Comprehensive Prevention and Control Strategies for Soil Continuous Cropping Obstacles of Facility Chili Pepper in Guangxi

Jie QIN[1], Qihan LUO[2], Shuifang ZHU[1], Dexian HUANG[3]*

1. College of Smart Agriculture, Yulin Normal University, Yulin 537000, China; 2. Yulin Public Security Bureau, Yulin 537000, China; 3. Environmental Sanitation Workstation in Wuming District, Nanning City, Nanning 530100, China

Abstract As a crucial economic crop in Guangxi region, chili pepper is facing increasingly severe challenges of continuous cropping obstacles. In this paper, the causes of continuous cropping obstacles in chili pepper soil are deeply analyzed, covering multiple dimensions such as the dynamic changes in soil physicochemical properties, the imbalance of soil microbial community structure, and the gradual accumulation of soil borne diseases and pests. Subsequently, a set of comprehensive prevention and control strategy is proposed: soil improvement through the application of organic fertilizers, biological fertilizers, and soil conditioners; implementing agricultural strategies of crop rotation and intercropping, flexibly adjusting planting density and methods, to optimize crop layout and improve planting management measures; actively introducing natural enemies for biological control, while promoting the use of biopesticides and microbial preparations for biological control. In response to the actual situation of continuous cropping obstacles in chili pepper soil of Guangxi, it is suggested that innovative soil improvement technologies, improved planting management measures, and promotion of biological control methods should also be considered.

Key words Facility agriculture; Soil control; Comprehensive prevention and control; Facility vegetables

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As one of the important economic crops in Guangxi, facility chili pepper has had significant growth in both planting area and yield in recent years. However, with the increase of continuous cropping years, the problem of soil continuous cropping obstacles has become increasingly prominent, becoming a key factor restricting the sustainable development of the chili pepper industry. Soil continuous cropping obstacles not only lead to a decrease in chili pepper yield and quality, but also increase production costs and the frequency of pest and disease outbreaks. According to relevant research, continuous cropping obstacles can reduce chili pepper yield by 20% - 30%, and it can even reach over 50% in severe cases[1]. Therefore, it is of great practical significance for ensuring the healthy development of the chili pepper industry, increasing farmers' income, and promoting local economy by conducting comprehensive prevention and control strategies for soil continuous cropping obstacles of facility chili pepper in Guangxi.

1 Analysis on the causes of continuous cropping obstacles in chili pepper soil

1.1 Changes in soil physical and chemical properties In Guangxi region, the problem of soil continuous cropping obstacles during facility chili pepper planting is becoming increasingly prominent, among which changes in soil physicochemical properties are one of the key factors leading to continuous cropping obstacles. The abnormal fluctuations in soil pH, the decrease in organic matter content, the increase in soil compaction, and the accumulation of salt all have adverse effects on the growth of chili pepper. Research has shown that soil pH values deviating from the suitable growth range for chili pepper (6.0 - 7.0) can lead to an imbalance in nutrient absorption, which in turn affects the yield and quality of chili pepper[2].

Researchers have proposed various improvement measures to address the deterioration of soil physical and chemical properties. For example, by applying organic and biological fertilizers, it could increase soil organic matter content, improve soil structure, and enhance soil water and fertilizer retention capacity. In addition, the rational application of soil conditioners such as gypsum and lime has been proven to regulate soil acidity and reduce the accumulation of harmful salts in the soil, thereby creating a favorable soil environment for the healthy growth of chili peppers.

In the comprehensive prevention and control strategy, in addition to improving soil physical and chemical properties, a systematic prevention and control system should also be formed by combining planting management measures and biological control methods. For example, through crop rotation and intercropping, the life cycle of pathogens and pests can be broken, reducing the accumulation of harmful organisms in the soil. Meanwhile, the use of microbial agents such as phosphorus and potassium solubilizing bacteria and antagonistic fungi can effectively improve the soil microbial community structure and enhance the soil's self-healing ability[3]. Through the implementation of these comprehensive

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* Corresponding author.

measures, soil continuous cropping obstacles can be effectively alleviated, ensuring the sustainable cultivation of chili pepper.

