Research Progress on the Benefits of Biochar Farming on Paddy Fields and Its Polycyclic Aromatic Hydrocarbons

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Abstract: Biochar is a common adsorbent material in the market, and its benefits in soil improvement and crop growth promotion are gradually being developed and verified. This paper synthesizes the research results of the industry on the impact of biochar agricultural use on paddy fields, and focuses on the impact brought by the presence of polycyclic aromatic hydrocarbons, in order to provide more inspiration for scholars in this field in the future.

1. Introduction

Biochar is a highly aromatic solid material produced by pyrolysis (<700℃) of biomass materials, such as farmland waste, bamboo waste and poultry feces, under low or no oxygen environment[1]. According to the source of raw materials, biochar can be divided into charcoal, bamboo charcoal, rice husk charcoal, straw charcoal, garbage charcoal, sludge-based biochar, etc. The properties of these biochar are basically the same: they are all black carbon and highly aromatic [1]. The surface porosity is significant and the void size is different, so that it has environmental effects such as remediation of polluted environment, improvement of soil physical and chemical properties, crop yield and income increase, and greenhouse gas emission reduction [2].

2. Benefits of Biochar Agricultural

2.1 Improve Soil Physical and Chemical Properties and Affect Crop Growth

In terms of the composition of biochar, it is rich in carbon, hydrogen, oxygen, phosphorus, potassium and other mineral elements, which increases the content of soil organic matter and nutrients, and increases the yield of crops in acidic soil [3-4]. From the structural characteristics of biochar, the void structure of biochar increased the field water capacity of soil, promoted the formation of large aggregates of soil particles, promoted the fixation and retention of nutrients, and reduced nutrient loss. However, some research results in China are contrary to the above theory: Zhong Shuai [5] found that under the action of 0.1% straw biochar, the rice yield increase was obvious, but when the carbon application rate reached 5%, the rice yield was eliminated. Hou Yanwei [6] found that when 5% straw biochar was applied to farmland, rape yield decreased by 42.9%. It is generally believed that crop failure is caused by excessive use of biochar.

2.2 Curb Greenhouse Gas Emissions from Rice Fields

Under flooded conditions, paddy fields will lead to methane (CH4) and nitrous oxide (N2O) discharge in large quantities. The carbon sequestration and emission reduction effects of biochar have been verified in bamboo charcoal, straw charcoal, garbage charcoal, fruit charcoal and other types of biochar [7,8,9]. The aromatic ring structure and alkyl structure of biochar have good chemical and thermal stability, which makes the release of carbon in soil more slowly and continuously. Porous structure can adsorb organic matter, reduce mineralization intensity, and maintain carbon negative cycle state [10-11]. In terms of soil physical and chemical properties, biochar improves soil porosity, improves soil ventilation, inhibits methanogenic bacteria activity, and restricts denitrification process, thus reducing the production of CH4 and N2O [12]. Secondly, biochar's adsorption and fixation effect makes nutrients available to organisms, which is also one of the important reasons for inhibiting CH4 and N2O emissions [9]. When the input of biochar has a positive impact on crop yield, it will definitely promote photosynthesis and improve the ability of plants to fix CO2, thus forming a virtuous cycle of increasing yield-carbon sequestration and reducing emission-increasing yield.

3. Study on Polycyclic Aromatic Hydrocarbons (Pahs) in Agricultural Biological Carbon

Internationally, the content of polycyclic aromatic hydrocarbons in biochar has been limited to a certain extent: The ΣPAHs threshold of IBI Biochar is set within the range of 6-20 mg/kg [13]. European Biochar Certificate (EBC) stipulates that the ΣPAHs of ordinary biochar should not exceed 12 mg/kg. ΣPAHs in high quality biochar should not exceed 4 mg/kg[14].

However, many scholars are optimistic about PAHs in biochar. For example, Zielin´ ska and Oleszczuk [15] used the POM method (a passive sampler of polyoxymethylene) to quantify over 50 types of biochar.

4. Conclusion

The results showed that there was a significant relationship between the bioavailability of PAHs and the degree of aromatization of biochar (P=0.05). The bioavailable PAHs in biochar were only 0.17-216 ng/l, indicating low bioavailability. Other common methods for determining the bioavailability of organic pollutants, such as Tenax method and HPCD method, have not been used in the bioavailability study of PAHs in biochar.

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