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Biological and Chemical Management of *Fusarium solani* Causing Wilt in Eggplants

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ABSTRACT

Eggplants contain rich amount of anthocyanin, minerals and other nutrient. *Fusarium solani* causes wilt in eggplants which constrain the productivity of the crop. Carbendazim was most effective against *F. solani* which inhibited 100% mycelial growth at 1 ppm concentration on 3rd day. On the other hand, the use of biological agent i.e. *Trichoderma viride* was significantly effective against *Fusarium solani*. *Trichoderma viride* inhibited 22% mycelial growth of *F. solani* on 7th day under *in vitro* condition. At low concentration (<200ppm), *Thuja occidentalis* was promoted mycelial growth of *F. solani* and it was inhibited at high concentration (>200ppm). When *F. solani* was treated with composite of *T. viride* and carbendazim, the mycelial growth of *F. solani* was inhibited by 32.79% at 50%+1 ppm concentration on 7th day followed by composite of *T. viride* and *Thuja occidentalis* which inhibited the growth by 32.78 % at 50%+200 ppm concentration on 7th day.

KEYWORDS: Carbendazim, Eggplant, *Fusarium solani*, *Thuja occidentalis*, *Trichoderma viride*.

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INTRODUCTION

Brinjal is commonly known as eggplant, an imperative Solanaceous crop of sub-tropics and tropics region. Eggplant was originated in the Indian sub-continent[1,2,3] and grown as an imperative vegetable crop all over world generally in Indian subcontinent and Southeast to Asia such as Bangladesh, China, Pakistan and Philippines. In India, the eggplant is a most common vegetable at adapted to different climatic areas. It contains mostly water, protein, fibre and carbohydrates and rich source of minerals and vitamins. It also contains high amount of anthocyanin and low amount of glycoalkaloid.

It is well known that increasing agrochemicals including fertilizers has led to several side effects on the environment and human. Plant diseases play a direct role in the distraction of environment and natural resources in agriculture. Soil-borne pathogen causes disease in plants and cause important losses, fungi being the most aggressive. The distributions of some phytopathogenic fungi such as *Rhizoctonia*, *Fusarium*, *Alternaria*, *Colletotrichum* and *Helminthosporium* have spread during the last few years due to the changing farming[4].

Symptoms were first appearing in eggplant like slight yellow of foliage and lower leaves, wilting of upper leaves; the underground stems become dry and brown as a result cortical decay while roots have soft and water soaked appearance, drooping of the apical portion, diminutive growth, withering of undeveloped fruits and ultimately whole plant are drying[5]. When the stem and root are cut transversely, reddish-brown streaks are visible in the vascular tissues. In *Fusarium* wilt, Wilting of seedlings is also a common characteristic of the disease[5].

The *Fusarium* wilt has become a major disease caused by *Fusarium solani* in brinjal crop. *Fusarium solani* is a soil-borne fungus and is worldwide in distribution. The pathogen may be survived in the soil for many years and forms in the senescing tissues of the diseased plant[7]. *Fusarium solani* produced mycotoxin which is secondary metabolites that creates a serious threat to plants and animals[6]. There are several methods which are presently being used to control various plant pathogens such as physical, chemical, biological and cultural[7]. The management of crop disease is usually achieved by the use of synthetic pesticides. But, due to increased awareness about the risks involved in use of pesticides, much attention is being focused on the alternative methods of pathogen control[29]. The chemical fungicides mostly in those countries where pesticides are imported, the soil, water and air are polluted by the accumulation of obnoxious chemicals residues due to continuous use of fungicides[30]. The repeated and unsystematic use of fungicides have posed a serious threat for human health and existing human eco-geographical situation as some of them have previously been proved to be either mutagenic, carcinogenic or tetratogenic.

MATERIALS AND METHODS

Sample Collection:

The soil & plant samples of the healthy and wilted crop were collected from Para near Rajajipuram district Lucknow. These samples were carried out in sterile polythene bags for further studies.

Screening and detection of mycoflora from soil:

The soil mycoflora were isolated by using serial dilution technique and there were identified microscopically on the basis of morphology, conidial measurement ie. microconidia, macro conidia and chlamydospores[8,9,10].

