Application of waste materials in rapid soil maturation

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Abstract. With the implementation of the policy of linking the increase and decrease of urban and rural construction land, migration and relocation, as well as the reason of the high stripping cost of mature soil, more and more raw soil needs to be reclaimed for cultivated land, and the rapid ripening of raw soil has become a new problem that we are faced with. In this paper, the present research status of raw soil maturation is summarized, and the application research status of green material filter mud, fruit residue, construction waste powder particle and fly ash in raw soil maturation is expounded, and the improvement measures and suggestions for different soil types of acidified soil, saline alkali soil and clay are obtained.

1. Introduction

1.1. Significance of soil maturation study

Generally speaking, the soil of hollow village land reclamation is more natural than that of cultivated land. That is to say, for cultivated land, the cultivated layer soil is cultivated and fertilized by man, which has a high degree of soil maturation, loose soil, good structure, easy to cultivate, good aeration and permeability, and high fertility, so it belongs to the cultivated soil. However, the homestead land and the soil below the bottom layer of plough have low maturation degree, relatively compact, poor structure, difficult to cultivate, poor aeration and permeability, and low fertility. This part is called raw soil. For natural soil in the field, loose surface soil with a large number of plant roots distributed on the surface is mature soil, while the soil below is raw soil with compact plant roots that are difficult to penetrate.

Along with the social economy rapid development, significantly improved people's living standard, the scope of the improvement of the living conditions and significantly enhanced, national implementation of the urban and rural construction land increase or decrease hook at the same time, the migration will live scattered farmers move to small cities and towns to live and so on, there have been many across the abandoned old buildings and the hollow village. These hollow villages occupy an area of land, and sometimes they are also hiding places and activity places for criminals, which poses a threat to personal safety and wastes land resources. The implementation of hollow village land reclamation is very important for increasing cultivated land area and eliminating all kinds of hidden dangers. At the same time, rapid soil maturation is faced with new challenges and opportunities. It is
of great significance to study the rapid soil maturation to increase land yield and increase people's income.

1.2. Research status of soil maturation
At present, there are relatively few researches on soil maturation. According to the literature records: roller crushing, deep application of farm manure or NPK fertilizer, pea (alfalfa)/wheat pioneer mixed sowing, irrigation depth (30 cm), application of base fertilizer (biogas slurry + biogas residue) and foliar fertilizer (60% biogas slurry), repeated application of compost, increase seedling density and other comprehensive use properly, can make the soil quickly mature[1-9].

2. Research status of application of green materials in soil maturation

2.1. Research status of application of filter mud in raw soil maturation
In sugar production process, the mixed juice of protein, pectic substances, organic acids and other non sugar adverse to the boiling sugar crystallization of organic matter, therefore, must to clarify the mixed juice, namely to add calcium hydroxide into mixed juice, such as sulfur dioxide, phosphoric acid, protein, pectic substances, organic acid and other non sugar settle, organic matter of sediment by pressure filter or vacuum filter or the residue of centrifugal separation equipment, become the filter mud, it is one of the major by-product of sugar. The yield of filter sludge mainly varies with the production process conditions. At present, the clarification treatment methods adopted by the sugar cane mills producing white sugar in China can be basically divided into two categories: carbonic acid method and sulfurous acid method. Generally, the amount of ash added by sulfurous acid method is small, and the amount of filter mud accounts for 0.7-1.4% of the sugar cane press. The amount of ash added by carbonic acid method is large, and the amount of filter mud accounts for 4.5-5.0% of the sugar cane press.

Sulfurous acid filter mud contains rich organic matter, nitrogen, phosphorus, potassium nutrients and many other elements and trace elements. The application of filter mud can increase the microbial species and quantity in the soil, improve the physical and chemical properties of the soil, increase the content of organic matter in the soil, and improve the fertility of the soil. Because decompose, fresh filter mud is fast, release a lot of heat and ammonia, apply at crop immediately, can burn to death crop rootstock, should pile retting 6 weeks above to use, but cannot pile in the open air (filter mud dew bask in nitrogen of one day loss 10%, 10 days loss 30%). Therefore, when stacking the sludge, cover it with a film or cover it with mud.