1.2 Imbalance of soil microbial community In the production of facility chili pepper in Guangxi, soil microbial community imbalance is one of the key factors leading to continuous cropping obstacles. The diversity of soil microorganisms is closely related to soil health status. A healthy soil microbial community can promote nutrient cycling, inhibit the growth of pathogens, and maintain soil ecological balance. However, long-term continuous cropping of chili pepper can lead to a decrease in the number of beneficial microorganisms, while the number of pathogenic microorganisms such as *Fusarium* and *Phytophthora* increases, disrupting the original microbial balance. Therefore, it is one of the important strategies for preventing and controlling continuous cropping obstacles in chili pepper soil by restoring and maintaining the balance of soil microbial communities.

1.3 Soil borne diseases and pests accumulation In Guangxi region, the accumulation of soil borne diseases and pests in facility chili pepper production is becoming increasingly serious, becoming a key factor restricting the sustainable development of the chili pepper industry. According to relevant research, the incidence rate of soil borne diseases such as chili pepper blight and root rot disease in continuous cropping soil can reach more than 30%, and even lead to crop failure in serious cases[4]. Pests such as meloidogyne and cutworm also cause serious damage to the root system of chili pepper.

Research has found that through reasonable crop rotation and intercropping, the life cycle of pathogens and pests can be effectively interrupted, reducing the accumulation of pathogens in the soil. For example, rotation of chili pepper and rice can reduce the incidence rate of pepper blight by more than 20%[5]. In addition, the use of biological control methods, such as introducing natural enemies and using microbial agents, has also been proven to be effective control measures.

2 Research on comprehensive prevention and control technology

2.1 Soil improvement technology

2.1.1 Application of organic fertilizer and biological fertilizer. The application of organic and biological fertilizers is one of the key measures to improve soil and alleviate continuous cropping obstacles in the comprehensive prevention and control strategy for continuous cropping obstacles of facility chili pepper soil in Guangxi. The application of organic fertilizers can significantly increase soil organic matter content, improve soil structure, and enhance water and fertilizer retention capacity of soil. In addition, the microbial community in organic fertilizers can interact with the existing microorganisms in the soil, promote ecological balance of soil, and inhibit the occurrence of soil borne diseases. Biological fertilizers, such as nitrogen fixing bacteria, phosphorus solubilizing bacteria, and potassium solubilizing bacteria, can improve soil fertility and reduce dependence on chemical fertilizers by biologically fixing nitrogen and dissolving nutrients such as phosphorus and potassium in the soil.

2.1.2 Effectiveness of using soil conditioners. Soil conditioners can improve soil structure, enhance soil permeability and water and fertilizer retention capacity, thereby alleviating the deterioration of soil physical and chemical properties caused by continuous cropping. By applying humic acid soil conditioners, soil organic matter content can be effectively increased, soil particle structure can be improved, and root development can be promoted. In addition, the use of soil conditioners can also adjust the soil pH value, reduce the activity of harmful substances in the soil, and thus reduce the incidence of chili pepper diseases.

2.2 Planting management measures

2.2.1 Strategies for crop rotation and intercropping. In Guangxi region, the problem of continuous cropping obstacles in facility chili pepper soil is becoming increasingly prominent, seriously affecting the yield and quality of chili pepper. To address this challenge, crop rotation and intercropping strategies have been proposed and implemented to break the life cycle of pathogens and pests in the soil and restore soil ecological balance. By rotating chili pepper with corn or leguminous plants, the occurrence of soil borne diseases in chili pepper can be effectively reduced. The research shows that the incidence rate of root-knot nematode disease of chili pepper can be reduced by more than 30% under the rotation mode[6]. In addition, under intercropping mode of chili pepper and garlic, the natural compounds released by garlic have a significant effect on inhibiting chili pepper phytophthora. In practice, by constructing a diversified crop planting system, not only does it improve land use efficiency, but it also enhances crop resistance to diseases, thus achieving the goal of comprehensive prevention and control of soil continuous cropping obstacles.