Antagonistic activity of Trichoderma viride against Fusarium solani:

Fusarium solani was treated with *Trichoderma viride* using dual culture technique given by Huang and Hoes[11]. It was growing the antagonist and pathogenic organism on the same petriplate. Place a 5 mm mycelial disc cut from the margin of actively growing colonies of *Fusarium solani* near the periphery on one side of Petriplate containing Potato Dextrose Agar medium and place another disc of 5 mm of antagonist *Trichoderma viride* on the opposite side of same Petriplate. The Petri-plates were incubated at 26 ± 1 °C and mycelial growth of pathogen was recorded on the 3rd day, 5th day and 7 th day.

Treatment of Fusarium solani using systemic fungicide:

Carbendazim was evaluated for its efficacy on mycelial growth of *Fusarium solani* using poisoned food technique. Appropriate quantity of fungicide was separately dispensed in sterilized PDA medium to make 1 ppm, 2 ppm, 3 ppm, 4 ppm, 5 ppm concentration from stock solution of 1000 ppm concentration. The mycelial disc of 5 mm diameter, taken from 5th day old culture of the pathogen was aseptically placed in the centre of solidified PDA containing Petriplates. It was maintained three replicate for each concentration. The Petri-plates were incubated at 26 ± 1 °C and observations on the mycelial growth of test fungus were recorded on 3rd, 5th and 7 th day of incubation.

Treatment of Fusarium solani using homeopathic drug:

Thuja occidentalis was evaluated for its efficacy on mycelial growth of *Fusarium solani* using poisoned food technique. Appropriate quantity of homeo drug was separately dispensed in sterilized PDA medium to make 50 ppm, 100 ppm, 200 ppm, 500 ppm concentrations from stock solution of

1000 ppm concentration. The mycelial disc of 5 mm diameter, taken from 5th day old culture of the pathogen was aseptically placed in the centre of solidified PDA containing Petriplates. Three replications were maintained for each concentration. The Petriplates were incubated at 26 ± 1 °C and observations on the mycelial growth of pathogen were recorded on the 3 rd, 5 th and 7 th day of incubation.

Treatment of Fusarium solani using composite Trichoderma viride and Carbendazim:

In this method firstly three blocks of 5mm of *Trichoderma viride* cut from the actively growing margin of 5 days old culture was inoculated separately in 500 ml conical flask containing 300 ml of potato dextrose broth. After 15 days of inoculation the culture was filtered through Whatman filter paper no.44. After this culture filtrate was mixed with fungicide and homeopathy drug separately; and was poured on autoclaved and cooled down potato dextrose agar medium at different concentrations. The Petriplate containing the integrated and culture filtrate were inoculated in the centre of the Pertiplate with 5 mm block of 5th day old culture of the pathogen. The culture was maintained in triplicate for each concentration. The radial growth was measured on the 3rd, 5 th and 7 th day of incubation.

Percent inhibition test:

The percent growth inhibition of the pathogen was calculated by using following formula.

$$\% \text{ inhibition} = \frac{\text{Control} - \text{Treatment}}{\text{Control}} \times 100$$

RESULTS

Screening and detection of mycoflora from soil:

The dominating fungal species were *Aspergillus flavus, A. niger A. suluvious, chaetomium globosum, Fusarium soalni, Rhizoctonia solani, Trichoderma viride* and *Yellow mycelium.*

Antagonistic activity of Trichoderma viride against Fusarium solani:

The antagonistic activity of *Trichoderma viride* tested against *Fusarium solani* using dual culture technique under *in vitro* condition. Under in this experiment, *Trichoderma viride* inhibited 6%, 21% and 22% mycelial growth of *Fusarium solani* on the 3rd, 5th and 7th day respectively.

Treatment of Fusarium solani using systemic fungicide and homeopathic drug:

The cabendazim was most effective chemical fungicide that inhibited 100% mycelial growth of *F. solani* at 1ppm, 2 ppm, 3ppm, 4 ppm and 5 ppm concentration on 3rd, 5th and 7th day. On the other hand, homeopathic drug *Thuja Occidentalis* accelerated mycelial growth of *F. solani* at 50 ppm, 100

ppm, 200 ppm concentration while it was inhibited by 25.59%, 17% and 19.56% at 500ppm concentration on 3rd, 5th and 7th day respectively

Treatment of Fusarium solani using composite of Trichoderma viride with Carbendazim and Trichoderma viride with Thuja Occidentalis:

Fusarium solani treated with *Trichoderma viride* metabolite with fungicide Carbendazim at 10%+0.1ppm, 25%+0.5ppm, 50%+1ppm concentration on 3rd, 5th and 7th day. Showed that *Trichoderma viride* with Carbendazim accelerated mycelial growth of *F. solani* at 10%+0.1ppm concentration while mycelial growth of *F. solani* was controlled at 25%+0.5ppm and 50%+1ppm concentration. The highest inhibition (38.6%) of mycelial growth of *F. solani* was recorded at 25%+0.5ppm on 7th day.

