Research Progress on Calendula officinalis Pb/Cd Compound Pollution

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Abstract. This paper analyzes the existing treatment methods of heavy metal Pb and Cd pollution, and obtains the advantages and researchable value of phytoremediation technology. The research value of the short-lived flower crop Calendula officinalis in the adsorption of heavy metal Pb and Cd compound pollution. The research value of the short-lived flower crop Calendula officinalis in the adsorption of heavy metal Pb and Cd compound pollution. The research value of the short-lived flower crop Calendula officinalis in the adsorption of heavy metal Pb and Cd compound pollution.

1. Introduction
With the rapid population growth and rapid economic development in modern society, people's lives are getting better and better, but at the same time environmental problems have become increasingly prominent. In particular, the large-scale application of chemical fertilizers and pesticides causes various heavy metal pollutants to enter the soil, causing serious soil heavy metal pollution. Soil heavy metal pollution changes the chemical composition of the soil, directly or indirectly destroys the ecological structure of the soil, and migrates and accumulates through the soil-crop system, thereby affecting the safety of agricultural products and even human health. Therefore, the treatment of soil heavy metal pollution has become a hot and difficult point of research. Pb and Cd are the main heavy metal pollution elements in the soil. Their accumulation, concealment and irreversibility seriously threaten human health and even endanger people's lives. Pb is the most widely distributed in the environment, while Cd is very toxic and is the most harmful to the environment [1]. In addition, Pb and Cd are always present in the environment, and they often constitute compound pollution to the soil. Therefore, the treatment of Pb/Cd compound contaminated soil has become a hot and difficult research topic. Phytoremediation technology has gradually attracted the attention of scholars due to its green, pollution-free, and environmentally friendly characteristics.
2. Phytoremediation technology

Phytoremediation technology is a technology that uses the physiological characteristics of green plants to transfer, contain or transform pollutants to make them harmless to the environment, so as to achieve the purpose of controlling environmental pollution [2]. At present, the basic theoretical research and popularization of phytoremediation technology at home and abroad are mostly limited to heavy metal elements. Therefore, phytoremediation technology in a narrow sense mainly refers to the use of plants to remove heavy metals in contaminated soil. Brooks first proposed the concept of hyperaccumulative plants in 1977 [3], and then Chaney proposed the use of green plants to remove heavy metal pollutants from the soil in 1983 [4]. Since then, green phytoremediation technology has gradually been applied to the field of treatment of soil heavy metal pollution. Generally speaking, phytoremediation refers to the use of plants and their coexisting microorganisms to remove pollutants in the environment. According to the quantity, type, site conditions and types of plants used, the phytoremediation process can be subdivided into plant extraction, plant degradation, plant fixation, rhizosphere biodegradation and root filtration [5-6]. Among them, plant extraction is the most promising type of phytoremediation, and plants that can use plant extraction to over-absorb and accumulate heavy metals and transport them to their aerial parts are called hyperaccumulators.

There are two ways for plants to resist heavy metal stress, namely avoidance and tolerance. Avoidance means that plants use a certain mechanism to protect themselves from excessively absorbing high concentrations of heavy metals in the environment, thereby avoiding toxic damage; while tolerance means that plants improve their ability to absorb and store heavy metals while ensuring their own growth. There are two basic mechanisms of resistance, namely metal repulsion and metal enrichment. The former refers to plants that hinder the transportation of heavy metals in their own bodies or that plants absorb heavy metals and then excrete them. The latter mainly refers to plants that store heavy metals in the absence of heavy metals by combining them with cell walls, complexing with organic acids and proteins, or entering vacuoles. Biologically active form.

3. Research status at home and abroad

Phytoremediation technology is an environmental pollution control technology based on the theory of plant tolerance and excessive accumulation of certain or certain chemical elements, using plants and their coexisting microbial system to remove pollutants in the environment. As the current research on phytoremediation technology mainly focuses on heavy metal elements, phytoremediation technology in a narrow sense refers to the use of plants to remove heavy metal elements from contaminated soil. Plants that can use the extraction of plants to over-absorb and accumulate heavy metals and transport them to their aerial parts are called hyperaccumulators.

The core of phytoremediation is the selection of super-accumulative plants, which plays a decisive role in phytoremediation, but most super-accumulative plants have the disadvantages of slow growth and low biomass. From 1995 to 2009, a total of 18 species of plants from 4 families were discovered and used in the restoration of heavy metal contaminated soils, of which Cruciferae is the most representative. Although new hyperaccumulators have been discovered since then, so far only about 500 plants of 92 families have been identified as heavy metal hyperaccumulators, and most of them are Ni hyperaccumulators.

