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Application of Different Wastes in Soil Improvement in Mining Area

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Abstract

The treatment and utilization of fly ash, coal gangue and straw has become one of the focus issues of social concern. Rational utilization of solid waste to improve agricultural soil is one of the important ways to improve its comprehensive utilization level. This paper summarizes the application of different solid wastes as soil conditioners in soil improvement, and discusses the main problems and countermeasures in soil improvement, in order to provide scientific basis for the utilization of solid wastes as resources.

Keywords

Solid Waste; Mining Area; Soil Improvement.

1. Introduction

Coal is an important energy material in China and the material basis for the development of national economy [1]. In the process of mining and processing, it will produce a large amount of solid waste - coal gangue. Because the coal gangue is difficult to use and cannot produce economic benefits, it is often piled up in large quantities and eventually forms a coal gangue hill. A large number of coal gangue hills cause serious pollution problems in the mining area [2]. It not only directly occupies land resources, but also causes environmental pollution through spontaneous combustion and rainwater leaching. A large amount of coal gangue is piled up to form a steep slope. Under the influence of other external forces, it is very easy to collapse and slide, seriously endangering the nearby land vegetation and buildings, causing problems such as being buried and destroyed. Coal gangue is stored in the open air for a long time, which is prone to spontaneous combustion, and releases harmful organic substances and heavy metals that gradually enter the surface water, groundwater and land under the action of rainwater scouring and leaching, resulting in organic substances and heavy metals pollution of water and land [3].

At present, the measures for ecological control of coal gangue hills are to directly cover the soil layer after land consolidation of coal gangue hills, and then carry out vegetation reconstruction [4]. However, it is difficult to obtain the covering soil directly on the waste dump, and the amount of soil handling is large, which will also damage the ecological environment of the borrow area. Therefore, coal gangue is considered as the matrix filling material in the mining area [5]. This can not only realize the comprehensive utilization of coal gangue, but also reduce the repair and greening of gangue hills. However, coal gangue usually contains residual coal or

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organic matter, and under certain conditions, it is easy to cause spontaneous combustion [6], thus accelerating water evaporation, making it difficult for plant planting to survive, and the maintenance and management costs in the later stage gradually increase. Some researchers have proposed that the mixture of coal gangue and soil for matrix improvement can effectively improve the texture and structure of coal gangue hills and improve their water and fertilizer retention capacity [7]. To sum up, there are various ways of utilization and treatment of coal gangue. Due to the huge amount of coal gangue, it is still a very serious problem to completely solve millions of tons of coal gangue.

The use of single solid waste for soil improvement has certain limitations. For example, the coal gangue with special structure can only be used as the raw material for improvement. Only the topsoil of coal gangue can hardly be used as agricultural land. The particle property of fly ash is similar to light loam, and it also contains rich micronutrients. However, its major elements are insufficient, and its alkalinity is too high, which affects the soil microbial activity. If straw is used alone in soil improvement, the soil water holding capacity will become poor. The mixing of fly ash, coal gangue and straw in a certain proportion will make the matching matrix of soil improvement in the mining area have a good nutritional level, keep all kinds of nutrients in balance, and obtain ideal plant nutrition effect. At the same time, adjust the soil acidity and alkalinity of the gangue hill, which is more suitable for agricultural land planting vegetables and other crops. Therefore, it is of great significance to improve the soil matrix of the coal gangue hill. The development and utilization of the improved coal gangue hill is also in line with the national policy of sustainable development in China. At the same time, the recycling of solid wastes such as coal gangue, fly ash and straw into the soil improvement can not only reduce its pollution to the environment, but also produce objective economic benefits, and solve the problems of agricultural soil shortage and environmental pollution in the mining area, It is of great significance to realize green mining and sustainable development of mines.

2. Application Status of Different Solid Wastes in Soil Improvement

2.1. Application Status of Coal Gangue in Soil Improvement

The organic matter content of coal gangue itself is 15% - 25%, and it also contains a large amount of trace elements. After the application of coal gangue organic compound fertilizer in the field, the soil permeability is improved, the content of humic acid is increased, and the biological activity is also increased [8]. The acidity and alkalinity of coal gangue and the various trace elements and nutrients contained in it can be used to improve the soil, adjust the soil structure, increase the soil fertility, and make the soil more conducive to plant growth. The application of coal gangue organic compound fertilizer in the farmland of Yuncheng in Xiayukou Coal Mine, Hancheng, Shaanxi Province, has increased wheat production, and has a good effect [9]. Coal gangue contains organic matter, and rich nitrogen, phosphorus and potassium provide sufficient nutrients for plants to help them grow rapidly, so it can be used as microbial fertilizer, also known as microbial fertilizer [10]. Coal gangue microbial fertilizer is widely used, with high utilization rate, simple production process and low investment. When high-sulfur coal gangue is applied to alkaline soil, pyrite and organic sulfur react under the influence of microorganisms to produce sulfuric acid, which can be used to neutralize the basic substances in the soil, thus effectively improving the alkaline soil, also improving the soil porosity and permeability, and improving the crop growth environment.