Therefore, *Trichoderma viride* with *Thuja Occidentalis* treatment together showed as mycelial growth promoter of *Fusarium solani* at low concentration while at high concentration, mycelial growth of *Fusarium solani* was controlled. The treatment with *Trichoderma viride* with *Thuja Occidentalis* accelerated the mycelial growth of *F. solani* at 10%+50ppm and 25%+100ppm concentration, while at 50%+200ppm concentration, *Fusarium solani* was inhibited by 4.23%, 16.04% and32.78% on 3rd, 5th and 7th day respectively.

DISCUSSION

Fusarium solani is a soil-borne fungus which causes different types of diseases in many crops. The management of fungal diseases through various types of chemical fungicide have been made but these chemical fungicides are costly and harmful for human as well as environment. *Aspergillus flavus, A. niger, A. suluvious, Fusarium solani, Chaetomium globosum, Rhizoctonia solani* and *Trichoderma viride* were isolated from rhizosphere and non-rhizosphere soil of eggplant. Plant pathogen is causes many types of diseases in plant which constrain the productivity of plant. In case of agriculture, mostly farmers depend on chemical fungicides to control plant diseases. However, misuse of synthetic chemicals cause hazardous to both environment and health. The alternative method was used for replacement of chemical fungicides has led to use of biological control agents. *Trichoderma viride* and Carbendazim was positively effective to control mycelial growth of *Fusarium solani* at high and low concentration respectively. *Trichoderma viride* has the potential to control *Fusarium solani* and it inhibited 22% mycelial growth of *F. solani* on 7th day using dual culture method under *in vitro* condition. Chemical fungicide carbendazim was most effective against *F. solani* which inhibited 100% mycelial growth of *F. solani* at 1 ppm concentration on 3rd day using food poisoned technique under *in vitro* condition. *Thuja Occidentalis* was accelerated at less than 200ppm concentration while inhibited mycelial growth of *Fusarium solani* at more than 200ppm

concentration. When *F. solani* was treated with composite of *T. viride* and carbendazim the mycelial growth of *F. solani* was inhibited by 32.79% at 50%+1 ppm concentration on 7th day followed by composite of *T. viride* and *Thuja occidentalis* which inhibited the growth by 32.78 % at 50%+200 ppm concentration on 7th day. In the present study it may be concluded that on the basis of environment ecofriendly point of view, composite treatment of *T. viride* and *Thuja occidentalis* was most significant compare to other against *F. solani*.

Ramaraj et al. found similar result of *Trichoderma* species which effectively control the growth of *Fusarium oxysporum* under *in vitro* condition[12]. All isolated 26 *Trichoderma* strains was inhibited by 16 to 63% against diseases of *Fusarium graminearum* and *Fusarium oxysporum* under *in vitro* condition[13]. The antagonistic activity of *T. harzianum* was significantly effective against *F. oxysporum* which suppressed by 93.67% of *Fusarium* wilt and also promoted plant growth such as plant height, root length, fresh and dry weights of shoot and root[14]. *Trichoderma viride* effectiveness for the inhibition of mycelial growth of pathogen[15] and similar results were obtained by Narayanan et al., Weindling, Yadav et al.[16,17,18]. Rajput et al. reported that fungicides Carbendazim, Dithane M-45, Thiovit and Thiophanate-methane were tested against pathogen, it was found that carbendazim was significantly reduce the mycelial growth of *F. oxysporum* compared to another[19]. Choudhary et al. were also found the Carbendazim was inhibited 100% mycelial growth of *F. solani* at 100 ppm[15]. Gaikwad and Sen, Sharma reported that carbendazim inhibited the mycelial growth of *Fusarium solani* at 25 ppm on 7th day[20,21].

