Organic Regulation and Remediation of Pollution of Chaolin Soil in Shandong

Bairu Qu, Yang Wang, Guangkai Wang*, Bo Liu, Yaodong Lei and Hailong Song

Shandong Zhengyuan Geological Resources Exploration Co., Ltd., Jinan City, Shandong Province, 250101, China

*Corresponding author e-mail: 2019005@zyjs.com.cn

Abstract. In recent years, due to the frequent occurrence of excessive heavy metal content in the cinnamon soil in the Shandong region of China, the country and people have attached great importance to the pollution of heavy metal in the cinnamon soil. Heavy metal pollution has a wide range and long duration. Once it enters the human body, it will cause serious harm to human health. Therefore, the prevention and control of heavy metal pollution in Chaoshan soil in Shandong will be one of the focuses of current and future development in the field of environmental protection. In this paper, by sampling and analyzing the pollution of Chaozhou brown soil in Shandong area, the content range of heavy metals, accumulation and pollution of heavy metals in Chaozhou brown soil in this area were evaluated. Five organic regulators calcium-based mineral A and calcium On the effects of mineral B, biomass charcoal D, peat H and limestone E on the leaching toxicity of Cd in Chao cinnamon soil, three different types of organic regulators A, D and E were investigated in single and mixed application of Under the influence of the effective state of Cd, the compound organic regulator ADE with the best repair effect and its proportion were selected. The experimental results show that the organic mixed modifier shows a good reduction effect on the Cd effective state content in the heavy metal composite polluted tidal cinnamon soil, in which the mixed organic modifier 0.5% peat + 0.25% vermiculite + 0.25% bone meal Stone: Bone meal is 2: 1: 1) The best reduction effect.

Keywords: Shandong Area, Tidal Cinnamon Soil Pollution, Organic Regulation, Organic Remediation

1. Introduction

In recent years, due to the deepening of industrialization in Shandong, a series of subsequent pollution problems have emerged. Among them, heavy metals are not degraded by microorganisms, and they have the characteristics of persistence, toxicity and concealment in the environment [1, -2]. Once the heavy metal exceeds the standard, it will pollute the environment for a long time and pose a threat to the health of animals, plants and humans. However, the pollution of heavy metals in the clay soil is becoming more and more serious and has attracted global attention [3].

At present, chemical passivation remediation research is one of the main directions of the research
on heavy metal pollution remediation of tidal cinnamon soil at home and abroad [4-5]. Most of them are carried out by soil column leaching and pot experiments, but the heavy metal polluted tidal cinnamon soil used in the experimental research is mostly moist cinnamon soil with artificially added heavy metals. For the actual polluted tidal cinnamon soil, although Exogenous addition of heavy metals can ensure the consistency of the total amount of heavy metals, but the contents of various forms of heavy metals are greatly different [6-7]. The research on the remediation of actual contaminated tidal cinnamon soil has greater research value, because the ultimate purpose of the passivation repair technology to be applied is to repair the actual contaminated tidal cinnamon soil [8-9].

In this paper, we selected heavy metal cadmium polluted by fluvial brown soil in Shandong to pollute farmland fluvial brown soil for experiments, and studied and discussed three control materials A (calcium-based minerals), D (biomass carbon) and E (limestone) and their application. The influence of the pH value and bioavailable cadmium content of the Chao cinnamon soil, as well as the impact on the absorption of heavy metal cadmium by cabbage and cabbage, provide a certain theory for the selection of suitable remediation and control materials and application concentration for the local cadmium-contaminated farmland Chao Chao Basis and technical support [10]. In this paper, the effects of single and mixed application of organic and inorganic modifiers on the toxic leaching amount of Cd were studied using the TCLP method, and suitable organic and inorganic modifiers were screened as test modifiers for subsequent experimental studies. Through pot experiments, the effects of different amounts and proportions of modifier peat, vermiculite and bone meal in single application and mixed application of organic and inorganic modifiers on the dry weight and Cd content of water spinach were studied.

