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Study on Biological Control Technology of Plant Continuous Cropping Obstacle

Lirong He[1, 2, 3, 4], Yintian Xiao[1, 2, 3, 4]

[1]Shaanxi Provincial Land Engineering Construction Group Co., Ltd, Xi'an, Shaanxi, 710075, China;

[2]Institute of Land Engineering Technology, Shaanxi Povincial Land Engineering Construction Group Co., Ltd., Xi'an, Shaanxi, 710075, China

[3]Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Natural Resources, Xian, Shaanxi, 710075, China;

[4]Shaanxi Provincial Land Consolidation Engineering Technology Reseach Center, Xi'an, Shaanxi, 710075, China

Abstract

In view of the common and serious situation of continuous cropping obstacle, the main biological control techniques of continuous cropping obstacle were summarized, especially the biological control of continuous cropping obstacle. It can be seen that the biological control of plant diseases refers to the effective control technology of plant diseases by using beneficial bacteria (Bacillus, Pseudomonas, soil radiobacter and Pasteurella), beneficial fungi (Trichoderma, Gliocladium and Chaetomium) and actinomycetes with interspecific or intraspecific competition, antibiosis, reparasitism and inducing plant resistance. At present, most biocontrol bacteria are screened under the experimental conditions, and the biocontrol ability and effect of biocontrol strains in the field are unstable. In addition, the mechanisms of biocontrol bacteria to improve plant resistance and disease resistance are various, but the screening and combination of strains with synergistic effect is still a random process, and there is no effective theoretical guidance. In the future, it needs to be further studied, such as the use of cross-combination of biocontrol bacteria with disease resistance mechanism to synergistically resist disease, reduce plant morbidity and enhance the control effect. The application scope and applicable conditions of biocontrol bacteria, as well as the interaction between biocontrol bacteria and its metabolites on host plants and other beneficial microorganisms in soil, so as to improve their adaptability to environmental conditions, which plays a very important role in reasonably guiding the combined application of biocontrol bacteria.

Keywords

Continuous obstacles; Biological control; Prevention mechanism.

1. Introduction

Biological control of plant diseases refers to the effective prevention and control technology of plant diseases by using beneficial microorganisms or microbial metabolites. Its essence is to inhibit the activity of some pathogens or enhance the resistance of plants to diseases by using the antibiosis, competition, and reparasitism between microorganisms or within species, or by inducing the disease resistance of plants by microorganisms [1]. Plant diseases are one of the common hazards in agricultural production. Chemical methods are common control methods, but there are also shortcomings such as pesticide residues and environmental pollution. With

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the improvement of people ' s living standards, food safety issues have become more and more concerned. Chemical pesticides have problems such as environmental pollution, pesticide residues, and drug resistance, which seriously affect food safety and people ' s health. Biocontrol has attracted more and more attention due to its advantages of green environmental protection, no pollution and no residue, which is the only way for sustainable agricultural development [2].

2. Regulation Technology of Continuous Cropping Obstacle

2.1. Biological Control

Biological control of plant diseases refers to the technology for effective prevention and control of plant diseases by using beneficial microorganisms or microbial metabolites. Its essence is to inhibit the activity of some pathogens or enhance the resistance of plants to diseases by using the antibiosis, competition, and reparasitism between or within species of microorganisms, or the induction of disease resistance by microorganisms. Biocontrol has attracted more and more attention due to its advantages of green environmental protection, no pollution and no residue, which is the only way for sustainable agricultural development.

2.1.1 Biocontrol bacteria

Bacteria are the largest microbial population in soil, with the characteristics of fast reproduction, short cycle, strong biological activity, and diverse metabolites, which are widely used in biological control. At present, the biocontrol bacteria that are widely used mainly include Bacillus, Pseudomonas, soil radiobacter and Pasteurella. Among them, Bacillus can produce strong endophytes and have strong antagonistic effects on many pathogenic microorganisms, so it is widely used in the prevention and treatment of plant diseases.

2.1.2 Biocontrol fungi

Common biocontrol fungi are Trichoderma, Broom mold, Chaetomium, etc. Among them, Trichoderma is the most studied genus. Studies have shown that Trichoderma can not only prevent and control plant soil-borne diseases, but also promote the growth of plants and improve the absorption and utilization of nutrients [3].

2.1.3 Biocontrol actinomycetes

Actinobacteria are the first microorganism used for biological control. The main biocontrol actinomycetes are Streptomyces and its related groups. Many Streptomyces showed obvious antagonism against plant pathogens.

2.2. Biological Control Mechanism

The control mechanism of biocontrol bacteria mainly includes competition, antibiosis, parasitism and inducing plant resistance.

