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Trichoderma Spp. FOR MANAGEMENT OF *Sclerotium rolfsii*

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Abstract:

Sclerotium rolfsii Sacc, the most destructive phytopathogen of many plants belonging to different families. The Sclerotium resting structures can survive for long period in critical atmospheric conditions. Chemical control of pathogen of Stem Rot disease can provide certain degree of control but it also has side-effects on beneficial soil micro-organisms, human health and environment. The use of fungal biological control agents is a promising strategy developing in recent years. Specifically, Trichoderma is commonly used as the biological control agent against variety of phytopathogen including S. rolfsii. Trichoderma spp carries mycoparasitism, antibiosis, induced resistance against pathogen and competing it for nutrients and space to blocks the growth of Sclerotium rolfsii. These Trichoderma spp. T. amazonicum, T. taxi, T. evansii, T. martiale, T. theobromicola, and T. stromaticum are known to have good impact on the phytopathogens.

Keywords: *Trichoderma spp, Sclerotium rolfsii Sacc, bio-control agent.*

Introduction:

Sclerotium rolfsii Sacc is the most destructive pathogen of plants. Resting structures of *Sclerotium* (Sclerotia) are capable of sustaining the adverse environmental conditions such as high and low temperature. In India, among the soil borne fungal diseases, diseases caused by *Sclerotium rolfsii* are potential threats for the various plants.

Sclerotium rolfsii is especially severe on legumes, Solanaceous plants, cucurbits and other vegetables grown in rotation with beans (Hall, 1991). The fungus affects nearly 500 plant species comprising Composite and Leguminosae, Gramineous species are less susceptible (Mehen *et.al.* 1995).

Traditional control measures for *Sclerotium rolfsii* are the use of chemical fungicides which has ill-effects on the soil micro-organisms, human health and environment. Due to excessive use of chemical fungicides, the beneficial micro-organisms present in soil are also affected and ultimately it shows the effect on health of soil fertility also.

To deal with these adverse effects of chemical fungicides, the use of biological control agents is a good strategy now a days. *Trichoderma spp.* are known to possess the fungal biocontrol agent property. *Trichoderma* is also a growth promoter for plants.

Biological control of phytopathogen using *Trichoderma species*:

Trichoderma species are one of the most promising fungal antagonists being extensively used in disease suppression and act as effective antagonist against various soil borne pathogens (Chet *et al.*, 1981; Singh *et al.*, 2009; Ram and Singh 2017). They are primary producers of cell-wall-degrading enzymes which target pathogenic fungi, the phenomenon that makes them best suited for biological control in agriculture (Woo *et al.*, 2006). The Trichoderma spp. parasitizes phytopathogenic fungi through antibiosis, mycoparasitism, competition for nutrients, and induction of resistance. Moreover, it leads to the production of various secondary metabolites which aid in disease resistance against phytopathogens. These prominent features make them the most popular fungal biocontrol agent.

The biocontrol capability of *Trichoderma* was first reported by Weindling (1932), who studied the role of *T. lignorum* in the biocontrol of *Rhizoctonia solani*, causing disease in citrus seedlings. From this pioneer work, several literatures have reported on successful biocontrol by *Trichoderma spp.* Among different species of *Trichoderma, T. harzianum, T. virens, and T. viride* are the most popular ones exhibiting biological control (Singh *et al.*, 2009). They efficiently control root rots/wilt and foliar diseases in a wide range of crops and are antagonistic to a number of soil borne fungi like *Pythium, Phytophthora, Sclerotinia, Sclerotium, Rhizoctonia, Fusarium, Macrophomina*, etc. and even the root knot nematode *Meloidogyne spp.* The first report on its mycoparasitism ability was made by Cole-Smith *et al.*, (1971), who through microtome sections, demonstrated that medulla of infected sclerotia of *Sclerotium delphinii* was wholly replaced by hyphae of *T. hamatum* on agar plates. Likewise, Henis *et al.*, (1978) reported mycoparasitism of *Trichoderma spp.* against *S. rolfsii*, where within the infected fungal sclerotia chlamydospores were produced abundantly in place of conidia. With passage of time, various *Trichoderma spp.* have been found to demonstrate antagonistic effects against *S. rolfsii* in different crops.

