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Beneficial microorganisms in agriculture

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Abstract: Beneficial microorganisms are used more and more frequently in the field of agriculture. Beneficial microorganisms can be divided into growth promoting bacteria and biocontrol bacteria. Growth promoting bacteria include improving the nutritional state of plants (such as nitrogen fixing bacteria, phosphorus solubilizing bacteria, potassium solubilizing bacteria, etc.) and improving the state of plants themselves (producing plant hormones, ACC deaminase, ferricarrier, etc.). Beneficial microorganisms are often used as biofertilizers in agricultural production and multifunctional biofertilizers are preferred. In this paper, the classification of beneficial microorganisms and their application in agriculture were reviewed in order to provide reference for the study of beneficial microorganisms.

Keywords: Biofertilizer; Beneficial microorganisms; Growth-promoting bacteria; Biocontrol bacteria.

1. Introduction

There are many microorganisms hidden around and inside plants that interact with and influence each other. Those microorganisms that are beneficial to plant growth are called beneficial microorganisms[1, 2]. Beneficial microorganisms can be simply divided into two categories: one is growth-promoting microorganisms, which can directly or indirectly promote plant growth through life activities (nitrogen fixation, phosphorus solubilization, secretion of plant hormones and ACC deaminase, etc.[3, 4]), such as cyanobacteria and rhizobia; The other type is biocontrol microorganisms, which cannot directly promote plant growth, but can promote plant growth by reducing the infestation of pathogenic bacteria or pests[5-7], such as Bacillus thuringiensis, Trichoderma, Bacillus Velesiensis, etc.

2. Growth-promoting microorganisms

Growth-promoting microorganisms are widely distributed in the rhizosphere, soil surface, soil and plant tissues. They can promote plant growth through different life activities. According to their modes of action, growth-promoting microorganisms can be divided into two types: improving plant nutritional state and improving plant self-state.

2.1. Growth-promoting microorganisms to improve plant nutritional status

Growth-promoting microorganisms that improve the nutritional status of plants, such as those that have the functions of nitrogen fixation, phosphorus solubilization and potassium solubilization, can transform the nutrients in nitrogen, phosphate and potassium ores into forms that can be absorbed and utilized by plants, thus improving the nutritional status of plants. Nitrogen-fixing microorganisms can be divided into autogenous nitrogen-fixing bacteria, symbiotic nitrogen-fixing bacteria and combined nitrogen-fixing bacteria. Autogenous nitrogen-fixing bacteria can carry out nitrogen-fixing activities independently of plants in soil. Although the nitrogen-fixing efficiency is low, autogenous nitrogen-fixing bacteria are widely distributed and have strong adaptability, which is convenient for production, use and promotion. In 1893, Noglas discovered the first autogenous azotobacter (Pasteurella) in soil, which opened the curtain of the research on autogenous azotobacter. Later, Anabaena, Candida Linke and other autogenous nitrogen-fixing microorganisms were discovered successively. Symbiotic nitrogen-fixing microorganisms mainly include Rhizobium, cyanobacteria, and Frankella, which have excellent nitrogen-fixing ability, but only form symbionts with specific hosts. For example, a rhizobium can only form nodules on the roots of one or several legume plants, actinomyces frankeni can only form nodules with Alnus, Myxis, Seabuckthorn, and Equina, etc., and Cyanobacteria of Candida, Anabaena and other genera can only establish nitrogen-fixing symbionts with some specific fungi, bryophytes, ferns, and seed plants. Although the host is limited, the application of symbiotic azotobacter can significantly increase yields and reduce the use of chemical nitrogen fertilizer in legumes. Combined azotobacter is a transitional form between rhizosphere autogenous azotobacter and symbiotic azotobacter. Although it still has host specificity, it is free from the restriction of legumes. There are many species of phosphorus solublyces, mainly fungi, bacteria and actinomyces. The number of bacteria is the largest, and the fungal effect is the best. According to the different objects of action of phosphorus solubilizing bacteria, phosphorus solubilizing bacteria can be divided into organic phosphorus microorganisms (mainly relying on enzyme action) and inorganic phosphorus microorganisms (mainly based on acid production, supplemented by proton secretion and respiration). Potassium-releasing bacteria mainly include Bacillus glia, Bacillus annulus and Bacillus soil. In the process of their growth, acidic substances, enzymes and capsular polysaccharides secreted by them destroy the surface structure of minerals, and finally isolate the quick potassium required by plant root absorption.

