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Biocontrol Efficacy Of Trichoderma Species For Control Of Collar Rots Of Chickpea Induced By Sclerotium Rolfsii

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Abstract:- *Chickpea (Cicer arietinum L.) is a largely produced pulse crop around the world. Sclerotium rolfsii causes collar rot, which is becoming more prevalent. Botanicals & bioagents may be used in IDM to treat this disease. This is a serious disease that results of a significant reduction in chickpea growth. Sclerotium rolfsii is a soil-borne pathogen that induces root diseases in a wide variety of plants. It is a highly critical pathogen that affects a large range of crops all over the world. Trichoderma species have been shown to be highly effective against a variety of pathogens. This review shows the efficacy of the Trichoderma species on control of collar rot of chickpea induced by Sclerotium rolfsii.*
Keywords:- *Chickpea, Collar rot, Sclerotium rolfsii, Trichoderma species.*

1. INTRODUCTION

Chickpea is India's most commonly produced vast pulse crop, accounting for approximately 75 % of global pulse growth. Fusarium wilt, Ascochyta blight, collar rot, dry root rot, black Pythium rot, root rot, Phytophthora root rot, foot rot, wet root rot, Verticillium wilt, and seed rot are among the diseases that may affect chickpea crops.

Sclerotium rolfsii causes collar rot, which is becoming more prevalent. It is an economically significant pathogen that affects a variety of crops around the world. It has a broad host variety, with approximately 500 species in 100 families susceptible, with legumes, crucifers, and cucurbits being the majority popular hosts [1].

Multiple fungicides, bio agents and soil fumigants (Methyl bromide) may be used to prevent soil-borne plant pathogens such as Sc. rolfsii. Since the use of fungicides on a regular basis pollutes the atmosphere, it is necessary to minimize the quantity of chemicals which is used on soil.

Sc. rolfsii has a broad host variety, excessive pathogen formation, and the potential to produce excessive sclerotia that can last for years in the soil [2]. As a result, chemical treatment of S. rolfsii, which causes chickpea collar rot, is challenging. In this case, plant extracts & bioagents should be considered as an additional source for managing soil-borne disease due to presence of bioactive substances in high concentration.

Plant extracts are environmentally friendly and have defensive, curative, and antagonistic properties against a variety of infections [3-6]. Over the past two decades, there has been a lot of study on biological regulation of plant diseases. Trichoderma spp. has a long tradition of being used as biocontrol agents for plant diseases [7]. Bio control of plant pests can be remarkable, particularly when opponents on fungal pathogens have hyper parasitizing capabilities.

Through developing various hydrolytic enzymes, biological control agents may compete with pests and promote resistance mechanisms. Chitinase and -1, 3 glucanase are well-known funguscontrolling enzymes that break down two important cell wall materials chitin and -1, 3 glucan, according to Bosah et al. (2010) [8]. Aside from that, certain organic fungicides are commonly used to combat plant illnesses.

Their harmful effects on the climate or biodiversity, on the other side, is a problem. As a result, using organisms as biocontrol agents has proven to be a very promising and less risky way of managing plant disease. Bio-control of plant diseases has the ability to be a non-chemical alternative to harsh chemicals for plant protection [9].

Trichoderma species have been shown to be highly effective against a variety of pathogens [10]. Trichoderma spp. is a kind of fungus. they can develop unpredictable antibiotics, and their culture filtrates is also used to monitor fungi [11].

2. COLLAR ROT PATHOGEN

Sclerotium rolfsii is a pathogen occurring in tropical or sub tropical areas of the world with elevated temperatures. green bean, Groundnut, onion, lima bean, pepper, garden bean, tomato, cabbage, watermelon, and sweet potato are among the 500 organisms that the fungus will affect (Aycock, 1966)[12]. Sc. rolfsii's teleomorph was first found in Corticium centrifugum (Lev.) Bres. Curzi (1931)[13] further suggested Corticium rolfsii as the basidial condition of Sc. rolfsii.

Talbot (1973)[14] proposed that Sc. rolfsii's basidial condition belongs to the species of Athelia. It develops a large amount of branched, septate mycelium, white fluffy, with clamp attachments just on the major hyphae that spreads in a fan. On mycelium, small white tufts form, which later grow into smooth, rough, dark brown sclerotia. Sclerotia has a circular or irregular form which resembles a mustard seed when grown [15].

Several researchers used scanning electron microscopy to investigate the composition of sclerotia. An outer rind, a middle cortex, and an inner medulla make up each sclerotium's three layers. Flora Zarani & Christias (1997)[16] researched the three phases of sclerotial growth: initial, progress, and maturity. Sclerotial sizes have been recorded to vary from 0.1 to 3.0 mm [17].

