Heavy Metal Enrichment Characteristics of Poplar

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Abstract—Soil heavy metal pollution has become a focus of attention in the world. The poplar trees have some characteristics: easiness to plant, quick growth, strong resistance, and large biomass. Therefore, the poplar is taken as the example and this paper studies the enrichment characteristics of different heavy metalspaper. The results are shown that: (1) the enrichment ability of heavy metals by polar is: zinc > copper > cadmium > lead > nickel > chromium. As for different parts, the heavy metal enrichment capability of leaf is the largest. (2) The transfer ability of heavy metals by polar is: copper > cadmium> zinc > lead > nickel > chromium. Among them, the transfer coefficient of chromium by poplar stem is the largest, and leaf has the maximum transfer coefficient on the rest five heavy metals. In summary, the results indicate that zinc, copper and cadmium are the enrichment heavy metals of polar.

Keywords-Heavy Metal Pollution; Enrichment Characteristic; Poplar; Phytoremediation; Soil

I. INTRODUCTION

Refers to the soil heavy metal pollution due to human activities will be all kinds of heavy metals into the soil, the soil heavy metal content in the enrichment to increase significantly higher than that of soil background content and cause of the deterioration of the ecological environment quality pollution phenomenon[1]. International research on soil heavy metal pollution and repair began in the 1970 s [2]. Woody plants technology research started later, it was first been put forward by Nguyen et al.[3], in order to distinguish the herb repair plant. As time goes by, it caused the wide attention of scholars both at home and abroad. In 1995, Punshon[4] first developed a hydroponic screening methods, such as, selection willow with the resistance of Cu. Sweden's Tommy Landberg[5] studied different willow (Salix) in different soils concentration enrichment of Cd, found that some species plant of the willows (Salix) can enrichment a mass of Cd, and the absorbing state of different genotypes was different on the Cd. Yu Guoying [6] conducted a study about poplar body heavy metal element inside and outside the migration cycle during before and after the fallen leaves. Research found that as a fast-growing tree of the poplar the accumulation of Cd and Hg reached 34.93 mg/kg and 47.19 mg/kg, exceeded the controlled plants more than 10 times, growth and biomass not trouble find.

Therefore, this paper takes an example of poplar, according to poplar root, rhizome, diameter at breast height, branch and leaf five parts of the heavy metal content, analysis of heavy metals in different parts of the poplar distribution; On this basis, according to the different parts of the heavy metal content and the corresponding soil heavy metal content, this paper analyzes the heavy metal enrichment coefficient and transfer coefficient, and studies the heavy metal enrichment characteristics of poplar, in order to provide reference base for the phytoremediation of soil heavy metals pollution.

II. MATERIALS AND METHODS

A. Materials

In Huainan reclamation-area, screening plant grew well. This paper collected about twenty Poplars respectively by the root, rhizome, stem, branches and leaves, and then puted into the sample bags, and brought back to the lab for testing.

B. Methods

According to the research purpose to processing parts with these acquisition of plant sample, this paper first uses tap water to wash away the dust and soil that attached on the surface, once more use a secondary deionized water rinse it twice, and then with stainless steel knife chop after natural air, weight about 200g in ceramic disk. After filming in the 105 ℃ for 30 min, drum bellows in 50 ℃ drying to constant weight. Remove crushed, 60 mesh nylon screens set aside. This paper puts the sieving sample blending and sealed storage in a brown bottle, labeling with serial number for determination. Plant samples are accurately weighed for 4.0g through dry ashing method

and extract using HCL, and then using the graphite furnace method determination of heavy metal cadmium (Cd, Pb, Cu, Zn, Cr, Ni), the use of instruments for TAS - 986 atomic absorption spectrophotometer.

