Effects of Different Amelioration Materials on Soil Fertility in Abandoned Homestead Reclaimed Soil

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Abstract. Abandoned homestead reclaimed soil has poor structural structure and lack of nutrients. In this study, organic fertilizer (F), curing agent (S) and fly ash (C) were used as amelioration materials to improve nutrient content of abandoned residential land reclamation soil. After 3 years of wheat-corn rotation, soil samples were collected to determine soil organic matter, total nitrogen, available phosphorus and available potassium contents. The results showed that soil organic matter content at the depth of 0-30 cm soil layer in the treatments of F increased significantly due to organic fertilizer input. The content of total nitrogen, available phosphorus and available potassium in the treated soil with improved materials increased significantly compared with the control. It indicated that the addition of amelioration materials and continuous tillage had significant effect on improving soil fertility in the abandoned homestead reclaimed soil.

1. Introduction
The rational use of land and the effective protection of cultivated land are our basic national policies. In recent years, with the rapid development of the economy and society, especially the rapid advancement of new rural construction, the housing construction phenomenon of rural residents "one house with multiple houses", "abandoning old houses, planning new houses, and occupying cultivated land" is more common and expanding potential [1, 2]. This development trend of a large number of occupied farmland, homesteads and idle houses has led to an increasing demand for rural construction land. The contradiction between protecting cultivated land and ensuring development is more prominent, which has caused China to effectively protect cultivated land, achieve food security and stabilize rural society a certain hazard [3]. According to the statistical data of the second land survey of Shaanxi Province in 2009, the construction land area of urban villages in Shaanxi Province is 9.583 million mu, of which rural homesteads account for 73.2%, and the area of abandoned homesteads available for reclamation is nearly 850,000 mu, Accounting for 12.1% of rural homesteads, generally
showing a large number, uncoordinated distribution, low land utilization, planning difficulties and increasing trends [4]. Therefore, carrying out the reclamation work of the old abandoned homesteads in rural areas has a very important role in easing the tension between people and land at this stage.

The soil in the homestead reclamation area lost many of its original functions and characteristics due to the large number of bricks and stones, and the physical structure was seriously damaged. Moreover, the soil nutrient status was poor and the output rate was low, which seriously affected the yield and quality of crops. There is still a big gap as the use of farmland soil [5], which must be cultivated to meet the requirements of cultivated soil. Yan Rui et al. [6] research on the farmland reclamation soil in the Chengdu Plain found that under the wheat-jade rotation, "bacterial residue compost return" has a better effect on improving the physical properties of the farmland reclamation soil and improving soil fertility. Hua ying [7] rapidly increased the fertility of reclaimed farmland in rural homesteads in Chongqing by increasing the application of organic fertilizer, ash and bio-organic fertilizer. It can be seen that the addition of organic fertilizer not only improves the fertility of the reclaimed soil at the homestead, but also greatly improves the total amount of microorganisms and enzyme activity.

At present, the main way of fertilizing for homestead reclamation to improve soil quality is organic fertilizer, and there are few studies on other materials. In this study, taking the land remediation project of the Loess Hollow Village as the background, a field plot experiment was used to study the effect of different improved materials (organic fertilizer, curing agent, fly ash) on the fertility improvement of homestead reclamation soil. Looking for the best soil nutrient improvement materials to provide a theoretical basis for the rapid maturation of the soil after the remediation of the hollow village and the improvement of soil fertility.

2. Materials and methods

2.1. Overview of the test area
The experiment was set in Chuyuan Village, Ducun Town, Fuping County, Weinan City, Shaanxi Province. The area has a warm temperate continental climate, with an average annual precipitation of 473 mm, July to September precipitation accounts for 49% of the annual precipitation, annual evaporation of 1000 to 1300 mm, frost-free period of 225 d, annual average temperature of 13.4 ℃, and the total annual light energy radiation is 518.6 ~ 535.0 kJ·cm².

