

A Review on the Improvement of Saline-alkali Soil by Organic Fertilizer

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Abstract: In recent years, soil salinization has become a serious problem in the global environment. The application of organic fertilizer to improve saline-alkali soil has been widely concerned because of its advantages of improving soil fertility, improving soil structure and improving soil salt ion composition. This paper reviews the mechanism of saline-alkali soil improvement, and expounds the improvement prospect of organic fertilizer on saline-alkali soil from the influence of organic fertilizer on soil physical and chemical properties, water and salt transport law, crop yield and quality, in order to provide theoretical guidance for saline-alkali soil restoration.

Keywords: Salinization, organic fertilizer, water and salt transport, saline-alkali.

1. Introduction

In recent years, soil salinization has become a serious problem in the global environment. This problem is mainly caused by natural factors and human activities, and has become one of the major environmental risks. There are about 9.55×10^8 hm² saline soil in the world, occupying more than 100 countries and regions, increasing at a rate of $1.0 \times 10^5 \sim 1.5 \times 10^5$ hm² every year. Salinization not only causes the quality of cultivated land. At the same time, it also has a serious impact on national food security and regional ecological environment. Therefore, the treatment of saline-alkali soil is very important for alleviating food security and protecting ecological environment [1]. It is of great strategic significance to ensure the area of 1.8 billion mu of cultivated land, improve food production and food security by adopting the coexistence of rational development and improved utilization, vigorously improving the comprehensive agricultural production efficiency in saline-alkali areas and expanding the area of effective cultivated land. Application of organic fertilizer can effectively increase soil organic matter, improve soil available nutrients, improve soil structure, reduce soil bulk density, increase soil porosity [2], affect soil salt transport, improve soil salt ion composition, reduce soil pH value, and improve soil productivity.

2. Basic Theory of Saline-alkali Soil Improvement

The key to the management and improvement of saline-alkali land is to find out the law of soil water and salt transport, so as to scientifically regulate saline-alkali soil. Generally speaking, 'salt comes with water, salt goes with water' is the basic law of water and salt migration [3]. The migration of salt in saline-alkali soil is. It is caused by the complex water-heat-gas-salt interaction process. The composition of saline-alkali soil includes soil particles, salts and water. Moisture includes liquid water and steam, and gas includes steam and dry air. The evaporation caused by the difference between stomata and atmospheric humidity can cause the migration of

soil solution. Therefore, when the solubility is reached, the salt will precipitate into the soil pores. With the increase of salt analysis, the evaporation rate of water will gradually decrease. Most of the studies on the formation mechanism of saline-alkali soil at home and abroad focus on the soil water and salt transport model [4]. Through the characteristics of water and salt transport, measures are taken to control the gradual decrease of soil water evaporation, so that the salt on the soil surface can be effectively reduced, and the accumulation can be prevented, which is conducive to the restoration of saline-alkali soil.

3. The Improvement of Saline-alkali Land by Bio-organic Fertilizer

3.1. Effects of bio-organic fertilizer on soil physical and chemical properties

Studies have shown that the application of organic fertilizer can significantly improve soil structure, organic matter, mineral composition and other indicators [5], and increased soil organic matter content and microbial quantity and species. The physical and chemical properties of soil were significantly improved, and the soil microbial biomass carbon, soil respiration and enzyme activity were also increased in the saline-alkali land improved by bio-organic fertilizer. The application of bio-organic fertilizer can not only change the soil microbial community. Bio-organic fertilizer also affected the number of Fusarium oxysporum and main microbial groups in rhizosphere soil, caused changes in soil microbial community structure, and increased the number of bacteria, actinomycetes and soil microbial biomass carbon in rhizosphere soil.

3.2. Effect of bio-organic fertilizer on soil water and salt transport

Soil organic matter is closely related to soil bulk density and capillary porosity, which is the core of fertility and salt suppression. The mechanism of salt inhibition is that the soil organic matter content increases, the bulk density decreases,

and the capillary porosity decreases. When the groundwater rises to the soil layer with high organic matter content with the capillary attraction, the capillary fracture is accelerated, and the water runs upward in the form of vapor, while the salt is retained in the liquid water part, reducing the accumulation of salt in the surface soil. In addition, organic matter can also reduce the damage caused by salt stress to plants by coordinating hormone balance and improve salt tolerance. Zhang et al. [6] studied the improvement effect of different modifiers on severe saline soil in Hetao Irrigation District. It was found that organic fertilizer treatment combined with straw deep burial and gypsum improvement of severe saline soil significantly reduced the salinity, pH and Na⁺ content of 0~15 cm soil layer, improved soil structure, and was more suitable for crop growth.

3.3. Effects of bio-organic fertilizer on crop growth, yield and quality

Long-term application of bio-organic fertilizer can not only increase the yield of winter wheat, but also effectively improve the quality. The application of bio-organic fertilizer to soybean and corn also has similar effects. Compared with conventional chemical fertilizer treatment, the application of bio-organic fertilizer to soybean has better yield-increasing effect on soybean than corn under the same conditions. The main reason is that the application of organic fertilizer can simultaneously increase the number of grains per plant and 100-grain weight of soybean, while corn only increases its ear grain weight.

Applying bio-organic fertilizer and spraying organic fertilizer on fruit trees can significantly improve fruit quality and net photosynthetic rate. Shao et al. [7] used pot experiment to study the tomato yield of bio-organic fertilizer and chemical fertilizer treatment in secondary saline soil of facilities, which was 165.5 % higher than that of single bio-organic fertilizer treatment.

4. Conclusion

A large number of studies have shown that organic fertilizer has a significant effect on soil properties and crop yield after applying organic fertilizer to saline-alkali soil, such as increasing soil organic matter content and soil aggregate

number, reducing soil pH and soil bulk density, and improving total salt content and salt ion content. Therefore, reasonable application of bio-organic fertilizer can be used as one of the important measures to improve soil productivity and crop yield, which can not only increase yield and income, but also conform to the soil.

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