Owing to their inherent property as plant growth promoters and bio control agents, these fungi have been widely studied and commercially marketed as biopesticides, biostimulators, as well as soil amendments (Harman 2000; Lorito *et al.*, 2004; Khan and Mohiddin 2018). Now a days in the market, the commercial products of *Trichoderma* are available in various forms. *Trichoderma*-based products are booming in the agricultural market with more than 250 formulated products registered worldwide, which alone occupy 60% of the bio fungicide market (Singh *et al.*, 2012). All these products are being sold to farmers for disease control and in turn enhance their yield (Woo *et al.*, 2006).

Manjula *et al.*, (2004) evaluated 13 isolates of *Trichoderma spp.* for their antagonistic activity against *Sclerotium rolfsii*. The antagonists were selected based on their ability to inhibit the external growth of *S. rolfsii* from infected groundnut seeds. *T. viride* were identified as potent antagonists of *S. rolfsii*. *T. viride* produced extracellular chitinase and parasitized the mycelium of *S. rolfsii*.

Deng, *et al.*, (2007) isolated endophytic *Trichoderma longibrachiatum* EF5 from rice and demonstrated that *T. longibrachiatum* EF5 inhibits the growth of *S. rolfsii* pathogens by direct interaction as well as via the production of the microbial volatile organic compounds (mVOCs). The mVOCs also reduced mycelial growth and inhibited the production of sclerotia by altering the mycelial structure.

A study conducted by Yaqub & Shahzad, (2008), revealed that the disease of seed rot, damping off, root rot of sunflower and mugbean caused by *Sclerotium rolfsii* was prevented as well as the plant growth was enhanced when plants were treated with the conidial suspensions of *Trichoderma spp.* Similarly, the conidial suspensions of microbial antagonists prepared either in water or 10% sugar solution effectively suppressed root colonization by *S. rolfsii* and significantly enhanced plant growth as compared to control.

Mechanism of *Trichoderma* bio-control action:

Trichoderma spp. possess different mechanism to control phytopathogens which are as follows

Mycoparasitism:

One of the salient features of members of the genus *Trichoderma* is their ability to parasitize other fungi. Mycoparasitism is regarded as one of the most typical mechanisms exhibited by *Trichoderma* species for the management of *Sclerotium rolfsii* (Howell 2003; Vinale *et al.*, 2008). This process involves a chemotrophic growth of the antagonist on the host, followed by attachment and coiling around the pathogen hyphae (Chet *et al.*, 1990; Woo and Lorito 2007). The breakdown of the hyphal cell walls of *Sclerotium rolfsii* is done by various enzymes, such as chitinases, proteases, and β-1, 3-glucanases (Cruz *et al.*, 1992; Khetan 2001). β-1, 3-glucanases have the ability to degrade the cell wall and inhibit the growth of host mycelium and spore germination (Lin *et al.*, 2007). Proteases usually degrade the cell walls and *Sclerotium rolfsii* hyphal membranes of the host. The mycoparasitic activity of *Trichoderma* has been reported by many researchers against several pathogens (Mustafa *et al.*, 2009; Khan *et al.*, 2011a, b, c; Kotze *et al.*, 2011). Several physiological and biochemical factors facilitate the process of mycoparasitism. Omann *et al.*, (2012) explicated that G-protein-coupled receptor Gpr1 plays an important role in mycoparasitism. Similarly, Kumar *et al.*, (2010) recognized the role of mitogen-activated protein kinase (MAPK) in biocontrol activities. Deletion of the MAPK gene affects the biocontrol potential of *T. virens*, and the mutants were reported to be less efficient (Mukherjee *et al.*, 2012).