2.1 Symptomatology of Sclerotium Rolfsii

The disease causes dark-brown patches on root surface, which are normally unnoticeable, and a first noticeable signs are gradual yellowing & wilting of the leaves. The plant would ultimately die as a result of this (Nene et al. 1991)[18]. Due to its prolific growth and capacity to develop vast quantities of sclerotia that remain in the soil for several years, total eradication of Sc. rolfsii is almost unlikely (Punja 1988)[19].

Main disease control techniques involve the usage of tolerant cultivars and the application of artificial pesticides, but yield declines persist in many plants. The extensive usage of pesticide and fertilizers in farming activities has boosted crop yields significantly, but it has also a detrimental influence on the atmosphere and human health.

2.2 Distribution and Economic Importance of Sclerotium Rolfsii

Around 500 plant species are affected by the pathogen, along with vegetables, flowers, cereals, forage plants, and weeds. The pathogen induces foot rot or root rot in legumes, crucifers, tomato, chrysanthemum, peanuts, and tobacco, among other hosts (Anahosur, 2001)[17].

The pathogen is responsible for significant agricultural losses in a variety of crops. Ingale or Mayee (1986)[20] found that it killed 25% of groundnut seedlings in the cultivar JL-24 at Parbhani. Thiribhuvanamala et al. (1999)[21] found that S. rolfsii was responsible for 30% of tomato crop failure. According to Harinath Naidu (2000)[22], S. rolfsii induced 40-50 percent mortality in crossandra in the Andhra Pradesh district of Chittoor.

2.3 Pathogenicity Tests

Various methodologies were used to inoculate the plants further artificially with pathogen. Several researchers have looked into pathogen inoculation in the soil, including Kajal Kumar and Chitreswar Sen (2000)[23] as well as Anahosur (2001)[17]. Anitha Chowdary (1997)[24] used a seedling root dip in inoculum to cause sclerotial wilt in bell pepper. Rajalakshmi (2002)[25] used five sclerotia per plant at the collar area to inoculate crossandra plants.

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2.4 Effect of Trichoderma Species against Collar Rot

Ali A et al (2020)[26] found thatthe implementation of 3% dry biomass of C. album as a soil modification, either single or in combination either of the two Trichoderma types, T. viridi & T. harzianum showed an increase crop production of chickpea through S. rolfsii tension. Kulkarni (2007)[27] T. harzianum had the highest inhibitor of mycelial progress (59.81%), accompanied by T. harzianum of PDBC (57.97%), and Bacillus subtilis had the lowest inhibitation of mycelial progress (10.74 percent).

Basamma (2008)[28] founded that B. subtilis or P. fluorescens displayed the minimum inhibition, while Trichoderma spp. showed the maximum inhibition. Kumar R et al. (2012)[29] investigated that the antagonistic ability of Trichoderma organisms extracted from two separate soils, alfisols & inceptisols, and discovered that alfisol isolates had greater potential antagonism toward S. rolfsii, with inhibition of 44.68% and 47.89%, respectively, as opposed to inceptisol isolates, which had inhibition percentages of 3.97, 7.97, or 28.72.

Biomass accumulation and phenolic content were also stated to be higher in alfisol isolates than inceptisol isolates. Bisht S et al. (2013)[30] found that various species of Trichoderma spp. were measured towards the Curvularia leaf spot of maize, they discovered that Trichoderma harzianum, Th13, had the highest mycelial inhibitory growth (83.82%), led by Th-9 (80.29%), and Th-3 (80.29%).
(79.12 percent).

2.5 In Vitro and In Vivo Evaluation of Trichoderma Species

The dual culture method was used to test eight bioagents against the pathogen that triggers collar rot in chickpeas (S. rolfsii) (Morton & Strouble 1955)[31]. 20 milliliters of sterilised, chilled potato dextrose agar are added onto sterile Petri plates and permitted to set. The research fungi's mycelial disc was inoculated on one end, while antagonistic fungi was inoculated on the other.

In the case of bacterial antagonist assessment, the bacterium was streaked on one end of the Petri plate one day prior to the research fungus being put on the other end. The plates were incubated at 271°C, and the zone of inhibition was determined by calculating the clear difference between the test fungi' margin and the antagonistic organism's margin.

The pathogen colony diameter in the control plate was also measured. Vincent (1947)[32] proposed a method for calculating the percent inhibition of pathogen development. Ritesh Kumar et al. (2012)[33].

The antagonistic ability of Trichoderma organisms extracted from 2 separate inceptisols, alfisols and soils was investigated, and it was discovered that alfisol isolates had higher potential antagonism toward S. rolfsii, with percent inhibition of 44.68 and 47.89, respectively, as opposed to inceptisol isolates, which had inhibition percentages of 3.9, 7.9, and 28.7. Biomass accumulation & total phenol content were also documented to be higher in alfisol isolates than inceptisol isolates.

