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Potential Role of Streptomyces in Agricultural Crops

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Abstract:

Beneficial bacteria called Streptomyces spp. are essential to the rhizosphere of plants because they stimulate plant development and inhibit disease. They generate a variety of hydrolytic enzymes, siderophores, hydrogen cyanide, and antibiotics, all of which support their ability to operate as a biocontrol agent against bacteria and fungi. Streptomyces species also display characteristics that aid in plant growth, such as biological nitrogen fixation, mineral solubilization, and the release of hormones that stimulate plant growth, such as indole-3-acetic acid. The biocontrol and plant growth-promoting characteristics of Streptomyces spp. are highlighted in this study, highlighting their potential use as efficient biocontrol agents and plant growth promoters in sustainable agricultural methods.

Introduction:

Actinobacteria Streptomyces produces a range of antibacterial chemicals that are important to the plant rhizosphere. This aerobic, gram-positive bacterium grows into complex mycelium and colonizes a wide range of substrates. It is found in soil, compost, vermicompost, and fresh and marine habitats. Streptomyces produces phytohormones including gibberellic acid and IAA, which promote plant development. Streptomyces loves neutral to alkaline pH ranges of 6.5-8.0. It also generates secondary metabolites that have the ability to inhibit illnesses spread by seeds and the soil. Streptomyces colonizes the rhizosphere and rhizoplane as free-living saprophytes, which improves plant development, nitrogen fixation, and mineral solubilization. It works through a variety of mechanisms, including as competition, hyperparasiteism, destruction of fungal cell walls, and antibiotic synthesis. This paper investigates the potential of Streptomyces spp. for biocontrol and plant growth promotion.

Biocontrol traits of Streptomyces spp.

1. Production of hydrolytic enzymes-

- **Chitinase:** It has the ability to degrade chitin, an essential part of fungal cell walls, which stops the growth and development of the fungus.

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- **Cellulase:** It has the ability to degrade chitin, an essential part of fungal cell walls, which stops the growth and development of the fungus.
- **Lipase:** Lipids, which are sometimes an essential part of fungal membranes, are hydrolyzed by it, which eventually causes fungal cell lysis.
- **Protease:** It inhibits fungal growth by dissolving proteins, which may be necessary for the growth and development of fungi.
- **β-1,3-glucanase:** Fungal cell walls mostly consist of β-1,3-glucans, which are broken down by it, making it harder for fungi to keep their structural integrity. These hydrolytic enzymes are essential to the biological regulation of plant fungal infections.

2. **Production of siderophores**:

Beneficial organisms create siderophores, which chelate iron and render it inaccessible to pathogens, which require iron for survival. Certain siderophores have the ability to cause plants to develop a systemic resistance. They can also improve plant development by giving plants the critical iron they need to be healthy and resistant to disease. It has been observed that the majority of Streptomyces, including Streptomyces griseus, Streptomyces aureofaciens, and Streptomyces lydicus, create siderophores.

Production of HCN:

It is known that certain Streptomyces species generate hydrogen cyanide (HCN), a volatile substance with antibacterial action against pathogenic microorganisms, especially fungal infections, and a significant function in biological control. Several Streptomyces species that produce HCN include:

- **Streptomyces griseus:** It is known that this species produces HCN, a secondary metabolite with antibacterial and antifungal properties.
- **Streptomyces aureofaciens**: According to reports, this species produces HCN, which aids in the control of fungi that cause diseases like Fusarium oxysporum.
- **Streptomyces lydicus:** It has been demonstrated that this species produces HCN, which is important in preventing phytopathogenic fungus from growing mycelium or germination of their spores.
- **Streptomyces chrestomyceticus:** It has been observed that this species produces HCN, which has nematicidal action against Meloidogyne incognita, a worm that causes knots in roots.

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Production of Antibiotics:

Over 60% of all known antibiotics are produced by Streptomyces species, which are well-known for their capacity to create a wide variety of antibiotics. Because Streptomyces is an important source of bioactive chemicals for both human health and plant protection, these antibiotics are effective not only against human diseases but also against plant pathogens.

Plant Growth Promoting traits of Streptomyces spp.:

Plant Growth Promoting (PGP) features have been documented in Streptomyces spp. growing in the rhizosphere, or the region around plant roots. These qualities lead to:

- Improved root length and enhanced shoot length; more tillers and panicles in cereals; higher grain/fruit output in cereals, legumes, and other crops;

Streptomyces promote plant growth through various mechanisms, including:

- Biological nitrogen fixation, which transforms atmospheric N2 into forms that plants can use.
- Mineral solubilization, which increases plants' availability of phosphorus, potassium, and zinc
- The release of plant growth hormones, such as the auxin derivative indole-3-acetic acid (IAA), which encourages cell division and elongation. Streptomyces spp. can boost agricultural yields, improve plant nutrition, and raise plant resilience to disease and stress by encouraging plant growth and development.

Conclusion:

The adaptable bacteria Streptomyces spp. is essential to the rhizosphere of plants because they have characteristics that both promote plant development and serve as a biocontrol agent. Their production of hydrolytic enzymes, siderophores, hydrogen cyanide, and antibiotics renders them efficacious against bacterial and fungal pathogens. Simultaneously, their mechanisms for promoting plant growth, such as biological nitrogen fixation, mineral solubilization, and secretion of plant growth hormones, enhance crop yields and enhance plant nutrition. Streptomyces species provide an important resource for sustainable agricultural techniques because to their capacity to regulate soil-borne and seed-borne illnesses, stimulate plant development, and improve plant resilience to stress and disease. To completely understand the mechanisms of action of Streptomyces spp. and to create practical techniques for their use in agriculture, more study is required.

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