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Trichoderma: A Potential Biocontrol Fungus for Ecofriendly Disease Management

Jogender
M.Sc. Research Scholar, Department of Genetics & Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana

SUMMARY

The novel technological advancement in all fields of agriculture has improved agricultural production, but some modern practices affect the environment badly. The recent challenge faced by modern farming system is to achieve higher yields in environment-friendly manner. Thus, there is an immediate need to discover eco-friendly solutions such as wider application of biocontrol agents. Among various types of species being used as biocontrol agents, including fungi and bacteria, fungal genus Trichoderma has a remarkably diverse metabolism capable of catabolizing a wide variety of substrates as well as producing a wide variety of secondary metabolites (SMs) and different kinds of enzymes which play a major role in biocontrol activity like degradation of cell wall, tolerance to biotic or abiotic stresses, hyphal growth etc. SMs play pivotal roles in chemical defense and communication, and some of them have demonstrated important antibiotic abilities in biocontrol applications. The plant-Trichoderma-pathogen triangle is a complicated web of numerous processes. Trichoderma spp. are avirulent opportunistic plant symbionts. In addition to being successful plant symbiotic organisms, Trichoderma spp. also behave as a low cost, effective and ecofriendly biocontrol agent. Among other biocontrol mechanisms, antibiosis, competition and mycoparasitism are among the main features through which microorganisms, including Trichoderma, react to the presence of other competitive pathogenic organisms, thereby preventing or obstructing their development.

INTRODUCTION

Agricultural sector plays an important role in human society, serving as the backbone for the economy as well as food-nutrient security in India.The new technological advancement in all fields of agriculture have improved agricultural production, but some modern practices affect the environment badly. In agriculture,pathogens are threat to crop production. The extensive use of fungicides in various parts of the world for years has increased the pollution level in soil and water and adverse effect on food quality and human health.Apart from this, the chemicals tend to become less efficient due to the development of resistance among the pathogen over the time.Over the years, there has been tremendous shift in pest management strategies due to growing concern on account of adverse effect of crop protection chemicals on biodiversity, environment, human beings as well as live stocks. Consequently, emphasis has shifted from use of chemical pesticides to environment friendly bio-rational based pest management practices with major emphasis on plant products and microbe-based pesticides. Pesticides are common tool for managing plant pests but are hazardous to human health, live stocks and environment. Hence, it is necessary to look for alternative disease management practices, which include the use of ecofriendly biological control agents. Biological Control Agent **(BCA)** can be defined as the use of natural efficient strains of any microorganisms or modified organisms that reduce the incidence or severity of diseases caused by plant pathogens. It exhibits an antagonistic activity toward a particular phytopathogen. Fungi ***Trichoderma*** have been known since 1920s for their capability to function as biocontrol agent against plant pathogens.

