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Trichoderma spp. A biocontrol agent and their role in agriculture: A review

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Abstract
In the world, the customary agricultural practices are influenced by different issues, for example, diseases, pests, dry spell, diminished soil richness; certain elective plant ailments control techniques and because of utilization of unsafe synthetic pesticides, contamination and a worldwide temperature alteration. There ought to be natural controls that can take care of these issues. Growths and microscopic organisms are the different sorts of natural control operators engaged with biocontrol action. Among them, growths allocated to variety *Trichoderma* assume a significant role in controlling the contagious plant diseases. The diverse *Trichoderma* spp. are known to create various sort of compounds which have a huge job in biocontrol action like cell divider debasement, hyphal development, and adversarial movement against plant pathogens. *Trichoderma* spp. is free-living cosmopolitan species communicating with roots, soil and foliar conditions. *Trichoderma* species are quickly developing, great contenders rivaling different microorganisms. Besides, they repress or debase pectinases and different compounds that are basic for plant-pathogenic organisms. The present audit is centered on the biocontrol capacity of the *Trichoderma* species.

Keywords: *Trichoderma*, biocontrol, phytopathogens

Introduction
Persoon was the main who depicted the class *Trichoderma* in the year 1794. Persoon announced three species, out of which, just one was acknowledged. Nonetheless, Persoon's grouping was dubious and conflicting (Rifai, 1969) [19]. Rifai (1969) [19] made the main genuine endeavor. He creates an attainable arrangement of the sort *Trichoderma*. The framework depended on species morphology just as on the idea of species totals. He characterized nine total types of *Trichoderma* utilizing his characterization framework. The most morphological investigations of *Trichoderma* dependent spp. on key morphological qualities completed by Bissett (1984, 1991) [3, 4]. In his investigations, he recognized four geneus of (*Trichoderma, Pachybasium, Longibrachiatum,* and *Hypocreanum*). Lieckfeldt *et al.*, (1998) [14] likewise referenced the utilization of atomic procedures for recognizing the species. They expressed that morphological attributes for recognizing *Trichoderma* species, is as a rule continuously supplanted by sub-atomic devices, which give a progressively solid type of species ID. Samuels (1996) [21] performed advance investigation of the variety *Trichoderma*. He created sub-atomic procedures based methods for order of the variety, which incredibly improved comprehension of the class particularly at species level. Druzhinina *et al*., (2005) [9] depicted the investigation of species inside the variety *Trichoderma* on by the utilization of sub-atomic apparatuses. They portrayed the advancement of an oligonucleotide standardized tag significant way to deal with the ID of *Hypocrea/Trichoderma* species known as Trich OKEY. The particular application programming is accessible at www.isth.info. Harman *et al*., (2004) [11] led an exploration about specie ID of *Trichoderma* on both morphological and atomic premise and they announced 75 recognized types of ***Trichoderma*.**

Morphology of *Trichoderma*
The morphology of *Trichoderma* was first time described by Rifai (1969) [19]. *Trichoderma* is a septate fungus and produces highly branched conidiophores with a conical or pyramidal outline. He further described that *Trichoderma* species form floccose or tufted colonies of

various colors (white, yellow, green), which can be used to identify and differentiate about various species of the genus. Gams and Bissett (1998) [10] conducted their research on morphology of *Trichoderma*. They described that *Trichoderma* species are characterized by rapid growth, mostly bright green conidia and a repetitively branched conidiophore structure. Species of the genus produce a broad array of pigments from bright greenish-yellow to reddish in color, although some are also colorless. Similarly, conidial pigmentation varies from colorless to various green shades and sometimes also gray or brown. Other than pigmentation, species identification within the genus is difficult because of the narrow range of variation of the simplified morphology in *Trichoderma.*

Different Role of *Trichoderma* spp. in Agriculture

***Trichoderma* as Plant Growth Enhancer**

Trichoderma strains are known to associate with plant roots and root ecosystems. They are also plant symbiont and opportunistic avirulent organisms, able to colonize plant roots by mechanisms similar to those of mycorrhizal fungi producing compounds that stimulate growth and plant defense mechanisms. This mechanism includes plant root colonization and rhizosphere modification.

