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Good Fungi, Big Gains: *Trichoderma* for Healthy Farm

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After independence, the Green Revolution led by N.E. Borlaug and M.S. Swaminathan helped India become self-sufficient in agriculture by using high-yield seeds, fertilizers, and synthetic chemicals. But overusing these chemicals has caused serious problems like soil damage, stronger plant diseases, and the loss of helpful soil microbes. To address these issues and move toward sustainable farming, using beneficial living organisms has become an important option. This article looks at *Trichoderma*, a naturally occurring and highly effective fungus, as a key part of this change. We discuss where it comes from, how it fights plant diseases (including mycoparasitism and antibiosis), and how it can be used on farms. By adding *Trichoderma* to farming, soil health improves, plants absorb more minerals, and crop yields stay high—without the environmental harm caused by synthetic chemicals.

Keywords: Bio-control agents, Fertilizers, Fungicides, Sustainable, *Trichoderma*.

The only thing which comes first to mind when thinking about word “fungus” is root rot, blights, wilts and mildews. But the world is vaster and more expanded above our expectations you can't imagine and we don't think about those microscopic superheroes residing beneath the soil surface, hunting those pathogens and helping your crops to thrive. *Trichoderma* – it is one of those beneficial microscopic organisms which is naturally occurring, highly aggressive “Good Fungus” acting as a safeguard and tonic for your plants.

The use of Synthetic chemicals for disease management and soil fertility has had a negative impact on their long-term use. That's why the farming world is shifting towards sustainable, chemical-free solutions. *Trichoderma* has emerged as a keystone for farms. By surrounding the roots of crops, they fight pathogens, also making roots grow faster and healthier, and improving nutrient uptake. To achieve good yields and healthier soil, putting this superhero to work would be a smart move for your farm.

What is *Trichoderma* ?

Trichoderma is a genus of beneficial fungus found in almost all types of soils and environmental conditions. It can colonize plant roots and fight soil-borne pathogens. Sometimes, it also combats foliar pathogens (pathogens that affect leaves) by releasing special hydrolytic enzymes such as cellulases (enzymes that break down cellulose), chitinases (enzymes that break down chitin), and proteases (enzymes that break down proteins). These enzymes affect pathogen virulence, enabling the plant to thrive. The efficacy of *Trichoderma* was first identified as an agricultural tool in the 1930s. This discovery formed the basis for the production of modern biopesticides. Today, about 50% of commercial biopesticides are based on *Trichoderma*. Several *Trichoderma* species are now recognized and used as beneficial bio-control agents in commercial production. These include *T. harzianum*, *T. viride*, *T. asperellum*, *T. hamatum*, *T. asperelloides*, and *T. gamsii*.

How it works

Mycoparasitism - It is the main mode of action for *Trichoderma*, where it coils around the disease-causing fungus (e.g., *Fusarium* wilt in pulses and vegetables), secreting enzymes that help in dissolving the cell wall contents of the pathogen and consuming them.

Antibiosis - After establishing in soil and rhizosphere (soil area around plant roots), *Trichoderma* releases certain antibiotics or chemicals that inhibit the growth of pathogens and their establishment (e.g., *Fusarium*, *Rhizoctonia*, *Pythium*, etc.) before their approach to the root zone, thus acting as a natural weapon.

Competition - The growth of *Trichoderma* is much greater than that of pathogens, which provides it an advantage over pathogens in occupying the space and essential nutrients in soil, leaving nothing for disease-causing fungi to survive.

Boosting plant immunity - The activity of *Trichoderma* in soil makes the plant more alert about the pathogen attack, which initiates the working of the plant's natural defence mechanism, allowing the production of enzymes and toxins and building up immunity for future attacks and stress.

Boosting nutrient uptake and yields

Apart from controlling diseases, *Trichoderma* contributes to improved uptake of valuable nutrients from soil to aid plant growth and yield. It has been found in various studies and by researches that solubilization of complex minerals is carried out by these biocontrol agents through secretion of some enzymes and organic acids (e.g., phytase) which helps in breaking down of complex insoluble to mobile nutrients like zinc, manganese, phosphorous easily absorbable. This process is also supported by root development by *Trichoderma* as they colonize the rhizosphere and make the availability of more organic matter, which leads to growth in the population of more beneficial microorganisms. The physical and chemical properties of soil are significantly influenced by microbial activity as they break down plant debris and other dead matter into complex organic substances that form stable aggregates in soil. Through its activity in these areas of making availability of nutrients and organic matter to plants, it is sometimes also referred to as a "biofertilizer."

Just as it unlocks phosphorus and zinc, *Trichoderma* also ensures crops have access to iron-a vital element plants need to form chlorophyll. In soils where iron is scarce, the fungus releases siderophores (small, specialized molecules that act like microscopic magnets) to attract and bind trace amounts of available iron. This mechanism serves a brilliant dual purpose: it directly feeds the plant, resulting in greener, healthier foliage, while simultaneously starving soil-borne pathogens. Because disease-causing fungi also desperately need iron to function and infect crops, *Trichoderma's* ability to hoard this element stops pathogens in their tracks.

