EFFECT OF *Trichoderma harzianum* AND SOME SELECTED SOIL AMENDMENTS AGAINST DAMPING OFF DISEASE OF SOME WINTER VEGETABLE

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CERTIFICATE

This is to certify that the thesis entitled, ***"EFFECT OF Trichoderma harzianum AND SOME SELECTED SOIL AMENDMENTS AGAINST DAMPING OFF DISEASE OF SOME WINTER VEGETABLE"*** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN PLANT PATHOLOGY,** embodies the result of a piece of bona fide research work carried out by **Md. Minhaj Uddin Registration No. 08-03188,** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

I further certify that any help or sources of information, as has been availed of during the course of this investigation has been duly acknowledged.

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MY BELOVED

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ABSTRACT

Effect of *Trichoderma harzianum* and some selected soil amendments against damping off disease of some winter vegetable were studied in the field condition during the period of 2008-2009 at Sher-e- Bangla Agricultural University, Dhaka. Soil application with poultry waste, cocodust, vermicompost, ash, sawdust, khudepana, cowdung, solarized sand, *Trichoderma harzianum* and or seed treatment with *Trichoderma harzianum* were evaluated against damping-off, seed germination and growth characters of potato, tomato, eggplant, chilli, cabbage and cauliflower seedlings. All the treatments were significantly reduced percent damping-off of these six vegetable over untreated control. The most effective treatment was *Trichoderma harzianum* followed by poultry waste and vermicompost in terms of suppressing damping-off disease incidence with increasing plant growth characters. The highest seed germination percentage of potato (94.00%), tomato (92.00 %), chilli (86.67%), eggplant (94.33%), cabbage (88.00%) and cauliflower (90.00%) was recorded in T_{11} (Seed treatment with *T. harzianum* + Soil application with *T. harzianum).* The most effective control measure for damping-off diseases of selected winter vegetable was recorded in $T_{11.}$ The highest growth character was observed in T_{11} ((Seed treatment with *T. harzianum* + Soil application with *T. harzianum*), T_{12} (Seed treatment with *T. harzianum* + Soil application with poultry waste) & T_{14} (Seed treatment with *T. harzianum* + Soil application with vermicompost) respectively. It was also found that, *Trichoderma harzianum* treated seed sown in different amended soil showed better result in all parameters than seed sown only on amended soil. Among the different soil amendments, poultry waste and vermicompost have promising effect on seed germination, percent damping-off and seedling growth characters of six selected winter vegetable seedlings.

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CHAPTER I

INTRODUCTION

Vegetable are protective food rich in vitamins and minerals which are essential for maintaining good health. Vegetable crops assume great importance in view of widespread malnutrition that exists in Bangladesh. Increased production and consumption of vegetable could alleviate the malnutrition and improve nutritional standard of our people. Vegetable in Bangladesh can be grouped into summer, winter and year round on the basis of growing season. Major winter vegetable includes cabbage, cauliflower, potato, tomato, eggplant, radish, amaranth, bottle gourd etc. (Siddiqui, 1995). Tomato, cabbage, cauliflower, potato, eggplant and chilli are high value crops among vegetable in Bangladesh. They play vital role in human nutrition. Most of them supply carbohydrate, protein, fats, vitamins and minerals. Our farmers may be able to get economic benefits when producing and marketing them early in the season.

Potato (*Solanum tuberosum*) as one of the most important food crops is an accepted fact and belongs to the family solanaceae. Potato was grown in 520000 hectares of land and the production was 7.8 lac mt. in 2007-2008 (BBS 2009). Depending on quality, the cost of seed covers 25 to 50% of the total cost of production of potato (Rashid, 1987). By using true seeds per hectare seed rate can be reduced from 2.0 tons (tuber seeds) to 100 gm (Chaudhury *et al.* 1987). Potato tuber carries numerous pathogens including viruses whereas a limited number of diseases are transmitted through true potato seeds (Jones, 1982). These considerations have leaded the International Potato Centre (CIP) along with other research institutes to study the use of true potato seed as an alternative method of potato production. Egg-plant (*Solanum melongena L.*) is the second most important vegetable crop next to potato in Bangladesh in respect to acreage and production (BBS, 2009). It belongs to the family Solanaceae. The total area of eggplant cultivation is 47745.34 hectare where 18387.45 ha in kharif season and 29357.89 ha in rabi season with total annual production of

334217.38 mt and the average yield is 7.0 t/ha in 2007-2008 (BBS, 2009) .It is grown round the year both as winter (rabi) and summer (kharif) crops. Tomato (*Lycopersicon esculentum L.*) is another popular, nutritious and a delicious vegetable in Bangladesh.It belongs to the family Solanaceae. The popularity of tomato among consumers has made it an important source of vitamin A and C in diets. Tomato and its products are gaining popularity day by day for its various uses such as salad, soup sauce and juice. A ripe tomato contains around 94% water with the higher content of vitamin A, B & C including calcium and carotene (Bose and Som 1990). In Bangladesh tomato is cultivated mainly in homestead gardens as well as fields during winter and in limited scale as summer season. Tomato was grown 19651 hectares of land in Bangladesh, the production being 143041mt. in 2007-2008 (BBS 2009).

Cabbage (*Brassica oleracea var capitata L*) is an important member of the cole crops, and belongs to the family Cruciferae. It is one of the most important leafy vegetables and extensively grown in Bangladesh mainly in winter season. It is cultivated in an area of 16232.39 hectares with a production of 211097mt. (BBS, 2009).Cabbage has highly nutritive value and high consumers demand. The edible portion of cabbage is head, which is formed by large number of fleshy leaves overlapping one another. Cauliflower (*Brassica oleracea Linn.var.botrytis*) is one of the popular winter vegetable of Bangladesh and belongs to the family Cruciferae. The area under this crop is increasing rapidly and the farmers are gradually adopting it as a cash crop. Cauliflower was grown 15844.94 hectares of land in Bangladesh, the production being 156483 mt. in 2007-2008 (BBS 2009). Chilli (*Capsicum annum*) is one of the most important spice crop in the world. It is the most important crops in Bangladesh under the family Solanaceae having nutritive value especially rich in vitamin C. In Bangladesh it occupies the second position next to onion. Chilli is the most essential spice in Bangladesh and is used extensively by the poor as well as rich in their daily food. It is specially liked for its taste .Its green fruits as well as ripe fruits are used as spice for preparing curries, salad etc. and also used in stuffing. Chilli is also grown in all season and all areas of Bangladesh. In Bangladesh the total area of chilli plant cultivation is 94447.33 ha where 22291.49 ha in kharif season and 72155.87 ha in Rabi season with the total production of 117765mt .in 2007-2008 (BBS 2009).

The yield of the vegetable is very low in Bangladesh (13 t/ha, BBS 2009) compared to that of other developed countries (30-70 ton /ha) of the world (FAO 1999). There are many factors responsible for the low yield of vegetable in our country and among them fungal disease play a vital role. About 13 different diseases so far recorded in Bangladesh in eggplant (Das *et al*, 2000 and Rashid, 2000). Among the various diseases *Sclerotium rolfsii, Fusarium oxysporium and Rhizoctonia solani* causing damping off has treated as the major constraints of eggplant cultivation in our country. Although the total cultivated area and production of tomato in our country have increased gradually over the last few years but productivity is still very low 6.46ton/ha compared to the average of the world yield 26.29 ton /ha (FAO 2003). Diseases are one of the major constrains for such low yield of the crop causing about 30-40 % yield loss annually (Anon, 1992). Disease caused by soil borne pathogen such as *Sclerotium rolfsii, Fusarium oxysporium f.sp. lycopersici* and *Rhizoctonia solani* are causing damping off is the most prevalent throughout the tomato growing areas in Bangladesh. Outside Bangladesh the disease have been reported in many countries including India (Nene *et al.*1986). Pre and post- emergence damping off is the most common and prevalent disease of seedlings of potato raised from TPS (True Potato Seed) affecting seed germination and seedling survival. A number of soil borne pathogens are known to be associated with the disease. Of them *Fusarium* spp., *Rhizoctonia solani, Pythium* spp., *Sclerotium rolfsii* and *Erwinia* spp. are predominant (Elango, 1986; Grinstein *et al.* 1986 and Martin and Torres, 1989, Dey, 2005). These organisms have been frequently reported to cause severe reduction in seedling stands of a variety of crop plants (Gamarra *et al.*1986). Torres (1989) reported up to 70% plant loss at CIP research stations due to damping off after transplantation.

Damping off is serious disease of vegetables grown in nursery bed. The most common fungi reported to be responsible for damping off are *pythium spp., Fusarium* *oxysporium, Sclerotium rolfsii, Rhizoctonia solani* and *Phytophthora sp.* etc (Singh ,1984). The fungi *Fusarium oxysporium, Sclerotium rolfsii, and Rhizoctonia solani* are soil inhabiting pathogens with wide host range and thereby, very difficult to control them (Rangswami, 1988; Talukder, 1974; Singh, 1984; Elango, 1986; Das ,1984; Martin and Torres, 1989).

There are several methods for controlling damping off disease. Control measures like host resistance has not yet become a viable control measure. No resistant variety has yet been developed and released against these soil borne pathogens causing damping off of cabbage, cauliflower, potato, tomato, eggplant and chilli at seedling stage in our country and also in the neibouring countries like India, Pakistan, Srilanka etc. Recently, soil solarization has been shown to be successful in controlling several soil borne pest and weeds which are extremely used in different parts of the world especially in Israil (Dey, 2005; Islam, 2005; Mihail and Alcorn, 1984; Chean and Katan, 1980; Elad *et al.*, 1980; Katan *et al.*, 1980; Grinstein *et al.*, 1979 and Katan *et a.l.*1976). Organic soil amendment is another important option and eco-friendly approach for controlling damping off causing soil borne pathogen by developing suppressive soil such as poultry waste and saw dust (Patil and Katan, 1997; Dey, 2005; Islam, 2007). Another soil amendment such as vermicompost is also effective against damping off of tomato and eggplant seedlings (Szczech, 1999).

In case of bio-control agents such as like *Trichoderma spp.* have effective ability to reduce disease caused by pathogenic fungi (Harman and Lumsden, 1990) *Trichoderma* has been found to penetrate and live in the plant root cortex (Kleifeld andChet, 1992). In response, the level of lignin in root and shoots is increased. At the same time *Trichoderma spp.* have the ability to stimulate the growth of the different plant (Inbar *et al.* 1994). Applications of beneficial microorganism (e.g. *Trichoderma*) to the propagative mixture during seedling production in the nursery make the use of such microorganisms for both plant growth enhancement and biological control more feasible. As damping off causing pathogens are wide range and can persist virtually in all types of crops debris make it very difficult to control. Moreover, biological control is less disruptive to ecosystem than that of chemical pesticide (Baker and Cook, 1974).Bio- control with beneficial microbes manipulates the environment with around a crop to favour organisms that contribute to plant health and vigour rather than simply applying pesticides to destroy a range of microorganisms including the target pathogen. Under the scenario discussed above, identification of the components for management of damping off of cabbage, cauliflower, potato, tomato, eggplant and chilli is an urgent demand. But there exists a few evidence of research work for management of damping off of cabbage, cauliflower, potato, tomato, eggplant and chilli in Bangladesh. Considering the above facts, the present research work was carried out to achieve the following objectives:

1. To evaluate the efficacy of seed treatment and soil application with *Trichoderma harzianum* on seed germination and reducing damping- off disease of selected winter vegetable seedlings.

2. To evaluate the efficacy of different soil amendments on seed germination and damping off disease of selected winter vegetable seedlings.

3. To evaluate the combined effect of *Trichoderma harzianum* and some selected soil amendments on damping off disease suppression and growth characters of selected winter vegetable seedlings.

Chapter 2

Review of literature

CHAPTER II

REVIEW OF LITERATURE

Seedlings of eggplant, tomato, Cabbage, cauliflower, Potato and chilli are frequently attacked by damping off disease in seed bed. A number of soil organisms are involved to cause this disease. The organisms are *Rhizoctonia solani*, *Pythium spp*, *Fusarium oxysporum* and *Sclerotium rolfsii*. Raicu and Stan (1977) isolated *Rhizoctonia solani*, *Pythium spp*, and *Phytophthora parasitica* from seed rot and damping off tomato seedlings. This disease is important threat for production of eggplant, tomato, Cabbage, cauliflower, Potato and chilli in our country. Evidences of research work regarding management of damping of eggplant, tomato, Cabbage, cauliflower, Potato and chilli are very limited. However some available and important findings on various aspects for management of damping off of seedlings has been complied and presented below.

Jayaraj *et al.* (2006) stated that the seed treatment with *T. harzianum* formulations reduced the incidence of damping-off disease of tomato by up to 74% and enhanced plant biomass under greenhouse and field (Tamil Nadu, India) conditions. Active colonization of *T. harzianum* in the rhizosphere of tomato plants was observed following seed treatment with the formulations.

Pratibha *et al.* (2006) cited that biological (soil solarization, *Trichoderma harzianum*, neem [*Azadirachta indica*] based products, and intercropping with onion), chemical (soil solarization, captan, carbendazim, Bion [acibenzolar], Pro Kissan, imidacloprid, iprodione, Mr. Phos, triazophos, and chlorothalonil) and integrated disease management (IDM; integration of treatments) systems were evaluated during 2002-04 for their efficacy against leaf spot (*Alternaria brassicicola*), downy mildew (*Peronospora parasitica*) and stalk rot (*Sclerotinia sclerotiorum*) of cauliflower (*B. oleracea var. botrytis subvar. cauliflora cv. Pusa* Synthetic) in New Delhi and Sikar

(Rajasthan), India. Superior disease control was obtained with IDM (69.7%), followed by the chemical (75.5%) and biological (86.4%) control systems. In New Delhi, the greatest increase in yield (163.32%) was obtained with IDM, followed by the biological (130.36%) and chemical (103.29%) control modules. In Sikar, the yield increased by 167.85, 135.59 and 107.0% with IDM, biological and chemical control modules, respectively.

Rahman, (2005) conducted an experiment for controlling collar rot of Chickpea where different cultural options were used. Among the different cultural options for controlling collar rot of Chickpea, Application of mustard oil cake @ 3 ton/ha and half decomposed poultry manure @ 5 ton/hectare 2 weeks before sowing seeds, were found to be the most effective options in reducing collar rot disease incidence.

Gulhane *et al.* (2005) stated that among the various diseases of tomato, damping off due to *Pythium spp.* is of considerable importance. The most common fungi causing damping off disease are *P. aphanidermatum, P. debaryanum, P. butleri and P. ultimum.* Among these, *P. aphanidermatum* was one of the most important pathogens to cause damping off of tomato. Therefore, it was thought necessary to manage this pathogen through biological control. Different isolates obtained from healthy seeds, phylloplane and rhizosphere of healthy tomato seedlings and plants were tested for their antagonistic effect. Only two fungal isolates, *Trichoderma harzianum and T. viride*, were found as strong antagonists on the basis of the effect of the antagonists on the germination of tomato seeds (on blotter), which were further used for seed treatment and found that they were very effective against the damping off pathogen. *T. harzianum* (7.6x107) and *T. viride* (8.1x107) significantly decreased the disease incidence.

