# *Trichoderma: An Environment Friendly Bio-control Agent*

**Aditya Kumar Sharma[1]*, Shailendra Kumar Mishra[2], Ankit Kumar[3], Abhishek Kumar Yadav[4] and Akhileshwar Vishwakarma[1]**

[1]*Research scholar, Department of Ag. Entomology,*
*B.R.D. PG. College Deoria- 274001, Uttar Pradesh, India*
[2]*Subject Matter Specialist, Entomology/Nematology,*
*Krishi Vigyan Kendra, Kotwa Azamgarh I -276207, Uttar Pradesh, India*
[3]*Research scholar, Department of Ag. Entomology,*
*A.N.D.U.A & T, Kumarganj-224229, Ayodhya, Uttar Pradesh, India*
[4]*Research scholar, Department of Ag. Entomology,*
*C.S.A.U.A & T, Kanpur- 208002, Uttar Pradesh, India*

**Corresponding Author**
Aditya Kumar Sharma
E-mail: adisharmajmd098@gmail.com

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## ABSTRACT

*Trichoderma* is a genus of filamentous fungi widely recognized for its role as an effective and eco-friendly biocontrol agent in sustainable agriculture. Major species such as *Trichoderma harzianum*, *Trichoderma viride*, and *Trichoderma longibrachiatum* have been extensively studied and utilized for the management of various plant pathogens. The bio control potential of *Trichoderma* is attributed to multiple mechanisms including myco-parasitism, competition for nutrients space, produce of antifungal metabolites and induction of systemic resistance in plants. It produces enzymes such as **chitinases, glucanases**, and **proteases** that degrade the cell walls of pathogenic fungi. Additionally *Trichoderma* enhances plant growth by improving nutrient uptake producing plant growth-promoting substances and increasing tolerance to abiotic stresses. Unlike chemical pesticides *Trichoderma* based formulations are biodegradable, non-toxic, and safe for humans, animals, and beneficial organisms. Its application reduces environmental pollution and supports the development of Integrated

Pest Management (IPM) strategies. Due to its versatility sustainability and effectiveness *Trichoderma* has become an important component of modern agriculture aimed at reducing chemical inputs and promoting soil health.

## INTRODUCTION

Species of *Trichoderma* are one of the small groups of beneficial fungi which have proven commercially viable as a biological control agent. This micro-organism is now registered as bio-fungicide in India, France, UK, Switzerland, Sweden, Belgium, Chile, New Zealand and the USA, and regulations are pending in several other countries. *Trichoderma* is completely safe for humans and livestock. Although, it is commonly considered as a contaminant that may cause infections in presence of certain predisposing factors but in 55 years of research there has been no account of recorded adverse reaction. The predatory qualities of *Trichoderma* are a big part of the appeal of this fungus along with other associated benefits for commercial applications. The thought of biological control of plant pathogens by mycoparasite (hyperparasites) dates back to Weindling (1932). He discovered that *Trichoderma lignorum* would parasitize a number of soil borne fungi in culture and suggested controlling certain pathogenic fungi by augmenting soil with an abundance of this mycoparasite. Comprehensive reviews on the subject have been published in the past showing the production of chitinases to break down the mycelial cell walls of fungal plant pathogens as a major cause of bio control activity Barnett and Binder (1973).

### Description and Natural Habitats

*Trichoderma* is a filamentous fungus that is widely distributed in the soil, plant material, decaying vegetation, and wood. *Hypocrea spp*. are the teleomorph of some of the *Trichoderma* species. *Trichoderma* thrives in the leaf litter or mulch and it requires a minimum organic carbon level of 1% to ensure proliferation in cropping locations. This species is a mycoparasite or saprophyte which feeds on pathogenic fungi. There are large number of photo graphic evidences highlighting this phenomenon where *Trichoderma* are seen actively parasitizing several groups of plant pathogens.

### Species of *Trichoderma*

The genus *Trichoderma* has five major species utilized in bio control of plant diseases *viz*. *Trichoderma harzianum*, *Trichoderma koningii*, *Trichoderma longibrachiatum*, *Trichoderma pseudokoningii,* and *Trichoderma viride*. Morphological features of the conidia and phialides help in differentiation of these species from each other.

### Cultural Features

Colonies of *Trichoderma* grow rapidly and mature within 5 days at 25°C. Its colonies develop as wooly and compact mycelium on potato dextrose agar (PDA) medium. At the time of sporulation scattered blue-green or yellow-green patches are formed. These patches may form concentric rings. They are more readily visible on PDA in comparison to Sabouraud dextrose agar. The fungal growth is pale, tan, or yellowish in colour on the reverse side of cultures.

***Trichoderma***

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**Microscopic Features**

Septate, hyaline hyphae, conidiophores, phialides, and conidia are observed. Some of the species like *Trichoderma longibrachiatum* and *Trichoderma viride* also produce chlamydospores. Conidiophores are hyaline branched and occasionally display a pyramidal arrangement. Phialides are hyaline, flask shaped, and inflated at the base. They are attached to the conidiophores at right angles. The phialides may be solitary or arranged in clusters. Conidia (3 m in diameter) are one-celled and round or ellipsoidal in shape. They are smooth- or rough-walled and grouped in sticky heads at the tips of the phialides. These clusters frequently get disrupted during routine slide preparation procedure for microscopic examination. The colour of the conidia is mostly green.

**Screening of strains can be conducted in four ways:**

1. Selection of active strains in relation to plant pathogens.
2. Screening isolate/s which has high biotechnological indexes.
3. Analysis of pathogen properties for plant, useful insects, animals and peoples.
4. Search of low economic value substrates which are convenient for cultivation and saving of spores' activities.