2.2. Experimental design
The experiment started in June 2015. In order to simulate the land condition of abandoned homesteads for remediation, the soil of 30 cm on the surface of the test plot was stripped, and the raw soil collected from the abandoned homesteads of Yuzihe Village in Chengcheng County was backfilled. The cell size is 2 m×2 m. In this study, organic fertilizer (chicken manure), curing agent, and fly ash were used as improved materials, and their application rates were: 22.5 m³·hm⁻², 600 kg·hm⁻², 75 m³·hm⁻². Taking the treatment without adding any modified materials as a control, a total of 4 treatments were set, and each treatment was repeated 3 times. Apply the improved materials evenly to the backfill soil, and mix them manually. The planting of winter wheat began in October 2015, and the winter wheat-summer corn rotation planting has been carried out for three years. Among them, the maize variety is Xianyu 335, the seeding amount is 60,000 plants·hm⁻², and the hole seeding; the wheat variety is Xiaoyan 22, the seeding amount is 105 kg·hm⁻², and all treatments are compounded with 10 kg of compound fertilizer before sowing each season·hm⁻².

2.3. Analytical methods
Organic matter: Determination by potassium dichromate external heating method; Total nitrogen: 2 mol·L⁻¹ KCl solution leaching (water-soil ratio of 5:1), Kjeldahl nitrogen analyzer; Effective phosphorus: 0.5 mol·L⁻¹ NaHCO₃ leaching-molybdenum-antimony colorimetric method; quick-acting potassium: NH₄Ac leaching-flame photometric method [8]
2.4. Data statistics and analysis

The test data was preliminarily sorted out by Excel 2007 and related charts were drawn, and SPSS 19.0 software was used to test the significance of LSD_{0.05} difference.

3. Results and analysis

3.1. Effect of adding different improved materials on soil organic matter content

Soil organic matter is an important material basis for soil fertility, as a carrier and source of soil nutrients, and has a profound impact on various physical, chemical, biological properties and nutrient accumulation of soil [9]. The effects of adding different improved materials on the organic matter content of the soil profile vary (Fig. 1). Due to the addition of organic fertilizers, the F treatment greatly increased the content of soil organic matter in the 0-30 cm soil layer compared with other treatments, reaching 13.9~19.7 g·kg⁻¹, but the soil layer below 30 cm was significantly reduced, Only 5.15~7.14 g·kg⁻¹.

![Fig. 1 Effect of adding different improved materials on the organic matter content of soil profile](image)

3.2. Effect of adding different improved materials on soil total nitrogen content

Before the planting of crops, the reclaimed soil at the homestead was raw soil with a very low total nitrogen content of only 0.21 g·kg⁻¹. After 3 years of wheat-corn rotation, different levels of soil fertilization treatment in the soil at different levels the content has changed greatly. The total nitrogen content of each treatment showed an "S" type trend of first decreasing, then increasing, and then decreasing (Fig. 2). Compared with the control, adding different improved materials can significantly increase the total nitrogen content of the soil and increase with the depth of the soil layer. There is no significant difference between C, F and S treatments in the 0~15 cm soil layer; the total nitrogen content of each treatment in the 30~45 cm soil layer is C > F > S; The control treatment without adding any improved materials had a total nitrogen content in the 0~60 cm soil layer that was significantly lower than the treatment with the improved materials. In short, adding improved materials can significantly increase the total nitrogen content of the soil.

![Fig. 2 The effect of adding different improved materials on the total nitrogen content of the soil profile](image)
3.3. Effect of adding different improved materials on soil available phosphorus content
The effects of adding different improved materials on the effective phosphorus content of the soil profile vary (Fig. 3). In the 0~15 cm soil layer, F and S treated soil had the highest available phosphorus content, but the difference between them was not significant; C treated soil had lower available phosphorus content, but significantly higher than the control. In the 15~30 cm soil layer, the difference between C, F and S treatment is not significant, and CK treatment is the lowest. In the 30~45 cm soil layer, the available phosphorus content of the soil in F treatment is still the highest and the difference between the remaining treatments is not significant. In the 45~60 cm soil layer, the difference in available phosphorus content between the treatments with the improved materials was not significant, but it was significantly increased compared to the control. In short, the addition of improved materials can significantly increase the effective phosphorus content of the soil, especially the effect of increasing the effective phosphorus content of the soil in the 0~30 cm tillage layer.