Pandey, and Pandey (2005) stated that study was undertaken to determine the behaviour of some biological control agents (BCAs) against damping off pathogen-complex in different vegetable crops under different soil conditions. Seeds of tomato (cv. Sel-7), brinjal [aubergine] (cv. Punjab Sadabahar) and chilli (cv. LCA-235) were coated with pure culture of different BCAs (*Trichoderma viride, T. virens [Gliocladium virens], T. harzianum, T. koningii, Aspergilus niger-V* isolate and *Bacillus subtilis*). Small plastic pots were filled with 400 g soil in 3 different sets. The first set of soil was autoclaved to eliminate all the microbes from the soil and then infested with pure culture of test soil pathogen *(Fusarium solani, Rhizoctonia solani, Macrophomina phaseolina, Sclerotium rolfsii [Corticium rolfsii] and Pythium aphanidermatum*), separately. One plate of 7 day old culture for each pathogen was blended in 50 ml of sterile distilled water and 1 ml of this culture from each pathogen was mixed all together. The inoculum was mixed in the soil at 5 ml/pot to make sick soil. The potentiality of different BCAs varied from crop to crop where seed texture, seed mycoflora and seed pathogen might be additionally responsible for this variability.

Gulhane *et al.* (2005). Conducted that the antagonistic effect of different isolates obtained from healthy seeds, phylloplane and rhizosphere of healthy tomato seedlings was evaluated against *Pythium aphanidermatum*. Only two fungal isolates, *Trichoderma harzianum* and *T. viride*, were found as strong antagonist on the basis of inhibiting the mycelial growth of the pathogen compared to the bacterial antagonists *Bacillus subtilis* and *Pseudomonas fluorescens*. The culture filtrates of the antagonists were found effective in controlling the radial growth of the damping off pathogen in vitro

Thiruvudainamb *et al.* (2004) stated that the Greenhouse experiments were conducted to determine the efficacy of different biological control agents (*Pseudomonas fluorescens, Trichoderma viride and Azotobacter chroococcum*) and other methods (soil solarization) in managing damping off caused by *Pythium aphanidermatum* in tomato. Tomato seeds were treated with *T. viride, P. fluorescens and A. chroococcum* at 4, 10 and 15 g/kg, respectively. *T. viride, P. fluorescens and A. chroococcum* (500 g, 2.5 kg and 500 g/ha, respectively) were also mixed with farmyard manure (FYM) and applied to the soil. The percent disease control was also highest in *P. fluorescens* seed treatment and soil application, followed by *T. viride* seed treatment and soil application.Soil solarization was the least effective method in increasing seed germination and reducing postemergence damping off in tomato

Rao and Srikant-Kulkarni 2003 conducted an experiment for the efficacy of *Trichoderma harzianum,* T. *viride, T. koningii, Pseudomonas fluorescens, Penicillium, Gliocladium virens* and *Aspergillus niger* in controlling potato wilt caused by *Sclerotium rolfsii [Corticium rolfsii]* was determined in vitro. *T. harzianum* recorded the highest mycelial growth inhibition (60.74%) and width of inhibition zone (4 mm) and the lowest sclerotia size (0.81 mm) and sclerotial production.

Tate (2003) stated that four *Trichoderma harzianum* products at their recommended rates, i.e. Tri-D 25 (1 kg), Trichogrow (3 kg), Rootshield (5 kg) and DRHCI (0.1 kg), were sprayed onto potato cut seeds planted into sub-plots of the BQ-mulch trial, conducted in Opiki, New Zealand, to protect the young plants by colonizing the roots systems. Observations made on 15 March [year not given] revealed that Trichogrow plots had the lowest percentage of decayed stem bases (9.5%) and percent tubers with pink rot (1.4%), followed by DRHCI, Tri-25 and Rootshield. All four treatments resulted in similar total weights of tubers per plant (1.39-1.51 kg), but Rootshield recorded a slightly lower weight of clean tubers than the rest. However, the difference in clean tuber yields between Tri-D25 (1.46 kg/plant) and Rootshield (1.23 kg/plant) could translate into a difference of approximately 12 t/ha. The differences in disease incidence were due to the differences in the number of CFU applied per ha and the different strains of *T. harzianum* used in each product.

Ali *et al.* (2002) conducted an experiment during 1995-97 to determine and efficient method of controlling damping -off disease, mostly caused by *Fusarium oxysporum, Sclerotium rolfsii* [*Corticium rolfsii*] and *Rhizoctonia solani,* in true potato cv. HPS-

11/13 seedlings. Treatments comprised of burning of straw; maintenance of soil moisture at 40,60 or 80% field capacity, application of formalin, and application of fungicides such as Vitavax 200[carboxin+thiram], Ridomil [metalaxyl]. All the treatments, showed better control of the disease compared to the control. Application of formalin resulting in the lowest mean disease incidence (8.77%) followed by Vitavax 200 (10.38%).

Goswami and Islam (2002) reported that *Trichoderma spp.* showed greater inhibition of tomato wilt pathogen (*F.oxysporum f.sp. lycopersici)* in dual culture technique.

Ghosh (2002) conducted that an attempt was made to study the biological control efficacy of fungal antagonists (5, 3 and 1 isolates of *Trichoderma viride, T. harzianum and Gliocladium virens,* respectively) in managing the damping off of chilli (*Capsicum frutescens*) caused by *P. aphanidermatum.* In vitro assessment of mycoparasitism showed that out of nine isolates of antagonists, *T. viride-2* inhibited the growth of the pathogen maximum, followed by *T. harzianum-3* and *G. virens.* Similarly, chilli seed dressing with fungal antagonists (conidial suspension of 5-6x1010/ml) gave same nature of result against both pre-emergence and post-emergence damping off in both sterilized and unsterilized soil.

Prasad *et al.* (2002) found that the efficacy of the biological control agent *T. harzianum* was tested on various inoculate levels of *F. udum*, the pigeon pea wilt pathogen, in a field study. Even at the highest pathogen density (log 5.34), soil amendment with *T.harzianum* ranged between 4.3 and 13.7%. In general, soil application of *T.harzianum* was found to be more effective than seed treatment.

Ghosh (2002) conducted that an attempt was made to study the biological control efficacy of fungal antagonists (5, 3 and 1 isolates of *Trichoderma viride, T. harzianum* and *Gliocladium virens*, respectively) in managing the damping off of chilli (*Capsicum frutescens*) caused by *P. aphanidermatum.* In vitro assessment of mycoparasitism showed that out of nine isolates of antagonists, T. viride-2 inhibited the growth of the pathogen maximum, followed by *T. harzianum-3* and *G. virens*. Similarly, chilli seed dressing with fungal antagonists (conidial suspension of 5-6x1010/ml) gave same nature of result against both pre-emergence and post-emergence damping off in both sterilized and unsterilized soil.

Siddique *et al.* (2002) used sesame oil cake and ash both at 2% to control foot rot of brinjal caused by *S.rolfsii.* When oil cake and ash applied at early flowering stage, recovery from the disease was increased 86.67%, and respectively. At peak fruiting stage 66.67% recovery was recorded for both treatments whereas, the recovery of infected plants was only 30% under control.

Bernal *et al.* (2001) observed 70% inhibition of *Fusarium oxysporum f.sp cubense* with *Trichoderma spp.* using dual culture on potato-dextrose-agar medium.

Kavi *et al.* (2001) stated that the efficacy of *Trichoderma viride*, *T. harzianum*, and *T. hamatum* as hyperparasites of *R. solani* was investigated in the laboratory. *R. solani*, isolated from potato cv. Kufri Sinduri, and one of its antagonists were contained in a Petri dish and incubated at 25 degrees C for 72 h. *T. harzianum* was the most capable of parasitizing *R. solani,* followed by *T. viride*. The other antagonists failed to parasitize *R. solani.* The parasitism by *T. harzianum* is briefly discussed.

Kovics *et al.* (2001) stated that invitro antagonism was studied on PDA in Petri dishes. Strains grown on PDA were put on the surface of 14-day-old culture of *Rhizoctonia solani* colonies. Discs with both pathogen and beneficial fungi, were grown in bi-culture to examine the efficacy of antagonism by agar-gel diffusion test, cellophane-disc diffusion test and seed treatments. However, by the end of 24, 36 and 48 h growth, there was no sufficient metabolite production to detect them biologically. Metabolites of *Trichoderma viride (Tv-5), T. hamatum (Th-2) and T. virens [Gliocladium virens] (Tvr-1)* did not allow *Rhizoctonia solani* growth at all. *T. harzianum (Th-33)* and *T. tomentosum* (Tt-44) strains showed more than 50%

inhibition rate by the fourth day. The other strains also had some effectiveness but below 50% efficacy. Seed treatment showed 67.90-98.77% efficacy of *Trichoderma* strains.

Zapata *et al.* (2001) stated that a high incidence of root rot and basal canker was observed on aubergine cv. Violeta Larga in Buenos Aires, Argentina. *Fusarium solani* and *Rhizoctonia solani* were isolated and identified as causal agents. Pathogenicity tests indicated separate inoculations at sowing led to damping off. Thirty-six strains of fluorescent *Pseudomonas*, with potential antagonist activity, were isolated from healthy plant rhizospheres from the same field then tested in dual cultures against *F. solani* and *R. solani*. Strain P218 was selected for their ability to inhibit pathogen growth. In vitro tests against isolated *Trichoderma harzianum* strain THA was was successful. A biological control test of damping-off in aubergine with P2 18 and TH1 as antagonists was carried out in the greenhouse. The interaction and antagonist effects were not significant. There were no observed biological activities. Since P218 and TH1 were effective in basal canker and root rot control of adult aubergine, induced by the same pathogens, changes in the application strategy are recommended. Biswas and Sen. (2000) showed that dual culture of 11 isolates of *Trichoderma harzianum*, three isolates, viz., T8, T10 and T2, were effective against *Sclerotium rolfsii* the causal agent of stem rot of groundnut and they overgrew the pathogen up to 92,85 and 79%, respectively. In pot trials T8 and T10 isolates reduced stem rot incidence significantly when delivered as seed dressing or soil application.

Islam *et al.* (2000) conducted an experiment and was during 1995-96 and 1996-97 in Bangladesh on true potato seed (TPS). The treatments were soil moisture at 40,60, and 80% filed capacity (FC), soil amendment with sawdust (0.75 t/ha), soil treatment with straw burning (15 cm thick), formalin (1%), Vitavax 200 (0.2%), Ridomil MZ72 (0.2%), Apron 35 SD (0.2%) and Captan (0.2%) at 5 litres a.i/m2. three soil -brone fungal pathogens (*Sclerotium rolfsii, Rhizoctonia solani and F. solani*) were identified to be associated with damping off of seedlings from TPS. All the treatments were effective in reducing the damping-off disease of potato seedlings in TPS but their efficacy significantly differed. Formalin and Vitavax 200 showed excellent performance in controlling the disease. Soil moisture at 60% FC, straw burning and sawdust amendments also reduced damping-off incidence.

Niknejad *et al.* (2000) found that the antagonistic fungi *T. harzianum* and *T. viride* were used to control tomato Fusarium wilt caused by *F.oxysporum f.sp. lycopersici,* and their effect on the weight and height of tomato plants were determined. The antagonist *T. harzianum* was appeared to be best in comparison to *T. viride.* The antagonists had a positive effect on plant height and weight.

Huang-Jenn Wen and Huang-Hung Chang (2000) conducted an experiment use ten agricultural wastes were tested for their suitability as substrates for the growth of cabbage seedlings. Growth medium (RGM), rice hull, carbonized rice hull, peanut husk, coconut fibre, bagasse meal or wasted cotton. The optimum composting period for SFMC and SGMC was 10 and 6 weeks, respectively. A new container medium (SSC-06) was formulated using SFMC, carbonized rice hull, shrimp and crab shell meal, blood waste, and lime. The SSC-06 medium was suitable for growth of cabbage (*cv. EC-KELLY*) seedlings and was suppressive to *Rhizoctonia solani AG-4.* The suppressive effect of 20-day-old SSC-06 medium on colonization of cabbage seeds by *R. solani AG-4* was reduced after it was steamed in 100 degrees C hot air for 15-30 min. However, the inhibitory effect was restored to the steamed SSC-06 medium by inoculation with *Trichoderma harzianum* isolate TH-05 at a concentration of 105 cfu/g dry medium. After the medium was steamed for 5, 10, 15, 25 or 30 min, no fungal colonies were recovered.

Rajappan and Ramaraj (1999) stated that the efficacy of 4 fungal biocontrol agents (*Trichoderma viride, T. harzianum, T. hamatum and Gliocladium virens*) and 2 bacterial biocontrol agents (*Pseudomonas fluorescens and Bacillus subtilis*) were evaluated against the cauliflower wilt pathogen, *Fusarium moniliforme* [*Gibberella fujikuroi*] in vitro. Among the fungal biocontrol agents *T. harzianum* produced the maximum inhibition zone of 15 mm compared with the minimum of 7 mm produced by *T. hamatum*. There was no significant difference between the inhibition zones produced by P. fluorescens and *B. subtilis*. Soil application of talc-based formulation of *T. harzianum*, *P. fluorescens*, *G. virens* and *T. viride* effectively controlled cauliflower wilt under field conditions.

Charati *et al.* (1998) conducted a pot experiment during kharif 1997 to study the effect of seed treatment with *Trichoderma spp.* on the incidence of Fusarium wilt (*F.oxysporum f.sp. vasinfectum*) of cotton (cv. DH-2). The seed was treated with talc formulated *T.viride* and *T.harzianum* at 2, 4, and 6g/kg seed. The results showed that all treatments were significant. Damping-off and root rot diseases of sugar beet caused by *R. solani, S.rolfsii, Fusarium spp. Mucor spp. Alternaria spp. Pythium debaryanum* were greatly reduced by *T.harzianum* and resulted in increased root weight both in pot and field experiment (Abada, 1994).

Roy, *et al.* (1998) conducted that Seed treatments of *Trichoderma viride, T. harzianum and T. koningii* reduced damping off of cabbage caused by *Rhizoctonia solani* in both sterilised and unsterilised soil. Treating cabbage seeds with a spore suspension of *T. viride and T. harzianum* separately was more effective than the application of antagonist to the soil at the inoculum rate of 2.0% (w/w). Seed treatment reduced pre and post-emergence damping off incidence and enhanced seedling vigour. The combination of seed treatment and soil application with *Trichoderma spp.* further reduced the pre- and post-emergence damping off of cabbage in the nursery.

Datnoff *et al.* (1995) stated that *T.harzianum* was significantly superior among the two commercial formulations of *T. harzianum* and *Gliocladium intraradices* in controlling Fusarium crown and root rot of tomato.

the nursery on cabbage and sugar beet. However, the inert materials had a negative effect on lettuce seedling emergence.

Lin and Lo (1988) reported that the use of mixture as a soil amendment at the rates of 0.5-2% (w/w) greatly or completely inhibited damping off and root rot of cucumber caused by *P. aphanidermatum* under greenhouse and field conditions. Among the various combinations of the components of S-H mixture tested in the laboratory, urea was the main factor responsible for inhibition of mycelia growth and oospore survival. Siliceous slag had some additive effect. Urea alone was almost as effective as S-H mixture in reducing the pathogen population and suppressing the disease, but the suppressiveness was lost after 25 days of incubation. Soil amended with urea + siliceous slag remained suppressive for at least 28 days, the longest period tested.