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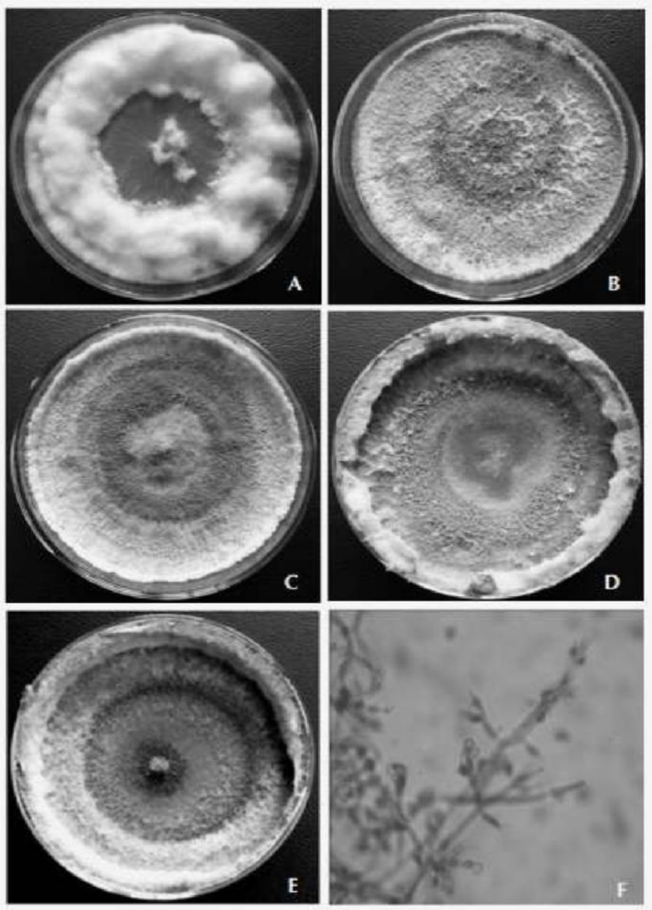

Figure 1: Colony of different T. harzianum isolates and on PDA Media (a) Th-1; (b) Th-2; (c) Th-3; (d) Th-4 (e) Th-5; (f) Micrograph of T. harzianum [33]

Sunaina Bisht et al. (2013)[34] studied the impact of different Trichoderma spp. strains on Curvularia leaf spot in maize and discovered that Trichoderma harzianum impaired mycelial development the most (83.82 percent), accompanied by Th-9 (80.29 percent), and Th-3 (80.29 percent) (79.12 percent). Biological monitoring is a cost-effective, environmentally sustainable, and alternative solution to disease prevention.

As opposed to bacterial antagonists, both Trichoderma organisms displayed more hyphal inhibition. Kulkarni (2007)[35]found that T. harzianum (Dharwad isolate) had the highest inhibition of mycelial growth (59.81%), accompanied by T. harzianum of PDBC (57.97%), and Bacillus subtilis had the lowest inhibition of mycelial growth (10.74 percent).

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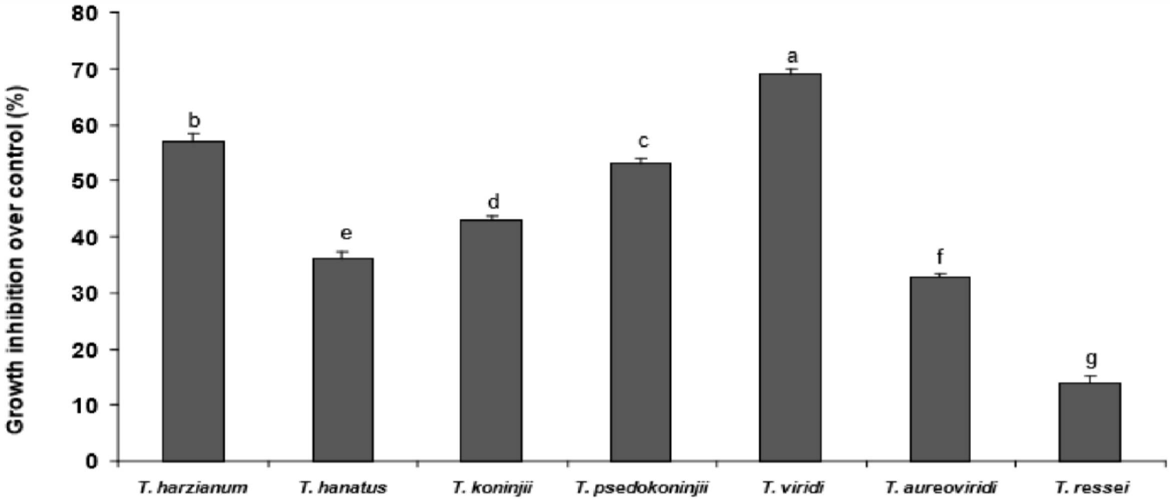