III. RESULTS AND ANALYSIS

A. Heavy Metals Enrichment Characteristics of Poplar

According to the experimental data from different parts of poplar can be determined in the different topsoil for different heavy metal Bioaceumulation Factor, named BF. BF is a reference standard to measure the plant ability aiming at some heavy metal enrichment capacity. The calculation formula is:

$$BFi = \frac{Pi}{Si} \qquad (1)$$

In the formula:

BF_i—The enrichment coefficient of element i

P_i— Element I content in plants, mg/kg;

S_i— Element in plant growth medium content i, mg/kg.

BF is the positive correlation relationship with plant heavy metal enrichment capability, namely the larger BF value the ability of heavy metal accumulation is stronger. Especially the aerial parts of the plant body organs, the larger enrichment capability the organs have, its ability to repair the heavy metal is stronger. A hyper-accumulation plants, plants for the BF>1 is one of the obvious performance characteristics.

Calculate according to Eq. 1, each part of the six kinds of heavy metals in the poplar average enrichment coefficient, shown in Table 1.

TABLE I.   ENRICHMENT COEFFICIENTS OF HEAVY METALS

Part	Cu	Zn	Cr	Ni	Pb	Cd
Root	1.20	1.79	0.08	0.11	0.06	0.64
Rhizome	0.46	1.31	0.06	0.03	0.12	0.26
Thoracic stem	0.50	2.46	0.10	0.02	0.13	0.27
Branch	1.23	3.15	0.05	0.12	0.09	0.66
Leaf	1.43	3.18	0.12	0.17	0.16	1.19

According to Table 1, the characteristic of the different heavy metal enrichment in poplar body are analyzed, as shown in Fig. 1.
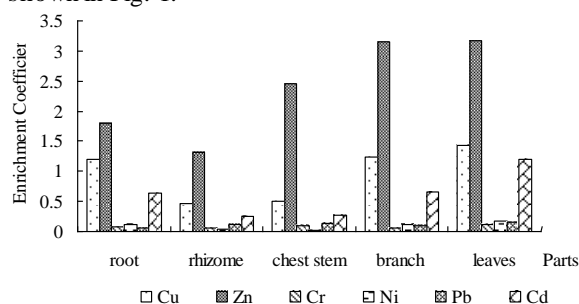

Figure 1. Enrichment characteristics of heavy metal

According to table 1 and Fig. 1: The order of Cu enrichment capability in poplar body is: leaf > branch > root > thoracic stem> rhizome, so we can know compared with thoracic stem and rhizome poplar leaves, branches, roots are Cu main enrichment parts. Zn in poplar body enrichment capability in the order: leaf > branch > root > rhizome > thoracic stem, and all value of number are greater than 1, shows that whole poplar has strong enrichment for heavy metal Zn. Cr in poplar body enrichment ability manifest that: leaf > thoracic stem > rhizome > branch > root, and the roots of Cr enrichment coefficient is 1.40, shows that the roots is the main parts of poplar for Cr enrichment. Ni in poplar body enrichment capability rank is that: leaf > branch > root > rhizome > thoracic stem, and enrichment coefficient all less than 0.5, its stand the enrichment capability of poplar for Ni is weaker. The order of Pb enrichment capability in poplar body is: leaf > thoracic stem > rhizome > branch > root, enrichment coefficient all less than 0.5, it's also expression that the enrichment capability of poplar for Pb is weaker. Cd in poplar body enrichment capability set size in the order: leaf > branch > root > thoracic stem > rhizome, and leaf, shoot, root of enrichment coefficient is greater than 0.5, shows that poplar leaves, twigs, roots are metal Cd enrichment main parts

B. Heavy MetalsTransferCharacteristics of Poplar

Transfer coefficient is a ratio of the ground and underground part of element content in the plant, the larger of transfer coefficient is, the heavy metals from the root to the different organs above ground transport ability is stronger. Transfer coefficient is greater than 0.5, the plant can transferred most of the heavy metals to the ground, is advantageous to the heavy metal recycling. Its computation formula for:

$$Ti = \frac{Pui}{Pdi} \qquad (2)$$

In formula:

Ti—the transfer coefficient of element I;

Pui—Elements in the plant I part of the content on the ground, the unit mg/kg;

Pdi—The content of element I in plant underground part (full amount), the unit mg/kg.