Chapter 3

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

3.1. FIELD EXPERIMENT

3.1.1 Experimental Site:

The Experiment was conducted in the farm field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

3.1.2 Experimental Period:

The Experiment was carried out during the period from November, 2008 to February, 2009.

3.1.3 Climate of experimental site:

The experimental area belongs to the subtropical climate was characterized by the high rainfall, high humidity, high temperature, relatively long day during April to September and scanty rainfall, low humidity, low temperature and short day period during October to March. The later period is favorable for vegetable t cultivation.

3.1.4 Characteristics of soil:

The description of the Agro-ecological Zone (UNDP and FAO, 1988) and soil properties of the experimental soil properties of the experimental site was as follows:-

Agro-ecological region	: Madhupur Tract (AEZ-28)
Land Type	: Medium high land
General soil type	: Non-Calcareous Darkgray floodplain soil
Soil series	: Tejgaon
Topography	: Up land
Elevation	: 8.45
Location	: SAU Farm, Dhaka.
Field level	: Above flood level
Drainage	: Fairly good
Firmness (Consistency)	: Compact to friable when dry.

3.1.5 Variety used in the experiment:

SL.NO.	Name of the vegetable	Variety name
01	Potato	BARI TPS-1
02	Chilli	BARI Marich-1 (Banglalanka)
03	Cabbage	BARI Badhakopi-1 (Provati)
04	Cauliflower	BARI Fullkopi-1 (Rupa)
05	Brinjal	BARI Bagun-5(Nayan Tara)
06	Tomato	BARI Tomato-2 (Raton)

3.1.6 Collection of Seeds:

All the varieties were collected from Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh.

3.1.7 Treatments used in the experiment:

The following treatments were used in this experiment

T_1= Soil application with *Trichoderma harzianum*

T_2= Soil application with poultry waste

T_3= Soil application with cocodust

T_4= Soil application with vermi compost

T_5= Soil application with ash

T_6= Soil application with sawdust

T_7= Soil application with khudepana

T_8= Soil application with cowdung

T_9= Soil application with solarized sand

T_{10}= Seed treatment with *Trichoderma harzianum*

$T_{11} = T_{10} + T_1$

$T_{12} = T_{10} + T_2$

$T_{13} = T_{10} + T_3$

$T_{14} = T_{10} + T_4$

$T_{15} = T_{10} + T_5$

$T_{16} = T_{10} + T_6$

$T_{17}= T_{10} + T_7$

$T_{18}= T_{10} + T_8$

$T_{19}= T_{10} + T_9$

T_{20}= Untreated control.

3.1.8 Collection of test materials:

Trichoderma harzianum collected form plant pathology division Bangladesh Agricultural Research Institute (BARI), Gazipur. Poultry waste colleted from Agargaon bazaar, Cocodust colleted from Aoronnak nursery, Agargaon, vermicompost, ash, sawdust, cowdung and solarized sand collected from SAU farm. Khudepana collected from the pond of Sher-e-Bangla Agricultural University, Dhaka,

3.1.9 Preparation of seed bed:

The experimental seed bed was prepared by thoroughly ploughing followed by laddering to have a good tilth and the land was properly leveled before sowing. Fertilizers and manures were applied on the seed bed as per recommendation of BARC (1997). A temporary polythene shade was made on the seed bed during the period of experiment.

3.1.10 Design and Layout of the experiment:

The experiment was laid out in Randomized Complete Block Design (RCBD) having three replication for each treatment. The individual seed bed size was 3m×1m. There were evaluated 20 treatments in the experiment as described before and 60 seed bed (cabbage, cauliflower, potato, egg-plant, tomato and chilli) were used in this study. Six crop seeds were sown in one seed bed. Block to block and seed bed to seed bed distance were 2m and 1m, respectively.

3 .1.11 Preparation of bio agent (*Trichoderma harzianum*)

An effective isolates of *Trichoderma harzianum* was used in this experiment. The antagonistic *Trichoderma* was mass multiplied in PDA media kept at 25^0C for 7-10 days. The fungal mat suspension was made by scraping the 10-15 days old culture substrate with the help of blender and adjusted the concentration 10^6 spore/ml. Pedreschi *et al.* (1997).

Plate 1. Preparation of spore suspension (*T. harzianum)* by blender machine.

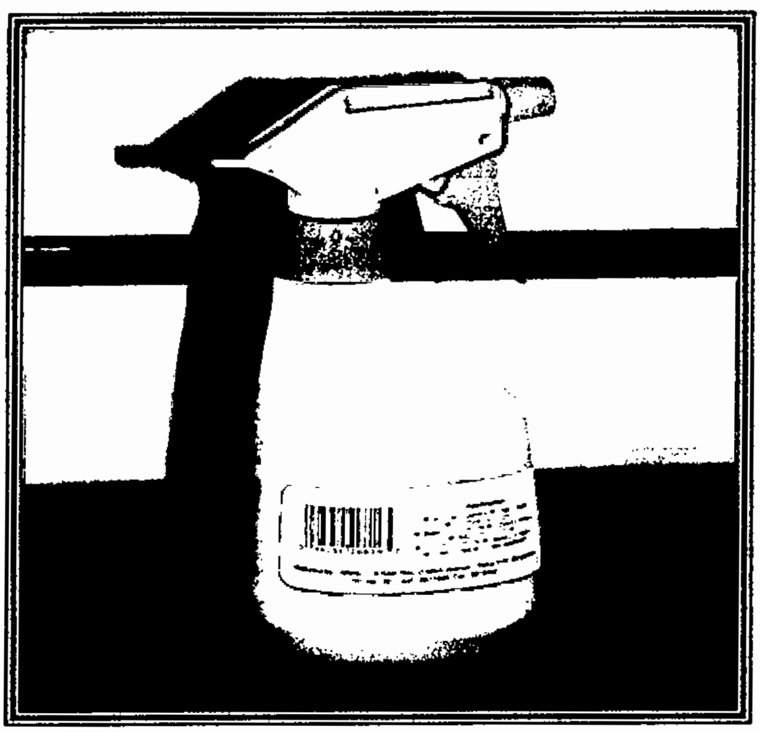


Plate 2. Application *T. harzianum* spore suspension by hand sprayer.

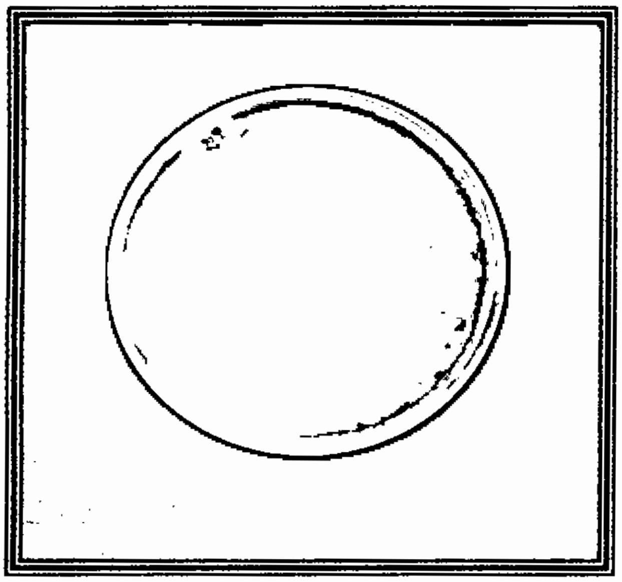


Plate 3. Pure culture of *Trichoderma*

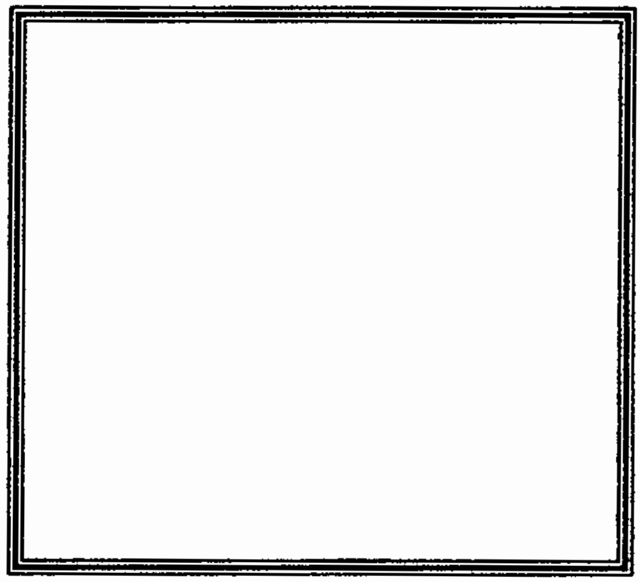


Plate 4. Conidia of *Trichoderma harzianum* (X 400).

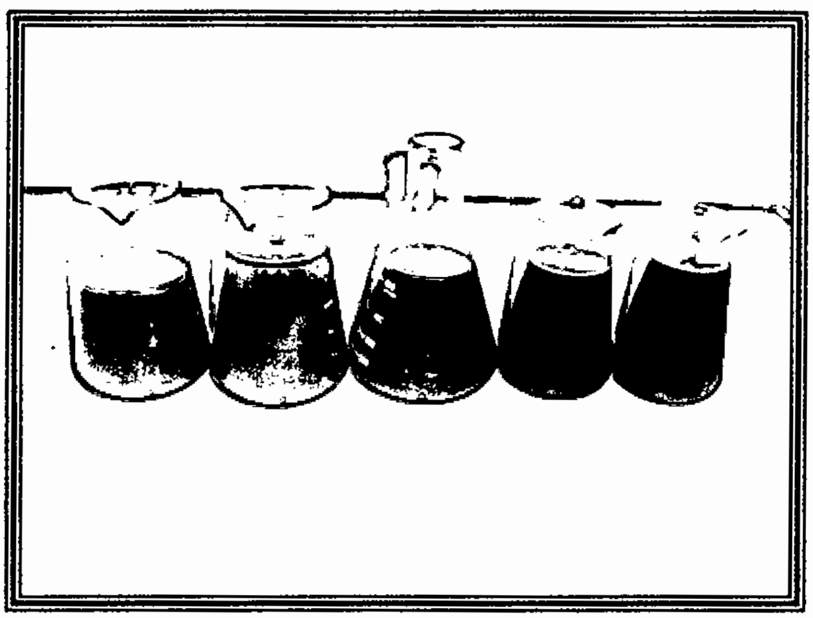


Plate 5. Spores suspension of *Trichoderma harzianum*

3. 2 Procedure of application of different treatments:

3.2.1 Application of *Trichoderma harzianum*

The soil of the specific plot were drenched with the spore suspension @ 1 lit/seed bed with the help of compressed air hand sprayer following pulverized the soil to mix up the *Trichoderma harzianum* spores through out the soil.

3.2.2 Application of poultry waste

Poultry waste @10 kg was applied to the soil in specific seed bed at twenty days before sowing and mixed with the soil properly for proper decomposition, growing antagonistic microorganisms and developing suppressiveness.

3.2.3 Application of cocodust:

Cocodust @ 3 kg was applied to the soil in specific seed bed at twenty days before sowing and mixed with the soil properly for proper decomposition, growing antagonistic microorganisms and developing suppressiveness.

3.2.4 Application of vermi compost:

Vermi compost@ 3 kg was applied to the soil in specific seed bed at twenty days before sowing and mixed with the soil properly for proper decomposition, growing antagonistic microorganisms and developing suppressiveness.

3.2.5 Application of ash

Ash @ 5 kg was applied to the soil in specific seed bed at twenty days before sowing and mixed with the soil properly for proper decomposition, growing antagonistic microorganisms and developing suppressiveness.

3.2.6 Application of sawdust

Sawdust @5kg was applied to the soil in specific seed bed at twenty days before sowing and mixed with the soil properly for proper decomposition, growing antagonistic microorganisms and developing suppressiveness.

3.2.7 Application of khudepana

Khudepana @ 10 kg was applied to the soil in specific seed bed at twenty days before sowing and mixed with the soil properly for proper decomposition, growing antagonistic microorganisms and developing suppressiveness.

3.2.8 Application of cowdung:

Cowdung @ 10 kg was applied to the soil in specific seed bed at twenty days before sowing and mixed with the soil properly for proper decomposition, growing antagonistic microorganisms and developing suppressiveness.

3.2.9 Application of solarized sand:

Solarized sand @ 10 kg was applied to the soil in specific seed bed at twenty days before sowing and mixed with the soil properly.

3.2.10 Seed treatment with *Trichoderma harzianum*

Seed treatment with bio-agent was done by dipping the seeds in the fungal spore suspension of bioagent (*Trichoderma harzianum*) for 1 hour @ 10^6 spore/ml concentration, Pedreschi *et al.*(1997). After treatment, the seeds were allowed to air dry up for 6 hours before sowing.

3.2.11 Sowing of seeds:

200 seeds of each crop were sown in the seed bed. The seeds were sown in the field continuously in lines and were covered by soil with the help of hand.

3.2.12 Intercultural operation:

After emergence of seedlings various intercultural operations like irrigation, weeding & loosing the soil were done for better growth and development of crops.

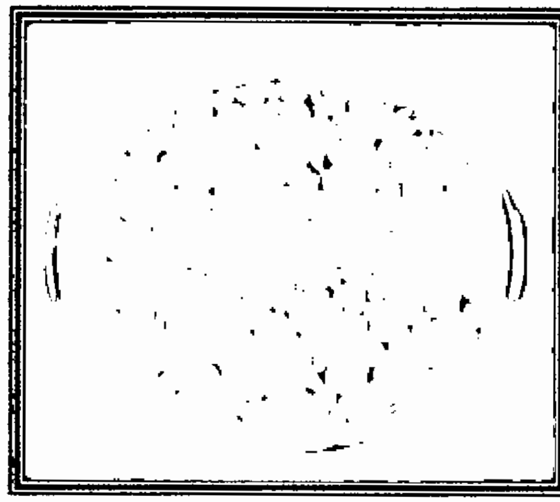
3.2.13 Isolation of causal organisms of damping off infected seedlings:

The diseased plants were collected form the seed bed and were taken to the laboratory. The diseased plant was cut into small pieces (about 0.5-1cm) and surface sterilized by dipping in $HgCl_2$ solution (0.01%) for 30 second. The cut pieces were then washed in sterilized water for three times and were placed into PDA media in sterilized petridish with the help of sterile forceps and incubated at 25 ± 1^0 c for 7-10 days. Latter the pathogen was purified using hyphal tip culture method grown on PDA media at 25 ± 1^0 c for 2 weeks. Causal organism was identified under stereomicroscope and compound microscope. The collected diseased plants were also kept in 3 layers of blotter in plastic petridish that was soaked in sterilized water. After 7days of incubation the sclerotia were formed. The sclerotia were carefully picked up and transferred on to fresh PDA plate and incubated at 20^0 c for 7 days. After 7 days floppy mycelial growth was observed.