Fig. 2: Growth inhibition of S. rolfsii due to interactions with different Trichoderma species. Vertical bars show standard errors of means of four replicates. Values with different letters at their top show significant difference (P≤0.05) as determined by LSD Test.[49]

Trichoderma organisms have been widely reported as mycoparasites (Doley and Jite, 2012)[36] and are frequently used as anti-microbial agents. Other plant pathogenic fungus is thought to be antagonistic to some Trichoderma types (Bosah et al., 2010)[37]. Different mechanisms, such as rivalry, antibiosis, myco-parasitism, cause tolerance, and inactivation of pathogen compounds such as enzymes, are used to parasitize other plant pathogenic fungi.

Trichoderma species' direct mycoparasiticbehaviour has been proposed as one of the important mechanisms for their anti-microbial activity toward plant pathogenic fungi (Mishra et al., 2011)[38]. Different Trichoderma species have previously been found to develop antibiotics such as trichodermin, trichodermol, harzianum A, and harzianolide that may aid in the reduction of harmful pathogen results (Mishra, 2010)[39]. Trichoderma organisms have been shown to have antagonistic action against a variety of phytopathogens [36-38].

Furthermore, various scientists such as Khattabi et al. (2004)[40] and Rekha et al. (2012)[11] have used the dual culture method in antagonistic research. A strong zone of inhibition was found in dual culture, suggesting antibiosis between pathogen and antagonist. From one animal to the next, the extent of inhibition differed.

Similarly, the ability of isolates of various Trichoderma organisms to control S. rolfsii has been discovsered to vary (Omar and Maha, 2010)[41]. Furthermore, T. viride showed a 68 percent reduction in pathogen development. Trichoderma's development of volatile and nonvolatile metabolites, and also extracellular hydrolytic enzymes, could explain the creation of an inhibition zone at the touch between Trichoderma and S. rolfsii (El-Katatny, 2001)[42].

Trichoderma spp. were found to have biocontrol action toward Macrophomina phaseolina in vitro by Aly et al. (2007)[43], and Mishra et al. (2011)[38] discovered that Trichoderma species are widespread rhizosphere inhabitant and handle several fungi-caused soil-borne plant diseases. Rekha et al. (2012)[11] found that T. harzianum culture filtrates inhibit the development of zoospores and germ tubes, as well as mycelial growth, in S. rolfsii.

Table 1. Inhibition efficiency of different Trichoderma species

No.	Treatment	Percent inhibition	References
1	Trichoderma harzianum	85.55	Kumar R et al. (2011)[46]
2	Pseudomonas fluorescens	72.22	
3	Trichoderma mutants	81.50	Sharma KK et al. (2020)[47]
4	Trichoderma harzianum-55	70	Sab JA et al. (2014)[48]
5	T. harzianum NBAII	63	
6	T. viride IIHR	59	
7	T. harzianum IIHR	37	
8	T. viride GKVK	36	
9	T. harzianum GKVK	32	

In another research, T. viride culture filtrate prevented Sclerotinia sclerotiorum mycelial development by developing an antibiotic-like compound (Kapil and Kapoor, 2005)[44]. Similar results are backed by Karthikeyan et al. (2006)[45], who observed that T. viride culture filtrates prevented pathogen development as well as sclerotial germination. Among other stuff, Trichoderma spp. chitinases destroy the chitin in S. rolfsii cell walls, which assists in the invasion of S. rolfsii mycelium [36].

As a consequence, toxic and or fungistatic metabolites produced by Trichoderma species against S. rolfsii have been discovered in recent studies. Several researchers investigated various Trichoderma organisms as the strongest anti-microbial for inhibiting the growth of a few plant pathogens associated with seeds & soil [38]. The proof for T. reesei's antagonistic ability is inconclusive.

3. CONCLUSION

Chickpea is India's most produced pulse crop, accounting for approximately 75 % of global pulse growth. Sclerotium rolfsii causes collar rot in the chickpea. It is a serious disease that results of a significant reduction in chickpea growth. The findings of the present review will be beneficial in controlling the collar rotting of chickpea induced by Sclerotium rolfsii. The disease controlling efficiency of Trichoderma species was discovered to have important benefits in the control of chickpea collar rot induced by Sclerotium rolfsii.

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