Some scholars use the measures: such as sulphurous acid method filter mud + compound microbial bacteria, bio-organic fertilizer produced by functional bacteria fermentation sugar mill sludge, solid fermentation of straw and sugar mill sludge to develop Trichoderma bio-organic fertilizer, filter mud organic-inorganic compound fertilizer once base, and so on. They can promote crop growth and increase crop yield[10-13], but studies have shown that sludge can reduce soil acidity[14].

2.2. Research status of application of fruit residue in soil maturation
Dregs are the solid parts of a plant's fruit, including skins, flesh, seeds, and stems, that are left after the plant has been pressed to extract its juice or oil. China is the world's largest apple planting country, with an annual output of more than 25 million tons of apples, ranking first in the world, accounting for about 40% of the world's total output. China's concentrated fruit juice production is very large, the annual apple juice production can produce apple residue of nearly 3 million tons, plus other fruit juice production, such as pear juice, peach juice, strawberry juice, etc., the amount of residue produced is close to 10 million tons. China is a large agricultural and population country, and the demand for food and crops is also large, so the use of chemical fertilizer in China has been high, reaching more than 40 million tons at the beginning of this century. The use of a large amount of slag and fertilizer not only causes the waste of resources, but also causes environmental pollution.
The organic fertilizer produced by fruit residue fermentation is seldom used in soil improvement. Li Honghui et al. applied jointly various fertilizers and soil improver (a new soil improver developed by Shaanxi qinshui company on the basis of "the technology of fulvic acid fermentation by fruit residue "), what is conducive to the rapid maturation of new farmland [15]. Liu xiaofei et al. used fulvic acid fermenting from fruit residue as the carrier of fulvic acid soil modifier, relying on the soil reclamation project of Yan ’an ditch, they carried out research on the rapid ripening technology of newly cultivated soil, and the improvement effect was significant [16]. However, according to the analysis of experimental statistical data, soil acidification tends to occur after addition, and the acidification becomes more obvious with the increase of addition amount.

2.3. Research status of application of construction waste in soil maturation

According to statistic, the average life span of our country building is in 25~30 years, be less than the 60% that international building life minimum fixed number of year sets. The demolition of such a short-lived building will generate hundreds of millions of building waste every year, accounting for 30%~40% of the total urban waste. According to the rough statistics on the loss of construction materials of brick and concrete structure, whole cast-in-place structure and frame structure, in the construction process of every 10,000 square meters of buildings, only the construction waste will produce 500~600 tons; For every 10,000 square meters of old buildings demolished, 7,000 to 12,000 tons of construction waste will be generated [17]. Waste brick materials are the main component of waste building resources in China, accounting for nearly 50% of the total waste building materials in China. In addition, the existing clay brick building stock in China is huge [18]. Therefore, there are abundant construction waste resources and huge reserves, providing a substantial material basis for reuse and promising application prospects.

In recent years, Chinese experts and scholars have actively studied and introduced advanced ideas and applied methods from developed countries, and conducted more theoretical study and practical test, which has greatly promoted the research on the recycling of waste building materials in China. At present, the research results mainly discuss the recycling of construction waste from the aspects of recycling methods, recycling technologies and recycling strategies [19~25]. Among all kinds of utilization methods, most researches are conducted on recycled aggregate, such as using gradation aggregate of various particle sizes or waste brick powder to prepare recycled mortar, while few researches are conducted on analyzing the properties of bricks in soil [26,27]. The research of Paulo B et al. shows that the old clay brick material has the characteristics of large mass, high moisture content and low strength [28]. Studies by Thomas Nehls et al. show that roots enter brick holes or attach themselves to brick faces to utilize water and nutrients stored in bricks, and bricks provide potassium, magnesium, calcium and sulfur better than sandy soil [29]. After mixing the planting substrate, soil and seeds in a certain proportion, Wang Chengming filled the internal pores of the recycled brick aggregate planting concrete with grouting method or layered seeding method. With necessary maintenance and management, the plants could grow healthily and well on the surface [30]. These studies show that the pore size, permeability and other factors of construction waste are suitable for crop growth.