Root rot pathogen causing economic destruction in agricultural field and fungicidal efficacy of *Arnica montana* and *Thuja occidentalis* on germination, growth, yield of crop and root rot fungi *Fusarium* spp, *Rhizoctonia solani* and *Macrophomina phaseolina*. These homeopathic pellets were found to be effective against inhibition of mycelial growth of test fungi under *in vitro* condition[22]. *Thuja occidentalis* was containing antifungal activity and it was significantly inhibited mycelial growth of *F. solani*. Hanif and Dawar were found similar result in the inhibition of *Fusarium solani* under *in vitro* condition[23]. *Thuja occidentalis* were tested *in vitro* showed antifungal activity against *A. parasiticus, Candida albicans, Fusarium solani, Macrophomina phaseolina, Saccharomyces cereviciae,* and *Trichophyton rubrum,*[24]. Gupta et al. studied that methanolic extract of *Thuja occidentalis* significantly inhibits *Fusarium* species, *Microsporium* species, *Aspergillus* species and *Penicillium* species[25]. Jagtap and Suryawanshi were used nineteen homoeopathic drugs against thiophanate methyl resistant mutant of *Fusarium oxysporum* f. sp. *cepae* and finally concluded that some homoeopathic drugs were more effective for controlling of plants, human and animal diseases[26]. Solanke et al. concluded that integrated management of *Trichoderma viride* and carbendazim reduced the growth of fungus significantly at different concentration[27].

Polygalacturonase-inhibiting protein is a leucine-rich that proteins found in transgenic sugar beet plants which inhibit polygalacturonase enzymes secreted by pathogens to break down plant cell walls during early stage of disease expansion and significantly inhibited *Rhizoctonia solani*, *Fusarium solani* and *Botrytis cinerea* [28].

