatments and metal* treatments were highly significant (p < 0.001) (Table 1) in soil, root, shoot and leaf. Only leaf was non-significant with metals.

Bioconcentration factor (BCF): The BCFs of Cd, As and Pb in A. procera at different concentrations are shown in Fig. 1. The BCFs of metal Cd and As increased when the concentrations were increased but decreased in Pb. The BCFs of metal Cd and As increased when the concentrations were increased but decreased in Pb. The BCFs of Cd at 1, 5 and 10mg/L were 0.743, 0.995 and 1.033 respectively. The BCFs of As at different treatments were 1.049, at 1mg/L, 1.964 at 5mg/L and 0.895 at 10mg/L. The BCFs were decrease in metal Pb when concentrations were increase. The BCFs of As of A. procera at 1, 5 and 10mg/L were 0.927, 0.751 and 0.600 respectively. The higher value of BCF indicates the ability of plant to concentrate metals in their tissues. Hence, A. procera could concentrate Cd and As in their tissues better than Pb. The present study shows that As
are toxic to *A. procera* as shown by the toxicity symptoms such as chlorosis, decreases in the biomass and total chlorophyll contents. Pb is much more toxic than As and Cd by species were increased when the exposure time and concentration of metal were increased. Similar result was found in *Pistia stratiotes* by Maine et al., (2001) in aquatic plant water lettuce. In plants, metal concentrations were reported to be higher in leaf and stem so it could be used in the restoration of contaminated soils. 

*A. procera* possesses the potential to accumulate metal in its tissue. The results revealed that under the experimental conditions, the accumulations of Cd, As and Pb by species were increased when the exposure time and concentration of metal were increased. Similar result has been related to differences in their root morphology indicating that a proportionate amount of Pb was being translocated to the above-ground biomass. Moreover, the tight binding characteristic of Pb to soils and plant materials makes a significant portion of Pb unavailable for root uptake by plants.

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