Popular Article

Popular Kheti

Volume -2, Issue-3 (July-September), 2014

Available online at www.popularkheti.info

ISSN: 2321-0001

Biological Disease Management through Trichoderma

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The use of biological agents is becoming an increasingly important alternative to chemical control against insects, weeds and diseases in agriculture. The success of this method depends on the nature antagonistic characters and the mechanisms of action of microorganism. Fungi are the most important biological agents against plant pathogens. Trichoderma species are common filamentous imperfect fungi. The mycoparasite ability of Trichoderma species against some economically important plant pathogens allows for the development of biocontrol strategies.

Introduction

Biocontrol or Biological control can be defined as the use of natural organisms or genetically modified, genes or gene products the effects of undesirable organisms to favor organisms useful to human, such as crop, trees, animals and beneficial microorganisms. This strategy of control is ecologically clean and compatible with different models of agriculture organic biological and pathogen management. Biocontrol agents are widely regarded by the general public as natural and therefore non-threatening products, although risk assessments must clearly be carried out on their effects on non-target organisms and plants. Moreover, knowledge concerning the behavior of such antagonists is essential for their effective use. One of the most interesting aspects of the science of biological control is the study of the mechanisms employed by biocontrol agents to effect disease control. Bacteria and fungi are the most important biological agents against plant pathogens. Particular bacterial strains in certain natural environments prevent infectious diseases of plant root. How these bacteria achieve this protection from pathogenic fungi has been analyzed in detail in biocontrol strains of fluorescent Pseudomonads. During root colonization these bacteria produce antifungal antibiotics, elicit induced systemic resistance in the host plant or interfere specifically with fungal pathogenicity factors.

Trichoderma in Disease Management

Trichoderma spp., are free-living fungi that are common in soil and root ecosystems. They are highly interactive in root, soil and foliar environments. They produce or release a variety of compounds that induce localized or systemic resistance responses in plants. Trichoderma strains have long been recognized as biological agents, for the control of plant disease and for their ability to increase root growth and development, crop productivity, resistance to abiotic stresses, and uptake and use of nutrients. Trichoderma lacks in chlorophyll and hence possess

heterotrophic mode of nutrition requiring performed organic matter and hence it is the main competitor for organic nutrients inthe rhizosphere of crop plants. It has ability to adopt extreme soil conditions viz. Soil temperature, moisture and fungicidal load added in the soil and that is why, it is gaining importance in the field of biological control of plant diseases.

Description of the Fungus

Fungal species belonging to the genus *Trichoderma* are worldwide in occurrence and easily isolated from soil, decaying wood, and other forms of plant organic matter. They are classified as imperfect fungi, in that they have no known sexual stage. Rapid growth rate in culture and the production of numerous spores (conidia) that are varying shades of green characterize fungi in this genus. The reverse side of colonies is often uncolored, buff, yellow, amber, or yellow-green, and many species produce prodigious quantities of thick walled spores (chlamydospores) in submerged mycelium. *Trichoderma* species are fungi with teleomorphs belonging to the Hypocreales order of the Ascomycota division. These fungi colonize woody and herbaceous plant materials, in which the sexual telemorph (genus *Hypocrea*) has most often been found. However, many strains, including most biocontrol strains, have no known sexual stage. In nature, the asexual forms of the fungi persist as clonal, often heterokaryotic, individuals and populations that probably evolve independently in the asexual stage. Trichoderma has conidiophores erect, highly ramified, more or less conical, verticullate bearing flask shaped phialides, singly or ellipters.Conidiophors bear subglobose or ellipsoid, slimy, nonseptate phialospores. These phialospores are often gathering in balls at opening of phialids. Trichoderma has become a model biocontrol afent in the management of plant disease because of the following characters

- It is easy to isolate and culture.
- It is ubiquitious.
- It grows rapidly on many substrates.
- It is non-pathogenic to higher plants

Benefits of Trichoderma

1. **Disease Control:** Trichoderma is a potent biocontrol agent and used extensively for post-harvest disease control. It has been used successfully against various pathogenic fungi belonging to various genera, viz. Fusarium, Phytopthara, Scelerotina
2. **Plant Growth Promoter:** Trichoderma strains solubilize phosphates and micronutrients. The application of Trichoderma strains with plants such as grasses increases the number of deep roots, thereby increasing the plant's ability to resist drought.
3. **Biochemical Elicitors of Disease Resistance:** Trichoderma strains are known to induce resistance in plants. Three classes of compounds that are produced by Trichoderma and induce resistance in plants are now known. These compounds induce ethylene production, hypersensitive responses and other defence related reactions in plant cultivates.
4. **Transgenic Plants:** Introduction of endochitinase gene from Trichoderma into plants such as tobacco and potato plants have increased their resistance to fungal growth. Selected transgenic lines are highly tolerant to foliar pathogens such as Alternaria alternata, A. solani, and Botrytis cirerea as well as to the soil-borne pathogen, Rhizectonia spp.
5. **Bioremediation:** Trichoderma strains play an important role in the bioremediation of soil that are contaminated with pesticides and herbicides. They have the ability to degrade a wide range of insecticides: organochlorines, organophosphates and carbonates. Trichoderma species can be identified based on the morphology and colour of the colonies obtained on the potato dextrose agar medium. Further identification can be confirmed on the basis of the morphology of the conidia and conidiophores of different Trichoderma species when viewed under a microscope.