2.2. Growth-promoting microorganisms that enhance the plant's own state

The microorganisms that enhance the plant state can regulate the level of plant hormones and the growth state by secreting plant hormones, ACC deaminase and ferriferous carriers. These microorganisms help to break plant growth

restrictions and enhance plant resistance. Combined with superaccumulation plants, they can accelerate the repair of heavy metal contaminated soil. Beneficial microorganisms in plant rhizosphere such as Pseudomonas, Bacillus and Acinetobacter have the ability to secrete plant hormones such as auxin, cytokinin and gaelicin, and the secreted plant hormones can affect the levels of hormones in plants and thus affect the growth state of plants. ACC deaminase secreted by beneficial microorganisms such as Pseudomonas, Acinetobacter and Panthenium can reduce ethylene content in plants and enhance plant stress resistance. The microorganisms of Pesudomonas, Azotobacter, Bacillus, Rhizobium and Agrobacterium could secrete iron carriers, which enhanced the plant tolerance to heavy metal stress.

3. Biological control of microorganisms

Biocontrol bacteria are widely distributed and have a variety of species. Currently, fungi, bacteria and actinomyces are the most studied.

The main fungal biocontrol bacteria include Trichoderma, Saccharomyces, Penicillium lavuviae, Trichoderma firmicutes and mycorrhizal fungi. Inhibit or kill pathogenic bacteria or diseases and pests mainly through antibiotics, hyper parasitism, competition, lysozyme and protease, so as to promote the growth of host plants.

Bacterial biocontrol bacteria mainly include Bacillus, Pseudomonas, Agrobacterium tumefaciens and Pasteurelli, etc. The main biocontrol mechanisms are antimicrobial action, competition action, bacteriolytic action, protease action and phage[22, 23].

Actinomyces can antagonize pathogenic bacteria or diseases and pests through antibiotics, competition, lysozyme and protease, mainly Streptomyces and its varieties.

4. The application of beneficial microorganisms

Chemical fertilizers have made great contributions to the increase of food production, but the non-renewable raw materials of chemical fertilizers, environmental pollution during production and use, and health hazards caused by long-term heavy use are urging people to find new alternatives. Biofertilizers, which are mainly composed of beneficial microorganisms, are currently the best alternatives to chemical fertilizers. Although they are slightly less stable, they can completely replace or even surpass chemical fertilizers as long as they are used scientifically.

Biofertilizers can be divided into three types: single biofertilizer, compound biofertilizer and compound biofertilizer. Single biofertilizer refers to the fertilizer containing only one kind of beneficial microorganism. Although it is very targeted in function, it is easy to be affected by environmental factors, so that the fertilizer effect cannot be fully played. Compound biofertilizer refers to containing two or more kinds of beneficial microorganisms, the same function of beneficial microorganisms' collocation, can enhance the stability of fertilizer; The combination of beneficial microorganisms with different functions will enhance the comprehensiveness of biofertilizers. Although biocontrol bacteria can be used alone as "biopesticides" to kill or control pathogenic bacteria or disease pests in the field, but more often combined with biopromoting bacteria as biofertilizers, biofertilizers containing biocontrol microorganisms can replace chemical fertilizers at the same time, but also reduce the use of chemical pesticides. Mixed biofertilizer is a product made by mixing beneficial microorganisms with nitrogen, phosphorus, potassium or organic matter. This kind of fertilizer can not only directly supplement soil nutrients, but also play the function of biofertilizer, enhance the utilization rate of nutrients, and keep the fertilizer long-term.

5. Conclusion

At present, many countries are controlling the application amount of chemical fertilizers, and gradually replacing chemical fertilizers with biofertilizers mainly composed of beneficial microorganisms. Although biofertilizers cannot completely replace chemical fertilizers, studies have shown that replacing part of chemical fertilizers will not cause yield changes. It will become a research focus in the next stage to increase the ratio of biofertilizer to chemical fertilizer as much as possible by mining more efficient beneficial microorganisms, developing more stable biofertilizer formula and improving the use of biofertilizer.

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