Trichoderma is…

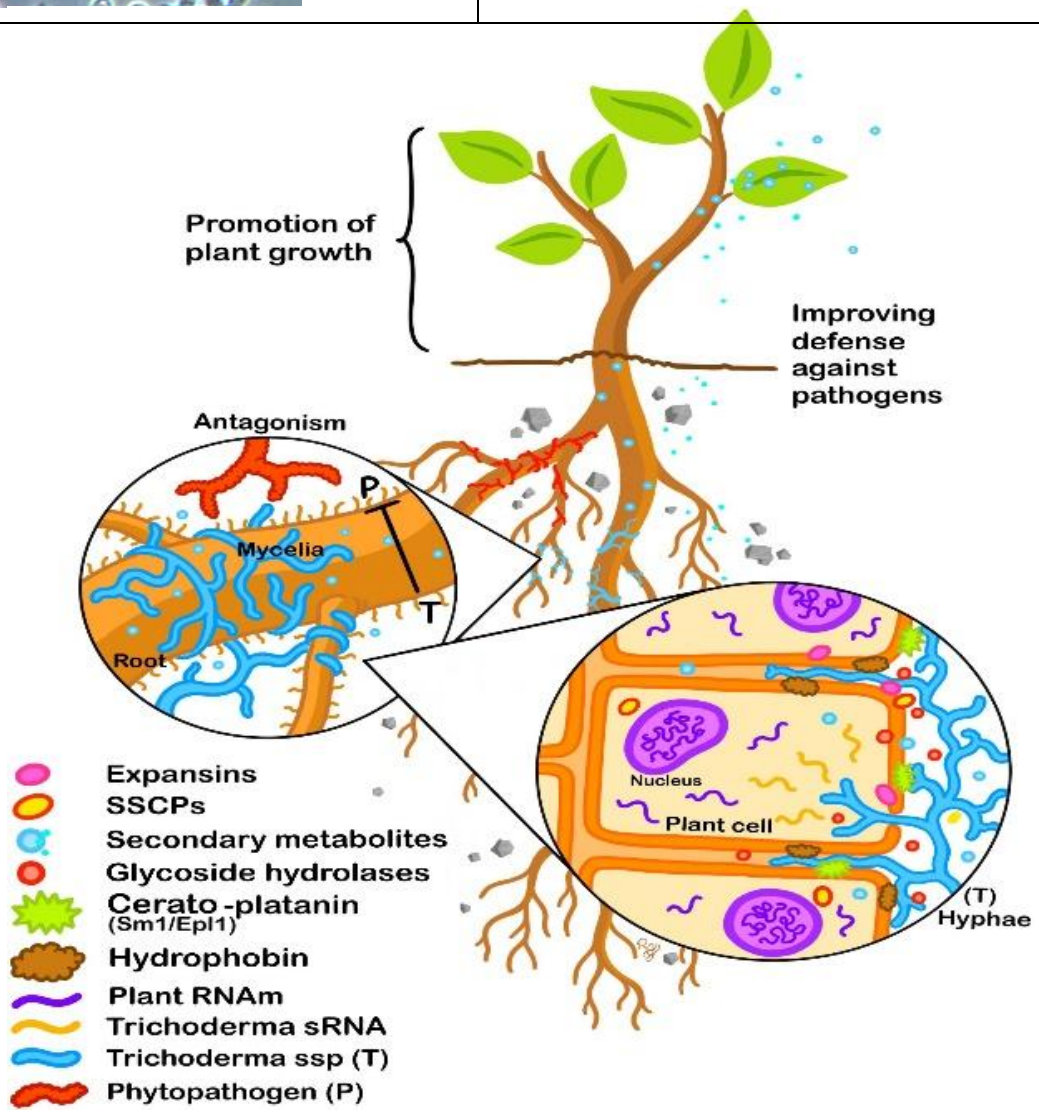
- Free living
- Ubiquitous
- Highly proliferating
- Non-pollutive
- Easily accessible
- Nonphytotoxic
- Systemic ephemeral
- Readily biodegradable
- Cost effective
- Synergistic effect
- Longer shelf life
- Greater compatibility

Trichoderma produces different kinds of enzymes which play a major role in biocontrol activity like degradation of cell wall, tolerance to biotic or abiotic stresses, hyphal growth etc. They can be used either to improve health of crop plant or to increase the natural ability to degrade toxic compounds by some plants in soil and water. *Trichoderma*-based bio-fungicides are booming in an agricultural market with more than 50

formulations registered products worldwide. Presently, Trichoderma spp.-based products are considered as relatively novel type of biocontrol agents.

