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Remediation of heavy metals in loess with mineral and organic fertilizer

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Abstract: As the treatment of heavy metal contaminated soil has been effective in recent years, the remediation of heavy metal contaminated soil has been neglected. During the process, the migration of heavy metal elements after adding minerals or organic fertilizers, there is little research on the migration of heavy metals in underground soils and above-ground plants under the action of minerals and organic fertilizers. Under the action of organic fertilizer and minerals, is the migration law of different heavy metals in the soil the same as before? After adding mineral material montmorillonite and organic fertilizer, will it cause differences in the accumulation effect of heavy metals in different parts of the plant? Organic fertilizer has a passivation effect on heavy metal contaminated soil, but it will promote plant growth and affect plant biomass. Will the increase in biomass increase the accumulation of heavy metals in plants after adding organic fertilizer? All these problems need to be solved by us.

Keywords: Heavy metals; minerals; Soil remediation.

1. Introduction

Loess is a kind of soil with special properties. It is one of the main soil types in Shaanxi Province and is widely distributed in northwestern my country. The loess in the

Northwestern Loess Plateau has continuous distribution, complete stratum, large accumulation thickness, and relatively continuous time [1]. In recent years, due to farmland ecological environment, industrial "three wastes" discharge, agricultural irrigation water and other possible pollution sources, heavy metal pollution in the soil of the loess area has been serious. The "Twelfth Five-Year Plan for the Comprehensive Prevention and Control of Heavy Metal Pollution" issued by the Ministry of Environmental Protection in 2011 pointed out the regional nature of heavy metal pollution, and Shaanxi Province was listed as one of the key control provinces. In 2014, the National Soil Pollution Survey Bulletin jointly issued by the Ministry of Environmental Protection and the Ministry of Land and Resources showed that the total soil point-excess rate of the country was 16.1%, and that of cultivated land, woodland, and grassland was 19.4%, 10.0%, and 10.0%, respectively. 10.4%, 2.6% of moderate pollution and above, mainly heavy metal pollution, of which the over-standard rate of cadmium is 7% [2]. In a press conference held by the Environmental Protection Department of Shaanxi Province in February 2017, it was pointed out that the soil environmental safety in Shaanxi Province is generally good. The soil environmental risks in the province mainly come from the tailings ponds and smelting waste residues of the lead-zinc mines in southern Shaanxi, and Feng County and Fengxiang in Baoji Heavy metal pollution caused by lead and zinc mining and smelting in the county, gold mining and processing in Tongguan County, molybdenum mining in Weinan, non-point source pollution caused by fertilizers, pesticides, and animal manure caused by food and agricultural production in Guanzhong, oil and gas mining belts in northern Shaanxi The coming sludge pollution and so on. In April of the same year, the Second Environmental Protection Supervision Group of the Shaanxi Provincial Party Committee pointed out that Weinan City has done a lot of work on ecological environmental protection, but due to the long-term impact of energy and chemical industrial structure and other factors, there are still some shortcomings in environmental protection work. And weak links. As of October, the city's soil heavy metal pollution area has reached 106 km^2, and only 3 km^2 has been treated. The Second Central Ecological Environmental Protection Supervision Team implemented the environmental governance in Shaanxi Province in November 2018. The results report was carried out in May 2019. The inspection team believes that the environmental rectification work in Shaanxi Province has made positive progress and results, but the rectification task has a long way to go, and there is still a long way to go in the remediation of heavy metal contaminated soil. Therefore, there are still many deficiencies in the study of soil heavy metal pollution remediation. This study is to clarify the migration law of heavy metals in soil and plants under the condition of adding mineral passivators and organic fertilizers, and aims to provide for the

remediation of soil heavy metal pollution. The theoretical basis provides scientific and technological support for farmland farming with light heavy metal pollution.

2. Migration of heavy metals in soil

After entering the soil, heavy metals cannot be degraded by microorganisms and are difficult to eliminate. When they accumulate in the soil to a certain extent, they will be toxic to the soil-plant system and affect the yield and quality of crops. Smith E et al. [3,4] showed that the heavy metals in crops mainly come from contaminated soil, especially some crops that easily absorb heavy metals, such as vegetables and rice, etc. The soil pollution of heavy metals is more harmful to them [5,6]. Heavy metals in the soil, such as Cd, As, Pb, Cu, Zn, etc., can easily cause harm to human health through the food chain through crops, such as cancer, pain, blood disease, skin disease, etc.[5,7-9]. In addition to the migration and transformation of heavy metals in contaminated soil in the soil-plant system, affecting the growth of plants and the quality and safety of agricultural products, it can also gradually migrate to water bodies (including surface and groundwater bodies) through surface runoff and leaching, thereby affecting water bodies. Water quality and ecological environment produce non-point source pollution [10,11].

A large number of studies have been carried out on the migration and transformation mechanisms of heavy metals and pollution remediation [12-17]. Shangguan Yuxian et al. [12] studied the migration and form transformation of heavy metals in the soil by natural leaching of large soil pillars. The results showed that the heavy metals remaining in the soil pillars after the simulation test were mainly distributed on the surface layer of the soil (0-30 cm), while the deep layer (>30 cm) is less, and the residual rate of 6 kinds of heavy metals in 4 kinds of soils is sandy soil <fluvo-aquic soil <black soil <red soil. Zhang Siyu et al. [13] determined the cumulative release characteristics of heavy metals in the soil under leaching conditions through experiments. The results showed that the leaching concentration of each heavy metal basically followed the trend of first increasing and then slowly decreasing, which existed between the leaching volume and pH value. A certain negative correlation, a certain positive correlation with conductivity [14]. Many scholars have found through static soaking and dynamic leaching simulation experiments that the particle size, composition, pH of the solution, temperature, solid-liquid ratio, etc. of waste rock will affect the properties of waste rock and the release and migration of harmful components under physical and chemical conditions [18,19].

