

Research Progress and Trend of Biochar based Microbial Fertilizer

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Abstract

Biochar based microbial fertilizer has loose porous structure, which can improve soil structure, improve soil fertility, promote crop growth, and provide strong support for agricultural sustainable development. In this paper, the research progress of biochar based microbial fertilizer in the preparation process, fertilizer efficiency research, application effect and other aspects was reviewed, and it was pointed out that in the future, in-depth research should be carried out in the aspects of preparation process and performance optimization, microbial strain screening and function enhancement, application effect and mechanism research, standardization and standardization system establishment, application field expansion and technology innovation.

Keywords

Biochar Based Microbial Fertilizer; Research Progress; Research Trends.

1. Introduction

With people's attention to environmental protection and sustainable development, the problem of soil pollution and ecological damage caused by traditional chemical fertilizers has become increasingly prominent. Excessive use of chemical fertilizers leads to soil acidification, nutrient loss, and damage to soil microorganisms and ecosystems. Therefore, seeking more environmentally friendly and sustainable fertilizer alternatives has become an important research direction in the field of agriculture.

Biochar is a kind of carbon material obtained by pyrolysis or gasification of biomass. It has porosity, high specific surface area and good adsorption performance[1]. It can adsorb a large amount of water and nutrients, relieve soil pH, and improve soil water and fertilizer conservation capacity. Microbial fertilizer is a kind of organic fertilizer which is made from microorganisms through fermentation, extraction and processing. It can improve soil fertility, promote soil microbial diversity and activity, and is conducive to soil ecological restoration and protection. Biochar based microbial fertilizer is an environmental functional material with developed pore structure, rich functional groups and strong adsorption performance. It can be used as a carrier of microbial inoculum to enhance the persistence, survival and colonization of microorganisms in soil and plant roots. Biochar based bacterial fertilizer has a positive impact on soil nutrient content and crop growth. It is an efficient and environmental friendly fertilizer, which can significantly improve soil structure, improve soil fertility, reduce the use of chemical fertilizer, and promote the healthy growth of crops. The advantages of biochar based microbial fertilizer are mainly reflected in the following aspects:

1) Improve soil structure: the porosity of biochar can increase the total porosity of soil, improve soil permeability and improve soil physical structure[2]. At the same time, the activities of microbial flora contribute to the formation of soil aggregate structure and enhance the ability of soil water and fertilizer conservation.

2) Improve soil fertility: microbial agents in biochar based microbial fertilizers increase the supply of nitrogen, phosphorus, potassium and other nutrients in the soil through the processes of nitrogen fixation, phosphorus and potassium solubilization[3]. In addition, microbial metabolites such as amino acids and vitamins can also provide rich nutrition for plants.

3) Reduce the amount of chemical fertilizer: biochar based bacterial fertilizer can significantly improve the utilization rate of chemical fertilizer and reduce the loss and volatilization of chemical fertilizer. According to the research, the use of biochar based bacterial fertilizer can reduce the amount of chemical fertilizer by about 30%, and the fertilizer efficiency is not reduced or even better[4].

4) Promote crop growth: the microbial flora in biochar based microbial fertilizer can inhibit harmful bacteria in the soil and reduce the occurrence of diseases and pests. At the same time, its rich nutrition supply and soil improvement are conducive to the healthy growth of crops and improve the yield and quality of crops[5].

5) Environmental protection and green: as a green agricultural material product, the production process and use process of biochar based bacterial fertilizer meet the environmental protection requirements. It can not only reduce the use of chemical fertilizers, but also reduce the use of pesticides and reduce environmental pollution.

2. Research Progress of Biochar based Microbial Fertilizer

2.1. Preparation Process:

The preparation process of biochar based bacterial fertilizer includes the preparation of biochar, the screening and cultivation of microbial agents, and the combination of the two[6]. At present, researchers have explored a variety of preparation methods of biochar, such as thermolysis, hydrothermal carbonization, and tried to modify biochar by physical, chemical or biological methods to improve its adsorption performance and slow-release performance[7]. At the same time, according to the specific crop and soil conditions, high-efficiency and stable microbial agents were screened out and compounded with biochar to prepare biochar based bacterial fertilizer with excellent performance.