Taxonomical Classification

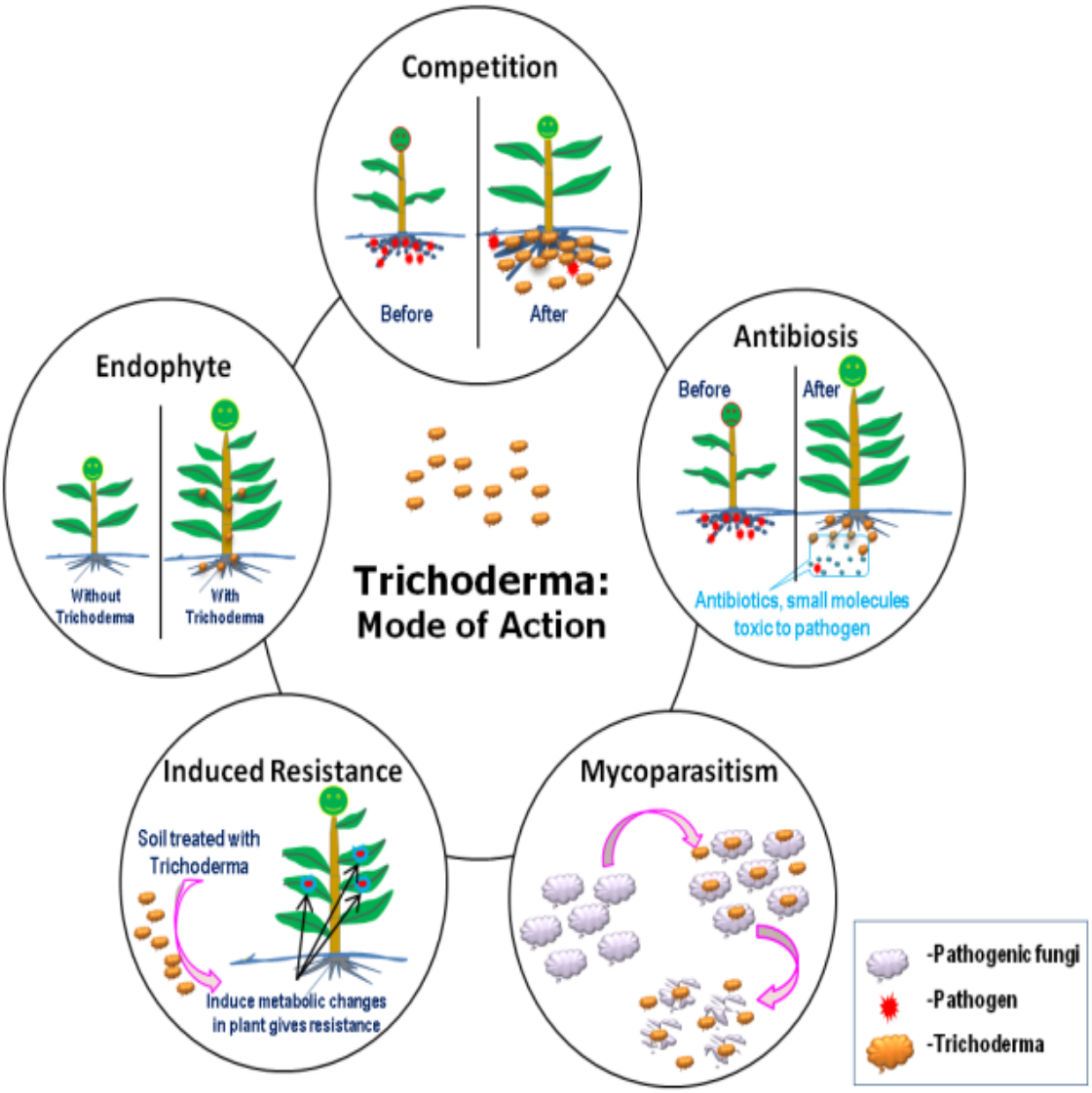
Kingdom	Fungi
Division	Ascomycota
Subdivision	Pezizomycotina
Class	Sordariomycetes
Order	Hypocreales
Family	Hypocreaceae
Genus	*Trichoderma*



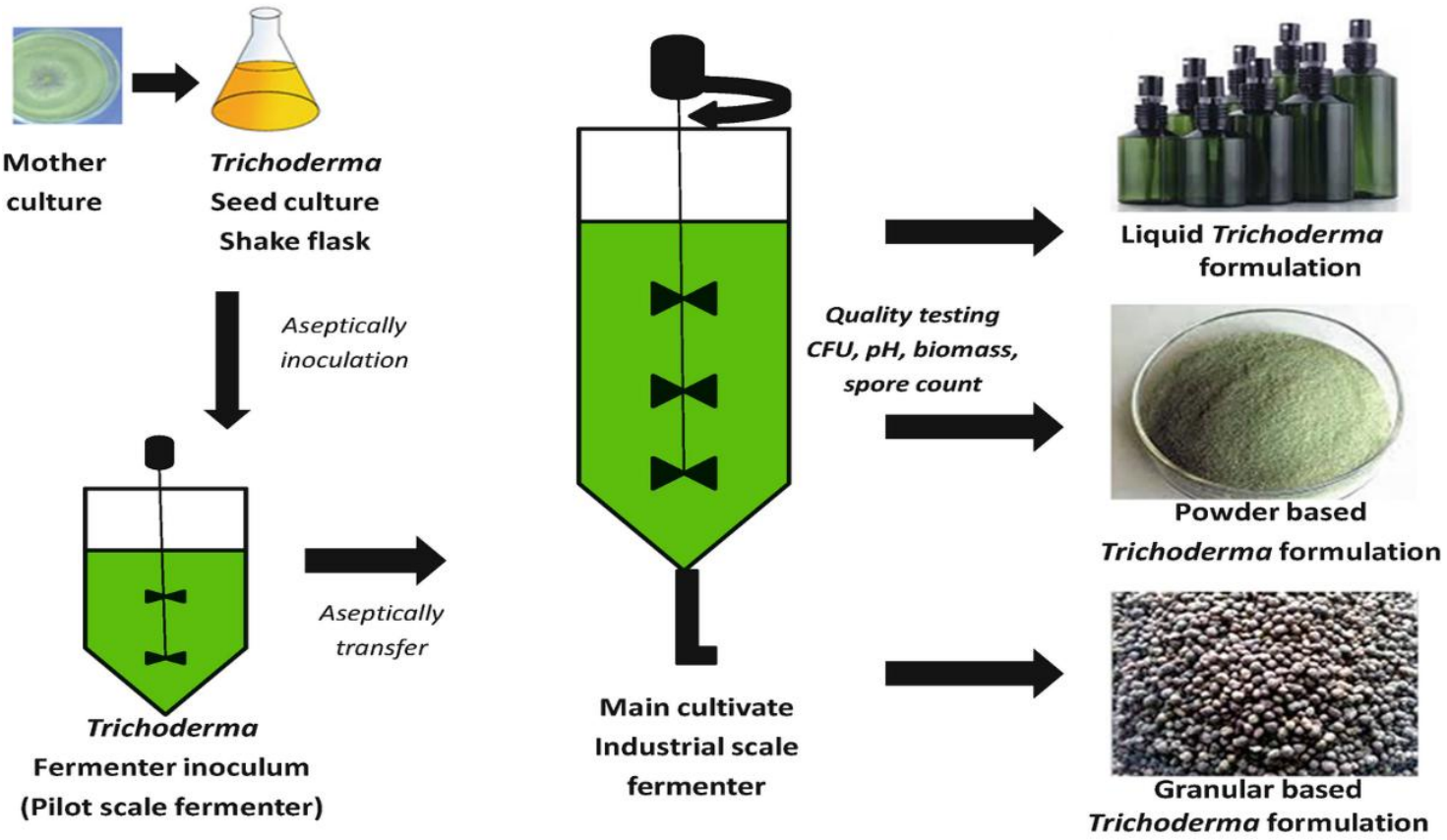
`Plants are capable of perceiving microorganisms by coordinating processes to establish different forms of plant–microbe relationships. Plant colonization is governed in fungal and bacterial systems by secreted

