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Trichoderma spp: An Effective Biocontrol Agent

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SUMMARY

Trichoderma spp. have long been recognized as biological agent, for the control of plant diseases and for their ability to increase root growth and development, crop productivity, resistance to abiotic stresses and uptake and use of nutrients. Due to continuous use of agro-chemicals and pesticides it caused the resistance in pathogens. They produce or release a variety of compounds that induce localized or systemic resistance responses in plants. Biocontrol mechanisms of *Trichoderma* spp. antagonist microorganisms, such as *Trichoderm*a spp. reduce growth, survival or infections caused by pathogens by different mechanisms like competition, antibiosis, mycoparasitism, induced resistance in plants and plant growth promotion.

INTRODUCTION

The increased refection on environmental concern over pesticide use has been instrumental in a large upsurge of biological disease control. Development of fungicide resistance among the pathogens, ground water and foodstuf pollution and the development of oncogenic risks has further encouraged for the exploitation of antagonistic microfora in disease management. Amids the various antagonist used for the management of plant diseases, *Trichoderma* and *Pseudomonas* plays a vital role in the management of plant diseases (Nakkeeran *et al.*, 2010). *Trichoderma* spp. are free-living fungi that are common in soil and root ecosystems. They are highly interactive in root, soil and foliar environments. *Trichoderma* spp. have long been recognized as biological agents, for the control of plant diseases and for their ability to increase root growth and development, crop productivity, resistance to abiotic stresses and uptake and use of nutrients.

Mechanisms of *Trichoderma* spp.

Trichoderma spp. employ several antagonistic mechanisms against plant pathogens. These include competition, antibiosis, mycoparasitism, induced resistance in plants and plant growth promotion.

Competition

Most of the soil borne pathogens are controlled by the competition for space or court of infection on roots and seeds. Competition among microorganisms occurs only when resources such as soil nutrients and space are limited. In this situation, antagonistic microbes produce secondary metabolites capable of inhibiting or slowing growth and other activities of pathogenic fungi, thus conferring ecological advantages over its competitors. In addition, *Trichoderma* spp. are naturally resistant to many toxic compounds, including herbicides, fungicides and phenolic compounds. Therefore, they can grow rapidly and impact pathogens by producing metabolic compounds that impede spore germination (Fungistasis), kill the cells (antibiosis) or modify the rhizosphere. eg. By acidifying the soil so that the pathogens cannot grow. Most fungi including *Trichoderma* produce various forms of siderophores, which help the fungi to overcome adverse soil conditions. Siderophore production can be beneficial to the plant and microbes for two reasons: (1) siderophore production by antagonist fungi can suppress the growth of plant pathogens by depriving it of an iron source and (2) siderophores can help in solubilizing iron that was unavailable to the plant.

Antibiosis

Antibiotics are low molecular weight secondary metabolites produced during nutrient limiting conditions. It is involved in releasing of secondary metabolites that inhibit the effect on other parasitic fungi and prevents them to become active parasites or kills them. It is not only effective against other forms of fungi but also active against various bacteria and virus that may cause threat to the fungi. The secondary metabolites released by the fungi are trichorovins and trichodecenins. The cells exposed to antibiotics of *Trichoderma* spp. creates ultra-structural changes like retraction of plasma lemma, breakdown of organelles, disintegration of

cytoplasm, loss of turgor and weakening and death of host cells. eg. Antimicrobial activities could be the result of several secondary metabolites such as peptaibols, terpenes, polyketides, gliotoxin and gliovirin produced by fungi.

Mycoparasitism

Mycoparasitism relies on the production of lytic enzymes by the mycoparasite for the degradation of cell walls of the host fungus. Mycoparasitism is a direct mechanism for biological control that works by parasitizing, detecting, growing and colonizing pathogen. Mycoparasitism is a complex type mechanism that generally involves the production of a cell wall lytic enzyme. It involves four sequential steps

1. Chemotropism and recognition
2. Attachment and coiling
3. Cell wall penetration
4. Digestion of host cell

Trichoderma spp. detect other fungi, grow straight towards them and its sequentially produce hydrolytic cell wall degrading enzymes. *Trichoderma* spp. attach to the host and coil hyphae around the host, form appressoria on the host surface, penetrate the host cell and collapse the host hyphae. Production and regulation of lytic enzymes such as chitinases, glucanases and proteases by *Trichoderma* spp. also play key roles in the mycoparasitism/biocontrol process. eg. *Trichoderma* spp. coiled over *Pythium* resulting in cell wall lysis, vacuolation and coagulation of protoplasm (Kumar *et al.*, 2020).