2.4. Research status of application of fly ash in raw soil maturation

China is a large country producing coal, coal as the basic fuel for electricity production. Steady development of energy industry in China, power generation capacity annual growth rate of 7.3%, the rapid development of power industry, has brought the rapid increase of fly ash emissions, emissions from coal-fired power plant every year, the total amount of fly ash increases year by year, fly ash emissions of 125 million tons in 1995, about 150 million tons, 2000 by the year 2010 will reach 300 million tons, to our country's national economic construction and ecological environment caused great pressure.

Fly ash is observed under a microscope as a composite of crystal, glass and a small amount of unburned carbon. Unburned carbon particles are loose and porous, and can be widely used to transform heavy clay, raw soil, acid soil and saline-alkali soil to make up for the defects of plate and
stick. Fly ash contains a large amount of nutrients necessary for water-soluble silicon, calcium, magnesium, phosphorus and other crops, and can be used as agricultural fertilizer\cite{31-34}. Ma Chenghua can make the soil mature and achieve the purpose of increasing production through a large amount of application of organic fertilizer (including slag ash)\cite{35}. Kuang Xinyu et al. have found that coal gangue, rock and soil stripping, fly ash, etc. can be used as topsoil substitute materials. \cite{36}. Hu Ya et al. studied that adding organic fertilizer and fly ash could increase the yield of crops significantly\cite{37-40}.

However, some scholars have shown that the composition and physical and chemical properties of fly ash differ greatly due to differences in combustion conditions (especially combustion temperature), dust removal and ash removal methods, and desulfurization processes. Zn, As, Hg, Pb The contour volatile elements are more concentrated in the fly ash, and the potentially toxic substances in the ash cause pollution to the soil and groundwater\cite{41,42}. Fly ash can make plants sprout normally, but it can't make plants grow normally, and the plant has high content of heavy metals\cite{43}. The order of environmental quality index and potential ecological risk index of heavy metals in Shenbei is Cd>Hg>As>Cr>Pb\cite{44}.

3. Conclusion

Faced with the severe situation of resource constraint, serious environmental pollution and ecosystem degradation, the reuse of waste resources has become an important means to solve resource crisis and alleviate pollution.

3.1. Suggestions for improving the selection of soil acidification materials

Since the 1980s, soil acidification has become more and more serious in China. The acidified land area has expanded to more than 40% of China's cultivated land area, and it often happens in large pieces. Especially in the south of China, the acidification of soil is more serious due to acidic soil and more rain\cite{45}. Currently, reasonable fertilization, organic fertilizer and lime are used to improve soil acidification\cite{46,47}. However, it can only change the pH of surface acidic soil, but it is difficult to change the properties of deep soil\cite{48}. Long-term or large use of lime will cause soil consolidation, but also cause the imbalance of calcium, magnesium, potassium and other elements in the soil, resulting in crop loss\cite{49}. Stronger reacidification occurs when lime is discontinued\cite{50}. The filter mud can reduce the acidity of the soil and improve the pH value of the soil. It is suggested that the biological fertilizer made by the filter mud can improve the acidified soil, such as southern lateritic soil, so as to avoid soil hardening caused by long-term lime application.

3.2. Suggestions on the selection of improved saline-alkali soil materials

Desulphurization gypsum, soda, humic acid, acetylated glucose, lactobacillus and other improvers are generally selected for salt-alkali land improvement\cite{51-60}. Some scholars pomace fermentation is added in the yellow spongy soils of fulvic acid efficient soil conditioner II type (45% or higher organic matter, N, P$_2$O$_5$ and K$_2$O 5% or higher) 50 kg and I type (humic acid acuity 40 g/L, N, P$_2$O$_5$ and K$_2$O 200 g/L) or 30 kg, 40 kg, 20 kg, and with the increase of adding amount, acidification, the more obvious, with the increase of modified dosage, pH from 8.09 before adding lower 7.73, 7.61, 7.46 respectively\cite{17}, so try to the application of the modifier of pomace fermentation to produce the alkaline-saline land.

3.3. Suggestions for improving clay material selection

Heavy clay has poor aeration and permeability, which is unfavorable to the growth and development of crops, and easy to cause difficulties in seedling emergence or root rot. Add construction waste recycling particles (physical cutting and crushing of construction waste) to heavy clay, and there are pores in the interior, which not only facilitates the water and air circulation, but also increases the pores' water retention. By regenerating construction waste into micro particles and mixing them with heavy clay, the permeability can be enhanced and water and fertilizer can be preserved.
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