Disease Control

Trichoderma spp. are very widely used to control various crop diseases effectively and some of them are given below.

Name of the Crop	Name of the Disease	Disease causing micro-organism
Clusterbean	Dry root rot	Macrophomina phaseolina
Banana, Cotton,	Wilt	Fusarium
Mungbean	Root rot, wilt	Macrophomina, Fusarium
Ginger, Turmeric,	Rhizome rot	Pythium
Brinjal	Root rot, wilt	Phytopthara, Fusarium
Chilli, Tomato,	Damping off	Pythium

Method of Application

Seed treatment*:* Mix 10g of Trichoderma formulation per litre of cow dung slurry for treatment of 1kg of seed before sowing, particularly for cereals, pulses and oilseeds.

Nursery treatment*:* Drench nursery beds with@ 5 Trichoderma formulation per litre of water before sowing.

Cutting and seedling root dip*:* Mix 10g of *Trichoderma* formulation per litre of water and dip the cuttings and seedlings for 10 minutes before planting.

Soil treatment*:* Mix 1kg of *Trichoderma* formulation in 100 kg of farmyard manure and cover it for 7 days with polythene. Turn the mixture in every 3-4 days interval and then broadcast in the field.

Trichoderma formulations*:* Important commercial formulations are available in the name of Sanjibani, Guard, Niprot and Bioderma. These formulations contain $3x10^6$ cfu per 1 g of carrier material.

Bio-control mechanisms of *Trichoderma*

Antagonist *Trichoderma*, reduce growth, survival, infections caused by pathogens by different mechanisms like competition, antibiosis, mycoparsitism, hyphal interactions, and enzyme secretion.

Competition*:* It is the phenomenon in which the pathogen and the introduced biocontrol agent (antagonist) compete for the availability of space and nutrients. During this process, the antagonist may suppress the growth of the pathogen population in the rhizosphere and thus reduce disease development. For example, Trichoderma harzianum reduces collar rot in elephant foot yam by 80-85%.

Antibiosis*: Trichoderma* strains are known to produce antibiotics and toxins, which are volatile or nonvolatile in nature, and have a direct effect on other organisms. Examples of such chemicals are trichothecin and a sesquiterpine, Trichodermin that has antimicrobial effect on bacteria and fungi.

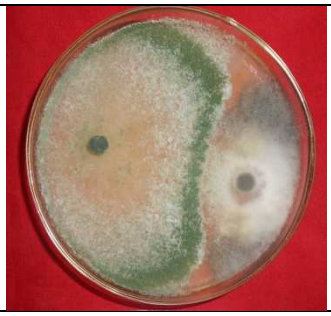
Mycoparasitism: It is the phenomenon in which the antagonist fungi parasitize other fungi. The mechanism covers different stages of interactions.

First stage: Chemical stimulus of pathogenic fungi attracts the antagonist fungi and induces a chemotropic response of the antagonist.

Second stage: Recognition between the pathogen and the antagonist is due to the lectins.

Third stage: It is followed by the interactions between hyphae of the pathogen and the antagonist. The antagonist (Trichoderma) hyphae either grow along the host hyphae or coil around it and secrete different lytic enzymes such as chitinase, glucanase and pectinase that are involved in the process of mycoparasitism. Examples of such interactions are T.

harzianum acting against Fusarium oxyporum, F. roseum, F. solani, Phytophthara colocaciae and Sclerotium rolfsii.

		
Trichoderma	Biocontrol mechanisms of *Trichoderma*	*Macrophomina*

Conclusion

Biological control is one of the best alternatives against some plant pathogens. The limitations to biocontrol use are scarce knowledge on the ecology of rhizosphere and use of in vitro antagonism for selection of biological control agents. But, the advantages of this method are more. *Thichoderma* spp. that are common saprophytic fungi found in almost soil and micro flora, have been investigated as potential biocontrol agents because of their ability to reduce the incidence of disease caused by plant pathogenic fungi.