2.2. Application Status of Fly Ash in Soil Improvement

Fly ash contains a large number of nutrients and trace elements required by crops, and its organic matter content is also large, which is conducive to the growth of plant roots. The improvement of soil physical properties by fly ash is mainly reflected in increasing porosity,

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reducing bulk density and improving soil structure. After the fly ash is applied to the soil, the water content in the soil changes significantly. It is conducive to soil moisture preservation, making water, fertilizer, air and heat tend to be coordinated, and creating a good soil environment for crop growth. Applying fly ash to sandy soil can reduce the downward movement rate of wetting front and enhance the water holding capacity of soil. Fly ash is applied to clayey soil to make it loose and reduce soil bulk density. Fly ash can effectively reduce the soil bulk density, and the soil bulk density shows a gradual decreasing trend with the increase of the amount of fly ash. In addition, the application of fly ash can solidify heavy metals in soil and promote the absorption of heavy metals by plants. The large specific surface area and alkalinity of fly ash are conducive to the precipitation of heavy metals. The activities of microorganisms and enzymes in the soil mainly depend on the physical and chemical properties of the soil. The impact of fly ash on the physical and chemical properties of the soil indirectly affects it, and its own physical and chemical properties may also affect the activities of microorganisms in the soil. For example, when fly ash is added to Shajiang black soil as an improver, the soil porosity and soil permeability increase, and the soil temperature increases, thus promoting the mass reproduction of aerobic microorganisms, so that the number of microorganisms increases with the increase of fly ash application. When more than 150t of fly ash is applied per hectare, the variety and quantity of various microorganisms in the soil are significantly increased, and the soil enzyme activity is also significantly improved [11]. However, excessive use of fly ash will also limit the growth and reproduction of microorganisms due to its physical and chemical characteristics, such as pH value, salinity, and toxicity of some trace elements.

2.3. Application Status of Straw in Soil Improvement

Straw contains nutrients such as nitrogen, phosphorus, potassium, magnesium, calcium and sulfur needed for crop growth. After returning to the field, straw is decomposed in the soil, which can comprehensively improve the ecological benefits of soil water, fertilizer, gas and heat. The Technical Guidelines for Agricultural Green Development (2018-2030) recently issued by the Ministry of Agriculture and Rural Affairs of the People's Republic of China proposed to focus on the research and development of technologies such as "returning organic matter to the field and improving soil fertility". Crop straw can be used as a common organic material because of its rich organic matter and minerals and low price. Applying it into the soil can improve soil fertility and reduce the content of heavy metals in the soil. Huang Jichuan and other scholars found that when potted mustard was composted with corn straw, root microorganisms increased significantly, and soil enzyme activity was also significantly improved, which was more conducive to mustard growth [12]. Applying straw can also change the occurrence form of heavy metals in soil, passivate heavy metals, and help control heavy metal pollution. Kumar and other scholars studied the form of heavy metals Cu and Cd in soil after applying crop straw, and found that the soluble content of Cu and Cd decreased significantly [13]; Hu et al. added organic matter and straw to the soil polluted by heavy metals for composting, and found that the content of heavy metal elements such as Pb and Cu in the soil decreased significantly, and the concentration of heavy metals by black wheat straw was reduced to achieve the in-situ passivation of heavy metals [14].

3. Discussion

The research on the remediation of fly ash and coal gangue as soil modifiers is still in the laboratory stage. Although the experimental results of many researchers have proved that the improvement and remediation of soil by fly ash and coal gangue are effective and feasible, there are still some problems in the practical application process, and further exploration and research are needed. At present, there are the following problems in the practical application

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of fly ash and coal gangue as soil improvers: first, the application amount and types of fly ash and coal gangue. Before the fly ash and coal gangue are applied to the soil, the physical and chemical properties of the fly ash and coal gangue, the soil type and the physical and chemical properties of the soil shall be analyzed qualitatively and quantitatively. According to the test results, the application amount and types of the fly ash and coal gangue shall be determined, and the fly ash and coal gangue shall be reasonably and scientifically applied to improve and repair the soil to avoid negative impact on the soil. The second is the potential pollution of soil by heavy metals and toxic and harmful substances contained in fly ash and coal gangue. Heavy metals and toxic and harmful substances contained in fly ash and coal gangue entering the soil to be repaired will aggravate the soil deterioration, and even cause heavy metal pollution of groundwater around the soil to be repaired. According to the research, the application of fly ash at one time or a small number of times will not cause heavy metal pollution in a short time. However, whether it will cause heavy metal pollution to soil and groundwater in a long time remains to be studied. Third, the proportion of fly ash and other solid wastes. Due to the low content of organic matter and nitrogen elements in fly ash, single application of fly ash to improve soil can not provide balanced soil nutrition. The combined use of fly ash and other solid wastes can make up for the deficiency of its single application, but the type, proportion and combined use of solid wastes will affect the improvement effect. Therefore, through experimental research, suitable solid wastes matching with fly ash are screened, with proper proportion and reasonable combined use, to seek the best effect on soil improvement; At the same time, we should pay attention to the impact of these solid wastes on the environment, and actively conduct pollution risk assessment on the improved soil.

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