Antibiosis:

Antibiosis usually refers to the inhibition of targeted phytopathogen by volatile compounds or antibiotics produced by the antagonist (Irtwange 2006; Viterbo *et al.*, 2007; Haggag and Mohamed 2007). Many instances of successful biocontrol by *Trichoderma* species have been credited to the mechanisms of mycoparasitism and/or antibiosis. *Trichoderma* species is one of the several biological control agents producing various types of antibiotics (Lewis *et al.*, 1989; Handelsman and Stabb 1996). Volatile compounds like 6-pentyl-2H-pyran-2-one (6-PP) produced by *T. atroviride* play a vital role in *Trichoderma*–host-pathogen interactions (Lorito *et al.*, 2004). Apart from rhizospheric ones, a few endophytic species of *Trichoderma*, such as *T. amazonicum, T. taxi, T. evansii, T. martiale, T. theobromicola*, and *T. stromaticum*, also have biocontrol property and can protect plants from phytopathogens through modulation at omics level (Bailey *et al.*, 2006; Bae *et al.*, 2009; Druzhinina *et al.*, 2011). Not all of *Trichoderma spp.* are registered as biocontrol agents, although they are commercially available as plant growth promoters.

Competition:

Trichoderma competes with other phytopathogens for space and nutritional requirements (Wells 1988). Competition allows the biocontrol agent to displace the pathogen from the targeted zone. *Trichoderma spp.* shows excellent competition with other fungi for food and nutrients in the rhizospheric zone (Chet *et al.*, 1990; Irtwange 2006). It was reported that *T. viride* displaces *Chondrostereum purpureum*, the silver leaf pathogen of plum trees, by competing for nutrients (Corke and Hunter 1979). Similarly, *T. harzianum* checks the growth of *Fusarium oxysporum* by competing for both nutrients and rhizosphere colonization (Tjamos *et al.*, 1922). *Trichoderma spp.* is known to be an efficient producer of siderophore, which quenches iron from the soil and thus renders it unavailable for the pathogen. It modifies the rhizosphere through soil acidification, which becomes unsuitable for the growth of the target pathogen (Benitez *et al.*, 2004). Apart from iron and zinc, competition for carbon is also a deciding factor in determining the antagonism potential of different strains of *Trichoderma spp.* (Sivan and Chet 1989, Viterbo *et al.*, 2007). Few strains have the ability to colonize their rhizospheric zone throughout their lifetime. In a study, it was found that maize plant treated with *T. harzianum* strain had a twofold increment in root development in comparison with control (Harman *et al.*, 2004). Secondary metabolites such as koninginin A (Ram *et al.*, 2015) and 6-pentyl-alphapyrone act as plant growth regulators (Cutler *et al.* 1986, 1989). Whereas, citric and gluconic acids lower soil pH and facilitate solubilization of micronutrients and other mineral components (Harman *et al.*, 2004; Benitez *et al.*, 2004; Vinale *et al.*, 2008).

4. Induced Resistance:

Often to defend plants from pathogenic invasion, biocontrol agents induce local and systemic resistance in host plants to counter the attack of the pathogen. It emerged as a vital tool by which selected bio control agents build up their defence against a broad range of phytopathogens (Ram *et al.*, 2015). Plants generate induced resistance as a result of an interaction by a pathogen, upon the colonization of the roots by biocontrol agents or even after treatment with a specific chemical (Singh *et al.*, 2012). The first report of induced resistance with *T. harzianum* strain disclosed that on soil treatment, bean leaves were given induced resistance against diseases caused by pathogens such as *B. cinerea* and *C. lindemuthianum* (Bigirimana *et al.*, 1997). Jasmonic acid and ethylene are the principal components of induced systemic resistance. Certain strains of *Trichoderma* penetrate root tissues and induce a chain of biochemical and morphological alterations to trigger resistance responses in the host (Singh *et al.* 2011; Singh *et al.*, 2013b). Induced resistance has been reported to be effective in several monocots and dicots, against infection caused by fungi (*Phytophthora spp., R. solani, Alternaria spp., Colletotrichum spp., B. cinerea, Magnaporthe grisea*, etc.) and bacteria (*Pseudomonas syringae, Xanthomonas spp.*, etc.), and even in some viruses like cucumber mosaic virus (CMV) (Waghunde *et al.*, 2016).

Conclusion:

Trichoderma spp. are good bio control agent for the management of phytopathogen including *Sclerotium rolfsii* Sacc which cause tremendous loss in crop production.

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