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Research Progress on Remediation of Soil Heavy Metal Pollution by Garden Plants

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ABSTRACT. *In recent years, the momentum of global industrialization has been rapid, but the ensuing heavy metal pollution problems cannot be ignored. Remediation of heavy metal pollution in soil is a difficult project. The physical and chemical remediation technology used in the past has high cost and is easy to cause secondary pollution. Therefore, the increasingly mature bioremediation technology has become a hot spot, especially the plant remediation technology. According to the research at this stage, it is found that a variety of plants have a targeted enrichment effect on different types of heavy metals, and most plants are common, easy to cultivate, inexpensive, and common in garden plants. Therefore, while implementing garden plants to repair heavy metal pollution in the soil, it also has the effect of urban beautification.*

KEYWORDS: *Soil pollution, Heavy metals, Phytoremediation, Garden plants*

1. Introduction

In the 21st century, resource wars are no longer pure exploration and trade, protecting the eart's ecological resources and building ecological civilization have become a new trend. The soil resources, which are the basis of national survival, need more careful care and patience to repair. Heavy metal pollutants can not be decomposed by microorganisms in the soil, have small mobility, are not easy to leach with the water, and gradually accumulate. It is harmful to penetrate into all levels of the food chain through the ecological cycle, which needs special attention. Besides the natural weathering process, the natural migration process of wind and water transport, the main causes of these heavy metal elements in the soil come from human interference input, including the modern use of pesticides, the discharge of industrial waste water, atmospheric sedimentation and sludge accumulation.

Wang Shiyuan, a former Vice Minister of the Ministry of Land and Resources of China, quoted the data from the soil condition survey of the Ministry of Environmental Protection at the land survey press conference at the end of 2013. The area of cultivated land with medium and heavy pollution in the mainland of China is about 50 million mu, which is the first time that the Chinese government has released the total amount of medium and heavy pollution of cultivated land to the media. This not only means that China's land is facing serious pollution and

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degradation, which has caused harm to the ecological environment, but also revealed the reason for the emergence of large quantities of heavy metal "toxic food" on the domestic market, which has also caused damage to human health. The exposure of events such as "cadmium rice" and "heavy metal vegetables" is not only a moral alarm, but also a call for help from nature. According to the "remediation technology of heavy metal contaminated soil" published by Yang can in 2020, about 300 million mu of arable land in China is polluted, and about 12 million tons of food crops are lost each year due to heavy metal pollution of soil. According to sun Ning's statistics, there are more than 30 major heavy metal pollution incidents during the 12th Five Year Plan period, which have posed a great threat to people's life safety. Heavy metal pollution remediation project is imminent, which is not only responsible for the improvement of environmental quality, but also to meet the inevitable requirements of sustainable development of the environment.

2. Phytoremediation Technology

In soil heavy metal remediation projects, phytoremediation technology mainly uses the migration effect of plants and plant roots on pollutants, bioaccumulation and degradation ability of pollutants to repair soil ecological environment polluted by heavy metals. Because of its nature, high efficiency, environmental protection and no secondary pollution, it is also called green remediation technology. Its main methods can be divided into four categories: plant extraction, volatilization, fixation and root filtration. In busy and crowded big cities, as the landscape plants of urban beautification, they take the responsibility of soil restoration.

Since the new concept of phytoremediation was proposed and recognized internationally in 1983, scholars from various countries have conducted a lot of research on soil heavy metal pollution. In 1986, Professor Gao Zhengmin, a famous expert in soil science and ecology in China, expounded his academic viewpoint on using phytoremediation technology to restore soil ecosystem and productivity polluted by heavy metals. In 2001, Ke Shaoying believed that the side effects of the implementation of physical and chemical methods prompted people to seek a new economic, simple and non-destructive method of soil fertility, namely plant restoration. In 2014, Chuan Limin et al. put forward the urgency of remediation technology for soil heavy metal pollution, which needs economic, efficient and feasible advantages. In 2019, Fang Songlin and others believed that using plants to repair heavy metal pollution in soil could effectively change the severe situation of heavy metal pollution in China.

