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Remediation of contaminated soil by biochar

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Abstract: As a new adsorbent, biochar not only promotes plants, but also adsorbs and immobilizes heavy metal pollution. In this paper, the properties of biochar and the effect of biochar on soil remediation are systematically analyzed to provide reference for remediation of contaminated soil.

1. Introduction

Biochar is a kind of charcoal as soil modifier, which can help plant growth. It can be used in agricultural use, carbon collection and storage. It is different from traditional charcoal used in fuel. It is a kind of substance with high carbon content formed by low temperature pyrolysis of biomass under anoxic or anaerobic conditions. In soil treatment, biochar can not only increase soil carbon content, but also improve soil physical, chemical and biological properties, soil fertility and productivity [1] Biochar is alkaline, reducing soil acidity and the biological activity of heavy metals [2]. Soil fertility can be improved by having large specific surface area, high pore structure, strong adsorption capacity and good water retention. Because biochar has these unique properties, it can purify and improve contaminated soil. This paper discusses the remediation effect of biochar on defaced soil and provides reference for sustainable use of soil.

2. Nature of biochar

2.1 pH value

Due to the difference of biomass species and pyrolysis parameters, the pH value of biochar is generally between 7-12 [3] This is due to the abundance of oxygen-containing functional groups -OH and -COOH, the surface of biomass carbon COOH, These functional groups are also the basis of the unique good adsorption and hydrophilic or hydrophobic and acid-base buffering capacity of biomass carbon. As a result, the pH value of biochar is generally alkaline [4].

2.2 Specific surface area

Biochar has high surface energy and large specific surface area because of its loose and porous surface. The specific surface area of biochar will change with the change of pyrolysis temperature, and the specific surface area of biochar will increase accordingly in this process.

2.3 Surface functional groups

The surface of biochar is rich in oxygen-containing functional groups, and a few polar functional groups, such as carboxyl, carbonyl, phenolic hydroxyl, lactone and anhydride, constitute the good adsorption characteristics of biomass carbon [5] the water-holding capacity of biomass carbon is proportional to the number of polar functional groups.

2.4 CEC

The CEC of biochar is between the CEC of soil organic colloid and inorganic colloid. The CEC of biochar will increase with the increase of temperature, but more than 400℃ will decrease with the increase of temperature CEC the value will decrease accordingly.

2.5 Element composition

The composition of biochar elements is affected by pyrolysis temperature and biomass species. C, H, O is the main element of biochar. Of these, C generally account for more than 60 per cent, and other minerals mainly include KCl, SiO_2CaCO; and$_3$Ca phosphates, nitrates, and Mg, Al, Mn, Zn, Fe oxides or hydroxides [6].

3. Effects of biochar on soil remediation

3.1 Effects of biochar on soil improvement

The physicochemical properties of biochar make it applied to soil and have the function of improving soil. The first is to improve the physical and chemical properties of soil, such as changing soil texture, increasing field water holding capacity, significantly increasing soil pH, increasing salt exchange capacity and increasing soil CEC [2, 7] Second, increasing soil organic matter content due to strong adsorption of organic small molecules by biochar can increase soil organic carbon stability and increase soil organic matter level, thus increasing soil fertility [9] Third, biochar is rich in organic macromolecules and porous structure, and it is easy to form aggregates with soil.

3.2 Effects of biochar on crop growth

The application of biochar in farmland can increase seed germination rate, promote plant growth and increase crop yield. A study found that 20 t/hm^2 of biochar , compared with the control group, the yield of corn in the first year showed no significant change, but the yield increased significantly in the next three years by 28%,30% and 140%, respectively [9] However, some studies have found that the addition of biochar has inhibitory effect on crop growth. Zhang Wenling [10] based on the analysis of the reasons for the reduction of crop yield by biochar, it is concluded that the reasons for the reduction may be related to the lack of trace elements caused by the change of soil texture and pH value.

3.3 Effects of biochar on heavy metal contaminated soils

Biochar acts with soil heavy metal ions to reduce the harm of heavy metals by changing the morphological distribution of heavy metals and reducing their activity and migration ability. The main reason is that a large number of negative charges on the surface of biochar make its surface charge density very large and produce electrostatic attraction with heavy metals; another reason is the pore structure and huge specific surface area of biochar, which makes it strongly adsorb heavy metals.

4. Terminology

Because of its unique physical and chemical properties, biochar can not only increase the carbon content of soil, but also improve the physical, chemical and biological properties of soil, and improve soil fertility and productivity. Biomass carbon has a wide application prospect. Although it has played a certain role in remediation of heavy metal contaminated soil, improving soil water and fertilizer characteristics, affecting soil physical and chemical properties and soil microbes, the research on biomass carbon at home and abroad is still in its infancy, and various problems will appear in remediation of contaminated soil. Therefore, the practical remediation effect of biochar on soil heavy metals needs further theoretical research and demonstration.

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