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The Role of Microbial Fertilizer in the Prevention and Control of Flowers Plant Diseases and Pests

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Abstract
Microbial fertilizer, as a new type of biological agent, consists of active microbial groups such as nitrogen-fixing bacteria, phosphorus-decomposing bacteria, and Bacillus subtilis. This article analyzes the role, effect and related mechanism of microbial fertilizer in the prevention and control of flower diseases and pests from the perspective of microbial fertilizer. Through in-depth analysis of these effects and mechanisms, it can provide support and basis for the rational and efficient use of microbial fertilizer for the prevention and treatment of flower diseases and pests in the future.

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1. Introduction

Microbial fertilizer is the third-generation fertilizer developed based on the principles of soil microecology and plant nutrition. It provides nutrients for crops through the metabolic activities of active microorganisms. Its core components are nitrogen-fixing, phosphorus-degrading, and potassium-degrading microbial communities, which can improve soil structure and reduce fertilizer usage by 30% to 60%. This fertilizer is made from raw materials such as animal and plant amino acids and soybean protein through fermentation technology. Since the 21st century, it has been widely used in the agricultural field as a new type of biological product. Currently, there are 250 microbial fertilizer production enterprises in China, with an annual output of several million tons. In 2021, the Changchun Academy of Agricultural Sciences promoted this fertilizer in 12,000 mu of rice fields. By replacing chemical fertilizers, it continuously increased soil organic matter content, significantly reduced fertilizer usage, and increased rice yield by more than 5% while reducing pesticide usage by 20%. The production of this fertilizer has formed a standard testing system and also has the function of decomposing agricultural waste. Its application scope covers soil remediation and green planting fields [1]. Microbial fertilizer mainly functions through three main mechanisms: first, competitive inhibition, where it rapidly reproduces to occupy the ecological niche of plant roots, consuming oxygen, water, and nutrients in the soil, forming a biological barrier, and directly inhibiting the colonization and reproduction of pathogenic bacteria; second, inducing systemic resistance, through microbial-plant interaction signal transduction, activating defense signaling pathways such as salicylic acid and jasmonic acid, promoting the expression of plant defense genes; third, secreting antibacterial substances, such as lipopeptide antibiotics (surface-active substances, ivermectin, etc.) produced by Bacillus subtilis can directly damage the cell membrane structure of pathogenic bacteria.

2. The Advantages of Microbial Fertilizer

In the practice of flower cultivation, microbial fertilizer demonstrates multiple advantages: it can reduce the usage of chemical pesticides by 30-50%, and also improve the soil aggregate structure through microbial metabolic activities, regulate the pH value, and increase the organic matter content. Taking the prevention of rose powdery mildew as an example, the Hartz mold spores can rapidly germinate at the infected spots. The mycelium can not only physically penetrate the pathogen mycelium but also induce plants to produce anti-pathogenic substances such as chitinase and β-1,3-glucanase, achieving biological control effects. Compared with chemical pesticides, microbial fertilizer has significant advantages such as good environmental compatibility, no pesticide residues, and the pathogen is less likely to develop resistance. It is particularly suitable for greenhouse flower cultivation systems with severe intercropping problems, and can effectively alleviate secondary problems such as soil acidification and salinization [2].

Microbial fertilizer has demonstrated remarkable application effects in the prevention and control of plant diseases and pests. Its mechanism of action and practical application cases further validate its ecological value. At the molecular level, microbial fertilizer works synergistically through three pathways: competitive inhibition, induction of systemic resistance, and secretion of antibacterial substances. For instance, Bacillus subtilis not only secretes antibiotics such as surfactin but also forms biofilms to block pathogen invasion; while Arbuscular Mycorrhizal Fungi expand the root absorption range through a vast mycelial network, improving the plant's absorption efficiency of water and mineral elements, and indirectly enhancing the plant's stress resistance. Field trial data shows that microbial fertilizer exhibits excellent control effects on various plant diseases: for rose black spot disease, using a solution of Bacillus amyloliquefaciens for three consecutive applications can reduce the disease leaf rate from 85% to below 25%; when controlling orchid root rot disease, using a mixture of Trichoderma and humic acid organic fertilizer at a ratio of 1:3, it not only inhibits the growth of pathogenic bacteria but also stimulates the root system to secrete growth hormone-like substances, increasing the number of new roots by 40%. Environmental adaptability studies show that the efficacy of microbial fertilizer is significantly influenced by soil physical and chemical properties. In slightly acidic soils with a pH of 6.5-7.5 and an organic matter content of ≥2%, the efficacy of Trichoderma harzianum against powdery mildew is improved by more than 40% compared to alkaline soils. The study on strain ratio also confirms that a composite microbial agent has a more synergistic effect than a single strain. For example, when Bacillus subtilis and Pseudomonas fluorescens are compounded at a ratio of 2:1, through metabolic complementation, the control effect on rhododendron leaf spot disease is improved by 35% compared to a single strain, and the duration of efficacy is extended to 20 days. These empirical studies fully demonstrate that microbial fertilizer, through a multi-target and multi-pathway action mode, provides quantifiable and replicable biological solutions for the green control of plant diseases and pests.

