Study on Leaching Characteristics of Lead Contaminated Soil

Xiaoxiao Shu[1,2,3,4,5], Shenglan Ye[1,2,3,4,5]

[1]Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xi'an 710021, Shaanxi, China;

[2]Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xi'an 710075, Shaanxi, China;

[3]Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Natural Resources, Xi'an 710021, Shaanxi, China;

[4]Land Engineering Technology Innovation Center, Ministry of Natural Resources, Xi'an 710021, Shaanxi, China;

[5]Shaanxi Provincial Land Consolidation Engineering Technology Research Center, Xi'an 710021, Shaanxi, China.

Abstract

In order to explore the leaching changes of lead-contaminated soil in the vertical direction, this paper adopts an indoor leaching test, and sets up the leaching test of lead-contaminated soil with different bulk density and different particle size. The results show that lead is mainly concentrated on the surface of the soil and is not easy to move with water. 2000 mL is the demarcation point for the amount of heavy metal leaching. The soil bulk density of 1.0 to 1.4 is conducive to the release of Pb, and the soil particle size of <1mm releases a greater concentration of Pb^{2+}.

Keywords

Lead; Leaching; Soil; Heavy Metal.

1. Introduction

Since the reform and opening up, my country's economy has made great progress. At the same time, my country has also become one of the most polluting countries. The "National Survey Bulletin of Soil Pollution Status" shows that the pollution index of cultivated soil in my country alone is as high as 19.4%, of which Cr, Ni, Cu, Hg, Pb, As, polycyclic aromatic hydrocarbons and other pollutants account for the main part [1]. In addition to the migration and transformation of heavy metals in contaminated soil in the soil-plant system, which affects 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 [2,3]. The heavy metal lead (Pb) is one of the most serious heavy metal pollution elements, which is easy to cause human reproduction obstacles [4]. Excessive lead can damage gastrointestinal health, poison the kidneys, damage nerves, cause hypertension, lead anemia, affect human intellectual development, and reduce human immunity [5]. Therefore, it is very important to understand the leaching law of Pb pollution in heavy metals.

2. Materials and methods

The research area is located in the Fuping pilot plant of Shaanxi Provincial Land Engineering Research Institute. The annual average temperature is 13 °C, and the annual precipitation is about 510 mm. It is concentrated in June-September. host. The tested soil was loess developed from the parent material of loess, and its basic physical and chemical properties were determined before the start of the test, as shown in Table 1.

Table 1. Basic physical and chemical properties of tested soil

Test soil	Pb^{2+} content /(mg·kg^{-1})	pH	Organic matter /(g·kg^{-1})	Total nitrogen /(g·kg^{-1})	Available phosphorus /(mg·kg^{-1})	Quick-acting potassium /(mg·kg^{-1})
Lead-free contaminated soil	24.66	8.92	10.24	0.87	10.9	161
Lead contaminated soil	620.74	8.41	9.72	0.81	7.8	166

The test adopts indoor soil column leaching simulation test. Select two groups of bulk density levels of 1.0 g/cm^3 and 1.4 g/cm^3, set three groups of particle size levels (<1mm, 1-2mm, >2mm), each group of particle size content is greater than 80%, a total of 12 For each treatment, the packing particle size of each 30 cm column is different, and the specific treatment packing is shown in Table 2. Each treatment is recorded as soil layer 1, 2 and 3 according to 0~30 cm, 30~60 cm, and 60~90 cm respectively.

The experiment uses a plexiglass soil column with a total height of 100 cm and an inner diameter of 10 cm. When the soil column is filled, wire mesh, quartz sand, and filter paper are placed in sequence from bottom to top. The column body is provided with water outlets every 30 cm. , Install and insert the diversion device in the hole. The upper layer of the column is filled with contaminated soil with a thickness of 20 cm, filter paper is placed on the surface of the soil, and a 2 cm thick clean quartz sand is placed on the surface of the soil to prevent disturbing the surface of the soil after adding water. A drip irrigation point is set at an interval of 10 cm above to ensure that there is no adhering water infiltration. Minimize the generation of edge effects. During the soil leaching test, it is necessary to seal the top of the soil column with plastic wrap to prevent water evaporation.

Each treatment is repeated 3 times, and the intermittent leaching method is adopted during leaching, so that the soil has a certain reaction time. Before leaching, the soil column was rinsed with deionized water until the soil was saturated. The water volume of each leaching irrigation is 500 mL, and the leaching is performed every 3 days. The leaching solution of each layer is taken for measurement. A total of 8 leaching times, a total of 4000 mL, is about 510 mm of local rainfall. After leaching, the soil was taken in layers and the heavy metal residues in the soil column were measured.