Induced resistance in plants

Apart from *Trichoderma's* capacity to attack plant pathogens and inhibit its growth, many reports have shown the induction of systemic and local resistances against a wide range of pathogens. Both the inductions of systemic and local resistances in plants are the result of complex interactions between different elicitors released by microbes and plant receptors, which induces plant cells physiological and biochemical changes. However, these processes are possible when the systemic acquired resistance (SAR) triggers a resistance in the entire foliage and enhances production of the defense signal molecule, salicylic acid (SA), for further signalling. It occurs in a plant following the challenge inoculation of antagonist that triggers the expression of a set of genes which encode for pathogenesis – related proteins such as chitinases, b-1, 3-glucanases and thaumatin – like proteins with antifungal activity.

Plant growth promotion

Microbial organisms colonize a plant's root system and at the same time play a beneficial role in biological control, protecting the plant from soil-borne pathogens as well stimulating plant growth. *Trichoderma* spp. proliferate in the rhizosphere, establishing a symbiotic association, thus improving plant nutrition and growth in a natural way. It is able to colonize roots, improving plant nutrition, growth and development as well as enhancing plant resistance to abiotic stresses. Increasing plant growth by using biological control agents is usually attributed to an indirect effect associated with control of plant pathogens. Growth promotion may occur either directly or indirectly. Promotion of growth may occur either through biocontrol of deleterious pathogens or through the production of plant hormones like auxin, cytokinin or gibberellins.

Benefits of *Trichoderma* spp.:

Disease Control: *Trichoderma* spp. is a potential bio control agent and it is used extensively for soil borne diseases as well as foliar diseases. It also produces cell wall degrading enzymes against the pathogens.

Antibiotics: It produces antibiotics that can kill the plant pathogens.

Plant Growth Promoter: It solubilises phosphorus and micronutrients, increases the root length and help them to increase availability of nutrient and avoid moisture stress during dry season.

Biochemical Elicitors of Disease: It induces resistance in plants by releasing various chemicals.

Transgenic Plants: *Trichoderma* gene endochitinase are successfully introduced with tobacco and tomato plants and it shows a great resistance to fungal growth and selected transgenic lines are highly resistance to foliar pathogens and soil borne pathogen.

Bioremediation: It plays a great role in bio remediation of soil contaminated with high pesticides and herbicides. As it degrades a wide range of pesticides in nature and free soil from various contaminations.
Colonizing the Soil: It grow faster near root region and occupying space and show dominance against other microorganisms.
Part of Plants: It starts symbiosis with plants root and covers root hair and occupy physical space or root rhizosphere that avoids the multiplication of other plant pathogens in rhizosphere. It also increases the length and depth of root.
Nutrient Solubilising: It solubilising the phosphorus and micronutrient and increases the availability to the plant (Kumar *et al.*, 2020).

Method of Application of *Trichoderma* culture
Seed treatment: For small size seed, mix 4 gm of *Trichoderma* powder per kg of seed with water before sowing are recommended and for medium size seed, mix 8 gm of *Trichoderma* powder per kg seed with water is recommended and for large size seed, mix 10 gm of *Trichoderma* powder with water per kg seed is recommended before sowing.

Seed Priming: Seed priming with *Trichoderma* is performed in cereals, oil seed and pulses in which various materials (Cow Dung etc) are used with *Trichoderma* powder (10 gm per kg seed).

Soil Treatment: In which *Trichoderma* enriched vermicompost or compost are incorporated with field/ soil before seed sowing. *Trichoderma* feed on dead and decay plant and animal body and it can be grown in acidic and basic soil having adequate amount of moisture. During composting it will grow and rapid multiply in this compost and when it applies in field it enriches the soil physical, chemical and biological properties and directly/indirectly influenced crop growth.

Nursery Treatment: Just before sowing in nursery apply 5 gm *Trichoderma* powder or other *Trichoderma* product in 100 m^2 of nursery bed.

Cutting and Seedling root Treatment: Mix 10 gm of *Trichoderma* powder along with 100 gm vermicompost per liter of water and dip the cuttings and seedlings for 30 minutes before planting.

Plant Treatment: In perennial crop, drench the soil near root region 100 gm *Trichoderma* powder are apply directly or along with compost is recommended.

Foliage Apply: It is spray over the foliage at 3 to 4 gm *Trichoderma* after 8 to 10 days interval is recommended (Kumar *et al.*, 2020).

CONCLUSION

Trichoderma spp. is a promising candidate for the biological control of plant pathogenic fungi. *Trichoderma* spp. are correctly renowned for their capacity to generate a broad range of antibiotic substances that have the potential to parasitize a wide array of pathogenic fungi in the rhizosphere. In addition, *Trichoderma* spp. synthesize several metabolites which have a substantial influence on plant growth, along with stimulation of localized and systemic resistance and stress tolerance in plants.

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