Research on Soil Conservation and Improvement Technology in Zhaoyang District

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Abstract The environment of tobacco-growing soil directly affects the yield and quality of tobacco leaves. In order to solve problems of tobacco-growing soil degradation, low organic matter content and unbalanced soil nutrient supply and promote sustainable and healthy development of tobacco production, this paper comprehensively discussed conservation and improvement techniques of tobacco-growing soil based on existing problems in Zhaoyang District, aiming to provide reference for tobacco-growing soil conservation.

Key words Tobacco-growing soil; Conservation; Flue-cured tobacco; Fertilization; Improvement

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Soil is an important carrier for tobacco cultivation and plays an indispensable role in the process of tobacco cultivation. Nutrients required for tobacco growth mainly come from the soil. Soil nutrient content is an important indicator for evaluating soil fertility, which has a profound impact on the growth, development, and yield and quality of tobacco leaves[1-3]. In recent years, affected by the structural adjustment of agricultural industry, some tobacco fields in Zhaoyang District have been extensively managed, and the phenomena of long-term use of chemical fertilizers and only planting crops without cultivating land have been on the rise year by year, which has caused many problems such as the decline of soil organic matter content, soil acidity, pests and diseases, and seriously affected the yield and quality of flue-cured tobacco in Zhaoyang District, Zhaotong City. In this paper, the main problems of tobacco-growing soil in Zhaoyang District and the research on conservation and improvement techniques of tobacco-growing soil were reviewed, hoping to provide a theoretical basis and technical support for conservation of tobacco-growing soil in Zhaoyang District.

Main Problems of Tobacco-growing Soil in Zhaoyang District

Long-term continuous cropping

Zhaoyang District has a long history of planting flue-cured tobacco, which has exceeded 30 years. Some tobacco-growing areas have the phenomenon of continuous cropping all the year round. Numerous studies have shown that allelopathy, deterioration of biological environment and imbalance of soil nutrients are the main obstacles affecting tobacco continuous cropping[4-5]. Allelopathic substances in tobacco root exudates are increasing year by year under continuous cropping[6]. When allelopathic exudates are accumulated to a certain extent, they will inhibit the growth of tobacco roots, and with the increase of continuous cropping years, the soil will change from the bacterial type to the fungal type, leading to the enrichment or disappearance of dominant soil populations. The propagation of harmful pathogenic fungi will lead to a decrease in diversity and great changes in the diversity and stability of rhizosphere bacteria and actinomycetes, and diseases will occur frequently.

Fu *et al.*[7] studied the effects of different treatments on the carbon pool index of tobacco-growing soil and related chemical components, neutral aroma substances content and economic characters of flue-cured tobacco leaves. The results showed that continuous cropping degree had a great influence on tobacco-growing soil, which would lead to the decrease of total organic carbon content. The total organic carbon contents of soil with continuous cropping for 5 years and 10 years were 8.8% and 28.17% lower than that of rotation, respectively, and the longer the continuous cropping period was, the more the total organic carbon content decreased. Meanwhile, soil continuous cropping will lead to the decrease of total sugar and reducing sugar content in flue-cured tobacco, the decrease of potassium content and potassium-chlorine ratio in the middle and lower leaves of flue-cured tobacco, and the increase of nicotine and chlorine contents.

Tobacco farmers' awareness of cultivating and improving land is weak

First, with the development of urbanization, some tobacco growers take advantage of the winter leisure season to work in the city, and then return to their hometowns for planting in the flue-cured tobacco planting season, resulting in no surplus labor force for maintaining the winter leisure land and a state of

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desolation in the winter leisure land. Second, in recent years, although a variety of soil conservation measures have been taken, such as planting green manure, applying farm manure and organic manure, deep ploughing and field cleaning, the results have not been significant[8].

Soil acidification

The availability of soil elements is affected by soil pH, and the state and availability of most nutrients in acidic soil are reduced, which leads to insufficient nutrient absorption of tobacco plants, hindered root growth, reduced disease resistance and frequent tobacco diseases, which indirectly affect the yield and quality of tobacco leaves. Like traditional food crops, tobacco yield has also experienced a period of increasing yield by applying a large number of chemical fertilizers for a period of time. With the diversification and multiple purposes of fertilizers in the fertilizer industry, the unreasonable fertilization structure and the long-term application of acidic or physiological acidic fertilizers are widespread, which has promoted and accelerated the process of soil acidification[9-10]. In recent years, the proportion of acidic soil in tobacco-growing soil in Zhaoyang District is increasing, and the problem of soil acidification has gradually become one of the important factors restricting the sustainable development of Zhaotong tobacco.

Residual film pollution

Tobacco mulching film is made of polymer organic compounds, which are difficult to degrade under natural conditions. In the production of flue-cured tobacco, the film is not completely uncovered, and the growth of planting years leads to more and more plastic films remaining in tobacco-growing soil. Residual plastic film will affect the continuity of soil pores, hinder the movement of soil water and fertilizers, inhibit soil nutrients, and reduce the migration speed of nitrogen fertilizer[11]. Moreover, the study of Shu[12] has shown that the increase of residual plastic film led to a decrease in water infiltration and a decrease in soil moisture content, which might result in secondary salinization of the soil; and meanwhile, the decrease in soil permeability could also affect the formation of soil aggregates and the activity of soil microorganisms.