On the basis of Eq.2, count six kinds of metal in the poplar body transfer coefficient, the results are shown in table 2.

TABLE II.   TRANSFER COEFFICIENT OF HEAVY METALS

Part	Cu	Zn	Cr	Ni	Pb	Cd
Stem	0.33	0.60	0.66	0.17	0.68	0.76
Branch	1.26	1.06	0.42	0.90	0.70	0.97
Leaf	1.98	1.23	0.55	1.38	1.16	1.77
Transfer coefficient	3.57	2.89	1.63	2.45	2.54	3.50

According to Table 2, analysis of different heavy metals in the poplar transfer characteristics, as shown in Fig. 2.

According to Table 2 and Fig. 2 shows that the capability of the transfer of heavy metals by poplar stems is: Cd > Pd>Cr>Zn>Cu>Ni; Branch's ability to transfer of

heavy metals as follows: Cu>Zn>Cr>Ni>Pd>Gd; leaf's ability to transfer of heavy metals as follows: Cu> Cd> Ni>Zn>Pd>Cr; And poplar total transfer capability of heavy metals in turn: Cu>Cd>Zn>Pd>Ni>Cr, and Cu transfer coefficient is the largest with 3.57, Cd takes second place with 3.50; above all, Poplar has a strong transfer capability to Cu and Cd.
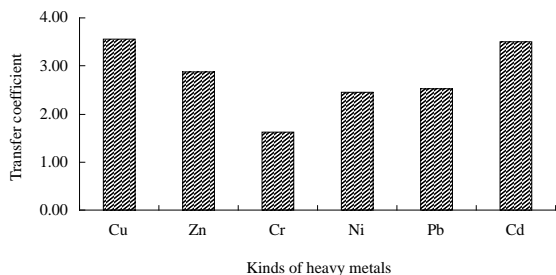

Figure 2. Transfer characteristics of heavy metal

IV. CONCLUSIONS

Through the above analysis, draw the following conclusions:

(1) Enrichment capability of poplar to heavy metal: The order of Cu enrichment capability in poplar body is: leaf > branch > root > thoracic stem> rhizome, so we can know compared with thoracic stem and rhizome, the poplar leave, branch, root are Cu main enrichment parts. Zn in poplar body enrichment capability in the order: leaf > branch > root > rhizome > thoracic stem, and all value of number are greater than 1, shows that whole poplar has strong enrichment for heavy metal Zn. Cr in poplar body enrichment ability manifest that: leaf > thoracic stem > rhizome > branch > root, and the root of Cr enrichment coefficient is 1.40, shows that the root is the main part of poplar for Cr enrichment. Ni in poplar body enrichment capability rank is that: leaf > branch > root > rhizome > thoracic stem, and enrichment coefficient all less than 0.5, its stand the enrichment capability of poplar for Ni is weaker. The order of Pb enrichment capability in poplar body is: leaf > thoracic stem > rhizome > branch > root, enrichment coefficient all less than 0.5, it's also expression that the enrichment capability of poplar for Pb is weaker. Cd in poplar body enrichment capability set size in the order: leaf > branch > root > thoracic stem > rhizome, and leaf, shoots, root of enrichment coefficient is

greater than 0.5, shows that poplar leave, twig, root are metal Cd enrichment main parts.

(2) Capability of the transfer of heavy metals by poplar stems is: Cd>Pd>Cr>Zn>Cu>Ni; heavy metals transfer ability of branch as follows: Cu>Zn>Cr>Ni>Pd>Gd; heavy metals transfer ability of leaf's as follows: Cu> Cd> Ni>Zn>Pd>Cr; And poplar total transfer capability of heavy metals in turn: Cu>Cd>Zn>Pd>Ni>Cr, and Cu transfer coefficient is the largest with 3.57, Cd take second place with 3.50; above all, Poplar overall has a strong transfer capability to Cu and Cd.

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