2.2. Fertilizer Efficiency Research:

A large number of studies have shown that biochar based bacterial fertilizer has significant effects on improving soil structure, improving soil fertility, promoting crop growth and increasing yield. The porous structure and high specific surface area of biochar enable it to adsorb and fix nutrients in soil, reduce nutrient loss and leaching, and improve nutrient utilization. Microbial agents can promote the decomposition of organic matter and the transformation of nutrients in soil by secreting organic acids, enzymes and other active substances, and provide rich nutrients for crops.

2.3. Application Effect:

The application effect of biochar based bacterial fertilizer on a variety of crops and soil types has been verified. For example, the application of biochar based bacterial fertilizer on corn, wheat, rice and other food crops can significantly improve the yield and quality of crops[8]; Applying it to fruit trees, vegetables and other cash crops can improve the quality and flavor of fruits. In addition, biochar based bacterial fertilizer also has many functions, such as improving soil, reducing the occurrence of diseases and pests and so on.

3. Research Direction of Biochar based Microbial Fertilizer

As an innovative fertilizer in modern agriculture, the future research direction of biochar based bacterial fertilizer will focus on improving fertilizer efficiency, enhancing environmental benefits, and promoting the sustainable development of agriculture.

3.1. In Depth Study on Preparation Process and Performance Optimization

Continue to explore more environmentally friendly and efficient preparation processes of biochar based bacterial fertilizer, such as low-temperature pyrolysis and catalytic pyrolysis, to improve the yield and quality of biochar, while reducing energy consumption and pollutant emissions; By adjusting the ratio of raw materials, pyrolysis conditions and other parameters, the pore structure, specific surface area and surface functional groups of biochar were optimized to further enhance the adsorption and retention capacity of nutrients, and provide a good living environment for microorganisms[9].

3.2. Screening and Function Enhancement of Microbial Strains

Microbial strains with significant growth promoting, disease resistance, stress resistance and other functions for specific crops are screened from nature or cultivated through genetic engineering technology, and they are combined with biochar matrix to form biochar based bacterial fertilizer with multiple functions[10]; The interaction mechanism between microorganisms and biochar was studied. By adding exogenous substances or regulating environmental conditions, the function of microorganisms was further strengthened, and the fertilizer efficiency and stability of biochar based bacterial fertilizer were improved[11].

3.3. In Depth Study of Application Effect and Mechanism

Carry out long-term and large-scale field trials to comprehensively evaluate the application effect of biochar based bacterial fertilizer under different soil types, climatic conditions and crop types, including the improvement of crop growth, yield, quality and soil physical and chemical properties; In order to provide theoretical basis for optimizing the application of biochar based microbial fertilizer, the transformation process, nutrient release law and the interaction mechanism with crop roots in soil were discussed.

3.4. Establishment of Standardization and Standardization System

Establish standards for the preparation, detection and application of biochar based bacterial manure, including standards for raw material selection, preparation process, product quality and application effect, so as to standardize the market order and ensure product quality and consumer rights and interests; Strengthen the promotion and demonstration of biochar based bacterial fertilizer, improve farmers' awareness and acceptance of new fertilizer through technical training and on-site guidance, and promote its wide application in agricultural production.

3.5. Expand Application Fields and Technological Innovation

Explore the application potential of biochar based bacterial fertilizer in non-agricultural fields such as ecological restoration and sewage treatment, such as soil pollution control and water environment improvement; Combined with modern biotechnology, information technology and other high-tech means, carry out research on the intelligent production and precise application of biochar based bacterial fertilizer, so as to improve the utilization efficiency and economic benefits of fertilizer.

4. Conclusion

In summary, biochar based bacterial fertilizer, as a new type of fertilizer, can solve the problems of soil pollution and ecological damage caused by traditional chemical fertilizers. Multiple advantages such as improving soil structure, enhancing soil fertility, reducing fertilizer usage, and promoting crop growth can provide support for sustainable agricultural development. In the future, with in-depth research on preparation processes and performance optimization, screening and functional enhancement of microbial strains, in-depth exploration of application effects and mechanisms, establishment of standardization and normalization systems, and continuous promotion of expanding application fields and technological innovation, biochar based bacterial fertilizers are expected to be widely used, making greater contributions to achieving agricultural green transformation and ecological environment protection.

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