Application of *Trichoderma* on the Farm

Now that we know how *Trichoderma* works, how do we actually get it into the field? Farmers can easily introduce this beneficial fungus using these practical, low-cost methods:

- 1. Seed Treatment:** Instead of relying on chemical coatings to prevent early diseases like damping-off, seedling blight, and root rot, you can coat your seeds with *Trichoderma* before sowing. Simply mix 5 to 10 grams of powder per kilogram of seed. This creates a protective armor around the seed, ensuring it grows safely during those vulnerable early stages.

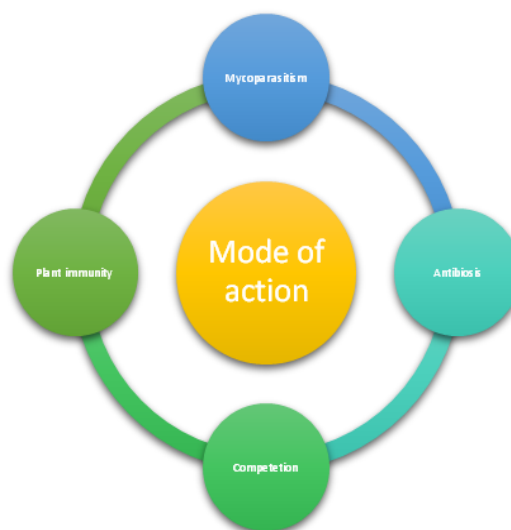


Fig. Mode of action of *Trichoderma*

2. **Nursery / Root Dip:** Vegetable seedlings are highly sensitive to soil pathogens when transplanted. To protect them, dip the bare roots of the seedlings into a liquid *Trichoderma* solution right before planting in the main field. This coats the roots in a defensive layer, helping the plant establish quickly and develop a strong root system.
3. **Soil Enrichment:** Instead of relying entirely on chemical fertilizers like Urea, DAP, or MOP, you can supercharge your soil by combining bio-controls with your compost. Mix 1 to 2 kg per acre of *Trichoderma* (in powder or liquid form) into your compost or farmyard manure. Let it rest for a few days so the fungus can multiply, and then broadcast it across your field before sowing.
4. **Foliar Spray:** *Trichoderma* isn't just for the dirt! You can mix a liquid formulation and spray it directly onto the leaves of the crop. The fungus forms an invisible, living shield on the plant surface, blocking airborne fungal diseases from entering the leaves and stems.



Fig. Application on farm

Benefits for crops and soil

The routine use of heavy agricultural chemicals has eventually led to dead, sterile dirt by killing off the soil's natural microbiome. However, this state can be reversed, by adding beneficial fungi back into the ground, you can rejuvenate the soil microbiome and keep your land fertile for generations to come. As discussed earlier, these biological agents unlock trapped phosphorus, zinc, and other essential nutrients in the soil, making them readily available to your crops. Over time, the regular use of biocontrol's reduces your dependence on expensive synthetic fertilizers, making sustainable farming much easier on your pocket. Furthermore, plants with a strong, well-developed root system are proven to be more consistent in delivering high yields. Crops treated with *Trichoderma* show exactly these results in field studies. The fungus stimulates the growth of deeper roots, which helps the plant reach hidden water sources and take up more nutrients. This builds a robust immune system, allowing the crop to easily manage both biotic and abiotic stresses, showing remarkable resistance to high temperatures, drought, and high soil salinity. Last but not least, *Trichoderma* acts as a powerful underground shield against almost all major soil-borne diseases. It actively hunts down pathogens like *Fusarium*, *Pythium*, *Phytophthora*, and *Rhizoctonia*, eliminating them before they can even establish themselves in the soil. By stopping these threats early, it successfully prevents devastating crop diseases like root rot, wilt, and damping-off.

Conclusion

A good yield not only comes from quality seeds or through fertilizers you use but also from what is cooking beneath in soil. A healthy soil reflects its productivity and fertility through the activity of the microbiome. *Trichoderma* is like accomplishing two goals with a single action. The first goal is killing the bad fungus before they get into action and harm the crop, and the second is acting as a natural growth booster by acquiring nutrients and root development. The need for expensive machinery for the application of biocontrol is of no use, as they can be easily applied through seed coating, broadcasting, root dip, etc., before sowing and planting. Carrying forward this good practice makes less burden on your pocket as need of chemicals is reduced overtime and makes your soil softer, healthier and richer leading the crop to survive harsh conditions and generating a good yield. Use of such biocontrol is not only about greener rather eco-friendly. It's a proven smart farming practice protecting crops, healing your land, and at last putting a healthy harvest in your hand.

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