Research Progress of Remediating the Heavy Metal Contaminated Soils with Rape

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Abstract. The problem of heavy metal pollution in soil is becoming more and more serious, which seriously threatens the ecosystem and human safety. In recent years, there have been more and more studies on the use of plants to remediate heavy metal contaminated soil. The toxicity of rapeseed and the detoxification mechanism of rapeseed to heavy metals, the enhancement method of rapeseed in the remediation of heavy metal pollution in soil, and the research prospect of remediation of heavy metal contaminated soil by rapeseed.

1. Introduction
With the rapid development of industrialization and urbanization, the content of heavy metals in the soil increases year by year. Due to the characteristics of long cycle, strong concealment and irreversibility of soil heavy metal pollution [1], it will not only affect crop yield and quality, but also through the food chain and other means. Harm to human health, therefore, it is urgent to carry out research on remediation of heavy metal contaminated soil. Among many heavy metal contaminated soil remediation technologies, phytoremediation has received widespread attention in recent years because of its low cost, little disturbance to the soil, and low secondary pollution [2]. Rapeseed is one of the oil crops planted in a large area in China. It has a well-developed root system, fast growth rate, high above-ground biomass, and strong resistance to stress [3]. The accumulation effect of cadmium, lead and other elements is obvious. This article reviews the remediation effect of rape on heavy metal contaminated soil.

2. Rape absorption of heavy metals and distribution and migration characteristics of heavy metals in rape
Enrichment coefficients and transport coefficients are usually used to characterize the distribution characteristics of heavy metals in plants. Enrichment coefficients can reflect the enrichment capacity of plants to heavy metals, and transport coefficients are used to reflect the migration of heavy metals in plants.

The research by Wang N et al. [4] showed that different parts of rapeseed had different enrichment ability for the same heavy metal element: rapeseed stems and leaves had stronger Cd enrichment
ability, while roots had stronger enrichment ability for Pb. The distribution and migration characteristics of different heavy metal elements in rape are also different: compared with Pb, rape shows a very strong enrichment capacity for Cd; the transport capacity is Cd > Pb; that is, the Cd absorbed by the rape will be transferred more to the ground part, and Pb will stay in the underground part. Li H L et al. [5] analyzed the distribution of heavy metals in various organs of rape, and found that the accumulation order of Pb and As in each organ was leaf > pod > stem > seed, and the accumulation rule of Zn, Cu and Cd was leaf > Root > pod > stem > seed. The research by Yang H F et al. [6] found that rape has weaker Cu enrichment ability and stronger Zn enrichment ability. Cu is more likely to accumulate at the root of rape, and the amount of migration to stem and leaves is less, while Zn It mainly accumulates in the aerial parts of rapeseed, which makes it easier to harm human health through the food chain. Yang Y et al. [7] compared the absorption and accumulation characteristics of heavy metals in different rape varieties, and found that the heavy metal content in rape stems and fruits is very low, Pb is mainly concentrated in the roots of rape, Cu, Zn, and Cd are mainly accumulated in the roots and leaves of rape; The accumulation of heavy metals in leaves showed the highest concentration of Zn and the lowest concentration of Cd, and the accumulation of heavy metals in roots showed the highest concentration of Pb and the lowest concentration of Cd.

3. Heavy metal toxicity to rape and its detoxification mechanism

3.1. Heavy metal toxicity to rape

Seed germination is the initial life stage for plants to perceive the external environment, and it is also the most sensitive stage to changes in the external environment. The germination status of seeds directly affects the growth and biological yield of plants. The germination rate, germination index and vitality index are often used to evaluate the germination status of seeds. Different concentrations of heavy metal stress have different effects on seed germination. Low concentration generally promotes seed germination. With the increase of heavy metal concentration, the germination capacity of seeds will decrease, and too high heavy metal concentration will inhibit seed germination. By studying the effect of Cu and Pb pollution on rape seed germination, Zhang L H et al. [8] found that heavy metal stress had different degrees of inhibition on rape seed germination, and showed a downward trend with increasing mass concentration. The degree of inhibition is shown as vitality index > germination index > germination rate. The effects of Cu and Pb stress on seed germination are greater, because the damage of heavy metals Cu and Pb to plants exceeds the range of plant self-repair, which in turn has a toxic effect on embryos and buds.

Another manifestation of the toxic effect of heavy metals on plants is to prevent growth. Poorly tolerant plants are susceptible to heavy metal pollution. When their photosynthesis decreases, absorption will be inhibited, and growth and biomass will be inhibited accordingly. The more tolerant type must consume more energy in order for the cell to function normally and adapt to a bad environment. Plants have strong growth potential and large amounts, and heavy metal accumulation will also increase accordingly, and larger biomass is also conducive to the improvement of purification efficiency. Zhang Y L [9] studied the effect of heavy metal pollution of soil on rape and other crops. The results showed that Cu, Hg, and Cd elements would inhibit the growth of the aboveground and roots of rapeseed. Although the dry weight of aboveground parts of Cd treatment increased slightly, overall The yield of crops has decreased, and the content of harmful substances in crops has increased significantly.