3. The Core Mechanism of Microbial Fertilizer

3.1. Soil Improvement and Disease Suppression

The beneficial microorganisms in microbial fertilizer, such as Bacillus subtilis and Trichoderma harzianum, can decompose residual fertilizers in the soil, form aggregates, improve air permeability and water retention capacity. At the same time, they compete for nutrients and space to inhibit the reproduction of pathogenic bacteria like Fusarium and Pythium, reducing the incidence of root rot and powdery mildew. For example, the Iwamoto Enzyme Technology can reduce flower root rot by over 40%.

3.2. Synergy of Probiotic Promotion and Disease Resistance

Nitrogen-fixing bacteria and phosphorus-solubilizing bacteria can activate soil nutrients, promote root development, and enhance the flower's resistance to diseases. For instance, the North Plant Microbial Fertilizer contains 2 billion live bacteria per milliliter. It can promote new roots within 7 days and increase leaf thickness by 50% in 30 days.

4. Common Flower Disease Control Plan by Microbial Fertilizer

4.1. Root Rot

Apply the bacterial agent containing Bacillus subtilis (such as Bacteria Net) to the roots by irrigation. Within 24 hours,a biological barrier is formed, and the rate of root rot can be reduced from 35% to below 4%. Orchid root rot can be controlled by diluting liquid bacterial fertilizer like Orchid Fungus King 1000 times and irrigating the roots twice a month to inhibit bacterial growth.

4.2. Leaf Diseases (Powdery Mildew, Gray Mold)

Spray the composite microbial agent (such as Bacteria Liqing). Hartz mold can parasitize the mycelium of gray mold, reducing the spore count by 80%.

For the initial stage of powdery mildew, apply the spore-forming Bacillus licheniformis preparation. Within 2 days, the powdery layer turns brown and dries.

4.3. Soil-Borne Diseases (Stem Rot, Yellow Leaves)

The use of microbial agents in combination with organic fertilizers can repair damaged root systems and improve yellow leaves. For example, Rotifungus Tek has a cure rate of 80% for root rot [3].

5. Matters Need Attention

5.1. Temperature and Timing

The microbial fertilizer's activity should be exerted in an environment ranging from 10 to 32 degrees Celsius. It is recommended to use it in spring and autumn. Its effectiveness will be limited during summer when it is hot or winter when it is cold [4].

5.2. Avoid Mixing with Fungicides

Chemical fungicides will kill beneficial bacteria. They should be used at least 7 days apart [5].

5.3. Quality Selection

The inspection in 2024 showed that the qualified rate of microbial fertilizers was 94.4%. However, it is necessary to pay attention to whether the effective viable bacteria count meets the standard (such as>2 billion per gram) [6].

6. Conclusion

Although microbial fertilizer has demonstrated significant advantages in the prevention and control of plant diseases and pests, its industrial application still faces technical bottlenecks and promotion obstacles. In terms of biological stability, the activity of microbial strains is significantly affected by environmental fluctuations: when the soil temperature is below 15℃, the enzymatic activity of most functional bacteria decreases and their proliferation rate slows down; while above 35℃, it is prone to protein denaturation, resulting in a decrease in metabolic activity, which causes a 30-50% variation in efficacy in regions with large seasonal temperature differences. The compatibility study of agricultural chemicals shows that the presence of chemical pesticide residues poses a serious challenge, especially when microbial fertilizer is used 7 days after the application of benzimidazole fungicides (such as carbendazim), it will cause the survival rate of viable bacteria to drop sharply to below 30%. The compatibility test of microbial fertilizers reveals that uncomposted farmyard manure will compete fiercely for carbon sources with functional bacteria during decomposition, and at the same time produce inhibitory substances such as organic acids and ammonia gas, causing the number of bacterial colonies to decrease by 60% within 48 hours. To address these technical challenges, current research has proposed a series of solutions: in the formulation process, the use of a double-layer encapsulation technology with sodium alginate and chitosan can increase the survival rate of microbial strains to over 90% within the pH range of 4-9 and the temperature range of 10-40℃; in terms of application norms, a time interval system based on the half-life of pesticides is established, such as organic phosphorus pesticides need to be spaced 10-15 days before applying microbial fertilizer; in terms of innovative application modes, a special substrate composed of Trichoderma fungi and composted sheep manure (with a C/N ratio of 20:1) at a 1:5 ratio has been developed, which can provide stable carbon and nitrogen sources and extend the efficacy of the microbial agent to 45 days. It is worth noting that the research on the variability of flower varieties reveals that bulbous plants such as lily have a lower tolerance to bacillus spores than rose by 30-40% due to the presence of a large amount of phenolic substances in the root secretions, which requires the formulation of crop-specific microbial agent formulas and application schemes. Through innovative means such as encapsulation technology, precise application, and species adaptation, the technical potential of microbial fertilizer in green control of flowers is expected to be transformed into large-scale application results.

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