2. Proposed Method

2.1 Hazardous Soil Pollution Hazard

Pollution of heavy metals in Chao cinnamon soil has the characteristics of latent, irreversible and serious consequences. Therefore, heavy metals are an important type of pollutant that affects the ecological environment security of Chao cinnamon soil. The heavy metals Hg, Cd and As have the most prominent effects. The hazards of heavy metal pollution in Chao cinnamon soil mainly include the impact on the Chao cinnamon soil system, as well as the harm to plant growth and human health.

(1) Impact on the tidal cinnamon soil system

The Chao cinnamon soil system mainly contains the fertility of Chao cinnamon soil, microorganisms and enzymes in the Chao cinnamon soil. After being affected by heavy metals, the Chao cinnamon soil can not only change the properties of the Chao cinnamon soil to a certain extent, but also cause the respiration of the Chao cinnamon soil to increase exponentially, thereby reducing the efficiency of microbial conversion of organic matter and leading to the death of microorganisms.

(2) Harm to plants

The harm of heavy metal pollution in Chao cinnamon soil to plants is mainly because it can react with the nutrient elements necessary for plant growth to produce precipitation, which affects the absorption of plants. At the same time, heavy metals can be absorbed by plants and accumulated in large amounts in their bodies, which in turn affects the plant's metabolic system to prevent or inhibit plant growth. When the concentration of cadmium in the Chao cinnamon soil increases to a certain value, it will reduce the rate of photosynthesis of plants and hinder plants from absorbing organic nutrients and water.

2.2 Organic Regulation and Remediation of Tidal Cinnamon Soil Pollution in Shandong

(1) Organic control of the pollution of the tidal cinnamon soil in Shandong

1) Organic regulator

Organic regulators come from a wide range of sources and are economically cheap. As regulators of Chao cinnamon soil, they can not only use their organic matter to passivate heavy metals in Chao
cinnamon soil, but also improve the fertility of Chao cinnamon soil.

2) Regulator for organic composite materials

The tidal cinnamon soil contaminated by heavy metals is often contaminated by multiple heavy metals, and the repair effect of a single regulator on different heavy metals is different and specific.

(2) Organic remediation of tidal cinnamon soil pollution in Shandong

1) Mechanism of chemical adjustment and repair of Chao cinnamon soil

Organic complex organic regulators contain a variety of organic functional groups, which can combine with heavy metals under certain conditions, thereby reducing the toxicity of heavy metal elements in the moist clay.

2) Repair with organic modifier

Organic matter content and reduce the effective state content of Cd, and increase the metabolic activity of the micro-clay soil microorganisms. Although organic modifiers have a good remediation effect on heavy metal-contaminated tidal cinnamon soil, some organic modifiers have low mineral nutrient content, and adding them to the tidal cinnamon soil alone cannot provide the nutrients necessary for the growth of certain plants.

3) Organic complex

Organic modifiers such as fulvic acid, peat and biomass charcoal contain a large amount of oxygen-containing groups such as -COOH and -OH. These active groups can chelate with metal ions to form organically bound metal substances with poor mobility. In terms of increasing the proportion of the organic matter in the moist cinnamon soil, it is beneficial to improve the metal cation exchange capacity of the moist cinnamon soil.

3. Experiments

3.1 Experimental Materials

The laboratory research institute used the tidal cinnamon soil from the surface layer (0 ~ 20cm) of the tidal cinnamon soil in the paddy field in the heavy metal contaminated area near Shandong area. After removing the sand and leaves, it was placed in a cool and ventilated place to air dry. Chao cinnamon soil and modifiers A (peat), C (vermiculite), and D (bone meal) were used in the experiment.

3.2 Experimental Method

Weigh multiple 2.0kg samples of Chao Cinnamon into clean flower pots (10 × 20cm), add different modifiers to the flower pots according to the addition plan, and mix well, and regularly water the flower pots. The moisture content of the cinnamon soil sample is 60% ~ 70% of the field water holding capacity. Soil samples were collected after 0d, 7d, 14d, 21d, 28d, 35d, and 42d, and the effective state concentrations of Cu, Zn, and Cd in the soil samples were measured, and the heavy metal forms in the Chao cinnamon soil were determined after 42d. All the above treatments were repeated three times, and the result of the experiment was the average of three repeated experiments.

