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# Trichoderma: A Potent Biological Control Agent for Plant Disease Management

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Plant diseases caused by pathogens have resulted in a decreased crop yield, growth and development. Chemical pesticides are one of the many methods to prevent yield losses due to pathogens now-a-days. Chemical-based pesticides control plant diseases very effectively and suppress plant pathogens but these are not eco-friendly. It not only causes pathogen resistance, but it also pollutes water bodies, harming fish and other aquatic life, beneficial insects like honeybees, predator insects and other non-targeted organisms such as plant growth promoting rhizobacteria-fungus (PGPR & PGPF). The application of microbiological technologies to plant cultivation, which are based on microorganisms with bio stimulant qualities, is a crucial component of a sustainable agricultural strategy. Biocontrol, or Biological Control, can be defined as the use of natural organisms, or genetically modified, genes or gene products, to reduce the effects of undesirable organisms to favour organisms useful to human, such as crops, trees, animals and beneficial microorganisms.

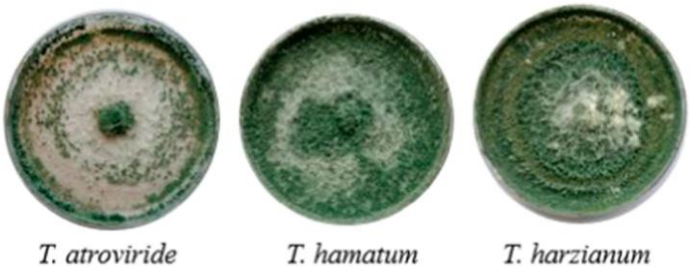
The use of Biological Control Agents (BCAs), which are based on living microbes or their metabolites, as well as natural materials, to control plant diseases is effective. The fungus *Trichoderma*, a low-cost biocontrol agent that can establish itself in different pathosystems, has moderate effects on soil balance and does not harm beneficial organisms that contribute towards pathogen's control.

**What is *Trichoderma* spp?**

*Trichoderma* spp. are the most widely utilized biocontrol agents for a variety of root, shoot and postharvest pathogens. *Trichoderma* are asexual, free-living fungi reproduced by chlamydospores, ascospores that interact extensively in root, soil and foliar habitats and can survive to all pH ranges of soil with optimum temperature of 25-35°C. *Trichoderma* is widely used because of its ability to form mycorrhiza like associations with plants. The species *T. harzianum*, *T. viride* and *T. hamatum*

**Modes of Action of *Trichoderma***

The various mode of action employed by *Trichoderma* are described below:



*T. atroviride* *T. hamatum* *T. harzianum*

**Mycoparasitism**

Mycoparasitism refers to an antagonistic interaction in which one fungus parasitizes the other fungi. *Trichoderma* species have a unique ability to parasitize other fungi which entails a direct attack of one fungal species (say *Trichoderma*) on another one. This involves a series of intricate sequential actions beginning with recognition of the fungal strain by *Trichoderma*, progressing to effective penetration into the host fungi, attack on cellular machinery and finally killing of the host. *Trichoderma* spp. produce various enzymes that breakdown polysaccharides, β-glucans, cellulose and chitin present in the cell walls of the plant pathogenic fungi allowing for cell penetration.

**Antibiosis**

The mechanism of action of Antibiosis is a biological interaction that primarily occurs between microorganisms in which one is negatively impacted. Low molecular weight diffusible antibiotics produced by *Trichoderma* that inhibit the growth of antagonistic fungi are involved in the antibiosis that takes place during contact. The method of antibiosis in the case of *Trichoderma* entails the creation of tiny, diffusible chemicals which prevent the growth of other microbes.

**Competition**

Competition for space and nutrients always arises when microorganism interacts and in areas where nutrients are scarce. It is one of the reasons for the death of many microorganisms. *Trichoderma* species are widely regarded as aggressive competitors because they rapidly grow alongside with the developing root system of the treated plant when added to the soil or administered as seed treatments.

**Induced resistance**

Treatment with *Trichoderma* species induces resistance in the host plant, which is another biological

control mechanism. Some *Trichoderma* strains colonize plant roots and penetrate the epidermis. There, they release chemical compounds that cause localized or systemic plant resistance responses.

**Mechanism for biological control by *Trichoderma* spp.**

Recognition and invasion towards plant pathogenic fungal-like species through cell wall disruption and absorption of released nutrients known as mycoparasitism

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Induce the resistance of plant towards diseases by root architecture alteration during the interaction with pathogens

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Attack the root-knot and cyst nematodes by destroying nematode eggs and second phase juvenile, also some segment of adult nematodes.

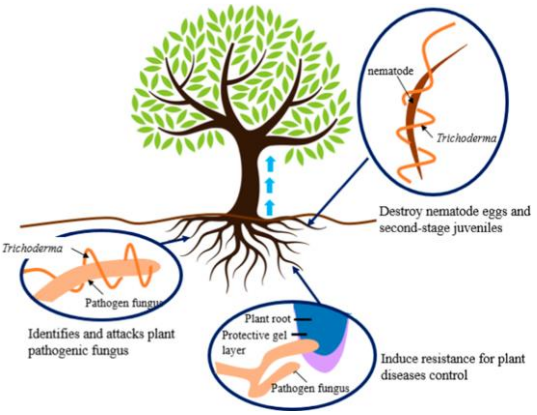


**Table 1: Few examples of *Trichoderma* spp. in Plant disease management**

| Disease | Crop | Causal agent | Biocontrol strain |
|---|---|---|---|
| Root rot disease | Eggplants | *Macrophomina phaseolina* | *T.harzianum* |
| Damping off | Pepper | *Phytophthora capsici* | *T.harzianum* |
| Fruit rot | Tomato | *Rhizoctonia solani* | *T. viride* |
| Brown spot | Tobacco | *Alternaria alternata* | *T.harzianum* |
| Sheath blight | Rice | *Rhizoctonia solani* | *T.harzianum* |
| Collar rot | Tomato | *Sclerotium rolfsii* | *T. virens T.harzianum* |
| Web blight | Beans | *Sclerotinia sclerotiorum* | *T. viride* |

**Conclusion**

The excessive use of pesticides in agriculture degrades soil quality causes pathogens to develop resistance against chemicals and endangers non-targeted organisms. As a result, it is an excellent moment to look into such agricultural practices or approaches to attain agricultural sustainability. In this regard, *Trichoderma* can be an appropriate bio-agent that contributes significantly to the goal of sustainable agriculture. *Trichoderma* is gradually becoming popular among progressive farmers as an alternative to chemical fertilizers and pesticides. Slow rate of multiplication and colonization, susceptibility to biotic and abiotic stressors, inadequate pathogen eradication and high cost are the key reasons for its low adoption among the farmers. To overcome these challenges alternative strains of *Trichoderma* should be identified that can multiply and colonize rapidly, least affected by environmental conditions and have a broad host range on pathogens. Dissemination of knowledge regarding advantages of *Trichoderma* and adverse effects of chemical fertilizers and pesticides should be done at the farmer's level. Furthermore, attention should be placed on practices such as organic farming and integrated pest management (IPM) for *Trichoderma*'s widespread acceptance.

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