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Trichoderma: a particular weapon for biological control of phytopathogens

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Plant diseases have been concerned with mankind since agriculture began and played a crucial role in the destruction of natural resources and contributing 13 to 20 per cent losses in crop production worldwide (Anon., 1993). In particular, soil-borne pathogens cause important losses, fungi being the most aggressive. The distribution of several phytopathogenic fungi, such as *Pythium*, *Phytophthora*, *Botrytis*, *Rhizoctonia* and *Fusarium* have widely spreaded during the last few years due to change the introduced in farming with detrimental effects on crops of economic importance. In addition, not only growing crops but also stored fruits prey to fungal infection (Chet *et al*., 1997). Chemical control of plant diseases can be impressive but this is comparatively a short term measure and additionally, the accumulation of harmful chemical residues sometimes causes serious ecological problems. In recent years, the increasing use of potentially hazardous chemicals in agriculture has been resulted in growing concern of both environment and public health properties. Moreover use of such chemicals entails a substantial cost to the nation and developing country like India can not afford it. By contrast, biological control is risk-free when it results in enhancement of resident antagonists. Moreover, an integrated approach promotes a degree of disease suppression similar to that achieved with full fungicidal treatment. For about 70 years, *Trichoderma* spp. have been known to attack other fungi, to produce antibiotics that affect other microbes and to act as biocontrol microbes (Weindling, 1934). Antagonists of phytopathogenic fungi have been used to control plant diseases and 90 per cent of such applications have been carried out with different strains of *Trichoderma* (Monte, 2001). The success of *Trichoderma* as biocontrol agents (BCAs) is due to their high reproductive capacity, ability to survive under very unfavorable conditions, efficiency in the utilization of nutrients, capacity to modify the rhizosphere, strong aggressiveness against phytopathogenic fungi and efficiency in promoting plant growth and defense mechanisms. These properties have made *Trichoderma* a ubiquitous genus present in any habitat and at high population density (Misra and Prasad, 2003).

The genus *Trichoderma*

The etymology of *Trichoderma* is taken from thrix (hair and derma) skin. *Trichoderma* is free living, asexually reproducing and filamentous fungi. It is an exceptionally good model of biocontrol agent as it is widely spread, easy to

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isolate and culture, multiply rapidly on many substrates, act as mycoparasite, strong opportunistic invaders, avirulant plant symbionts, competes for food and site, prolific producers of spores and powerful antibiotics, antifungal compounds, secondary metabolites and enzymes. These properties make these fungi ecologically very successful and are the reasons for their ubiquitousness (Kubicek *et al*., 2002).

Occurrence of *Trichoderma*

Trichoderma is presented nearly in all types of temperate and tropical soils, commonly found in variety of soil types such as agriculture, forest, prairie, salt marsh and desert soils in all climatic zones. Besides this, it is also found colonizing roots, litter, decaying/decorticated wood, decaying bark and various plant materials at all climatic zones/latitudes. For example, *Trichoderma* constituted up to 3 per cent of the total fungal propagules in a wide range of forest soils and 1.5 per cent in pasture soils in a wide range of crops (Brewer *et al*., 1971; Danielson and Davey, 1973; Domsch *et al*., 1980).

Discovery of *Trichoderma*

The genus *Trichoderma* was first proposed as a genus over two hundred years ago by Persoon (1794) in Germany. He showed microscopically similar fungi described as appearing like mealy powder enclosed by a hairy covering. The four species were proposed by Persoon i.e. *T. viride, T. nigroscens, T. aureum* and *T. roseum*. However, the *Trichoderma* is presently considered as *Trichoderma* Pers. Ex. Fr. In India, it was first time isolated by Thakur and Norris during the year 1928 from Madras. The potential value of the genus *Trichoderma* as bioagents was first reported by Weindling in 1932.

Taxonomical position of *Trichoderma*

Kulkarni and Sagar (2007) mentioned the taxonomic position of *Trichoderma* as asexual stage and *Hypocrea* as sexual stage.

Position	Asexual stage (Conidia)	Sexual stage (Ascospore)
Kingdom	Fungi	Fungi
Phylum	Ascomycota	Ascomycota
Sub-Division	Deuteromycotina	Ascomycotina
Class	Hyphomyctes	Pyrenomycetes
Order	Monilliales	Sphariales
Family	Monilliaceae	Hypocreaceae
Genus	*Trichoderma*	*Hypocrea*

Species of *Trichoderma*

There are high level of diversity among the species of *Trichoderma*. Totally, 104 species of *Trichoderma* have been recorded internationally (*www.isth.info.in*) and 13 species from India which were isolated from various substrates and locations.

Biological control of phytopathogens by *Trichoderma* species

There have been numerous reported on the ability of *Trichoderma* species to antagonize a wide range of commercially important plant pathogens combined with their ability to reduce the incidence of diseases caused by these pathogens in a wide range of crops. Research in the field of biological control is now focused on understanding how disease control is achieved. For instance, research is being directed towards understanding the mode of action of *Trichoderma*. The antagonistic nature of *Trichoderma* was demonstrated more than seven decades ago (Weindling, 1934). Although, the mechanisms by which disease control is achieved by *Trichoderma* species are not clear. Scientists undoubtedly involve one or more of the following; mycoparasitism and hyphal lysis, antibiosis, competition for nutrients and space and promotion of plant growth (Cook and Baker, 1983).

Advantages of *Trichoderma*

In general, *Trichoderma* species 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. It is a potential bioagent for the management of fungal seed and soil borne pathogens. It is also known to suppress plant parasitic nematodes. It does not lead to development of resistance in plant pathogens, no phytotoxic effects, do not creat any pollution problems as it is eco-friendly, promote plant growth, induces resistance in host, solubilize phosphorus and micronutrients and hence increase soil fertility. It significantly minimizes losses due to crop diseases and reduces cost of production, increases yield, quality and profit. Many *Trichoderma* species are of great economic importance producing hydrolytic enzymes *viz*., 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 (Wilson, 1996).

Disadvantages of *Trichoderma*

However in addition to their usefulness, some species of *Trichoderma* pose a threat to the horticultural industry. For example, reduction in mushroom yield by as much as 50 per cent have been attributed to *Trichoderma* infection and hence it is considered as a harmful parasite of mushroom (Fletcher, 1990). It also affects on the organ (liver) transplanted in human (Samuels, 1996). The disease is the major constraint in economical production as it inflicts heavy crop losses. The drawbacks of chemicals are well known in scientific and farming community. Hence, the farmers have started for eco-friendly plant disease management (EPDM) or biological based Integrated Disease Management (BIDM). *Trichoderma* proved worldwide accepted technology for the biological control of plant diseases particularly for seed and soil borne diseases.

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