Research on Conservation and Improvement Techniques for Tobacco-growing Soil in Zhaoyang District

Improving the tobacco planting system

Based on the characteristics of tobacco-growing soil, varieties of flue-cured tobacco and climate environment in Zhaoyang District, a scientific, reasonable and systematic flue-cured tobacco planting system should be established according to local conditions, so as to promote the virtuous cycle of tobacco field ecosystem and reduce the occurrence of pests and diseases. Meanwhile, it can make full use of limited production resources to obtain higher economic benefits and lay a solid foundation for the sustainable development of flue-cured tobacco in Zhaoyang District.

Combining green manure with tobacco cultivation Green manure is a nutrient-rich biofertilizer made from green plants. There are a variety of different types of green manure with rich organic matter content and nutritional elements. Planting green manure can effectively improve the soil aggregate structure of tobacco planting, enhance soil's ability to retain fertilizers and water and supply fertilizer, and promote the growth of tobacco plants. Studies have shown that planting alfalfa can effectively increase soil organic matter and total nitrogen content, enhance multiple elements, and improve the overall environment of tobacco-growing soil[13]. After being turned over, green manure can increase the organic matter content in the soil, as well as the microbial content and activity in the soil. And after baking, the contents of reducing sugar and total sugar in tobacco leaves increase, while the contents of nicotine and total nitrogen decrease[14].

Tobacco rotation Crop rotation refers to a planting method in which different crops or multiple cropping combinations are sequentially rotated between seasons or years in the same tobacco field. The full and rational utilization of various natural resources can be achieved by implementing a crop rotation system. Implementing tobacco rotation can improve soil properties and enhance soil fertility. Shouwang Township, Buga Township and Xiaolongdong Township in Zhaoyang District have a relatively large number of beef cattle, and these planting areas can be used to plant winter wheat. Winter wheat can improve acidic soil and well absorb nitrogen in soil. Wheat straw can not only be used as feed, but also be crushed and returned to the field as a fertilizer to increase the permeability of soil[15]. Adopting the mode of "tobacco-wheat-corn-tobacco" in alternate years can alleviate diseases such as tobacco mosaic virus and black shank[16].

Improving soil biological environment We can compensate for the ecological vicious cycle caused by continuous cropping by adding beneficial bacteria to enhance the soil biological environment. For a long time, the prevention and control of tobacco diseases has been mainly chemical pesticides, and due to the influence of geographical environment and resistance, the inhibition rate of specific chemical pesticides has become less and less obvious. Microbial agents, represented by biological control of black shank and black root rot in tobacco, have gradually become the focus of many scholars' attention. Studies have shown that *Bacillus*, *Pseudomonas* and *Trichoderma harzianum* have good antagonistic effects on *Phytophthora nicotianae*[17-19]. Based on the application of traditional pesticides, it is of great significance for soil ecological protection and sustainable development to find and establish a new comprehensive control method of biological pesticides and establish a control concept of coordinated development with diseases.

Balanced fertilization

Balanced fertilization of flue-cured tobacco emphasizes a balanced relationship, which mainly solves following problems: What is missing in the soil? What fertilizer should be added? How much should be applied? When should it be applied? Where should it be applied? And how should it be applied?

Soil testing and formula fertilization Soil testing and formula fertilization is based on soil testing and fertilizer field experiments. Based on the fertilizer requirements of crops, soil supply capacity

and the effects of various fertilizers, the application quantity, application period, and application method of nitrogen, phosphorus, potassium, and trace elements fertilizers can be proposed on the basis of reasonable application of organic fertilizers. Soil testing and formula fertilization must be based on nutrient abundance and deficiency of local tobacco-growing soil, and field experiments, soil nutrient testing techniques, fertilizer ratios and other techniques can be adopted to ensure that the soil testing and formula fertilization techniques are in line with the nutritional needs of tobacco. A scientific and reasonable fertilization plan should be designed to guide tobacco growers to apply fertilizers more scientifically.

Fertigation The fertigation technique is a fertilization method that accurately applies fertilizers needed by crops to the periphery of crop roots and capable of being effectively absorbed by the roots according to the demand for different nutrients in different growth stages of crops and the supply conditions of soil. The fertigation technique can effectively adjust the concentration of water and fertilizers, improve the use efficiency of fertilizers, and promote the absorption of nutrients by tobacco roots, thus improving the yield and quality of tobacco plants. Meanwhile, it can also reduce work and cost, and is thus a cultivation technique saving water and fertilizers. The study of Xiang *et al.* [20] showed that "one pipe and two rows" drip irrigation combined with fertilization not only reduced production cost, but also improved the production efficiency and quality of flue-cured tobacco.