In recent years, my country has made a lot of progress in searching for hyperaccumulating plants. For example, Yang Xiaoe et al. discovered a new kind of Zn hyperaccumulating plant called Sedum alfredii, which provides a new germplasm resource for future research on the mechanism of plant hyperaccumulation of Zn and repair of Zn contaminated soil [7]; Liu Wei and Shu Wensheng discovered and confirmed that Viola baoshanensis is a new Cd hyperaccumulation plant, providing new important materials for future research on the mechanism of plant hyperaccumulation of Cd and repair of Cd contaminated soil [8]; Su Dechun and Huang Huanzhong discovered that rapeseed flowers in Xikou have the characteristics of super-accumulative plants, which will provide new important materials for future research on the mechanism of plant hyper-accumulation of Cd and repair of Cd contaminated soil [9]; Wei Shu, Zhou Qixing and others discovered dandelion...
(Taraxacum mongolicum) Solanum nigrum (Solanum nigrum) and Conyza canadensis (Conyza canadensis) are highly tolerant to multiple heavy metal single and compound pollution, and have a good ability to accumulate Cd. They have the basic characteristics of hyperaccumulating plants, and they have further research. The value of [10]; He Xinhua, Chen Ligeng, etc. found that bayberry has strong absorption capacity and resistance to Pb, and the plants did not show symptoms of lead poisoning during the test period and grew normally. It can be considered that bayberry is a new type of Pb hyperaccumulation Plants [11]; Liu Xiumei, Nie Junhua, etc. found that Bidens pinnatifida and Sorrel have a good ability to accumulate heavy metals Pb, and both can be used to remediate soil contaminated by Pb [12]; Tang Yetao, Qiu Rongliang and others found that Arabidopsis paniculata (Arabis Paniculata L.) has the ability to over-enrich Pb, Zn, and Cd, which fills the gap in domestic multi-metal hyper-accumulating plants, and provides new germplasm resources for the research of plants that can repair heavy metal compound contaminated soil [13].

4. Conclusion and Prospects
Phytoremediation technology is an important part of the research on plant pollution chemistry of soil heavy metal pollution, and flowers and plants are an important part of plants, and flowers have the function of beautifying and greening the environment. Has a high value. Calendula, as an ornamental flower, is also grown in large quantities in my country. Calendula officinalis has strong adaptability and shows strong tolerance to heavy metal pollution [14], but at present, the actual application of calendula officinalis to repair Pb/Cd composite contaminated soil is relatively small. Therefore, taking the ornamental plant Calendula officinalis as the research object, studying its absorption and accumulation of heavy metals in the Pb/Cd compound contaminated soil can provide a theoretical basis for the use of flowers to repair heavy metal contaminated soil in the future.

References
[1] ZHAN Jinwu. Bidens pilosa L. response to heavy metal Cd and Pb stress and its repair potential [D]. Chongqing: Southwest University, 2013.
[2] Alkorta I, Hemández Allica J, Becerril J M, et al. Recent findings on the phytoremediation of soils contaminated with environmentally toxic heavy metals and metalloids such as zinc, cadmium, lead, and arsenic[J]. Environmental Science and Biotechnology, 2004, 3(1): 71-90.
[3] Brook R R, Lee J, Reeves R D, et al. Detection of nickeliferous rocks by analysis of herbarium specimens of indicnt or plants [J]. Geochemical Exploration, 1977, 5 (7): 49-57.
[4] Chaney R L, Malik M, Li YM, et al. Phytoremediation of soil metals [J]. Current Opinion in Biotechnology, 1997, 8 (3): 279-284.
[5] Arthur E L, Rice P J, Rice P J, et al. Phytoremediation-An overview [J]. Critical Reviews in Plant Sciences, 2005, 24 (2): 109-122.
[6] Macek T, Uhlik O, Jecna K, et al. Advances in phytoremediation and rhizoremediation [M]//Singh A, Kuhad R C, Ward OP. Advances in Applied Bioremediation. Heidelberg: Springer Berlin Heidelberg, 2009, 7 (3): 257-277.
[7] YANG Xiaoe, YOU Xinxian. Sedum alfredi H—A new zinc hyperaccumulator plant[J]. Science Bulletin, 2002, 4 (13): 1003-1006.
[8] SHU Wensheng, LIU Wei, LAN Chongyu. A new species of Violaceae in Hunan—Baoshan Viola [J]. Journal of Sun Yat-sen University: Natural Science Edition, 2003, 5 (3): 118-119.
[9] Su Dechun, Huang Huanzhong. Potential of rape as a super-accumulative phytoremediation of cadmium contaminated soil [J]. China Environmental Science, 2002, 18 (1): 48-51.
[10] Wei Shuhe, Zhou Qixing. Screening of plants with the characteristics of heavy metal hyperaccumulation in weeds [J]. Advances in Natural Science, 2003, 15 (12): 1259-1265.
[11] He Xinhua, Chen Ligeng. The effect of lead on the growth of bayberry seedlings [J]. Acta Porgiologica Sinica, 2004, 6 (1): 29-32.
[12] Liu Xiumei, Nie Junhua, Wang Qingren. Study on Pb uptake and tolerance of six plants [J]. Chinese Journal of Plant Ecology, 2002, 8 (5): 533-537.
[13] Tang Yetao, Qiu Rongliang, Zeng Xiaowen, et al. A new polymetallic hyperaccumulator plant——Arabis paniculata L. [J]. Sun Yat-sen University Journal: Natural Science Edition, 2005, 13 (4) : 135-136.

[14] Li Cuilan, Shao Zeqiang, Wang Yujun, et al. Enrichment characteristics of lead in several ornamental plants under hydroponic conditions[J]. Journal of Northeast Forestry University, 2011, 39 (1): 49-51.