![Fig. 3 Effect of adding different improved materials on the available phosphorus content in soil profile](image)

3.4. Effect of adding different improved materials on the content of soil available potassium
The soil developed with the parent material of loess is generally rich in total potassium, but in the absence of activation, the content of available potassium is often insufficient. Although the raw soil of the reclaimed land belongs to the loess, its available potassium content is relatively low, only about 70 mg·kg\(^{-1}\), which is a potassium deficiency level. After three years of planting crops, the soil available potassium content changes as shown in Fig. 4. Adding different improved materials has different effects on the available potassium content of the soil profile, and the soil available potassium content of each treatment varies with the depth of the soil layer throughout the soil profile. Increase and decrease, and the available potassium content of soil in the 0~30 cm tillage layer is significantly higher than that of the control, and there is no significant difference in the available potassium content between treatments in the soil layer below 30 cm.

![Fig. 4 The effect of adding different improved materials on the available potassium content in the soil profile](image)
4. Conclusions and discussions
The most important thing in the reclamation of waste homesteads as cultivated land is to improve soil quality. Since there is almost no human cultivation in the homestead, and there is usually a phenomenon of topsoil stripping during the reclamation process, the homestead soil is mostly raw soil, and its fertility is usually lower than that of conventional farming soil. Chen Liping et al. [10] analyzed the reclaimed land in the hilly area of Yizheng City, Jiangsu Province, and found that the content of nutrients such as organic matter, available phosphorus, and available potassium in the reclaimed soil are low, and the soil structure is poor.

Through the improvement and fertilization of the reclaimed soil of the homestead, its productivity will be gradually improved. But different fertilization measures have different effects on different regions and different soil types. Ren Shunrong et al. [5] found that the application of high amount of organic fertilizer can increase the organic matter and available nutrients content of the reclaimed soil in Tianjin homesteads and improve the physical structure of the reclaimed soil through field experiments. "Improver" and "organic fertilizer + inorganic fertilizer + straw" can be used as the most suitable fertilization method for Tianjin homestead reclamation. Yan Rui et al. [11] studied the influence of organic materials (straw, fungus residue, pig manure) on soil organic carbon and volatile organic carbon on the reclaimed soil of the homestead in the Chengdu Plain. The results showed that the "bacterial residue" under wheat-jade rotation "Compost return to field" treatment has a good effect on improving the soil structure of the homestead reclamation and improving soil fertility. Li Yanlin et al. [12] studied the dynamic changes and correlations of soil enzyme activity and microbial number under the combined application of three types of breeding wastes (straw, pig manure and bacterial residue) and chemical fertilizer, and found that "bacterial residue + chemical fertilizer" was applied which is a more suitable way to cultivate soil on the reclaimed homestead in Chengdu Plain.

The contents of organic matter, total nitrogen, available phosphorus, and available potassium in the soil are important indicators of soil fertility, and are also essential nutrients necessary for the growth of crops [13]. In this study, three different improved materials such as organic fertilizer, curing agent and fly ash were used to improve the reclaimed soil of the homestead. By studying the changes of soil organic matter, total nitrogen, available phosphorus, available potassium and other nutrient indicators, it was found that the addition of organic fertilizer after 3 years of "winter wheat-summer corn" rotation, the curing agent and fly ash have a certain effect on the improvement of soil nutrients in the reclamation of the homestead, and compared with the raw soil in the initial stage of reclamation, after 3 years of continuous crop cultivation. The contents of organic matter, total nitrogen, available phosphorus and available potassium have also been significantly increased.

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