Chlorophyll is an important substance for plants to carry out photosynthesis, and its content can characterize the strength of plant growth. Yang J F et al. [10] studied the effects of exogenous cadmium and lead pollution on the growth of rapeseed, and found that when 5 mg / kg of Cd was applied, the value of chlorophyll content in rapeseed was the largest, and the chlorophyll content decreased with the increase of Cd concentration, while Pb on Chlorophyll content has no obvious effect; the addition of low concentrations of Pb and Cd will promote the growth of rapeseed, and the addition of high concentrations will inhibit the growth, and the toxic effect of Cd on rapeseed is
greater; the effect of Cd on the dry matter weight of rapeseed is much greater than that of Pb. Another study [11] shows that adding heavy metals Cd and Pb to the soil will also affect the activity of nitrate reductase, root activity and free proline content in rapeseed, which also shows that the toxic effect of Cd on rapeseed is more serious than Pb. Wang A Y et al. [12] found that under low chromium stress, the emergence rate, seedling biomass and chlorophyll content of rapeseed were increased, but the change was reversed under high chromium stress, indicating that chromium concentration would exceed Growth and chlorophyll formation.

3.2. The detoxification mechanism of rape to heavy metals
Tolerance means that the plant has certain specific physiological mechanisms that allow higher concentrations of heavy metals to be concentrated in the plant, and the plant can survive normally. It has two basic ways: metal repulsion and metal enrichment. Metal repulsion means that plants absorb heavy metals and then excrete them, or hinder the movement of heavy metals in the body; metal enrichment means plants can detoxify heavy metals themselves, such as binding to cell walls or complexing with organic acids and proteins, etc. [13].

The research results of Wang A Y et al. [12] showed that chromium enriched in rape leaves is mainly concentrated in the cytoplasm, because the cell wall is the first barrier for heavy metals to enter the cell, and polysaccharides and protein molecules in the cell wall can combine with heavy metal ions to achieve storage. The effect is to reduce the toxicity of heavy metals to rapeseed, and the distribution of chromium in mitochondria and chloroplasts is the smallest, reducing the contact of chromium with protoplasts, ensuring that the enzymes required by rapeseed in life activities will not be affected, so that rapeseed can be carried out normally Photosynthesis and respiration.

4. Reinforcement of heavy metals in soil heavy metal pollution remediation
Because the activity of heavy metals in most heavy metal-contaminated soils is very low, plants cannot absorb them well, and most of the contaminated soils are compound pollutions, which increase the toxicity to plants and cause plants to fail to grow normally. If the soil is poor, water and fertilizer Poor performance will also affect the growth of repair plants. Therefore, agronomic enhancement methods can be used to improve the efficiency of plants to remediate soil contaminated by heavy metals. Commonly used agronomic enhancement methods include fertilization and soil pH adjustment [14]. The research results of Gao Q L et al. [2] showed that the accumulation and total enrichment of cadmium in rape shoots showed that acid soil was higher than alkaline soil, so acid soil was more conducive to the absorption of heavy metal cadmium by rape.

The absorption and accumulation of heavy metals by plants is closely related to the bioavailability of soil heavy metals. Most of the heavy metals have low biological activity in the soil, and few can be directly used by plants, which greatly limit the efficiency of plant remediation. Chelating agents pass through the soil The combination of heavy metal ions in the solution changes the presence of heavy metals in the soil, so that the heavy metals are desorbed from the surface of the soil particles and converted from the insoluble state to the soluble state, thereby greatly activating the heavy metals in the soil and creating benefits for heavy metal leaching or plant absorption Condition [15]. Chen Y et al. [16] studied the effect of chelating agent-rape combined remediation on cadmium-contaminated soil enzyme activity through pot experiments. The results showed that the three chelating agents EDTA, EDDS and oxalic acid all had significant phytoremediation efficiency in Cd-contaminated soil EDTA has the best effect and the best concentration is 3mmol / kg.

5. Conclusion
(1) Different parts of rapeseed have different enrichment ability for the same heavy metal element, and the distribution and migration characteristics of different heavy metal elements in rapeseed are also different.
(2) The detoxification route of rape to heavy metals is metal enrichment.
(3) Cooperating with fertilization, adjusting soil pH and combining with chelating agents can greatly improve the remediation efficiency of rape to heavy metal contaminated soil.

6. Existing problems and prospects
Rapeseed has great application prospects for repairing soil contaminated by heavy metals. However, its practical application in the treatment of soil contaminated by heavy metals still needs further research and exploration. The reason is that, first of all, most of the research on the removal of heavy metals in rapeseed is limited to the indoor simulation stage, which leads to certain difficulties in the practical application of rapeseed. Secondly, the mechanism of remediation of contaminated soil in rapeseed should be strengthened, including the relationship between the form of heavy metals in the soil and changes in plant rhizosphere environment, the impact of agronomic measures, soil pH, chelating agents and other measures on the remediation process of rapeseed, so as to guide The research and development of heavy metals in rape remediation soil, once again, the post-harvest resource utilization of rape remediation is also a matter of concern. If it is discarded at will, it will cause "secondary pollution" to the environment. Seeking an efficient post-harvest treatment technology for rape, to truly permanently remove pollutants, so as to achieve the real purpose of soil environmental management.

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