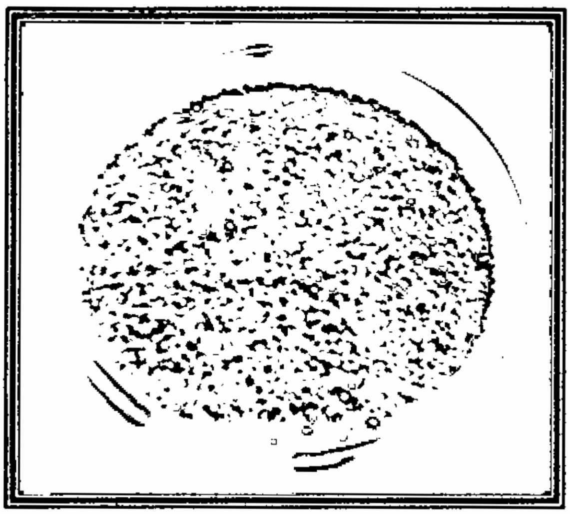
3.2.14 Interaction of *Trichoderma harzianum* with *Sclerotium rolfsii* and *Fusarium oxysporum* in the laboratory

Mycelium discs (5mm diameter) of each of the fungal isolates were cut from the edge of an actively growing fungal colony by a 5 mm diameter cork borer. One disc of *Sclerotium rolfsii* and one disc of *Trichoderma harzianum* were placed in PDA plate at the same distance. The plates were incubated at 25°C for 7 days. The same procedure follow incase of *Fusarium oxysporum.*

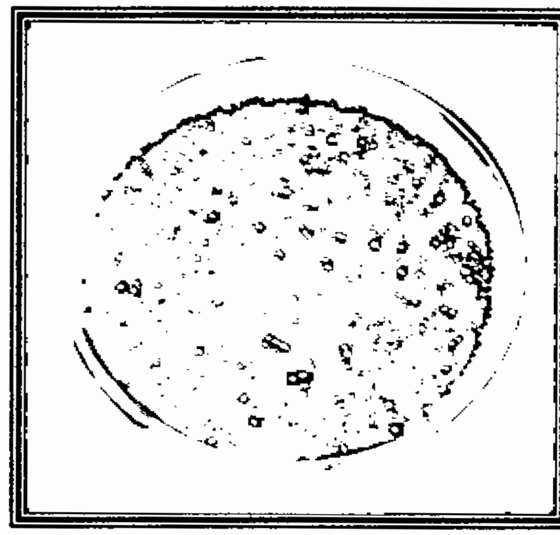
A. Seeds of Potato (TPS)
BARI TPS-1



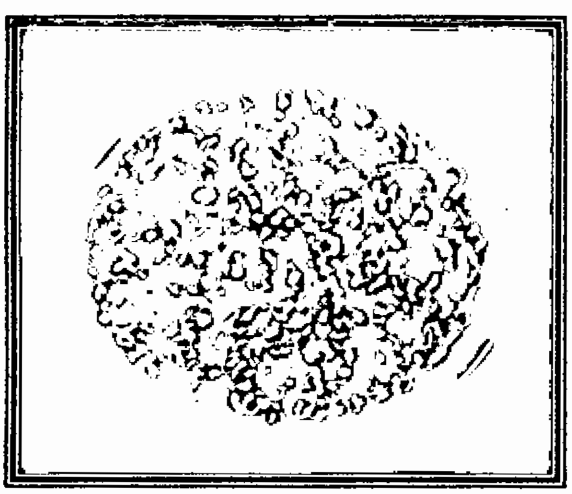
B. Seeds of Chilli,
BARI Marich-1(Banglalanka),



C. Seeds of Cabbage
BARI Badhakopi-1 (Provati)



D. Seeds of Cauliflower BARI
Fullkopi-1 (Rupa)



E. Seeds of Tomato BARI
Tomato-2 (Raton)

F. Seeds of Brinjal BARI
Bagun-5(Nayan Tara)

Plate 6. Photographs(A-F) showing seeds of different crops used in the experiment.

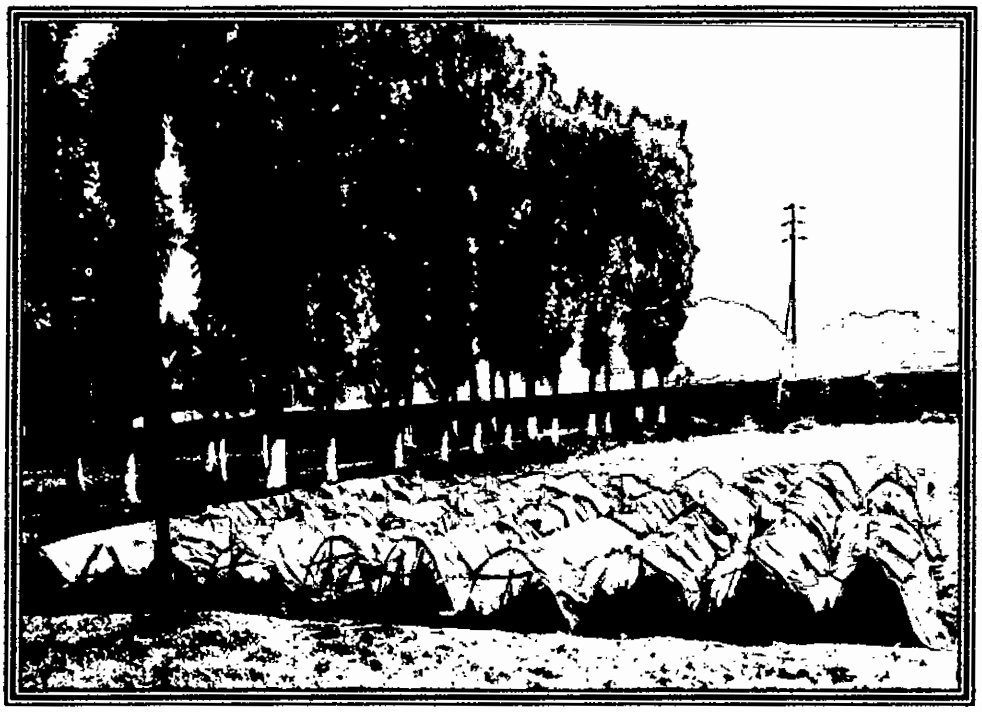


Plate13. Experimental view with shade

Plate14. Experimental view without shade

3.2.15 Recording of Data

Duration of germination of different seeds were different after sowing. Therefore, data were recorded after 3 days of germination. Data were recorded on percent germination at 7 DAS, 10 DAS, 13 DAS for potato, cabbage, cauliflower, tomato and 12 DAS, 15 DAS, 18 DAS for chilli and eggplant. Damping off disease incidence was recorded at 15, 20, 25 days after sowing for potato, cabbage, cauliflower, tomato and 20, 25, 30 days after sowing for chilli, egg-plant. Seedling growth characters such as shoot length, root length, seedling height, fresh shoot weight, fresh root weight, dry shoot weight, dry root weight and biomass were also recorded at 30 DAS for potato, tomato, cabbage, cauliflower and 35 DAS for chilli and egg-plant.

3.2.16 Analysis of Data

The data on various parameters were analyzed using analysis of variance to find out variation obtained from different treatments. Mean differences among the treatments were compared by Duncan's Multiple Range Test (DMRT).

Chapter 4

Results

CHAPTER IV

RESULTS

4.1. FIELD EXPERIMENT

4.1.1 Identification of causal organism

The causal organism was isolated infected plant in the laboratory. The fungus was purified and identified as *Fusarium oxysporum.* In PDA, the fungus grow whitish mycelium which latter developed gray colour colony due to the sporulation. The pathogen produce single cell of microconidia and 2-3 celled slightly curved macroconidia in pure culture (Plate 9). The sclerotia were carefully picked up and transferred on to fresh PDA plate and incubated at 20^0 c for 7 days. After 7 days fluppy mycelial growth was observed. After few days of mycelial growth, brownish sclerotia were formed on the media and the fungus was identified as *Sclerotium rolfsii.*

4.1.2 Duel culture of *Trichoderma harzianum* with *Fusarium oxysporum* and *Sclerotium rolfsii*

The growth of *Trichoderma harzianum* completely suppress the growth of *Fusarium oxysporum* within seven Days. And also the growth of *Trichoderma harzianum* completely suppresses the growth of *Sclerotium rolfsii* within seven Days.

Plate 9. Pure culture of *Fusarium oxysporum*

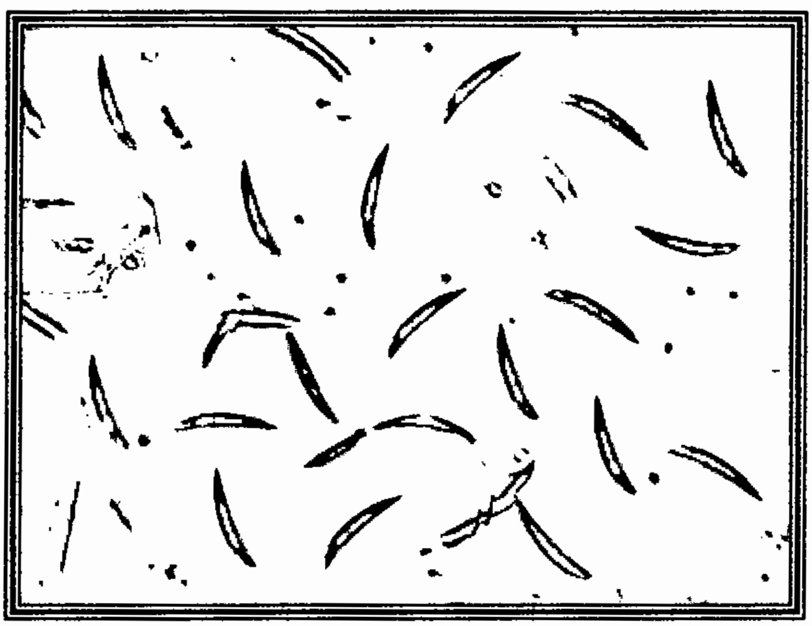


Plate 10. Macro and micro Conidia of *Fusarium oxysporum* under compound microscope (X 400)

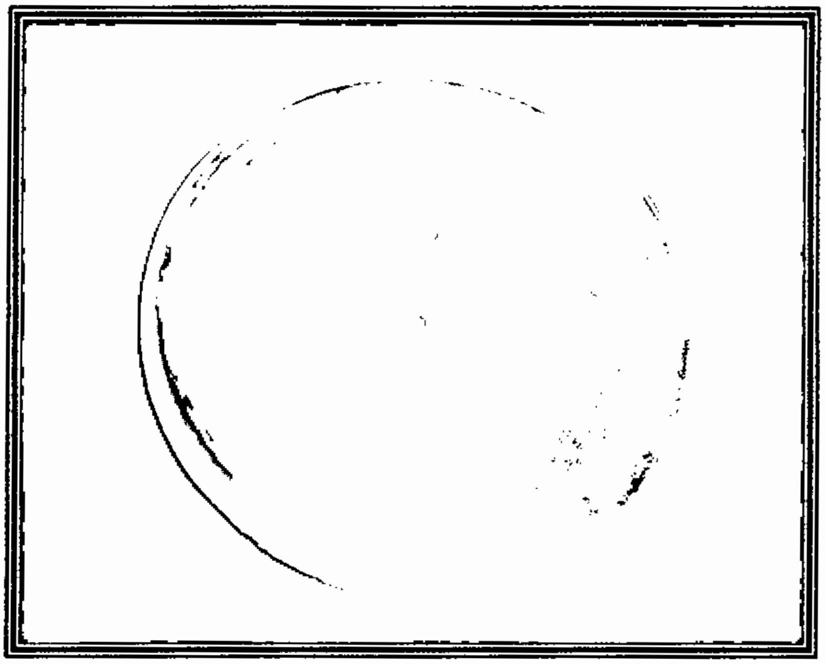


Plate 11. Pure culture *Sclerotium rolfsii.*

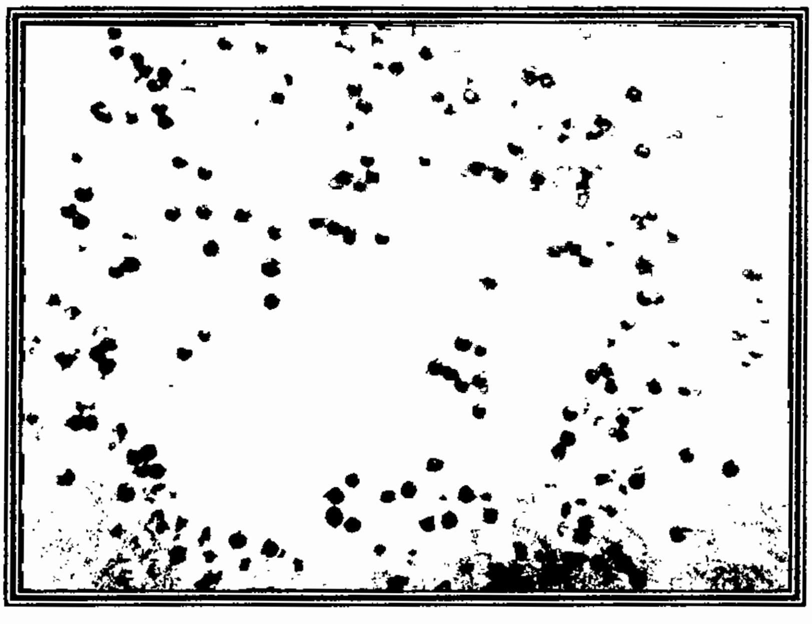
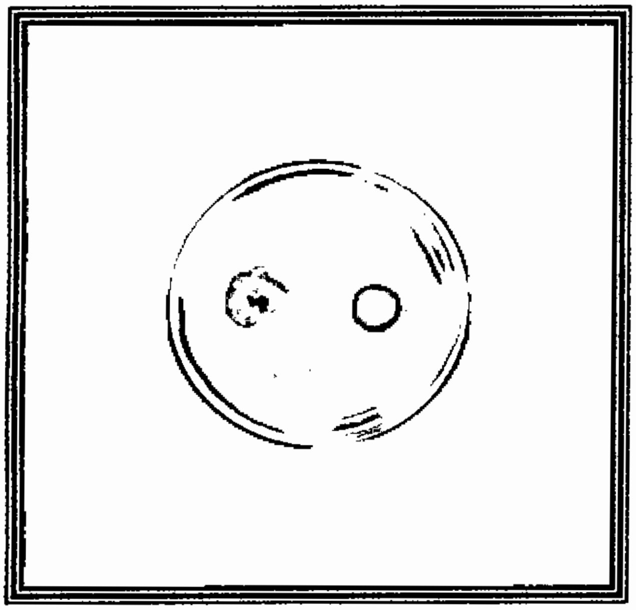
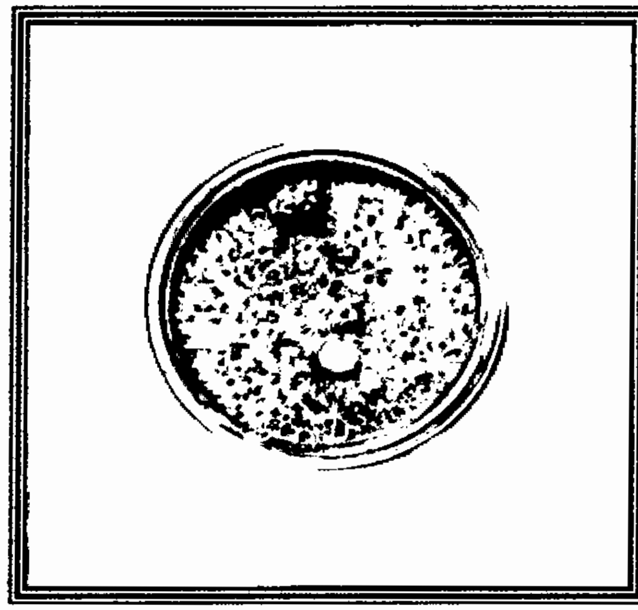