Table 2. Filling scheme of different treatment soil column

Soil bulk density /(g·cm^{-3})	Soil particle size distribution	Fill soil /cm	Codename
1.0	<1mm	0-90	A1
1.0	1-2mm	0-90	A2
1.0	>2mm	0-90	A3
1.4	<1mm	0-90	D1
1.4	1-2mm	0-90	D2
1.4	>2mm	0-90	D3
1.0	<1mm 1-2mm >2mm	0-30 30-60 60-90	A4
1.0	1-2mm >2mm <1mm	0-30 30-60 60-90	A5
1.0	>2mm <1mm 1-2mm	0-30 30-60 60-90	A6
1.4	<1mm 1-2mm >2mm	0-30 30-60 60-90	D4
1.4	1-2mm >2mm <1mm	0-30 30-60 60-90	D5
1.4	>2mm <1mm 1-2mm	0-30 30-60 60-90	D6

3. Results

In Figure 1, the concentration range of the leaching solution in the 0~30cm soil layer is 0~3.7 μg/L, and the concentration in the 30~60 cm soil layer is between 0-0.8μg/L, which is significantly lower than the concentration range of the 0~30 cm soil layer. The concentration range of 60~90 cm soil layer is 0~0.7μg/L, which is not much different from 30~60 cm soil layer. Pb^{2+} leaching is mainly concentrated in the 0~30cm surface layer and less migrates to the deep layer with water. The concentration of leaching solution in all soil layers first increased and then decreased with time. The 0~60cm soil layer showed a peak of Pb2+ release when the leaching water volume was 2000 mL (July 24). Deep, the peak appeared delayed, and the leaching peaks appeared after the 5th and 6th leaching in the A4 and A6 treatments, and the peaks appeared at the 4th leaching in the other treatments, which may be related to the different particle size of the filling. 0~90cm soil layer, the release amount of A treatment in the whole leaching stage is higher than that of D treatment, indicating that the smaller soil bulk density is conducive to the leaching of water-soluble Pb^{2+}. 0~30cm soil layer, the leaching trend of D treatment is D2>D3>D1>D6>D4>D5, indicating that when the bulk density is larger, the soil particle size combination also increases the water-soluble Pb^{2+} leaching risk compared with the same particle size.

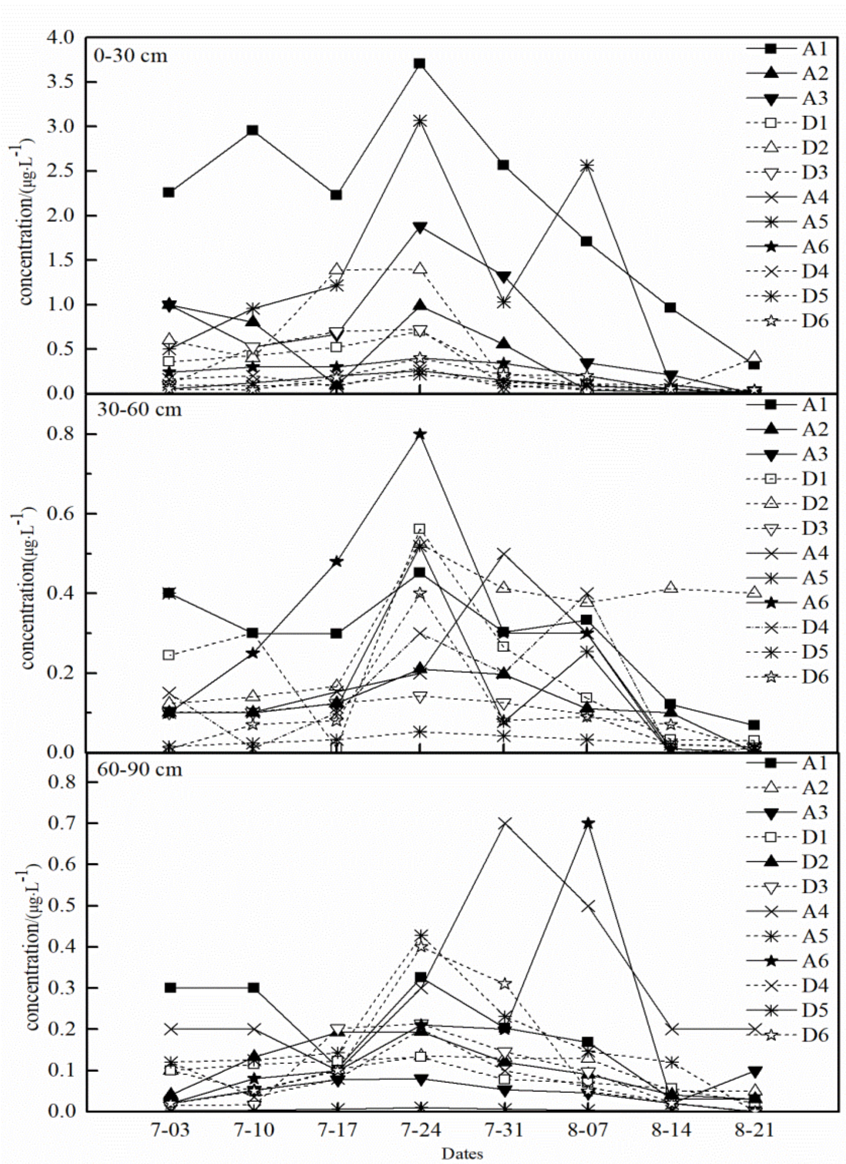

Fig. 1 Leaching characteristics of Pb2+ in 0- 90cm soil layer with different bulk density and particle size

4. Conclusions

The heavy metal Pb2+ is not easy to be leached downward with water, and 2000 mL is the demarcation point of heavy metal leaching. The soil bulk density of 1.0 to 1.4 is beneficial to the release of Pb, and the soil particle size of <1mm releases a greater Pb^{2+} concentration.

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