The species having a place with the variety *Trichoderma* are avirulent plant symbionts. They can initiate confined or precise protection from ailments and their causative pathogens through the arrival of metabolites. They further portrayed that the instruments engaged with prompted plant obstruction are still inadequately comprehended and to adventure such utilizations of *Trichoderma*, more research is required (Harman *et al*., 2004) [11]. Ruocco *et al*., in 2007 [20] directed an examination about hydrophobins, a class of little cystein-rich proteins that are communicated uniquely by growths. They portrayed that one impact that numerous *Trichoderma* strains initiate is upgraded root improvement is the hydrophobin the essential activating atom for this response. They further depicted that a strain of *Trichoderma*, the T22 hydrophobin prompts opposition just as establishing. Marra *et al*., (2006) [15] referenced that various advantages of these *Trichoderma* species on plant development and obstruction are expected changes in the physiology of plants. *Trichoderma*, subsequent to building up relationship with plant, adjusts plant's physiology and presents such changes which improves development of plant and make it impervious to various illnesses and ailment causing pathogens.

***Trichoderma* as Biocontrol Agent**

Organic control of plant pathogens is an alluring suggestion to diminish overwhelming reliance of current farming on expensive concoction fungicides, which cause ecological contamination as well as lead to the improvement of safe strains. Distinctive organic control operators (BCAs) can be utilized for the control of sicknesses. These incorporate microscopic organisms, parasites and actinomycetes. The most significant BCAs have a place with the class *Trichoderma.*

When contamination happens, a zone of compound collaboration creates at the destinations where *Trichoderma* hyphae connect with host's hyphae. Inside this zone of synthetic association, the *Trichoderma* hyphae are walled off by the plant yet are not slaughtered (Harman & Shoresh 2007) [12]. Dix and Webster (1995) [8] characterized mycoparasitism as the immediate assault of one parasite on another and can be commonly depicted as immediate opposition. Chet *et al.*, (1981) [7]. Papavizas (1985) [18] depicted that *Trichoderma* hyphae distinguishes and perceive the cell surface of the pathogen. At that point *Trichoderma* hyphae encompass its host and essentially develop along the host's hyphae. *Trichoderma* species emit of explicit lytic catalysts which debase the host cell divider. They further expressed that the principle lytic chemicals engaged with the corruption of the host cell divider are β-glucanase, chitinase and proteinases (Chet *et al.,* 1998) [6]. Bailey *et al*., in 2006 [1] announced a few strains are endophytes, i.e., they colonize roots, yet in addition the over the ground portions of plants. These are being examined for control of tropical tree infections, for example, those influencing cacao. They further referenced that endophytes give another viewpoint to biocontrol frameworks utilizing *Trichoderma* species with extra chances, yet it isn't known right now whether endophytic and root-colonizing capacities are the equivalent or separate wonders. Protection systems of *Trichoderma* involve both enzymatic and compound weapons, which make *Trichoderma* species productive mycoparasites, rivals, and biocontrol operators, having attributes that can be misused by utilizing *Trichoderma* or the metabolites emitted by these growths as organic fungicides to battle plant infections brought about by pathogenic parasites (Vinale *et al.,* 2009) [23]. Benitez *et al.,* (2004) [2] referenced *Trichoderma* species utilized with the end goal of natural control. As per them, after distribution of *Trichoderma lignorum* (later saw as *T. atroviride*) going about as a parasite on other organisms in 1932 by Weindling, bunches of work was done to recognize and portray naturally effective strains and types of *Trichoderma.* These days, the most significant species in this field are *T. atroviride* (in prior reports here and there misidentified as *T. harzianum*), *T. harzianum, T. virens,* and *Trichoderma asperellum*. The family *Trichoderma* includes an extraordinary number of fungal strains that go about as natural control specialist, the opposing properties of which depend on the initiation of various components (Benitez *et al*. 2004) [2]. *Trichoderma* species act like gatekeepers for their host. The reaction of *Trichoderma* to its host includes pressure reaction, reaction to nitrogen deficiency, cross pathway control, lipid digestion, and flagging procedures. Thus, *Trichoderma* satisfy every one of the requirements of its host, assuming an imperative job in its development and insurance from pathogenic trespassers (Seidl *et al.,* 2009) [22].