Plate 12. Sclerotia form in culture medium

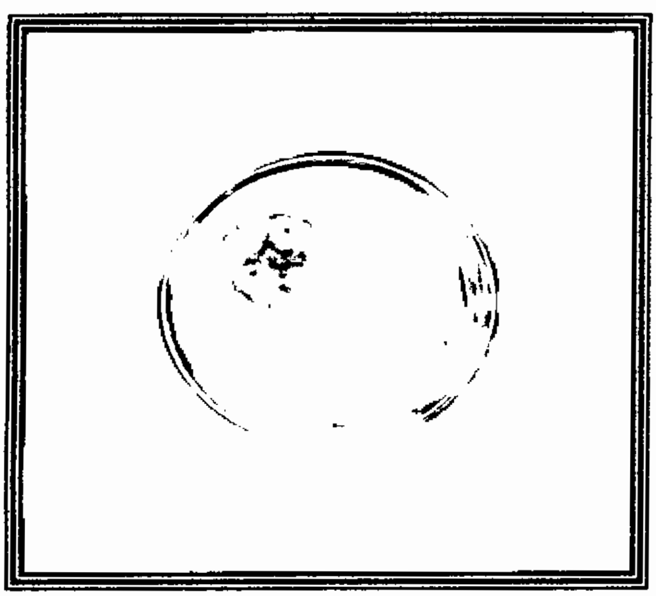


Initial stage of duel culture of *Fusarium oxysporum* and *Trichoderma harzianum*

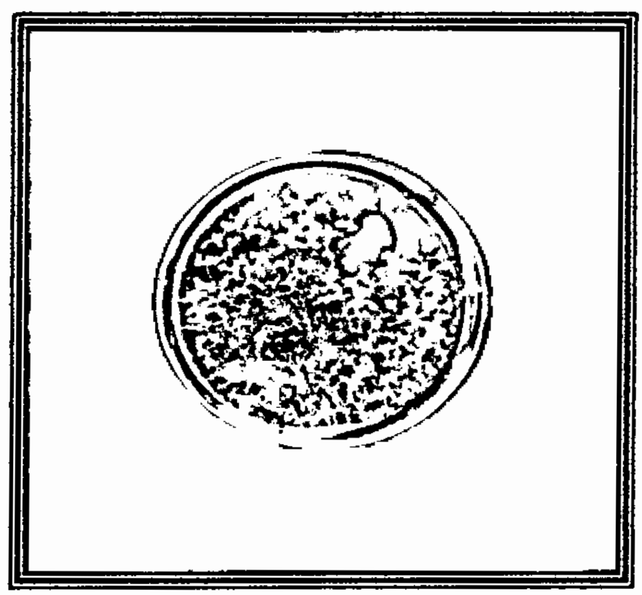


Trichoderma harzianum supress the growth of *Fusarium oxysporum* within seven Days,

Plate 13. Duel culture of *Trichoderma harzianum* and *Fusarium oxysporum*



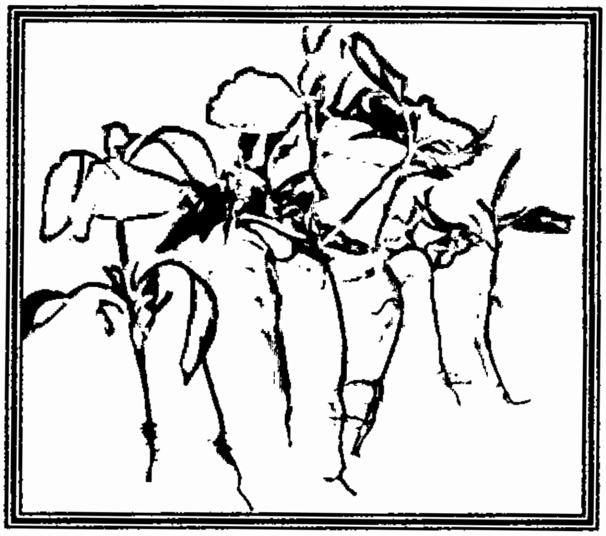
Initial stage of duel culture of *Sclerotium rolfsii* and *Trichoderma harzianum*



Trichoderma harzianum supress the growth of *Sclerotium rolfsii* within seven Days,

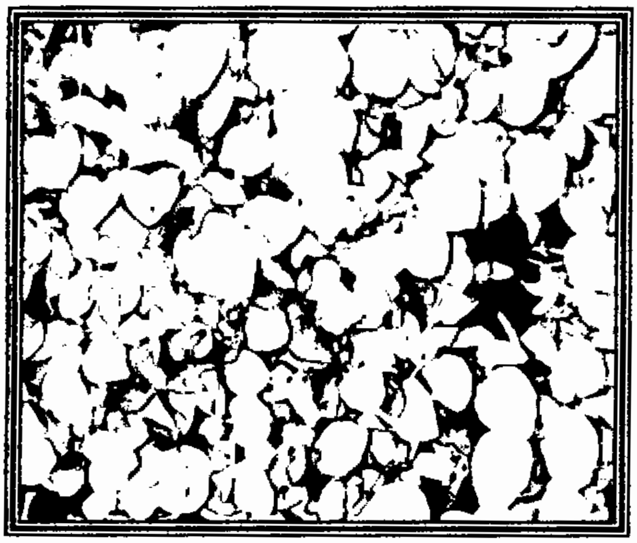
Plate 14. Duel culture of *Trichoderma harzianum* and *Sclerotium rolfsii*

Healthy Seedlings

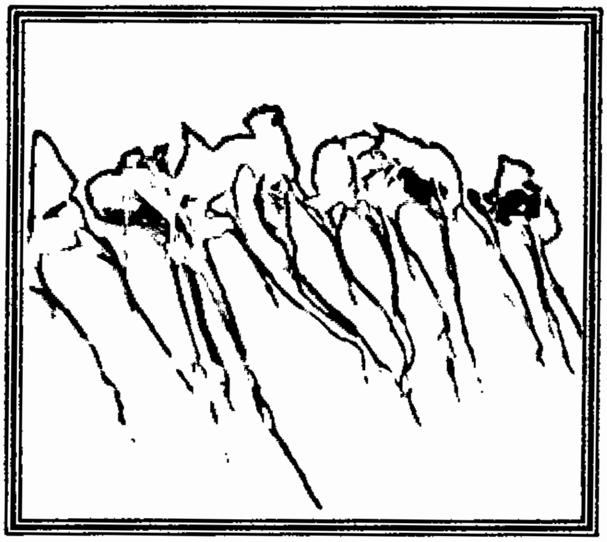


Infected seedlings

Plate 15. Healthy and Damping of infected seedlings of chilli

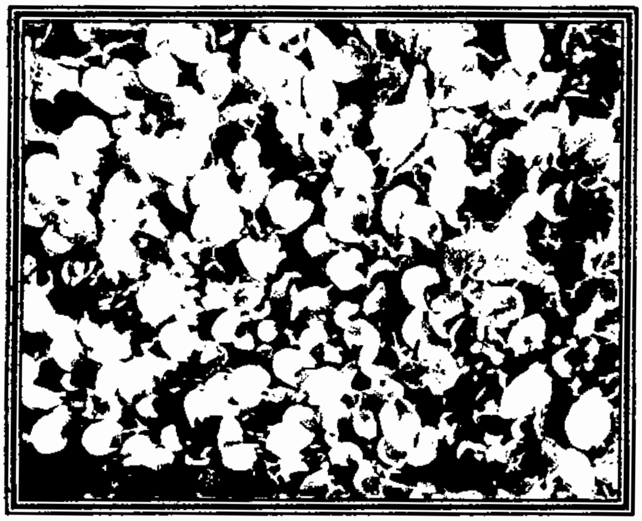


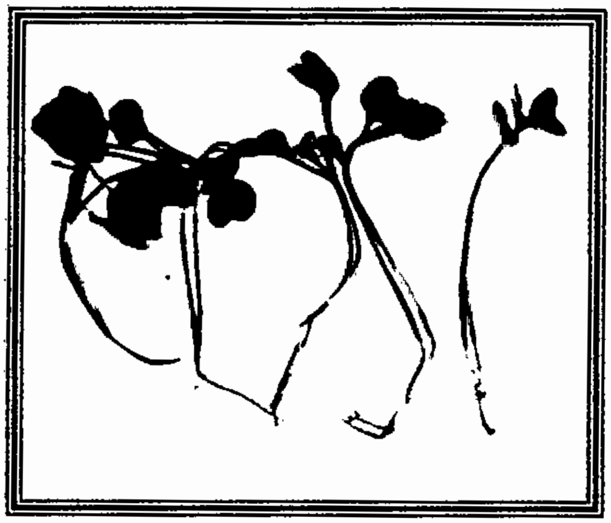
Healthy seedlings



Infected seedlings

Plate 16. Healthy and Damping of infected seedlings of egg-plant

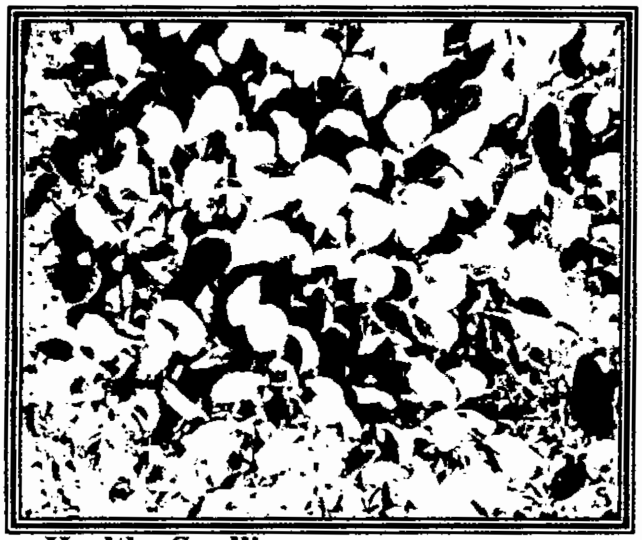




Healthy seedlings

Infected seedlings

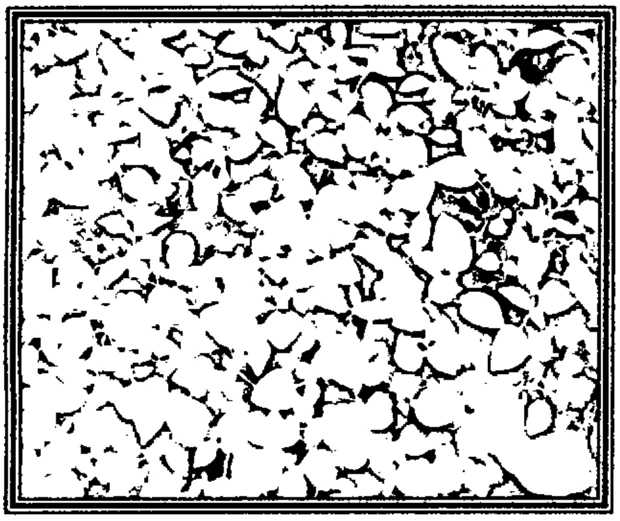
Plate 17. Healthy and Damping of infected seedlings of cauliflower



Healthy Seedlings

Infected seedlings

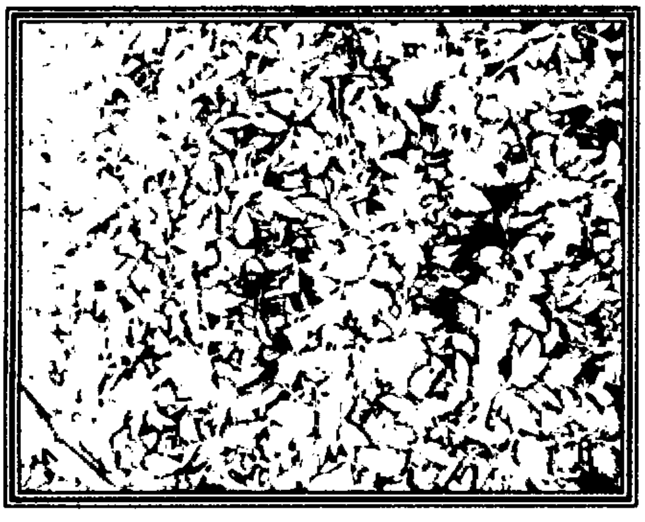
Plate 18. Healthy and Damping of infected seedlings of cabbage



Healthy Seedlings

Infected seedlings

Plate 19. Healthy and Damping of infected seedlings of potato (TPS).



Healthy Seedlings

Infected seedlings

Plate 20. Healthy and Damping of infected seedlings of tomato.