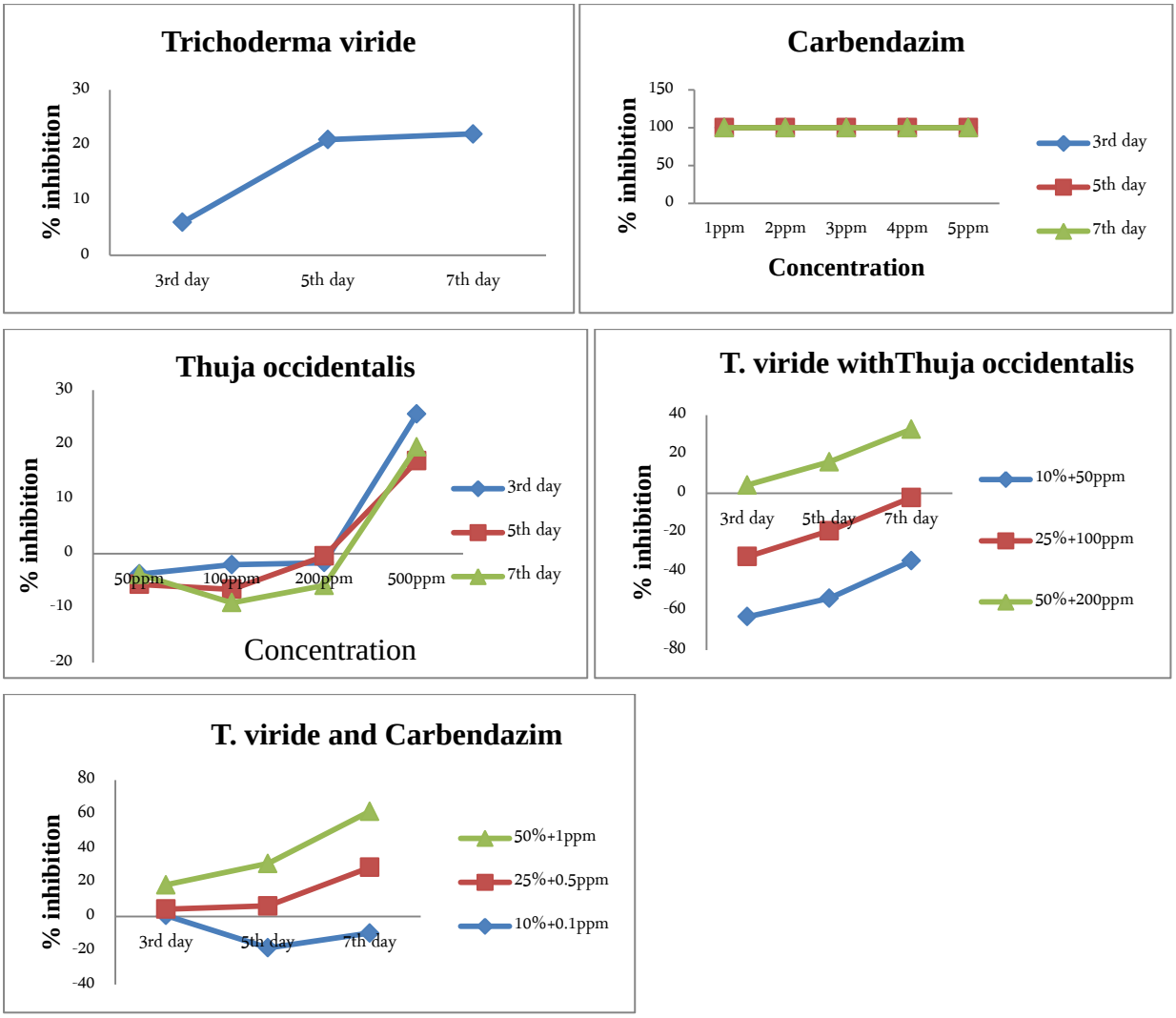

Figure 1. Percent Inhibition of Mycelial Growth of *Fusarium solani* under *in vitro* condition

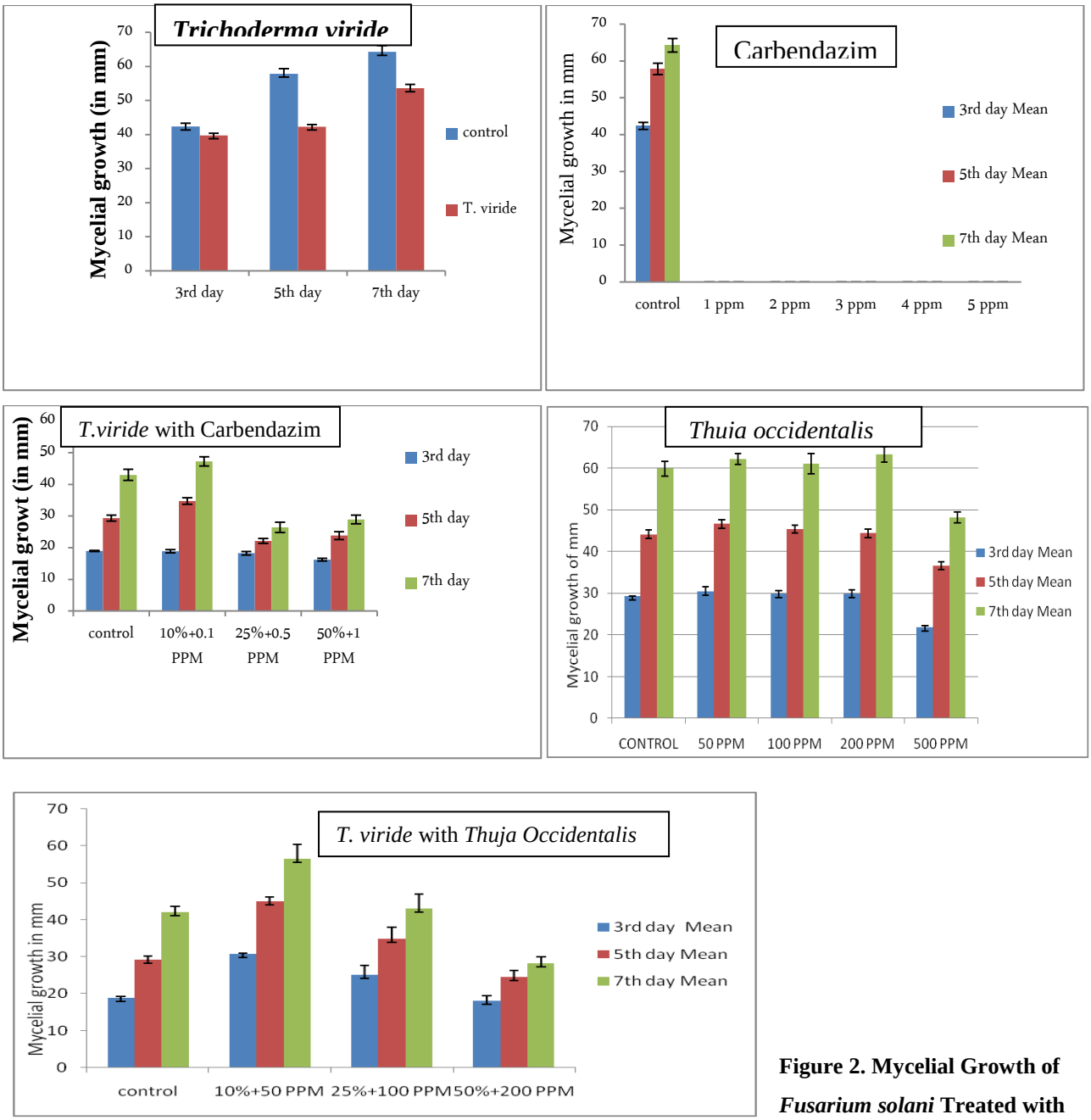

Figure 2. Mycelial Growth of *Fusarium solani* Treated with Chemical, Biological as well as Integrated at Different Concentration on 3rd, 5th and 7th day.