Use of *Trichoderma* in Industry

Kumar *et al.,* (2008) [13] led an examination about the utilization of *T. reesei* as biofuel. As indicated by them as a powerful cellulase maker, explore with *T. reesei* is these days especially centered around progress of productivity of the chemical created so as to diminish by and large expenses of generation of bioethanol from cellulosic squander material. Nevalainen *et al.,* (2005) depicted that modern utilization of filamentous parasites as a maker of heterologous proteins began over 20 years prior. These days, *T. reesei* is one of the most regularly utilized filamentous growths for heterologous protein generation. *Trichoderma* species are widely known for their safe mechanical scale protein generation for a more drawn out timeframe, *Trichoderma* spp. have likewise been effectively applied for generation of nourishment added substances and related nourishment items, having high wholesome quality and nearly less cost (Nevalainen *et al.*, 1994; Blumenthal 2004) [16, 5]. Oda *et al.,* in 2009 [17] referenced that proteins as well as metabolites of *Trichoderma* species are utilized as added substances. One of the items segregated from *T. viride* is a substance with trademark coconut-like fragrance, a 6pentyl-α-pyrone with anti-toxin properties, the creation of which was continually improved to arrive at convergences of in excess of 7 g/L in extractive maturation societies in *T. atroviride* these days. *Wiater et al.,* (2005) [24] presented another point of view in regards to the utilization of *T. harzianum* in industry. They depicted that *T. harzianum* mutanase can be utilized in toothpaste to avert aggregation of mutan in dental plaque

Advantages of *Trichoderma*

1. *Trichoderma* spp. are very useful for fabric detergent, animal feed production, fuel production, alternative to conventional bleaching, effluent treatment, degradation of organochlorine pesticides and biocontrol of crop diseases.
2. It is a potential bioagent for the management of fungal seed and soil borne pathogens. It is well known for its antagonistic activity against soil borne pathogens, such as *Fusarium, Pythium*, and *Rhizoctonia*.
3. It is also known to suppress plant parasitic nematodes.
4. It does not lead to development of resistance in plant pathogens, no phytotoxic effects, do not create any pollution problems as it is eco-friendly, promote plant growth, induces resistance in host, solubilize phosphorus and micronutrients and hence increase soil fertility.
5. It significantly minimizes losses due to crop diseases and reduces cost of production, increases yield, quality and profit.
6. Many *Trichoderma* spp. are of great economic importance producing hydrolytic enzymes, namely, cellulases, chitinases and xylanases, biochemicals and antibiotic products which have been applied to fields, such as food processing and pulp bleaching. In addition, some species produce heterologous proteins and others have been successfully used as biological control agents against a range of phytopathogens.

Disadvantages of *Trichoderma*

There are many advantages associated with the use of *Trichoderma*. However, in addition to their useful properties, there are some disadvantages associated with the use of *Trichoderma*.

1. Some species of *Trichoderma* pose a threat to the horticultural industry. For example, reduction in mushroom yield by as much as 50% has been attributed to *Trichoderma* infection and hence it is considered as a harmful parasite of mushroom.
2. It also affects the organ (liver) transplanted in human.
3. The disease is the major constraint in economical production as it inflicts heavy crop losses.

Conclusion and Future Research

Chemical based control is very effective, but there are some disadvantages associated with the use of these chemicals. The most dangerous thing with the use of these chemicals is the toxicity which they impart to the soil. That is why today people avoid the use of chemical based fungicide. Biosynthetic design of fungicide has presented a new era in the development of fungicide. The genes present in the fungi *Trichoderma* have the ability to enhance host plant's resistance against phytopathogenic fungi.

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