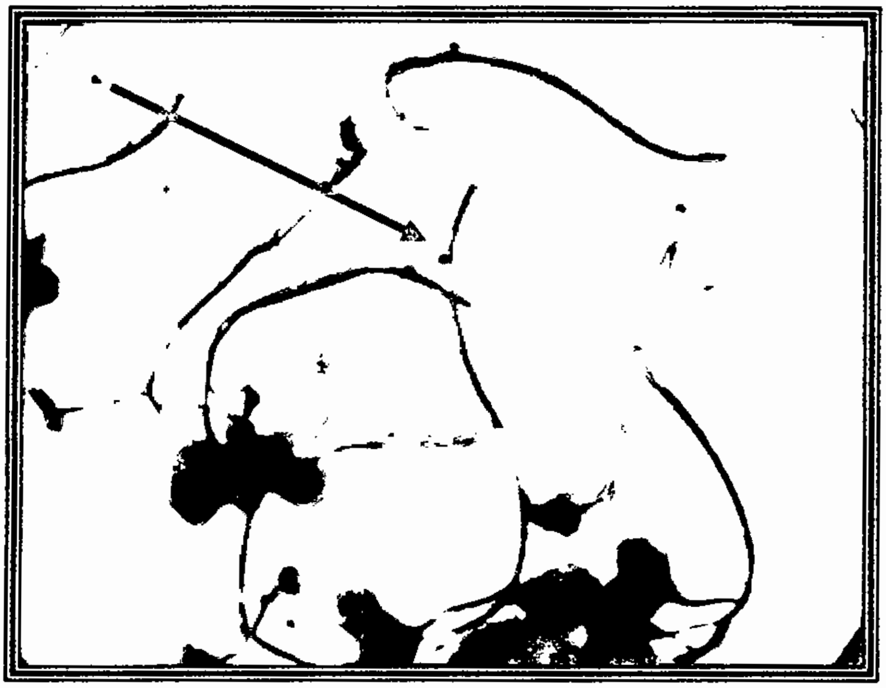


Plate 21. Sclerotia form in Blotter paper method on cauliflower seedlings

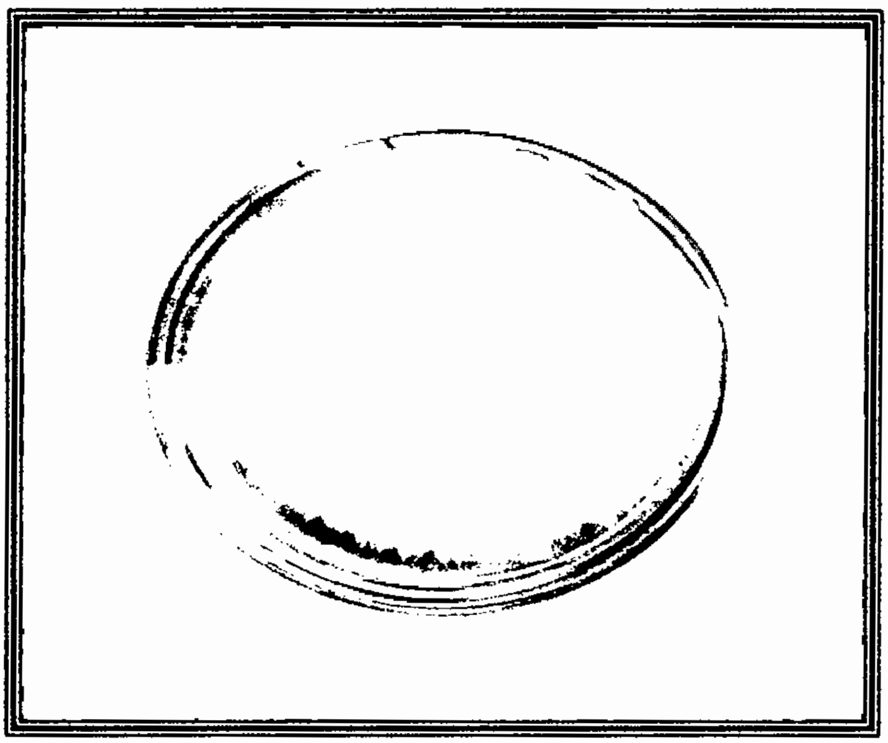


Plate 22. Fan shape growth of *Sclerotium rolfsii*

4.1.3. Effect of different treatments on seed germination of Potato and Chilli seedlings

The effect of different treatments on germination of potato and chilli seedlings at different days after sowing has been presented in Table 1. and significant variation. was observed. Regardless of sowing dates, the highest germination percentage of potato was recorded in T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*) where germination percentage was 82.00% at 7 DAS, 87.00% at 10 DAS and 94.00% at 13 DAS followed by T_1 (Soil application with *Trichoderma harzianum*). On the other hand, the lowest (28.33% at 7 DAS, 31.00% at 10 DAS and 34.00% at 13 DAS) germination percentage at different days after sowing was recorded in T_{20} (Control) where no treatments were used. At 7 DAS, statistically similar result was found in T_5, T_{16}, T_{17}, T_{18} & T_{19}. It has been also recorded that the treatments T_5, T_6, T_7, T_8, T_9, T_{10}, T_{16}, T_{17} and T_{18} did not show significant variation in terms of germination percentage of potato at 10 DAS.

Irrespective days after sowing, the highest germination percentage of chilli was recorded in T_{11} where germination percentage was 71.33% at 12 DAS, 79.33% at 15 DAS and 86.67% at 18 DAS followed by T_{14} (Seed treatment with *T. harzianum*+ Vermicompost). On the other hand, the lowest germination percentage at different days after sowing was recorded in T_{20} (Control) where no treatments were used. At 12 DAS and 18 DAS, statistically similar result was found in T_5 & T_{10}. At 15 DAS, T_4 (Soil application with Vermicompost) and T_{17} (Seed treatment with *T. harzianum*+ Khudepana) showed similar result in terms of germination percentage.

Table: 1 Effect of different treatments on seed germination of true potato and chilli seedlings at different days after sowing

Treatment	% Germination of true potato seedlings			% Germination of chilli seedlings		
	7 DAS	10 DAS	13DAS	12 DAS	15 DAS	18DAS
T_1 (Soil application with *Trichoderma harzianum*)	69.00 b	75.00 ab	80.00 b	64.00 b-d	70.67 b	76.67 bc
T_2 (Soil application with Poultry Waste)	61.67 cd	64.67 bc	71.00 d	61.00 f-h	64.33 fg	70.33 fg
T_3 (Soil application with Cocodust)	55.00 e	60.00 cd	66.00 e	57.67 j	61.33 i	67.00 jk
T_4 (Soil application with Vermicompost)	60.00 d	63.67 bc	70.00 d	62.33 d-fg	65.67 e	71.33 ef
T_5 (Soil application with Ash)	39.33 gh	44.00 ef	51.33 h	55.67 k	59.33 j	63.67 m
T_6 (Soil application with Sawdust)	34.33 ij	40.00 ef	50.00 h	57.33 j	59.67 j	65.33 l
T_7 (Soil application with Khudepana)	33.00 ij	36.33 ef	42.00 i	59.67 hi	63.00 h	66.67 jk
T_8 (Soil application with Cowdung)	31.67 jk	34.33 ef	41.00 i	60.67 gh	62.67 h	66.33 kl
T_9 (Soil application with Solarized Sand)	36.00 hi	41.33 ef	51.00 h	61.33 f-h	64.33 fg	67.67 ij
T_{10} (Seed treatment with *T. harzianum*)	33.00 ij	35.00 ef	40.00 i	54.33 k	60.33 ij	62.67 m
T_{11} (T_{10} + T_1)	82.00 a	87.00 a	94.33 a	71.33 a	79.33 a	86.67 a
T_{12} (T_{10}+ T_2)	64.00 c	70.00 bc	77.00 c	64.67 bc	68.67 c	76.00 c
T_{13} (T_{10}+ T_3)	60.00 d	65.00 bc	71.00 d	63.67 c-e	67.33 d	72.67 d
T_{14} (T_{10} +T_4)	48.00 f	64.00 bc	77.33 bc	65.33 b	70.33 b	77.33 b
T_{15} (T_{10} + T_5)	43.67 f	49.67 de	58.00 g	58.67 ij	62.67 h	68.67 hi
T_{16} (T_{10} + T_6)	40.00 g	45.00 ef	56.00 g	60.67 gh	63.33 gh	69.33 gh
T_{17} (T_{10}+ T_7)	38.67 gh	41.33 ef	51.33 h	62.00 e-g	66.00 e	70.67 ef
T_{18} (T_{10} + T_8)	36.33 g-i	39.00 ef	49.00 h	62.67 d-f	65.33 ef	71.67 de
T_{19} (T_{10}+ T_9)	39.67 gh	48.00 de	61.00 f	63.67 b-e	66.33 de	71.67 de
T_{20} (Untreated Control)	28.33 k	31.00 f	34.00 j	52.67 l	55.33 k	58.67 n
LSD (p=0.05)	3.439	13.22	2.757	1.506	1.127	1.174

4.1.4. Effect of different treatments on seed germination of tomato and eggplant seedlings

Highly significant variations were observed among the different treatments in respect of germination percentage of tomato at different days after sowing (Table 2). Irrespective days after sowing, the highest germination percentage of tomato was recorded in T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*) where germination percentage was 82.67 %at 7 DAS, 87.00% at 10 DAS and 92.00% at 13 DAS which was closely followed by T_1 (Soil application with *T. harzianum*) T_{12} (Seed treatment with *T. harzianum* +Poultry Waste) and T_{14} (Seed treatment with *T. harzianum*+ Vermicompost). On the other hand, the lowest germination percentage at different days after sowing was recorded in T_{20} where no treatment was used. At 7 DAS, statistically significant result was found in T_3, T_5, T_7, T_8 and T_{16} in terms of germination percentage. At 10 DAS, T_3, T_7, T_8 and T_{16} showed statistically similar effect in comparison to control (T_{20}) in terms of germination percentage.

The effect of seed treatment & soil application with bio-agent (*Trichoderma harzianum*) and soil application with soil amendment on germination percentage of eggplant at different days after sowing showed significant variation (Table 2). Irrespective days after sowing, the highest germination percentage of eggplant was recorded in T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*) where germination percentage was 80.00%at 12 DAS, 89.00% at 15 DAS and 94.33% at 18 DAS followed by T_1 (Soil application with *Trichoderma harzianum*) T_{12} (Seed treatment with *T. harzianum* +Poultry Waste) and T_{14} (Seed treatment with *T. harzianum*+ Vermicompost). On the other hand, the lowest germination percentage at different days after sowing was recorded in T_{20} (Untreated control). It has been found that T_{13} and T_{19} showed similar result in case of germination percentage at 12 DAS. At 15 DAS, T_2 and T_{19} showed statistically similar effect on germination percentage of eggplant. The treatment T_3, T_9, T_{15} and T_{17} did not show any significant difference in case germination percentage at 18 DAS of eggplant.

Table: 2 Effect of different treatments on seed germination of tomato and eggplant seedlings at different days after sowing

Treatment	% Germination of tomato seedlings			% Germination of eggplant seedlings		
	7 DAS	10 DAS	13DAS	12 DAS	15 DAS	18DAS
T_1 (Soil application with *Trichoderma harzianum*)	79.67ab	84.67 ab	82.67ab	76.00 b	81.3 b	86.33 b
T_2 (Soil application with Poultry Waste)	71.67 b-e	76.67 b-e	76.00 b-d	71.00 cd	76.00 cd	80.67 c
T_3 (Soil application with Cocodust)	63.67 e-g	69.00 e-i	70.00 c-e	66.00 ef	71.00 f	76.67 d
T_4 (Soil application with Vermicompost)	69.33 b-e	74.67 c-f	75.67 b-d	72.00 c	77.00 c	79.33 c
T_5 (Soil application with Ash)	61.67 e-g	66.33 f-i	67.00 de	63.33 gh	67.00 g	72.00 fg
T_6 (Soil application with Sawdust)	57.67 fg	64.00 g-i	66.33 de	60.00 i	64.00 h	70.33 g
T_7 (Soil application with Khudepana)	63.33 e-g	69.00 e-i	69.33 c-e	62.00 h	68.00 g	73.00 ef
T_8 (Soil application with Cowdung)	62.67 e-g	69.00 e-i	66.67 de	63.33 gh	68.33 g	71.67 fg
T_9 (Soil application with Solarized Sand)	68.00 c-f	74.00 c-g	66.67 de	67.00 e	71.00 f	76.33 d
T_{10} (Seed treatment with *T. harzianum*)	58.00 fg	63.00 hi	65.00 de	56.00 j	63.33 h	66.33 h
T_{11} ($T_{10}+T_1$)	82.67 a	87.00 a	92.00 a	80.00 a	89.00 a	94.33 a
T_{12} ($T_{10}+T_2$)	76.67 a-c	80.00 a-d	82.00 ab	75.00 b	81.00 b	86.00 b
T_{13} ($T_{10}+T_3$)	65.67 d-f	72.67c-h	75.00 b-d	70.00 d	76.00 cd	81.00 c
T_{14} ($T_{10}+T_4$)	75.00 a-d	82.33 a-c	83.67 ab	76.00 b	82.00 b	85.00 b
T_{15} ($T_{10}+T_5$)	66.00 c-f	72.00 d-h	73.33 b-d	67.00 e	72.00 ef	76.33 d
T_{16} ($T_{10}+T_6$)	61.67 e-g	68.00 e-i	72.67 b-e	65.00 fg	71.00 f	74.67 de
T_{17} ($T_{10}+T_7$)	67.67 c-f	73.00 c-h	75.00 b-d	66.00 ef	74.00 de	76.67 d
T_{18} ($T_{10}+T_8$)	65.67 c-f	72.00 d-h	75.00 b-d	67.33 e	73.00 ef	75.00 de
T_{19} ($T_{10}+T_9$)	70.67 b-e	77.00 b-e	79.67 bc	70.00 d	76.00 cd	81.00 c
T_{20} (Untreated Control)	54.00 g	59.00 i	61.00 e	51.00 k	56.00 i	62.33 i
LSD (p=0.05)	9.429	8.684	10.18	1.73	1.93	2.40

4.1.5. Effect of different treatments on seed germination of cabbage and cauliflower seedlings

The effect of different treatments on germination percentage of Cabbage and Cauliflower at different days after sowing showed significant variation (Table 3). Irrespective days after sowing, the highest germination percentage of Cabbage was recorded in T_{11} (Seed treatment with *T. harzianum* + Soil application with *T. harzianum*) where germination percentage was 72.00% at 7 DAS, 81.67% at 10 DAS and 88.00% at 13 DAS followed by T_1. Incase of cabbage T_{15} Showed similar effect in terms of germination percentage like T_{16}, T_{17}, T_{18} & T_{19} at 10 DAS. On the other hand, the lowest germination percentage at different days after sowing was recorded in T_{20} (Control) where no treatments were used. At 7 DAS, statistically similar result was found in T_5, T_{16}, T_{17}, T_{18} & T_{19} and at 10 DAS, T_5, T_6, T_7, T_8, T_9, T_{10}, T_{16}, T_{17} and T_{18} showed statistically similar effect in comparison to control (T_{20}) in terms of germination percentage. Irrespective days after sowing, the highest germination percentage of Cauliflower was recorded in T_{11} where germination percentage was 66.33% at 7 DAS, 77.67% at 10 DAS and 90.00% at 13 DAS followed by T_1. On the other hand, the lowest germination percentage at different days after sowing was recorded in T_{20} (Control) where no treatments were used. At 7 DAS, statistically similar result was found in T_5 & T_{10} and at 10 DAS, similar effect was also found in comparison to control (T_{20}) in terms of germination percentage. Irrespective days after sowing, the highest germination percentage of Cabbage was recorded in T_{11} which was closely followed by T_1 and T_{12} while the lowest germination percentage at different days after sowing was recorded in T_{20} which was closely followed by T_3, T_5, T_6, T_7, T_8, T_{10} and T_{16}.