Precision fertilization Precision fertilization is to improve fertilizer use efficiency by adjusting fertilization time, fertilization amount and the ratio of related nutrient elements according to the law of crop fertilizer demand, soil nutrient status, target yield and other factors, so as to obtain maximum economic benefit with scientific and reasonable input and finally achieve the goal of both economic benefit and natural resource protection. Firstly, based on spatial variation laws of soil nutrients in fertilization areas, crop nutrition diagnosis and accurate test of soil nutrients are realized. Secondly, a suitable fertilization model is determined to realize reasonable decision-making of fertilizing quantity. Thirdly, precision fertilization is achieved through reasonable fertilization methods. Studies have shown that using DGPS technology for locating sampling and GIS technology for analyzing and managing soil nutrients can promote the physical and chemical properties and economic benefits of tobacco leaves, and precision fertilization can effectively improve fertilizer use efficiency, make tobacco plants more balanced in nutrition, effectively reduce fertilizer input costs and increase the income of tobacco farmers[22].

Soil improvement techniques

Soil improvement techniques for tobacco-growing soil are an important measure that cannot be ignored in tobacco production, as they not only affect the exertion of fertilizer efficiency, but also affect the absorption of nutrients by roots, the growth of tobacco plants and the accumulation of substances.

Soil conditioners Applying soil improvers can effectively improve the physical and chemical properties and biological properties of soil and make soil more suitable for crop growth. Zhu *et al.* [23] showed that the application of Tianjiabao soil improver in tobacco fields in Yunnan could significantly improve the yield and quality of tobacco leaves, and meanwhile, the disease resistance of tobacco plants to wildfire, mosaic virus and brown spot was significantly improved. Using soil conditioners could effectively reduce soil bulk density, improve soil permeability, promote soil microbial activity, enhance crop disease resistance and further increase crop yield. The study of Yang *et al.* [24] showed that after applying chemical regulators, the moisture content of tobacco-growing soil could be enhanced, the agronomic characters of flue-cured tobacco at the maturation stage could be effectively improved, and the economic benefits of flue-cured tobacco could be improved.

Mixed application of organic and inorganic fertilizers Organic fertilizers are a type of compound multi-element fertilizer, with high organic matter content and various nutrients needed for crop growth. There are many kinds of organic fertilizers, including self-made compost, compost, manure, biogas manure, straw, green manure and commercial organic fertilizer. The fertilizer efficiency of organic fertilizers is released at a slow rate, so they can provide nutrients needed for flue-cured tobacco growth, improve soil water and fertilizer conservation capacity, effectively improve soil physical and chemical properties, promote tobacco plants to grow vigorously, and thus improve tobacco quality. Yang *et al.* [25] showed that the application of organic fertilizers could not only improve the pH of soil, but also increase the content of various nutrients in soil.

Biochar improvement Biochar is a stable, insoluble, highly aromatic and carbon-rich solid substance obtained by pyrolysis and carbonization of biomass at high temperature in an oxygen-deficient environment[26]. Studies have shown that the application of biochar can increase field water-holding capacity of soil, reduce soil bulk density and ammonium nitrogen content, and improve soil pore structure. Furthermore, it can increase the contents of nitrate nitrogen, available phosphorus and available potassium in tobacco-growing soil, promote the absorption of potassium in flue-cured tobacco production, and reduce the absorption of phosphorus and nitrogen and the accumulation of dry matter after topping[27], making the internal chemical components of tobacco leaves more coordinated and increasing neutral aroma substances.

Plastic film recycling Through market guidance, industry encouragement and tobacco farmers' active participation, we can implement the recycling system of waste plastic film to strengthen the management of waste plastic film in tobacco fields and promote the green development of tobacco-growing areas. Firstly, we should strengthen the propaganda of plastic film recycling, and publicize soil conservation through training, enhance environmental protection propaganda, and effectively mobilize tobacco growers' enthusiasm to collect and recycle waste plastic film. Secondly, the harm of residual film to tobacco-growing soil can be effectively avoided by using degradable plastic film. Thirdly, the universality of mechanized recycling can be effectively improved by using residual film collection machines for mechanized recycling and constantly improving them.

Prospects

Flue-cured tobacco is an important pillar industry for rural revitalization in Zhaoyang District. In order to promote tobacco quality and efficiency and increase farmers' wealth and income, in addition to appropriate supporting cultivation techniques, soil conservation needs to be strengthened. Soil conservation is a long-term persistent work. Zhaoyang District has a long history of tobacco planting, so it is necessary to adopt comprehensive measures to conserve soil and actively establish the concept of sustainable development of tobacco production. The government, industry, commerce and tobacco growers need to work together to scientifically plan soil conservation work, implement the low-taxation policy, establish a reasonable farming system, accelerate the pace of basic construction of farmland, and optimize the support and subsidy policies for tobacco-growing areas. It is necessary to strengthen the propaganda of soil conservation and improve tobacco growers' ideological understanding. Demonstration areas of soil conservation can be established to drive surrounding areas by radiation, so as to promote the implementation of soil conservation techniques and ensure the improvement of the quality of tobacco-growing soil and the yield and quality of flue-cured tobacco.

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