4. Discussion

4.1 Effect of Application of Regulators on PH and Effective State of Heavy Metal Cd

The application of regulators can effectively change the pH of the moist cinnamon soil, which in turn affects the activity of heavy metal Cd in the moist cinnamon soil, thereby affecting the passivation repair effect of heavy metal cadmium pollution in the moist cinnamon soil. It can be seen from Figure 5-6 that the addition of calcium-based mineral A, biomass charcoal D and limestone E can increase the pH value of the moist brown soil, and the amount of increase increases with the increase of the concentration of the regulator, and increases compared with the control 0.99 ~ 1.40, 0.51 ~ 0.74, 0.75 ~ 0.96 units, the difference is obvious. This is because the pH values of the regulators calcium-based mineral A, biomass charcoal D, and limestone E are 9.61, 8.37, and 8.78, respectively, which are higher than the pH value of the tidal cinnamon soil at 6.53.
Table 1. Effect of different organic regulators on soil pH

| Type of regulator | A  | ADE | AD  | AE  | E  |
|-------------------|----|-----|-----|-----|----|
| Soil pH (Test 1)  | 7.43 | 7.61 | 7.71 | 7.81 | 7.33 |
| Soil pH (Test 2)  | 7.31 | 7.73 | 7.52 | 7.78 | 7.24 |

As shown in Table 1 above, it can be seen that when the concentration of the modifier is 20 g or less, the addition of calcium-based mineral A, biomass charcoal D, and limestone E can all reduce the effective state of Cd in the damp cinnamon soil. The amount increases with the increase of the concentration of the regulator, and the passivation rates are 48.16 ~ 65.69%, 35.86 ~ 52.42%, 11.36 ~ 46.85% respectively; the compound regulator ADE with the best repair effect and its proportion are selected. At the same time, on the SG and JH two different types of Cd contaminated soil, the local common crops cabbage and cabbage were planted, the accumulation of heavy metal Cd in the crop body was studied, as well as the changes of Cd forms in the soil, and the compound The mechanism of action of the regulator ADE. When the concentration of the regulator is 10g regulator / kg of Chao cinnamon soil, the regulators A, D, E and their combined application can reduce the effective state of Cd in the Chao cinnamon soil, the order of reduction effect is A + D + E > A + D > A = A + E > D > E, the passivation effect is the best when the mixed application ratio of A, D and E is 10: 5: 1, and the passivation rate is 86.53%. It shows that the effect of compound passivator ADE is better than that of single application.

4.2 Dynamic Changes of Effective States of Cu, Zn and Cd in Chao Cinnamon Soil after Mixed Application of Modifiers

Figure 1 shows the change trend of the effective state content of Cu, Zn, and Cd with time after the peat, vermiculite and bone meal were applied to the heavy metal composite contaminated tidal cinnamon soil in different proportions. In the first 3 weeks, the effective state content of Cu, Zn, and Cd decreased rapidly, and in the fourth week, the effective state content decreased slowly, and the effective state content in the next two weeks was basically in a stable state, which was similar to the change trend of the effective state of heavy metals when applying the modifier. The experimental results are shown in Figure 1 below.

![Figure 1. Dynamic changes of soil available Cu after mixed application of modifiers](image)

As shown in Fig. 1 above, the Cd effect of passivation of tidal cinnamon soil in each mixed treatment group is significant (P <0.05), among which the passivation effect is best T15, that is, the mixed application of 0.5% peat, 0.25% vermiculite and 0.25% bone meal, The effective Cd content measured on the 42nd day was 3.27mg / kg, which was 57.25% lower than that in the blank group.
The worst passivation effect was T10, which was a mixture of 0.5% peat and 0.5% vermiculite. The effective content of Cd measured on the day was 4.49mg / kg, which was 41.31% lower than that in the blank group. Comparing the same dosage, the effects of mixed application of organic and inorganic modifiers and single application of organic or inorganic modifiers on Cd passivation found that mixed modifiers passivated Cd are better than single application of modifiers. The addition of modifiers does not guarantee that the heavy metal content of the crop reaches the national food standard. In the actual improvement and repair process, the pollution degree of the contaminated area needs to be considered, supplemented by other technical means to reduce the heavy metal content in the area, and then implement the improvement and repair and crop cultivation.