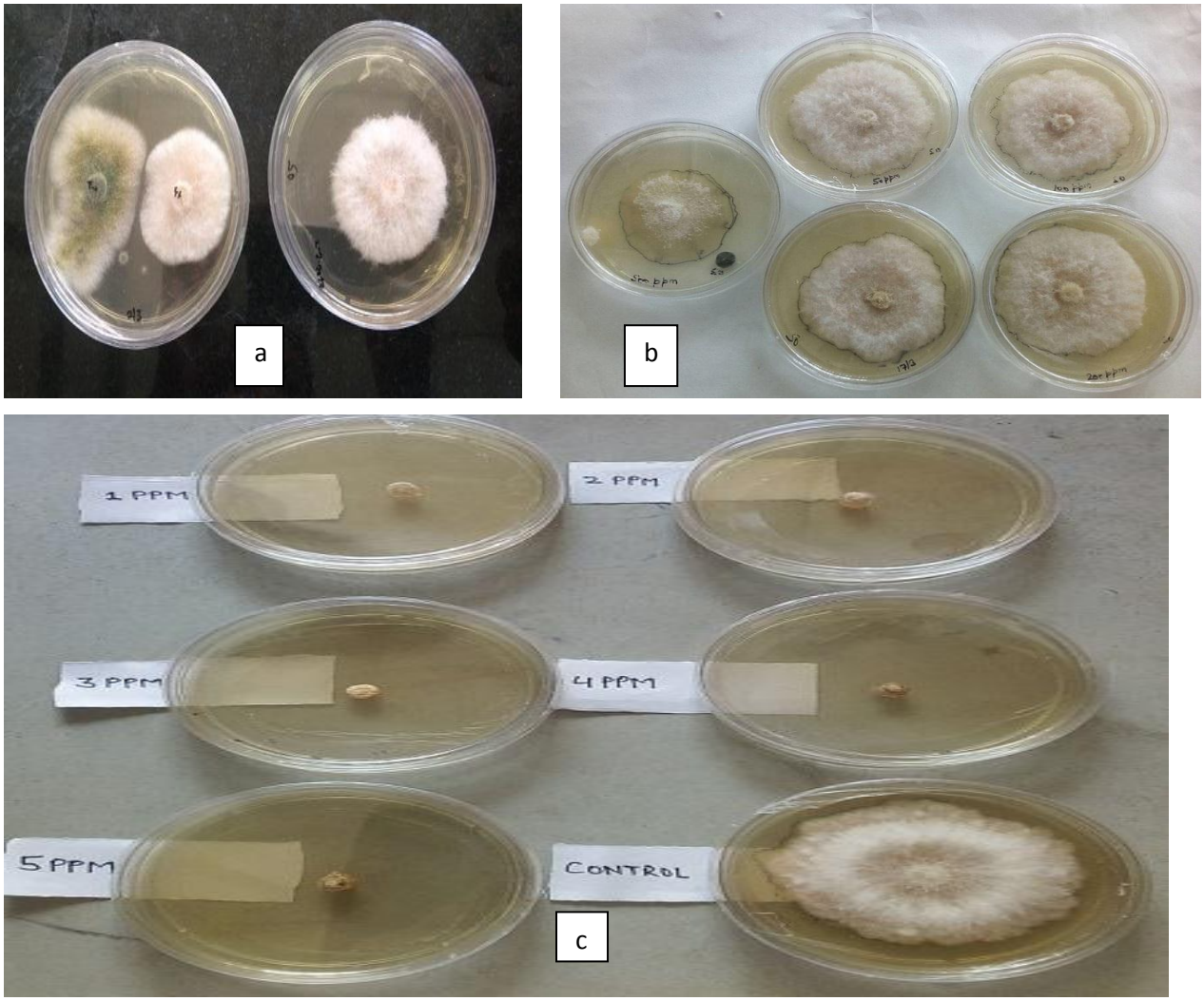

Figure 3. (a) Antagonistic Activity of *Trichoderma viride* (b) *Thuja occidentalis* (c) Carbendazim against *Fusarium solani*

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