3. Remediation of heavy metals in farmland

The technology for soil remediation of heavy metal contaminated farmland can be

divided into two categories: one is aimed at reducing the risk of pollution, that is, by changing the chemical form of heavy metals in the soil or combining with the soil, reducing their mobility in the environment And bioavailability; the other is to reduce the total amount of heavy metals, that is, to reduce the total concentration of heavy metals in the soil by removing heavy metals from the soil [15]. Studies have shown that: physical repair and phytoremediation are costly and the repair cycle is long, so for heavy metal pollution

For contaminated soil, a practical and feasible restoration measure that can ensure the safe production of crops should be chemical in-situ passivation [17]. The in-situ passivation restoration technology is more suitable for large-area medium light due to its advantages of fast restoration rate and simple operation. Degree of non-point source pollution [15]. The selected heavy metal-contaminated soil passivation repair materials are mainly divided into two types: single passivation materials and composite passivation materials, of which single passivation materials include inorganic passivation materials, organic passivation materials and new materials, composite passivation The material is composed of two or more passivation materials [20]. Among them, inorganic substances mainly include silicon-containing substances, calcium-containing substances, phosphorus-containing substances, metal oxide substances, and clay minerals, and organic substances mainly include organic substances and biomass charcoal. After these passivators are applied to the soil, they can not only improve the physical and chemical properties of the soil and supplement nutrients, but also make the heavy metals from the exchangeable state to the organic combined state and residue state through adsorption, precipitation, complexation, ion exchange and redox. Such as stable form transformation, thereby reducing the mobility and bioavailability of heavy metals [21]. In inorganic remediation, clay minerals can reduce the mobility of heavy metals due to their adsorption and coordination effects, and achieve pollution remediation. In addition, clay minerals have many types, wide functions, simple operation in the repair process, and obvious repair effects, so they have an irreplaceable role in the remediation of heavy metal contaminated soils [22]. Li Yanmei et al. [23] showed that the adsorption capacity of kaolinite and montmorillonite for heavy metals in clay minerals increased with the increase of pH value, and when the pH value was low, the surface of kaolinite adsorbed a large amount of H+ in the solution. Occupies the adsorption sites of heavy metal ions, which weakens the activity of kaolinite, and the adsorption capacity is not high. Lou Yanhong [24] found that the dissolved substances of apatite can form precipitation with lead ions to remove Pb in sewage. However, the effect of clay mineral treatment is affected by factors such as the type of contaminated soil, the restoration of the soil environment, the compound pollution, the degree of pollution,

and the type of clay minerals [25], and most of the clay minerals are used in water treatment, and they are more applied in the remediation of heavy metal contaminated soils. Less [22]. Therefore, in the process of remediating heavy metal contaminated soil, it can be considered to be combined with other remediation agents.

Organic matter mainly affects the oxidation-reduction potential through coordination exchange and changes in pH, causing heavy metals to precipitate, and indirectly affects the concentration and mobility of heavy metal ions in the soil. Wu Yaoguo [26] found that the changes in pH and Eh indirectly affect the soil particles. The surface characteristics, in turn, affect the adsorption of heavy metals in the soil. The humus contained in organic substances has many important complex functional groups and chelating groups, and its solubility determines the migration of heavy metals. If the solubility is large, the migration will increase, otherwise it will decrease [27]. A large number of studies have shown that soil organic matter, especially dissolved organic matter, promotes the dissolution of cadmium. However, studies have also shown that organic materials and organic fertilizers have a fixed effect on soil heavy metals. Red soil) has the opposite effect on pH in the soil [28].

4. Conclusion

Most of these studies have studied the migration of heavy metals in different soils. Some people have also studied the migration of heavy metals at different concentrations in the soil. As the treatment of heavy metal contaminated soil has been effective in recent years, the remediation of heavy metal contaminated soil has been neglected. During the process, the migration of heavy metal elements after adding minerals or organic fertilizers, there is little research on the migration of heavy metals in underground soils and above-ground plants under the action of minerals and organic fertilizers. Under the action of organic fertilizer and minerals, is the migration law of different heavy metals in the soil the same as before? After adding mineral material montmorillonite and organic fertilizer, will it cause differences in the accumulation effect of heavy metals in different parts of the plant? Organic fertilizer has a passivation effect on heavy metal contaminated soil, but it will promote plant growth and affect plant biomass. Will the increase in biomass increase the accumulation of heavy metals in plants after adding organic fertilizer? All these problems need to be solved by us. This time the main research is to study the migration of different heavy metals in the soil after adding organic sheep manure and clay mineral montmorillonite, and the relationship between plant biomass and heavy metal accumulation after adding materials. Therefore, clarifying the migration rules of heavy metals in deep soil and the migration and accumulation of plants is of great significance to the comprehensive implementation of pollution remediation research,

and can provide an effective scientific basis for subsequent research on the remediation of heavy metal contaminated soils.

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