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Effects of Different Exogenous Additive Materials on Soil Organic Matter and Cation Exchange Capacity

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Abstract

In order to solve the soil problem of low fertility after the abandoned homestead reclamation of Hollow Village in the loess area, and to improve the quality of the reclaimed soil in Hollow Village, a field experiment was conducted here. The field experiment included six different exogenous additive materials treatments. The research results showed that the content of soil organic matter and cation exchange capacity in the 0-10 cm soil layer was higher than that in the 10-20 cm soil layer under the treatments of six exogenous additive materials treatments. The combined treatment of fly ash + organic fertilizer had the best effect on the improvement of cation exchange capacity and organic matter in the 0-15 cm soil layer, and the increase was distributed. reached 113.0% and 38.8%. Therefore, the combined treatment of fly ash and organic fertilizer is a suitable improvement material for improving reclaimed soil fertility in the hollow village of the loess area.

Keywords

Hollow village; Reclaimed soil; Soil organic matter; Cation exchange capacity.

1. Introduction

With the rapid development of China's industrialization and urbanization, the amount of cultivated land decreases sharply, and the conflict between people and cultivated land is intensifying, which will threaten food security and healthy development of agriculture [1-2]. Widespread phenomenon of rural hollowing with that the scale of new house construction is constantly expanded while the housing lands in the village are abandoned and left idle, which has caused the destruction and occupation of a large number of arable land resources and the idleness and waste of high-quality land resources. It seriously threatens the protection of arable land resources and regional food security, and has become a major bottleneck limiting the construction of beautiful villages and the coordinated high-quality development of urban and rural areas [3-4]. It is of practical importance and urgency to enhance the structural stability and fertility feature of the reclaimed soil by applying different soil improved materials to mature and improve the reclaimed soil of hollow villages, so that the reclaimed soil can quickly recover its original functions and properties.

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2. Materials and Methods

2.1. Experimental Design

The localized field improvement test was designed as a randomized group field test with seven treatments: maturing agent (T1), fly ash (T2), organic fertilizer (T3), fly ash + organic fertilizer (T4), maturing agent + organic fertilizer (T5), maturing agent + fly ash (TMF), and control (CK) treatment with no improved material added. There were a total of 21 treatment plots, with an isolation zone in the middle of each treatment plot. Six improved materials with different treatments were evenly spread on the soil surface and mixed into the hollow village reclaimed soil at the depth of 0 to 30cm by artificial tillage, each experimental plot only used improved materials once, and other management measures and levels such as watering amount, chemical fertilizers consumption, pest control, etc. were kept consistent. See Table 1 for the specific treatment and amount of different improved materials.

Table 1. Experimental design of different improvement materials

Number	Treatment	Improved materials	Application amount
1	CK	Control (no modified material)	0
2	T1	Maturing agent (ferrous sulfate)	0.6 t hm-2
3	T2	Fly ash	45 t hm-2
4	T3	Organic fertilizer(chicken manure)	30 t hm-2
5	T4	Fly ash + organic fertilizer	(0.6+45) t hm-2
6	T5	Maturing agent + organic fertilizer	(0.6+30) t hm-2
7	T6	Maturing agent + fly ash	(45+30) t hm-2

2.2. Sampling and Measurement Methods

The soil samples were collected during the corn harvest, which were used to determine the soil organic matter and cation exchange capacity under different different improvement materials. Each tillage treatment adopts multi-point stratified sampling method, the original soil samples are collected in 0-15 cm and 15-30 cm soil layers. We avoid the impact on the soil structure during sampling and transportation, and then return it to laboratory to remove impurities and dry it naturally. Soil organic matter (SOM) was measured by the rapid dichromate oxidation method and cation exchange capacity was measured according to ammonium acetate method [7].

3. Results and Analysis

3.1. Effects of Different Improvement Materials on Soil Organic Matter

Soil organic matter content is an important condition for evaluating soil fertility level and plays a vital role in crop growth. Compared with the control treatment (CK), fly ash + organic fertilizer (T4), fly ash (T2), organic fertilizer (T3), curing agent + organic fertilizer (T5) and curing agent + fly ash (T6) Treatment significantly increased soil organic matter content (Figure 1). The organic matter content in the 0-10 cm soil layer was higher than that in the 10-20 cm soil layer under the treatments of the 6 different improved materials, and the order of the organic matter content in the 0-10 cm soil layer was CK< T1< T6< T3< T5< T2< T4 ($P<0.05$, Figure 1). It can be seen from Figure 1 that the soil organic matter content was the highest under T4 treatment, and the lowest organic matter content under the CK treatment.

In the 0-10 cm soil layer, compared with the CK treatment, the organic matter content in the T4 and T5 treatments increased by 113.0% and 66.7%, respectively; in the 10-20 cm soil layer, the T5 and T6 treatments increased by 56.9% and 13.2%, respectively, there was a significant

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difference between T4 and T5 treatments. The above analysis shows that since organic fertilizer and fly ash contain rich and balanced nutrients and organic matter, the combined treatment of organic fertilizer and fly ash can effectively increase soil organic matter content and improve soil fertility.

