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Study on the form, bioavailability and influencing factors of soil heavy metals

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Abstract

Taking heavy metals in contaminated soil as the research object, a comprehensive analysis of the occurrence and bioavailability of Cd, Pb, Zn and Cu in the soil is carried out. By studying the influence of various indicators and the form and bioavailability of heavy metals, it is revealed that it affects the occurrence of heavy metals. Factors related to morphology. When carrying out pollution remediation of heavy metals, based on the evaluation of the total amount of heavy metals in the soil, comprehensive consideration should be given to soil physical and chemical properties that have a significant correlation with the content of heavy metals, and targeted soil pollution control and remediation measures should be selected to achieve the due The effect of soil pollution treatment and restoration.

Keywords

Heavy metals; occurrence form; soil pollution; remediation.

1. Introduction

In recent years, my country's soil heavy metal pollution has become prominent. The results of the national soil pollution survey show that my country's industrial and mining wasteland soil heavy metal pollution is very prominent, and the main types of pollution are heavy metals such as Cd, Pb, Cu, and Zn [1]. Soil heavy metals can be absorbed by plants and enter the food chain, threatening animal and human health [2]. Studies have shown that the toxic effects of heavy metals are mainly related to their morphological composition [3]. It is generally believed that the effective form of heavy metals is the form that is easily absorbed by plants [4], and it is also the main form that produces ecological effects. Therefore, the research on the factors affecting the occurrence of heavy metals in the soil has attracted more and more attention from researchers, and some consensus has been reached, such as the negative correlation between pH and the content of heavy metal ion exchange state [5], and the relative content of different components of organic matter affects Focus on the content of the exchange state of heavy metal ions [6], but there are many factors that affect the occurrence of heavy metals in the soil, and the combination of influencing factors and the degree of influence under different soil geological background conditions are also different. Scientifically grasping the occurrence

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status of pollutant elements in the soil is the basis for blocking the ecological harm of polluting elements and implementing remediation [7]. Based on this, this research carried out research on the occurrence form and influencing factors of the main heavy metal elements, in order to explore the characteristics of the occurrence of heavy metals in the soil and the main influencing factors, in order to provide a basis for the completion of soil pollution prevention and control.

2. Soil organic matter

The relative content of different components of organic matter affects the content of heavy metal ion exchange states [6] The organic matter in the soil itself does not contain heavy metals, and the increase in organic matter content will not lead to the increase of soil heavy metal content [8], but it can cause the mutual transformation of heavy metal forms. . There is a negative correlation between organic matter content and soil pH [9]. With the increase of organic matter content and the decrease of pH, the insoluble heavy metal forms are transformed to form exchange states that can be absorbed and utilized by plants, which improves the bioavailability of heavy metals. On the other hand, organic matter can combine with exchangeable heavy metals in the soil to form organically bound heavy metals [10], resulting in a decrease in exchangeable heavy metals. Therefore, the relationship between the soil organic matter content and the effective form content of heavy metals is often complicated. Wang Hao et al. [11] found that the content of soil organic matter has a negative correlation with the exchange state of heavy metal ions; while Chen Jiangjun et al. [12] found that the correlation between soil organic matter and exchangeable heavy metals is positive or negative, and the law is not obvious. . Under the condition that the increase of organic matter content leads to the increase of ion exchange state and carbonate combined state content, although the water-soluble state content will decrease, the biological activity coefficient will still increase to a certain extent (correlation coefficient is 0.027). The bioavailability of the four heavy metals has an obvious relationship, and the increase of organic matter content will lead to the increase of the bioavailability of the four heavy metals[13]. Organic fertilizer contains a variety of organic functional groups, which can effectively adsorb heavy metals in the soil. Appropriate application of organic fertilizers, on the one hand, can improve the buffering capacity of the soil and reduce the toxicity of heavy metals in the soil; on the other hand, some heavy metals can form sulfide precipitation during the oxidation process of organic fertilizers, such as converting Cr(VI) into Cr(III) [14]. In addition, organic matter contains many organic acids (such as alginic acid, oleic acid, etc.), which can also form insoluble salts with heavy metals, thereby reducing the bioavailability of heavy metals.

3. Soil pH

pH is an important factor that affects the precipitation-dissolution, coordination-dissociation balance of heavy metals in the soil[15], and the pH value plays an important role in the form of heavy metal elements in the soil and soil adsorption. The drop of soil pH will cause its form to be easily absorbed and utilized by plants. This is because the increase of H^+ and other cations in the soil intensifies the exchange site competition of heavy metal ions in the soil and reduces the adsorption of heavy metal ions in the soil [16], which leads to a significant increase in the content of heavy metal ion exchange states, which increases the availability of heavy metals in the soil. When the pH of the soil increases, the adsorption of metal ions by the soil is more stable, and heavy metals exist in the form of insoluble hydroxides, and their effectiveness decreases. The addition of limestone increases soil pH, AP and EC, and significantly reduces the availability of heavy metals Cd, Cu, Pb, and Zn in the soil, and ultimately improves soil microbial diversity and enzyme activity. Aiming at acidic heavy metal pollution of farmland soil, based on the health

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of the soil environment, soil remediation through the precipitation of increasing soil pH is more effective than through ion exchange and adsorption [17]. The pH value of soil not only affects the ionic composition of the soil solution and various chemical reactions in the soil [18], but also affects the bioavailability of soil heavy metals, the migration of heavy metals in the soil-plant system, and the passivation remediation effect of heavy metal pollution. Plant growth is very important. When sepiolite is added to the soil, the concentration of heavy metals in the plant is also significantly reduced. There is a significant negative correlation between the concentration of heavy metals in the plant and the pH value of the soil. This is mainly due to the increase in the pH value of the soil leading to a decrease in the concentration of exchangeable heavy metals, which can be exchanged. State heavy metals are the forms directly absorbed and utilized by plants. Studies have found that within a certain range of pH variation, the dominant microbial community has strong stability in the soil ecosystem. The stability of this structure indicates that it is possible to adjust the function of the paddy soil by regulating and controlling the stable dominant microbial community[19].In contrast, the microorganisms c_AD3, o_Saccharimonadales, o_Acidobacteriales, o_Gaiellales, Occallatibacter, Jatrophihabitans, etc. are significantly negatively correlated with pH, indicating that pH has an inhibitory effect on these microorganisms.

4. Soil enzyme activity

Soil enzyme activity has obvious correlation with the pollution degree of soil heavy metals. The improvement of soil biological indicators is the key to evaluating the success of soil heavy metal remediation [20-21]. Soil enzymes are direct participants in soil biochemical processes and are sensitive to changes in soil physical and chemical properties and other environmental factors [22]. Urease is an important component of the soil nitrogen cycle, and catalase can promote the decomposition of hydrogen peroxide, thereby preventing the toxic effect of hydrogen peroxide on organisms [23], so soil enzyme activity is often used to characterize soil remediation effects [24] The addition of limestone and montmorillonite has a significant effect on catalase and urease activities in the soil. The addition of limestone can effectively reduce the bioavailability of heavy metals in the soil, improve the habitat of soil microorganisms, and increase the enzyme activity. The correlation between urease and soil physical and chemical factors is smaller than catalase.

5. Summary

Soil pH, EC and other physical and chemical factors, as well as organic matter, can affect soil Cd, Pb, Cu, Zn and other heavy metals. And effectively increase soil microbial diversity, increase the abundance of soil beneficial bacteria, thereby improving soil environmental functions, in which pH and organic matter content are key factors affecting the structure of microbial community.

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