effector molecules, suppressing plant defense responses and modulating plant physiology to promote either virulence or compatibility. Proteins, secondary metabolites, and small RNAs have been described as effector molecules that use different mechanisms to establish the interaction. Fungi belonging to *Trichoderma* genus interact with plants by inducing their defense system and promoting plant growth. **Effectors of *Trichoderma*** may play a key role in the success of colonization of the plant, first by establishing the initial contact and subsequently maintaining the fungus–plant interaction.

Trichoderma can work as biocontrol agents in several ways:



- It may grow faster or use its food source more efficiently than the pathogen, thereby crowding out the pathogen and taking over, known as nutrient **competition.**
- A biocontrol agent may excrete a compound that slows down or completely inhibit the growth of pathogens in the surrounding area of such a compound called **antibiosis**.
- It may feed on or in a pathogenic species directly known as **parasitism**.
- It may promote a plant to produce a chemical that protects it from the pathogen, which is **induced resistance**.
- They can grow in an **endophytic** way in other species and supports plant growth.



Product development process of different formulation of *Trichoderma* sp. using submerged batch fermentation

Roles of Trichoderma spp.

- **Impacts on Plant Morphology:**Many studies show that applying Trichoderma spp. to the rhizosphere of plants improves plant morphological features as root-shoot length, biomass, height, number of leaves, tillers, branches, fruits and so on.
- **Impacts on Plant Physiology:** Photosynthesis, assimilation nutrient and absorption, gas exchange, water usage efficiency, stomatal conductance and other physiological processes in plants all have been shown to be positively regulated by Trichoderma spp.
- **Impacts on nutrient solubilization and absorption:** Trichoderma-treated plants roots showed increased ability to investigate the soil and enhanced mineral intake. Various strains of Trichoderma release acids such as coumaricand citric acids, which aid in the discharge of phosphorus ions which appear to be inaccessible to plants in most soils.

Advantages

- Enhances yield along with quality of produce
- Boost germination rate
- Increase in shoot & root length
- Solubilizing various insoluble forms of phosphates
- Augment nitrogen fixing
- Promote healthy growth in early stages of crop
- Increase dry matter production substantially
- Harmless to humans and livestock
- Act against a wide range of pathogenic fungi
- Perpetuate themselves by producing ample spores

- Grow rapidly and quickly colonize the soil
- They can promote nutrient uptake and enhance plant growth.

CONCLUSION

Trichoderma spp. possess many qualities and they have great potential use in agriculture such as amend abiotic stresses, improving physiological response to stresses, alleviating uptake of nutrients in plants, enhancing nitrogen-use efficiency in different crops, and assisting to improve photosynthetic efficiency. The genome of Trichoderma spp. contains many useful genes, along with the ability to produce a great variety of expression patterns, which allows these fungi to adapt to many different environments. These new formulations, which combine biocontrol with biofertilization, are considered to be more effective than older products and active on a wider range of pathogens.

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