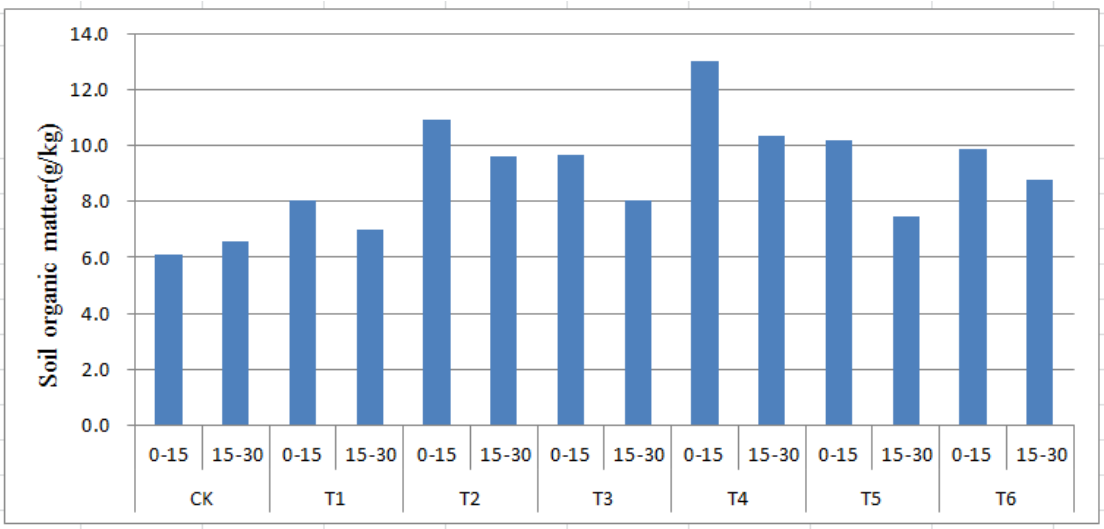

Figure 1. The content of soil organic matter under different improvement materials

3.2. Effects of Different Improvement Materials on Soil Cation Exchange Capacity

Soil cation exchange capacity is an important indicator reflecting soil fertility status and physical and chemical properties, and plays a key role in improving soil quality and maintaining soil productivity. Compared with the control treatment (CK), organic fertilizer (T3), fly ash + organic fertilizer (T4), fly ash treatment (T2) and curing agent + fly ash (T6) treatment significantly increased soil cation exchange capacity (Figure 2). The cation exchange capacity of 0-10 cm soil layer under the treatments of 6 different improved materials was higher than 10-20 cm. In the 0-10 cm soil layer, the order of soil cation exchange capacity was CK < T6 < T1 < T2 < T5 < T3 < T4 ($P<0.05$, Figure 2)， The soil cation exchange capacity was the highest under the T4 treatment, and the content of the cation exchange capacity under the CK treatment was the lowest under the six different improved materials.

In the 0-10 cm soil layer, compared with the CK treatment, the cation exchange capacity of the T3 and T4 treatments increased by 38.8% and 44.1%, respectively; in the 10-20 cm soil layer, the T3 and T4 treatments increased by 51.2% and 50.1%, respectively. %, the difference between T3 and T4 treatments was not very significant. In summary, the above analysis shows that since organic fertilizer and fly ash have developed specific surface area and multi-level pores, they can adsorb a large number of mineral particles. Therefore, after adding organic fertilizer and fly ash, the cation exchange capacity of soil can be effectively increased, and the soil cation exchange capacity can be enhanced. Fertilizer retention capacity of soil.

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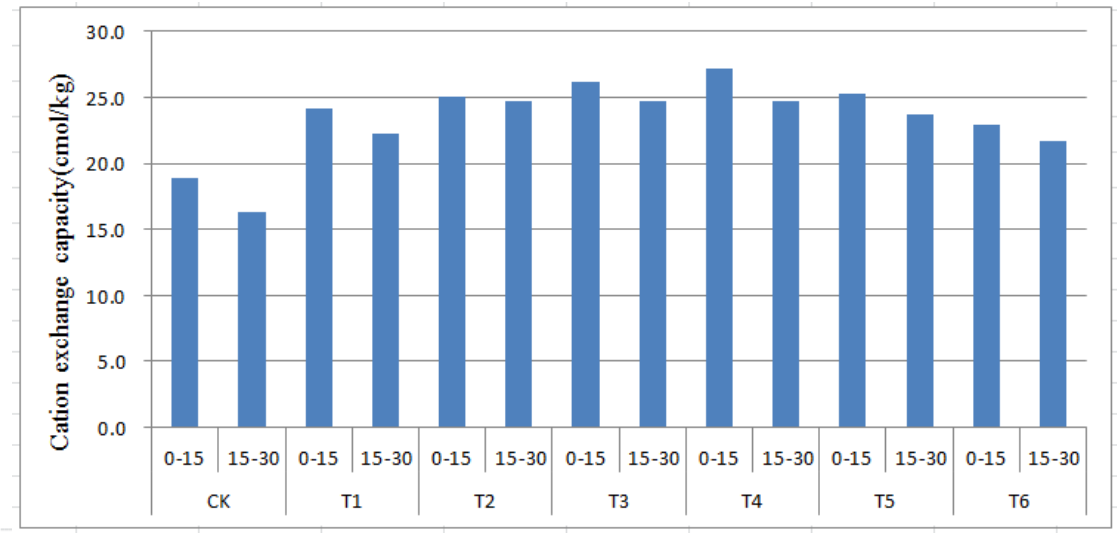

Figure 2. The content of soil cation exchange capacity under different improvement materials

4. Conclusions

The organic matter content and cation exchange capacity of the reclaimed soil in hollow villages with different improvement materials showed an increasing trend. Among them, the combined treatment of fly ash + organic fertilizer had the best effect on the improvement of cation exchange capacity and organic matter in the 0-15 cm soil layer, and the increase was distributed. reached 113.0% and 38.8%. The results show that the organic-inorganic combination treatment of fly ash and organic fertilizer is a suitable improvement material for improving the fertility of the reclaimed soil in the hollow village.

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