Based on the above information, it can be seen that the mixed modifier peat + vermiculite + bone meal added to the moist brown soil has a good passivation effect on the heavy metals Cu, Zn, and Cd, while the three modifiers are added at a ratio of 2:1:1.

5. Conclusions

Organic modifiers are added to Chao cinnamon soil, or by increasing the pH value of Chao cinnamon soil, or directly adsorbing heavy metal ions, or chemical precipitation reactions, etc., the effective state content of heavy metals in Chao cinnamon soil is reduced, thereby inhibiting plants from absorbing heavy metals in Chao cinnamon soil It is one of the effective means for the continued cultivation of moderately and slightly polluted agricultural land. In this pot experiment, the addition of organic modifiers can effectively reduce the content of Cd in water spinach, and the mixed treatment of 0.5% peat, 0.25% vermiculite and 0.25% bone meal is the best. Mixed organic modifiers can significantly reduce water spinach The reason for the Cd content in the body is: the mixed application of organic and inorganic organic modifiers can significantly reduce the effective state content of Cd in the Chao cinnamon soil; the elements silicon and calcium contained in the mixed organic modifiers can form a competitive relationship with heavy metals and effectively suppress Water spinach absorption of Cd; mixed organic modifiers can effectively promote the growth of crops, and the increase of crop biomass can achieve a dilution effect on heavy metal content to a certain extent. Organic modifiers can significantly increase the yield and income of water spinach, on the one hand, because organic modifiers added to the Chao cinnamon soil can effectively reduce the biological toxicity of heavy metals. In this experiment, mixed organic modifiers showed a better effect on plant growth. The mixed application of 0.5% peat, 0.25% vermiculite and 0.25% bone meal is the best.

References

[1] Shi Z , Zhang F , Wang C . Adsorption of phenanthrene by earthworms - A pathway for understanding the fate of hydrophobic organic contaminants in soil-earthworm systems[J]. Journal of Environmental Management, 2018, 212(APR.15):115-120.
[2] Sun J , Pan L , Tsang D C W , et al. Organic contamination and remediation in the agricultural soils of China: A critical review[J]. The ence of the Total Environment, 2018, 615(FEB.15):724-740.
[3] Shi Z , Yang S , Han D , et al. Silicon alleviates cadmium toxicity in wheat seedlings ( Triticum aestivum L.) by reducing cadmium ion uptake and enhancing antioxidative capacity[J]. Environmental Science & Pollution Research, 2018, 25(8):7638-7646.
[4] Centofanti T , Chaney R L , Beyer W N , et al. Assessment of Trace Element Accumulation by Earthworms in an Orchard Soil Remediation Study Using Soil Amendments[J]. Water Air & Soil Pollution, 2016, 227(9):350.1-350.14.
[5] Anyanwu I N , Semple K T . Phytotoxicity of Phenanthrene and Its Nitrogen Polycyclic Aromatic Hydrocarbon Analogues in Ageing Soil[J]. Water, Air, and Soil Pollution, 2015, 226(10):347.1-347.12.
[6] Reddy, Krishna R, Chaparro, Carlos, Saichek, Richard E. Iodided-enhanced electokinetic remediation of mercury-contaminated soils[J]. Journal of Environmental Engineering, 2015, 129(12):1137-1148.
[7] Peng XZ, Yang SX, Li FM, 等. [Effects of Three Industrial Organic Wastes as Amendments on Plant Growth and the Biochemical Properties of a Pb/Zn Mine Tailings][J]. environmental science, 2016, 37(1):301-308.

[8] Walawenders, W. P. Thermochemical Treatment of Hazardous Wastes[J]. giornale italiano di chirurgia vascolare, 2017, 7(3):241-246.

[9] Chen Z, Zhang Y, Gao Y, et al. Influence of Dissolved Organic Matter on Tetracycline Bioavailability to an Antibiotic-Resistant Bacterium[J]. Environmental Science & Technology, 2015, 49(18):10903-10910.

[10] Jorge P F, Gascó Gabriel, Méndez Ana, et al. Soil Pollution and Remediation[J]. International Journal of Environmental Research and Public Health, 2018, 15(8):1657-.