2.1 Plant Extraction

Plant extraction technology refers to the adsorption of heavy metals in soil by some plants that have enrichment effect on heavy metals. Heavy metals are transferred and stored in plant stems and leaves after being absorbed by plant roots, and then the stems and leaves are treated with the purpose of fundamentally removing heavy metal pollution in soil[1]. In 1994, Baker and others in the UK first

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used the principle of plant extraction to repair the land polluted by heavy metals with Thalaspi caerulesence, which provided the experimental basis for the feasibility of plant extraction. In 2005, Tang Yetao et al. also carried out the same experimental research, which led to the discovery of the first Chinese Arabidopsis conus with enrichment ability to lead, zinc and cadmium.

2.2 Plant Volatilization

Plant volatilization is a special substance secreted by the rhizosphere system of super enriched plants, which can transform the heavy metals in the polluted soil (mainly the heavy metals with low gasification point) into the form of gas, so as to volatilize to the surface of soil and plants and release to the atmosphere[2]. In 1997, banuelos et al. discovered the hemp which can transform the non heavy metal selenium in the soil into gas to remove, which confirmed the feasibility of plant volatilization. In 2000, Meagher discovered that tobacco can be used to convert the more toxic bivalent mercury in the soil into gaseous mercury, which can be volatilized into the atmosphere.

2.3 Plant Fixation

Plant fixation is to use some characteristics and special substances secreted by plants to absorb and transform toxic heavy metals in soil into less toxic or relatively harmless substances, so as to reduce the content of toxic heavy metals in soil and reduce the possibility of further pollution of soil environment or air environment[3]. In 1995, Dushenkov et al. found that the combination of lead and phosphate secreted by plants can form lead phosphate fixed at the root of the plant. This study used the principle of plant fixation to greatly reduce the harm of lead to the quality of the soil environment.

2.4 Root Filtration

Root system filtration technology is a kind of technology which can fully absorb and filter the harmful heavy metals in the polluted water by using some super enrichment plants with strong roots, and effectively treat the heavy metals in the water, with the purpose of repairing the water polluted by heavy metals[4]. In 1998, Hansen et al. found that the wetland near the Bay in San Francisco Bay area could absorb the waste water containing non-metallic selenium very well, which confirmed the role of root filtration.

3. Garden Plants with the Function of Heavy Metal Enrichment

Many kinds of plants in nature have enrichment effect on one or more heavy metal elements. The following is a brief introduction of plants with enrichment effect on cadmium, mercury and lead.

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3.1 Cadmium Enriched Garden Plants

In 2005, through field investigation, Nan Xuyang et al. found that cedar had a good enrichment effect on heavy metal cadmium; in 2009, Yang Weidong et al. found that weeping willow is a kind of garden plant that can accumulate cadmium through hydroponics experiment; in 2016, Lin Lijin et al. selected a kind of garden plant-cosmos sulphureus that can accumulate cadmium by high concentration cadmium pollution method.

3.2 Mercury Enriched Garden Plants

In 2010, through experimental research, Ding Zhenghua and others found that several main mangrove plants have enrichment effect on mercury; in 2012, Hou Jing and others used hydroponics test to study that petunia can be a super enrichment garden plant of mercury.

3.3 Lead Enriched Garden Plants

In 2004, He Xinhua et al. found that bayberries could effectively absorb heavy metal lead under hydroponics, so they could be used as lead super-enriched garden plants; in 2014, Cui Shuang and others found that the beautiful cherry tree has a strong tolerance to lead and can be used as an enriched garden plant for lead by using the pot test method; in 2016, during the field investigation, Yang Yaqin and others found that Osmanthus fragrans can be used as a lead rich garden plant.

4. Conclusion

Because of its natural and effective characteristics, phytoremediation technology has always been hot in the research of soil heavy metal pollution control. However, the research on super enrichment of garden plants is still a slow and patient process. Therefore, to reduce the heavy metal pollution of soil, everyone should take the responsibility, control from the source, and all walks of life should always adhere to the concept of environmental protection, take the road of sustainable development, and realize the ideal of “green water and green mountains are golden mountains and silver mountains”.

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