Table: 3 Effect of different treatments on seed germination of cabbage and cauliflower seedlings at different days after sowing

Treatment	% Germination of cabbage seedlings			% Germination of cauliflower seedlings		
	7 DAS	10 DAS	13DAS	7 DAS	10 DAS	13DAS
T_1 (Soil application with *Trichoderma harzianum*)	66.67 b	71.00 c	81.67 b	62.00 b	70.33 bc	82.00 b
T_2 (Soil application with Poultry Waste)	59 de	65.00 e	73.00 d	55.67 d	62.00 de	71.33 ef
T_3 (Soil application with Cocodust)	56 g-i	61.67 f-h	68.33 fg	46.00 hi	52.33 h	66.00 ij
T_4 (Soil application with Vermicompost)	57.67 e-g	63.00 f	71.00 de	51.00 f	58.00 f	77.00 d
T_5 (Soil application with Ash)	51.00 k	56.00 hi	63.00 i	45.00 i	51.00 hi	62.00 l
T_6 (Soil application with Sawdust)	54.67 h-j	61.00 g	67.33 g	43.33 j	49.67 ij	62.00 l
T_7 (Soil application with Khudepana)	55.00 h-j	63.00 f	65.00 h	47.00 gh	52.00 h	63.33 kl
T_8 (Soil application with Cowdung)	49.00 l	56.33 h	62.00 i	41.00 k	47.33 k	59.00 m
T_9 (Soil application with Solarized Sand)	54.00 ij	61.00 g	67.67 g	45.00 i	52.33 h	64.67 jk
T_{10} (Seed treatment with *T. harzianum*)	49.00 kl	54.67 i	61.67 i	41.00 k	49.00 j	58.00 m
T_{11} ($T_{10}+T_1$)	72.00 a	81.67 a	88.00 a	66.33 a	77.67 a	90.00 a
T_{12} ($T_{10}+T_2$)	64.00 c	73.00 b	80.00 b	61.00 b	71.00 b	80.33 bc
T_{13} ($T_{10}+T_3$)	60 d	65.33 e	73.00 d	53.00 e	62.33 de	73.00 e
T_{14} ($T_{10}+T_4$)	63 c	71.00 c	77.00 c	58.00 c	69.00 c	79.33 c
T_{15} ($T_{10}+T_5$)	56.67 f-h	62.67 fg	68.33 fg	53.00 e	61.00 e	68.00 h
T_{16} ($T_{10}+T_6$)	58.33 d-f	63.33 f	70.00 ef	51.33 f	61.33 de	70.00 fg
T_{17} ($T_{10}+T_7$)	59.00 de	69.00 d	68.33 fg	52.33 ef	63.00 d	67.33 hi
T_{18} ($T_{10}+T_8$)	53.00 j	62.00 f-h	70.00 ef	48.00 g	56.33 g	64.00 k
T_{19} ($T_{10}+T_9$)	59.00 de	68.00 d	73.00 d	51.00 f	63.00 d	69.00 gh
T_{20} (Untreated Control)	43.33 m	47.00 j	54.00 j	36.00 l	43.00 l	52.00 n
LSD (p=0.05)	1.948	1.539	1.885	1.400	1.595	1.691

4.1.6. Effect of different treatments on damping-off of potato and chilli seedlings

Different treatments used for the management of damping-off disease of vegetable in the present trial showed a statistically significant variation in respect of percent damping-off of vegetable seedling (Table 4). Irrespective days after sowing the highest result against damping-off of potato was recorded in T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*) while the lowest result was recorded in T_{20} (Untreated Control). No damping-off of potato seedlings was found in soil and seed treatment with *Trichoderma harzianum* at 15 DAS. Statistically similar result was found between T_{20}, T_{10} and T_7 in terms of percent damping-off recorded at 15 days after sowing. Irrespective days after sowing, the highest effect against damping-off of chilli was recorded in T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*) followed by T_{12} (Seed treatment with *T. harzianum* +Poultry Waste) and lowest effect against damping-off was recorded in T_{20}. No damping-off of chilli seedlings was found in T_{11} at 15 DAS. Another treatment was found specially, T_2 (poultry waste) and T_4 (vermicompost) better result in reducing percent damping-off of different vegetable in comparison to control at different days after sowing. Seed treatment and soil application with *Trichoderma harzianum* clearly indicates its good effect in reducing pre-emergence & post-emergence damping-off incidence and increasing seed germination of vegetable seedlings. It was also found that the effect against damping-off was higher in seed treatment with *Trichoderma harzianum* +soil application with *Trichoderma harzianum* seed bed than only soil application with *Trichoderma harzianum* seed bed. Soil application with soil amendment performed better against damping-off when seeds were sown in the seed bed by treated with *Trichoderma harzianum* than only soil application with different soil amendment.

Table: 4 Effect of different treatment on percent damping-off of potato and chilli seedlings at different days after sowing

Treatment	Percent damping-off of potato seedlings			Percent Damping-off of chilli seedlings		
	15DAS	20DAS	25DAS	20 DAS	25DAS	30 DAS
T_1 (Soil application with *Trichoderma harzianum*)	1.67 h	3.00 k	7.00 l	1.33k	2.33 l	4.67 i
T_2 (Soil application with Poultry Waste)	4.33 d-f	7.00 hi	13.33 gh	3.67 g-i	5.67 g-i	8.67 gh
T_3 (Soil application with Cocodust)	6.00 d-f	12.33 cd	17.67 d	4.00 f-h	6.33 f-h	9.33 fg
T_4 (Soil application with Vermicompost)	4.33 bc	8.33 gh	15.00 f	3.67 g-i	5.67 g-i	9.00 gh
T_5 (Soil application with Ash)	6.67 b-d	11.00 de	19.33 c	5.33 b-e	8.00 c-e	11.00 de
T_6 (Soil application with Sawdust)	5.67 b-d	14.00 b	21.33 b	5.67 b-d	9.33 bc	12.33 cd
T_7 (Soil application with Khudepana)	7.00 ab	12.00 cd	17.67 d	6.33 ab	8.33 b-d	13.67 bc
T_8 (Soil application with Cowdung)	6.00 bc	12.67 bc	21.00 b	5.67 b-d	9.67 b	15.00 b
T_9 (Soil application with Solarized Sand)	5.00 cd	9.33 fg	17.67 d	5.00 c-f	7.33 d-f	11.33 de
T_{10} (Seed treatment with *T. harzianum*)	7.00 ab	14.00 b	22.00 b	6.00 bc	9.33 bc	14.67 b
T_{11} ($T_{10}+T_1$)	0.00 i	1.00 l	2.33 m	0.00 l	0.33 m	2.00 j
T_{12} ($T_{10}+T_2$)	2.67 gh	5.00 j	10.33 k	2.00 jk	3.33 kl	4.67 i
T_{13} ($T_{10}+T_3$)	3.67 e-g	10.00 ef	12.67 hi	3.333 hi	4.67 i-k	7.67 h
T_{14} ($T_{10}+T_4$)	3.00 fg	6.00 ij	11.33 jk	2.67 ij	4.00 jk	6.00 i
T_{15} ($T_{10}+T_5$)	5.00 c-e	9.00 fg	15.33 ef	4.67 d-g	6.67 e-h	8.67 gh
T_{16} ($T_{10}+T_6$)	4.00 e-g	11.00 de	13.33 gh	3.67 g-i	5.33 h-j	8.67 gh
T_{17} ($T_{10}+T_7$)	5.00 c-e	10.00 ef	14.33 fg	5.00 c-f	7.00 d-g	10.67 ef
T_{18} ($T_{10}+T_8$)	5.00 c-e	10.00 ef	16.33 e	4.33 e-h	6.67 e-h	11.67 de
T_{19} ($T_{10}+T_9$)	3.67 e-g	7.00 hi	11.67 ij	3.67 g-i	5.33 h-j	8.00 gh
T_{20} (Untreated Control)	8.00 a	17.67 a	28.67 a	7.33 a	13.33 a	18.67 a
LSD (p=0.05)	1.266	1.341	1.227	1.076	1.274	1.410

4.1.7. Effect of different treatments on damping-off of tomato and eggplant seedlings

Different treatments used for the management of damping-off disease of vegetable in the present trial showed a statistically significant variation in respect of percent damping-off of vegetable seedling (Table 5). Irrespective days after sowing the highest result against damping-off of tomato was recorded in T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*) while the lowest result was recorded in T_{20} (Untreated Control). No damping-off of tomato seedlings was found in soil and seed treatment with *Trichoderma harzianum* at 15 DAS. The highest percent damping-off was recorded in T_{20} treatment (Untreated Control). Irrespective days after sowing, the highest effect against damping-off of eggplant was recorded in T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*) followed by T_{12} (Seed treatment with *T. harzianum* +Poultry Waste) and lowest effect against damping-off was recorded in T_{20}. No damping-off of eggplant seedlings was found in T_{11} at 20 DAS. In T_2 (poultry waste) and T_4 (vermicompost) treatments were showed better result in reducing percent damping-off of different vegetable in comparison to control at different days after sowing. Seed treatment and soil application with *Trichoderma harzianum* clearly indicates its good effect in reducing pre-emergence & post-emergence damping-off incidence and increasing seed germination of vegetable seedlings. It was also found that the effect against damping-off was higher in seed treatment with *Trichoderma harzianum* +soil application with *Trichoderma harzianum* seed bed than only soil application with *Trichoderma harzianum* seed bed. Soil application with soil amendment performed better against damping-off when seeds were sown in the seed bed by treated with *Trichoderma harzianum* than only soil application with different soil amendment.

Table: 5 Effect of different treatments on percent damping-off of tomato and eggplant seedlings at different days after sowing

Treatment	Percent Damping-off of tomato seedlings			Percent Damping-off of eggplant seedlings		
	15 DAS	20DAS	25 DAS	20 DAS	25DAS	30 DAS
T_1 (Soil application with *Trichoderma harzianum*)	1.33 l	4.67 j	7.67 l	1.33 j	2.33 j	4.33 l
T_2 (Soil application with Poultry Waste)	3.00 jk	6.00 i	11.00 jk	3.33 hi	5.33 hi	9.33 i
T_3 (Soil application with Cocodust)	4.67 e-h	8.67 e-g	13.67e-g	4.67 d-g	7.33 ef	11.00 g
T_4 (Soil application with Vermicompost)	3.33 i-k	8.00 e-h	12.67g-i	3.67 gh	6.33 f-h	10.33 h
T_5 (Soil application with Ash)	5.67 c-e	11.00 bc	14.67d-f	6.67 ab	8.67 cd	13.67 d
T_6 (Soil application with Sawdust)	6.33 b-d	9.33 de	18.00 c	5.00 c-f	9.33 bc	15.67 c
T_7 (Soil application with Khudepana)	5.33 d-f	11.33 bc	15.67 d	5.67 bd	8.67 cd	14.00 d
T_8 (Soil application with Cowdung)	7.33 b	10.33 cd	19.33 bc	6.67 ab	9.67 bc	15.67 c
T_9 (Soil application with Solarized Sand)	5.33 d-f	9.00 ef	13.33f-h	5.33 ce	7.67 de	14.00 d
T_{10} (Seed treatment with *T. harzianum*)	6.67 bc	11.67 b	19.67 b	6.00 bc	10.33 b	18.33 b
T_{11} ($T_{10}+T_1$)	0.00 m	0.67 l	2.67 m	0.00 k	0.667 k	1.67 m
T_{12} ($T_{10}+T_2$)	1.67 l	2.67 k	7.33 l	1.67 j	3.33 j	6.33 k
T_{13} ($T_{10}+T_3$)	3.33 i-k	6.00 i	10.00 k	3.33 hi	6.33 f-h	9.67 i
T_{14} ($T_{10}+T_4$)	2.33 kl	4.33 j	8.33 l	2.33 ij	5.00 i	8.33 j
T_{15} ($T_{10}+T_5$)	4.00 g-j	7.67 f-h	12.67g-i	4.00 f-h	6.67 e-g	11.67 f
T_{16} ($T_{10}+T_6$)	4.33 fi	7.00 hi	14.00e-g	3.67 gh	5.67 g-i	12.67 e
T_{17} ($T_{10}+T_7$)	5.00 e-g	8.67 e-g	11.67 ij	4.333 e-h	6.67 e-g	12.67 e
T_{18} ($T_{10}+T_8$)	3.67 h-j	9.00 ef	15.00de	4.00 f-h	7.00 e-f	11.67 f
T_{19} ($T_{10}+T_9$)	4.33 f-i	7.33 gh	12.00h-j	3.67 gh	5.67 gi	10.33 h
T_{20} (Untreated Control)	8.67 a	14.00 a	24.33 a	7.33 a	15.67 a	21.00 a
LSD (p=0.05)	0.9751	1.221	1.380	1.12	1.01	0.558

4.1.8. Effect of different treatments on damping-off of cabbage and cauliflower seedlings

Different treatments used for the management of damping-off disease of vegetable in the present trial showed a statistically significant variation in respect of percent damping-off of vegetable seedling (Table 6). Irrespective days after sowing the highest result against damping-off of cabbage was recorded in T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*) while the lowest result was recorded in T_{20} (Untreated Control). No damping-off of cabbage seedlings was found in soil and seed treatment with *Trichoderma harzianum* at 15 DAS. The percent damping-off recorded T_{20} (Untreated Control) was highest. This treatment was statistically similar with T_7 and T_9 at 15 days after sowing. Irrespective days after sowing, the highest effect against damping-off of cauliflower was recorded in T_{11} followed by T_{12} and lowest effect against damping-off was recorded in T_{20}. Lowest damping-off of cauliflower seedlings was found in T_{11} at 20 DAS. Another treatment was found specially poultry waste and vermicompost better result in reducing percent damping-off of different vegetable in comparison to control at different days after sowing. Seed treatment and soil application with *Trichoderma harzianum* clearly indicates its good effect in reducing pre-emergence & post-emergence damping-off incidence and increasing seed germination of vegetable seedlings. It was also found that the effect against damping-off was higher in seed treatment with *Trichoderma harzianum* +soil application with *Trichoderma harzianum* seed bed than only soil application with *Trichoderma harzianum* seed bed. Soil application with soil amendment performed better against damping-off when seeds were sown in the seed bed by treated with *Trichoderma harzianum* than only soil application with different soil amendment.