2.2.1 Competitive role

Competition is mainly refers to the biocontrol bacteria and soil pathogens through competition of living space, nutrition and colonization sites in plant roots. Competition between biocontrol bacteria and pathogens mainly includes space and nutrition competition. Spatial competition is the competition of biocontrol bacteria for the sites of plant surface or internal space, especially pathogen invasion. Biocontrol bacteria pre-colonized on the surface of plants to prevent the direct invasion of pathogens. When different plants were used as materials to study the resistance of AM mycorrhizal fungi to plant diseases and insect pests, it was found that there was a spatial competition between pathogens and AM, and the hyphae or cyst nematodes of pathogens decreased in tissues infected by AM fungi and nearby tissues [4～7]. Harman et al. [8] Studies have shown that Trichoderma can easily grow along the roots of treated plants regardless of soil or seed treatment. Bacon isolated an endophytic Bacillus subtilis strain from

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maize, which had the same survival site as the maize pathogenic fungi[9]. Yang et al.[10]treated wheat seeds with Pseudomonas fluorescens and found that the strain could form a layer of uniform protective layer on the surface of young roots, which protected the infection sites of pathogenic bacteria and reduced the infection opportunities when the strain colonized the roots. Nutrition competition is the competition between biocontrol bacteria and pathogens for carbohydrates, nutrients and other substances necessary for growth and development. Continuous cropping has seriously affected the absorption and accumulation of various nutrients by plants. The results showed that the contents of nitrate nitrogen, available phosphorus and available potassium in soybean plants decreased significantly under continuous cropping. However, some studies have found that the absorption of nitrogen in continuous cropping soybean plants remained within the normal range, but the absorption of phosphorus and potassium significantly reduced the absorption of trace elements in soybean under continuous cropping stress, while the absorption of medium element calcium increased significantly. Chet and mbar [11] studies have shown that Trichoderma can secrete efficient siderophores to chelate ions in the environment and compete for limited nutrients in the soil to inhibit the growth of pathogenic microorganisms under ion starvation. Pseudomonas can effectively and permanently inhibit the occurrence of Fusarium oxysporum f. carnation wilt by secreting iron-phaga to compete with Fe3 +. At present, bio-control bacteria in hot spots have competitive effects with pathogens, which is also one of the main mechanisms for bio-control microorganisms to play a role. Because of this competitive effect, biocontrol bacteria are usually inoculated before pathogen infection, so as to better play the role of biological control.

2.2.2 Antibiotic effect

Antibiotic effect refers to the inhibitory effect of metabolites produced by one microorganism on the growth of another microorganism. This metabolite is called antagonistic substances, including antibiotics, peptides, enzymes, etc. Antagonistic microorganisms inhibit or kill pathogenic microorganisms by secreting antagonistic active substances and control plant diseases, which is one of the important mechanisms for microbial control. The effects of antagonistic substances on pathogens are mainly through: (1) interfering or blocking a certain link in the microbial growth and metabolism system or damaging the enzyme system. (2) Antagonists of broad-spectrum antimicrobials generally inhibit the normal growth of microorganisms by inhibiting common metabolic pathways. (3) Changing the morphological structure of pathogenic bacteria.

2.2.3 Multiple parasitism

Reparasitism refers to the phenomenon that biocontrol bacteria recognize, contact and entangle specific binding sites on the surface of pathogenic microorganisms, and inhibit or dissolve the host mycelium after the penetration of secretory enzymes and other substances. It is one of the most important roles in the biocontrol mechanism of biocontrol bacteria. The enzymes secreted mainly include chitinase, cellulase, protease, glucanase and so on.

2.2.4 Induce Plant Resistance

There are defense systems and related enzymes in plants that can protect plants from exogenous invasion. Induced resistance plants are stimulated by external physical, chemical or biological factors, inducing plants to produce some compounds or related enzymes, so that plants can obtain disease resistance. The induced disease resistance of plants is closely related to the activity of inducible enzymes in plants. These enzymes mainly include polyphenol oxidase (PPO), phenylalanine hydrolase (PAL), catalase (POD), β-1,3 - glucanase, and chitinase. Many scholars at home and abroad have done a lot of research on the changes of main enzyme activities as phenol metabolites in the process of host-pathogen interaction. Most of the results showed that the defensive enzymes were activated after the host was treated by biocontrol

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bacteria, and the activities of PAL, POD, PPO, SOD, β-1,3-glucanase and chitinase were greatly enhanced, which improved the disease resistance and disease resistance of plants.

2.3. Other Prevention Mechanisms

Other control mechanisms of continuous cropping obstacles include reasonable rotation and intercropping, reasonable fertilization, soil disinfection, grafting or breeding resistant varieties and substrate cultivation.

3. Existing Problems

Although biological control has made some achievements in the control of plant diseases, there are still some problems on the whole. Most of the biocontrol bacteria were screened out under the experimental conditions, and no field experiment was carried out. There are many factors affecting the natural conditions in the field, so the biocontrol ability of biocontrol strains will also change, and the control effect is not stable. Moreover, the screening and combination of synergistic strains is still a random process, which lacks effective theoretical guidance.

A large number of studies have shown that the mechanisms of biocontrol bacteria to improve plant resistance and disease resistance are various, which may be either a single mechanism or a combination of multiple mechanisms. It depends on the relationship between plants, biocontrol bacteria and pathogens. None of the above biological control mechanisms for biocontrol bacteria has been proved to be present in each microbial system studied, and there will be no only one biological control mechanism for biocontrol bacteria in one system. One mechanism becomes dominant depends on environmental conditions and plant pathogenic species or the type of biocontrol bacteria studied.

4. Outlook

It has become another research hotspot of biological control to use the combination of biocontrol bacteria with cross-resistance mechanism to cooperate with disease resistance. In other words, the combination of multiple biocontrol bacteria can reduce the incidence of medicinal plants and enhance the control effect. Secondly, the scope and conditions of application of biocontrol bacteria, as well as the interaction between biocontrol bacteria and its metabolites on host plants and other beneficial microorganisms in soil, so as to improve their adaptability to environmental conditions, it also plays a very important role in guiding the combined application of biocontrol bacteria.

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