For developing effective bio control agent to combat damping-off in nurseries, we investigated fungal strains in the genus Trichoderma that was isolated from soil and fruiting bodies of *Ganoderma lucidum* Bhansali *et al*., (2003).

**Pathogen Interaction**

Mycoparasitism is a complex process, which include several successive steps. The interaction of *Trichoderma* with its host is specific. *Trichoderma* spp. has been extensively studied as bio control agents. The first detectable interaction shows that the hyphae of the mycoparasite grow directly towards its host. This phenomenon appears a chemotropic growth of *Trichoderma* in response to some stimuli in the host's hyphae or toward a gradient of chemicals produces by the host. When the mycoparasite reaches the host, its hyphae often coil around it or are attached to it by forming hook like structures. In this respect, production of appressoria at the tips of short branches has been described for *Trichoderma hamatum* and *Trichoderma harzianum*. The possible role of agglutinins in the recognition process determining the fungal specificity has been recently examined. Indeed, recognition between *Trichoderma harzianum* and two of its major hosts *Rosellinia solani* and *Sclerotium rolfsii*, was controlled by two different lectins present on the host hyphae. *Rosellinia solani* carries a lectin that binds to galactose and fructose residues on the *Trichoderma* cell walls. This lectin agglutinates conidia of a mycoparasitic strain of *Trichoderma harzianum* but did not agglutinate the non-parasitic strains. This agglutinin may play a role in prey recognition by the predator Moreover, because it does not distinguish among biological variants of the pathogen it enables the *Trichoderma* species to attack different *Rosellinia solani* isolates. D-glucose mannose residues inhibited the activity of a second lectin isolated from *Sclerotium rolfsii* apparently present on the cell walls of *Trichoderma harzianum*.

Following these interactions the mycoparasite sometime penetrates into the host mycelium, apparently by partially degrading its cell wall. Microscopic observations led to the suggestion that *Trichoderma spp*. produce and secrete mycolytic enzymes responsible for the partial degradation of the host's cell wall. The complexion and diversity of the chitinolitic system of *Trichoderma harzianum* involves the complementary modes of action of six enzymes all of which might be required for maximum efficiency against a broad spectrum of chitin-containing plant pathogenic fungi. The level of hydrolytic enzymes produced differs from host-parasite interaction analyzed. This phenomenon correlates with the ability of each *Trichoderma* isolate to control a specific pathogen. It is considered that Mycoparasitism is one of the main mechanisms involved in the antagonism of *Trichoderma* as a bio control agent along with chemotropic growth, secretion of extra cellular enzymes and lyses of host. Thus, the bio control ability of *Trichoderma* is most likely conferred by a number of mechanisms. Efficacy of the culture filtrates of different species of *Trichoderma* against the powdery mildew (*Leveillula taurica*) of cluster bean has revealed that *Trichoderma viride* effectively managed powdery mildew, while *Trichoderma harzianum* recorded the highest yield with percent increase in yield over the control.

### Method of application

1. **Seed treatment:** Mix 6 - 10 g of Trichoderma powder per Kg of seed before sowing.
2. **Nursery treatment:** Apply 10 - 25 g of Trichoderma powder per 100 m2 of nursery bed. Application of neem cake and FYM before treatment increases the efficacy.
3. **Cutting and seedling root dip:** Mix 10g of Trichoderma powder along with 100g of well rotten FYM per litre of water and dip the cuttings and seedlings for 10 minutes before planting.
4. **Soil treatment:** Apply 5 Kg of Trichoderma powder per hectar after turning of sun hemp or dhaincha into the soil for green manuring. Or Mix 1kg of Trichoderma formulation in 100 kg of farmyard manure and cover it for 7 days with polythene.

### Diseases controlled by *Trichoderma*

| Method of Application | Crops | Different type of Disease |
|---|---|---|
| Foliar application | Rice | Sheath blight (***Rhizoctonia solani***)<br>Bacterial leaf blight (***Xanthomonas oryzae pv. Oryzae***)<br>Sheath rot ((***Sarocladium oryzae***) |
| Tuber treatment | Potato | Damping off (***Pythium debaryanum***)<br>Black surf (***Rhizoctonia solani***)<br>Charcoal rot (***Macrophomina phaseolina***) |
| Soil/Seedling treatment | Tomato | Damping off (***Pythium aphanidermatum***)<br>Stem rot (***Sclerotium rolfsii* and *Sclerotinia sclerotiorum***) |
| Soil treatment | Cauliflower/ Pea | Damping off (***Pythium aphanidermatum***) |
| Rhizomes treatment | Turmeric/ Ginger | Rhizomes rot (***Pythium aphanidermatum***) |
| Soil treatment | Soybean | Damping off (***Pythium aphanidermatum***) |
| Seed treatment | Brinjal | Collar rot (***Sclerotium rolfsii***) |
| Soil treatment | Onion | Root rot [(***Fusarium oxysporium f. sp. cepae*** (**FOC**)] |
| Rhizomes treatment | Banana | Panama wilt (***Fusarium oxysporum f. sp. cubense***) |
| Soil treatment | Tea | Collar rot (***Agroathelia rolfsii***)<br>Black root rot (***Rosellinia arcuata***) |
| Soil treatment | Cucumber | Wilt (***Erwinia tracheiphila***) |
| Soil/Seedling treatment | Black paper/ Chilli | Root rot (***Phytophthora capsici***) |
| Soil treatment | Betel vine | Root rot (***Sclerotium rolfsii***) |
| Soil treatment | Strawberry | Damping off (***Pythium irregulare***) |

## CONCLUSION

*Trichoderma* serves as a promising biological alternative to conventional fungicides

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contributing significantly to eco-friendly plant disease management and sustainable crop production.

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