2.2.2 Adjustment of planting density and planting method. The adjustment of planting density and planting method is one of the key steps in the prevention and control strategy of continuous cropping obstacles in facility chili pepper soil of Guangxi. Reasonable planting density can effectively reduce the accumulation of pathogens in the soil, while promoting air circulation and light among chili pepper plants, and reducing the incidence of diseases. In addition, the adjustment of planting methods, such as using high bed cultivation instead of flat bed cultivation, not only improves the drainage performance of the soil, but also reduces the retention of water in the soil, thereby suppressing the spread of soil borne diseases.

2.3 Biological control methods

2.3.1 Natural enemy utilization and biopesticides. In the comprehensive prevention and control strategy of continuous cropping obstacles in chili pepper soil of Guangxi, the utilization of natural enemies and the application of biological pesticides are one of key links. By introducing natural enemies such as predatory and parasitic insects, the pest population in chili pepper fields can be effectively controlled, and the use of chemical pesticides can be reduced, thus reducing the negative impact of pesticide residues in

soil on the environment and crops. The use of ladybugs to control aphids or the release of *Trichogrammatid* to control Lepidoptera pests have shown good control effects in multiple experiments.

Biological pesticides, as a supplement to the use of natural enemies, also play an important role in the prevention and control of continuous cropping obstacles in chili pepper soil. Biological pesticides usually have the characteristics of strong selectivity, minimal impact on non target organisms, and environmental friendliness. When using Bt (*Bacillus thuringiensis*) preparation to control *Spodoptera litura* on chili pepper, its effective ingredients have specific toxic effects on *S. litura* larvae, while are safe for other non target organisms and the environment.

In the comprehensive prevention and control strategy, the combination of natural enemy utilization and biological pesticides can not only effectively control the continuous cropping obstacles of chili pepper, but also promote soil health and ecological balance. By establishing a dynamic balance between natural enemies and pests, the sustainability of chili pepper production can be achieved. By constructing an ecological model of pest – natural enemy – crop, the effectiveness of different biological control measures can be predicted and evaluated, providing scientific decision support for pepper cultivation.

2.3.2 Application effect of microbial preparations. The application effect of microbial preparations is particularly significant in the comprehensive prevention and control strategy of continuous cropping obstacles in chili pepper soil of Guangxi. Specific microbial preparations can effectively improve the physical and chemical properties of soil, such as increasing soil organic matter content and adjusting soil pH, thereby creating a more suitable environment for the growth of chili pepper. By applying microbial fertilizers containing phosphorus and potassium solubilizing bacteria, the content of available phosphorus and potassium in the soil increased by 15% and 20%, respectively, significantly promoting the nutrient absorption and growth and development of chili pepper. In addition, microbial preparations have also shown excellent performance in controlling soil borne diseases, such as *Bacillus subtilis* and *Trichoderma*. They competitively inhibit the growth of pathogenic bacteria, reducing the incidence of chili pepper root rot and blight disease. According to field test data, the incidence of diseases has been reduced by more than 30%.

3 Suggestions

The comprehensive prevention and control strategy for continuous cropping obstacles in chili pepper soil of Guangxi should focus on innovative soil improvement technologies, improved planting management measures, and promotion of biological control methods.

Firstly, the optimization of soil improvement technology should be based on in-depth analysis of soil physical and chemical properties. By introducing organic and biological fertilizers, the soil organic matter content can be effectively increased, the soil structure can be improved, and the soil's water and fertilizer retention capacity can be enhanced.

Secondly, the optimization of planting management measures requires consideration of crop rotation and intercropping strategies for chili pepper cultivation. By planning crop layout reasonably, the lifecycle of pests and diseases can be broken, reducing their impact on chili pepper growth.

Finally, the promotion of biological control methods should be combined with the application of microbial preparations, such as using antagonistic bacteria and fungi to inhibit the growth of pathogens.

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