Table: 6 Effect of different treatments on percent damping-off of cabbage and cauliflower seedlings at different days after sowing

Treatment	Percent Damping-off of cabbage seedlings			Percent Damping-off of cauliflower seedlings		
	15 DAS	20das	25DAS	15 DAS	20DAS	25 DAS
T_1 (Soil application with *Trichoderma harzianum*)	1.33 ij	3.33 hi	5.67 l	1.67 kl	3.67 jk	7.00 k
T_2 (Soil application with Poultry Waste)	2.00 g-i	5.67 fg	9.33 hi	3.33 i	5.00 ij	10.67 i
T_3 (Soil application with Cocodust)	2.33 f-h	5.00 fg	9.33 hi	5.33 fg	9.33 ef	13.67 ef
T_4 (Soil application with Vermicompost)	2.67 e-g	6.00 f	11.33 fg	4.33 h	7.67 gh	12.00 h
T_5 (Soil application with Ash)	3.00 d-f	7.67 e	12.67 de	6.67 d	11.67 cd	16.33 c
T_6 (Soil application with Sawdust)	3.67 cd	5.67 fg	12.00 ef	7.67 c	13.00 bc	15.00 d
T_7 (Soil application with Khudepana)	4.33 c	9.00 cd	13.33 d	6.67 d	13.67 b	16.67 c
T_8 (Soil application with Cowdung)	4.33 c	10.00 c	14.67 c	8.67 b	14.00 b	18.33 b
T_9 (Soil application with Solarized Sand)	3.33 de	6.33 f	11.33 fg	5.67 ef	9.67 ef	13.33e-g
T_{10} (Seed treatment with *T. harzianum*)	5.67 b	12.33 b	17.33 b	9.33 b	14.33 b	19.00 b
T_{11} ($T_{10}+T_1$)	0.00 k	0.667 j	2.33 m	0.33 m	1.33 l	4.33 l
T_{12} ($T_{10}+T_2$)	1.00 j	3.00 i	7.00 k	1.33 l	3.00 k	6.33 k
T_{13} ($T_{10}+T_3$)	1.33 ij	3.67 hi	8.67 ij	3.00 ij	5.67 i	9.00 j
T_{14} ($T_{10}+T_4$)	1.67 h-j	4.33 gh	8.00 jk	2.33 jk	5.00 ij	7.33 k
T_{15} ($T_{10}+T_5$)	2.33 f-h	10.00 c	10.33 gh	4.67 gh	8.33 f-h	13.00f-h
T_{16} ($T_{10}+T_6$)	3.33 de	8.67 de	10.00 h	6.00 d-f	10.00 e	12.00 h
T_{17} ($T_{10}+T_7$)	3.00 d-f	5.67 fg	11.33 fg	4.67 gh	11.67 d	12.33 gh
T_{18} ($T_{10}+T_8$)	2.67 e-g	6.33 f	10.33 gh	6.33 de	9.00 e-g	14.33de
T_{19} ($T_{10}+T_9$)	2.00 g-i	5.00 fg	9.333 hi	3.33 i	7.000 h	10.33 i
T_{20} (Untreated Control)	7.67 a	14.67 a	23.00 a	13.67 a	18.00 a	25.00 a
LSD ($p=0.05$)	0.772	1.198	1.016	0.866	1.304	1.099

4.1.9. Effect of different treatments on different growth characters of potato seedlings

The effect of *Trichoderma harzianum* and some selected soil amendment on different growth characters of potato seedlings was showed significant variation except dry root weight. (Table7). The seedling height of potato seedling ranged from 10.40 cm to16.30 cm where the highest count was recorded in T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*) followed by T_{12} (Seed treatment with *T. harzianum* +Poultry Waste) and lowest count was recorded in T_{20}. In case of shoot length, the highest shoot length was recorded in T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*) followed by T_{12} and lowest shoot length was recorded in T_{20} which was statistically similar with T_3, T_5 and T_8. The root length of potato seedling varied 0.85cm to 3.65cm where the highest root length was recorded in T_{11} and lowest in T_{20}. The highest fresh shoot weight and fresh root weight was recorded in T_{11} which was closely followed by T_{12}. No statistically difference was found in case of dry root weight but the highest count was recorded in T_{11}. The highest fresh shoot weight and biomass was recorded in T_{11} which was closely followed by T_{12}. The lowest growth characters were recorded in control seed bed where no treatments were used. Vermicompost also showed better performance than other soil amendment in terms of all growth characters of potato seedlings. Sawdust, khudepana, cocodust and cowdung showed significantly similar effect on growth characters of potato seedlings. From this experiment, it was found that all the growth characters were recorded higher when seeds were sown in different soil amendment applied seed bed after treated with *Trichoderma harzianum* than only soil application with different soil amendment.

Table: 7 Effect of different treatments on some growth characters of true potato seedlings

Treatments	Seedling height (cm)	Shoot length (cm)	Root length (cm)	Fresh shoot weight (gm)	Fresh root weight (gm)	Dry shoot weight (gm)	Dry root weight (gm)	Biomass (gm)
T_1 (Soil application with *Trichoderma harzianum*)	13.10 b c	10.13 b-d	2.97 b	0.832 b c	0.053 b-d	0.064 bc	0.005	0.885 bc
T_2 (Soil application with Poultry Waste)	12.75 b-d	10.29 b c	2.47 d	0.686 c-f	0.043 c-e	0.056 b-d	0.004	0.736 c-e
T_3 (Soil application with Cocodust)	11.22 i	9.25 f	1.97 g h	0.604 d-g	0.026 e-g	0.049 c-e	0.003	0.638 c-f
T_4(Soil application with Vermicompost)	12.00 e-h	9.74 b-f	2.33 d-f	0.722 c-f	0.036 c-f	0.053 cd	0.004	0.771 b-e
T_5 (Soil application with Ash)	11.48 h-i	9.55 b-f	2.27 d-g	0.590 e-g	0.028 f-g	0.038 d-f	0.002	0.627 c-f
T_6 (Soil application with Sawdust)	11.63 f-i	9.70 b-f	1.90 h	0.624 d-f	0.025 e-g	0.050 c-e	0.001	0.674 c-f
T_7 (Soil application with Khudepana)	11.47 g-i	9.62 c-f	1.85 h	0.548 fg	0.029 e-g	0.044 c-e	0.003	0.577 d-g
T_8 (Soil application with Cowdung)	11.47 g-i	9.34 e f	2.13 e-h	0.654 c-f	0.034 ef	0.056 b-d	0.002	0.687 c-f
T_9(Soil application with Solarized Sand)	11.47 g-i	9.53 d -f	2.07 f-h	0.651 c-f	0.032 ef	0.052 cd	0.002	0.683 c-f
T_{10} (Seed treatment with *T. harzianum*)	11.32 hi	9.87 b-f	1.45 i	0.427 g h	0.019 fg	0.032 ef	0.002	0.447 fg
T_{11} ($T_{10}+T_1$)	16.30 a	12.65 a	3.65 a	1.22 a	0.073 a	0.084 a	0.009	1.289 a
T_{12} ($T_{10}+T_2$)	13.25 b	10.35 b	2.90 b	0.931 b	0.066 ab	0.074 ab	0.007	1.00 b
T_{13} ($T_{10}+T_3$)	11.75 f-i	9.50 d-f	2.25 d-g	0.668 c-f	0.029 e-g	0.056 b-d	0.004	0.697 c-f
T_{14} ($T_{10}+T_4$)	12.53 c-e	9.77 b-f	2.77 b c	0.792 b-d	0.055 bc	0.060 bc	0.006	0.858 b-d
T_{15} ($T_{10}+T_5$)	11.93 e-h	9.41 e f	2.53 d-g	0.696 c-f	0.031 ef	0.046 c-e	0.003	0.728 c-e
T_{16} ($T_{10}+T_6$)	12.27 d-f	10.14 b-d	2.12 e-h	0.698 c-f	0.041 c-e	0.053 cd	0.003	0.739 c-e
T_{17} ($T_{10}+T_7$)	12.11 d-g	9.98 b-e	2.14 e-h	0.654 c-f	0.036 d-f	0.054 cd	0.004	0.697 c-f
T_{18} ($T_{10}+T_8$)	12.25 d-f	9.89 b-f	2.36 d-f	0.745 c-e	0.043 c-e	0.062 bc	0.004	0.531 e-g
T_{19} ($T_{10}+T_9$)	12.14 d-g	9.73 b-f	2.41 de	0.721 c-f	0.039 c-e	0.057 bc	0.003	0.760 b-e
T_{20} (Untreated Control)	10.40 j	9.22 f	0.85 j	0.321 h	0.012 g	0.023 f	0.001	0.333 g
LSD ($p=0.05$)	0.6003	0.579	0.278	0.163	0.016	0.016	NS	0.225

4.1.10. Effect of different treatments on different growth characters of chilli seedlings

The effect of *Trichoderma harzianum* and some selected soil amendment on different growth characters of chilli seedlings was showed significant variation except dry root weight. (Table 8). The seedling height of chilli seedling ranged from 14.17 cm to21.40 cm where the highest count was recorded in T_{12} (Seed treatment with *T. harzianum* +Poultry Waste) followed by T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*) and lowest count was recorded in T_{20}. In case of shoot length, the highest shoot length was recorded in T_{12} followed by $T_{11}$and lowest shoot length was recorded in T_{20}. The root length of chilli seedling varied 6.23 to 3.37 cm where the highest root length was recorded in T_{12} and lowest in T_{20}. The highest fresh shoot weight and fresh root weight was recorded in T_{12} which was closely followed by T_{11}. The highest dry root weight was recorded in T_{12} which was closely followed by T_{14}. The highest fresh shoot weight and biomass was recorded in T_{12} which was closely followed by T_{14}. The lowest growth characters were recorded in control seed bed where no treatments were used. Vermicompost also showed better performance than other soil amendment in terms of all growth characters of chilli seedlings. Sawdust, khudepana, cocodust and cowdung showed significantly similar effect on growth characters of potato seedlings. From this experiment, it was found that all the growth characters were recorded higher when seeds were sown in different soil amendment applied seed bed after treated with *Trichoderma harzianum* than only soil application with different soil amendment.

Table: 8 Effect of different treatments on some growth characters of Chilli seedlings

Treatments	Seedling height (cm)	Shoot length (cm)	Root length (cm)	Fresh shoot weight (gm)	Fresh root weight (gm)	Dry shoot weight (gm)	Dry root weight (gm)	Biomass (gm)
T_1 (Soil application with *Trichoderma harzianum*)	18.37 d	13.63 cd	4.73 f	2.10 e	0.185 f	0.397 e	0.020 d	2.28 d
T_2 (Soil application with Poultry Waste)	19.30 c	14.03 bc	5.27 cd	2.57 b	0.227 c	0.420d	0.040 b	2.77 b
T_3 (Soil application with Cocodust)	16.80 h	12.37 fg	4.43 h	1.49 h	0.155 hi	0.244 k	0.010 e	1.64 gh
T_4(Soil application with Vermicompost)	17.63 e	12.93 e	4.70 fg	2.350 cd	0.215 d	0.352 g	0.03 c	2.563 c
T_5 (Soil application with Ash)	16.40 i	12.13 gh	4.27 hi	1.20 i	0.145 j	0.208 m	0.010 e	1.34 j
T_6 (Soil application with Sawdust)	15.80 j	11.70 h-j	4.10 ij	1.08 i	0.128 k	0.277 h	0.004e-g	1.21 k
T_7 (Soil application with Khudepana)	16.13 i	11.80 hi	4.33 hi	1.0i	0.112 m	0.129 p	0.006e-g	1.18 k
T_8 (Soil application with Cowdung)	16.90 gh	12.5 e-g	4.37 h	1.45 h	0.128 k	0.163 o	0.006e-g	1.58 hi
T_9(Soil application with Solarized Sand)	15.70j	11.47 ij	4.233 hi	1.39 h	0.154 i	0.223 l	0.008ef	1.54 hi
T_{10} (Seed treatment with *T. harzianum*)	15.20 k	11.27 j	3.93 j	1.06 i	0.117 l	0.118 q	0.003fg	1.18 k
T_{11} (T_{10} + T_1)	20.30 b	14.37b	5.93 b	2.32 d	0.201 e	0.458 c	0.030 c	2.52 c
T_{12} (T_{10}+ T_2)	21.40 a	15.17 a	6.23 a	2.83 a	0.295 a	0.817 a	0.050 a	3.12 a
T_{13} (T_{10}+ T_3)	18.43 d	13.37 d	5.07 de	1.96 fg	0.182 f	0.267 i	0.020 d	2.14 ef
T_{14} (T_{10} +T_4)	19.07 c	13.63 cd	5.433 c	2.47bc	0.244 b	0.531 b	0.040 b	2.71 b
T_{15} (T_{10} + T_5)	17.23 fg	12.33 fg	4.90 ef	1.46 h	0.160 h	0.255 j	0.020 d	1.72 g
T_{16} (T_{10} + T_6)	17.20 fg	12.73 ef	4.47 gh	1.19 i	0.147 j	0.180 n	0.006e-g	1.33 j
T_{17} (T_{10}+ T_7)	17.47 ef	12.53 e-g	4.93 ef	1.35 h	0.126 k	0.131 p	0.010 e	1.47 i
T_{18} (T_{10} + T_8)	17.53 ef	12.53 e-g	5.00 e	1.90 g	0.143 j	0.180 n	0.009 e	2.04 f
T_{19} (T_{10}+ T_9)	16.73 h	11.87 hi	4.87 ef	2.06 ef	0.170 g	0.357 f	0.010 e	2.23 de
T_{20} (Untreated Control)	14.17 l	10.80 k	3.37 k	0.83 j	0.107 m	0.103 r	0.001 g	0.940 l
LSD (p=0.05)	0.319	0.426	0.237	0.127	0.0052	0.0052	0.0052	0.127

4.1.11. Effect of different treatments on different growth characters of tomato seedlings

The effect of *Trichoderma harzianum* and some selected soil amendment on different growth characters of tomato seedlings was showed significant variation except dry root weight (Table 9). The seedling height of tomato seedling ranged from 34.00cm to26.87cm where the highest count was recorded in T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*) followed by T_{12} (Seed treatment with *T. harzianum* +Poultry Waste) and lowest count was recorded in T_{20}. In case of shoot length, the highest shoot length was recorded in T_{11} followed by T_{12} and lowest shoot length was recorded in T_{20}. The root length of tomato seedling varied 6.06 to 3.78 cm where the highest root length was recorded in T_{11} and lowest in T_{20}. The highest fresh shoot weight and fresh root weight was recorded in T_{11} which was closely followed by T_{12}. The highest dry root weight was recorded in T_{11} . The highest fresh shoot weight and biomass was recorded in T_{11} which was closely followed by T_{12}. The lowest growth characters were recorded in control seed bed where no treatments were used. Vermicompost also showed better performance than other soil amendment in terms of all growth characters of chilli seedlings. Sawdust, khudepana, cocodust and cowdung showed significantly similar effect on growth characters of tomato seedlings. From this experiment, it was found that all the growth characters were recorded higher when seeds were sown in different soil amendment applied seed bed after treated with *Trichoderma harzianum* than only soil application with different soil amendment

Table: 9 Effect of different treatments on some growth characters of Tomato seedlings

Treatments	Seedling height (cm)	Shoot length (cm)	Root length (cm)	Fresh shoot weight (gm)	Fresh root weight (gm)	Dry shoot weight (gm)	Dry root weight (gm)	Biomass (gm)
T_1 (Soil application with *Trichoderma harzianum*)	31.83 bc	26.3 bc	5.48 b	3.88 b	0.260 c	0.220 c	0.029bc	4.143 b
T_2 (Soil application with Poultry Waste)	30.20 d-h	25.4 c-f	4.72e-g	3.49 cd	0.233 e	0.203 c-f	0.023c-e	3.72 cd
T_3 (Soil application with Cocodust)	28.72 i	24.20 fg	4.52 f-h	3.12 fg	0.203 h	0.183 g-i	0.020e-h	3.32 fg
T_4 (Soil application with Vermicompost)	29.55 f-i	24.53 d-f	5.02c-e	3.21 ef	0.183 j	0.200 d-g	0.020e-h	3.39 ef
T_5 (Soil application with Ash)	28.88 hi	24.58 d-f	4.30 gh	3.09 fg	0.213 g	0.190 f-h	0.017f-i	3.31 fg
T_6 (Soil application with Sawdust)	28.97 hi	24.63 d-f	4.33 gh	2.50 i	0.183 j	0.177 hi	0.018e-h	2.68 i
T_7 (Soil application with Khudepana)	28.73 i	24.50 ef	4.23 h	2.55 i	0.170 k	0.130 j	0.016g-i	2.72 i
T_8 (Soil application with Cowdung)	29.53 f-i	24.88 c-f	4.65 e-h	2.86 h	0.197 i	0.170 i	0.014 hi	3.05 h
T_9 (Soil application with Solarized Sand)	29.23 g-i	24.63 d-f	4.60 f-h	2.19 j	0.193 i	0.193 e-h	0.019e-h	2.38 j
T_{10} (Seed treatment with *T. harzianum*)	27.42 j	23.15 g	4.27 h	2.51 i	0.163 l	0.167 i	0.014 hi	2.67 i
T_{11} (T_{10} + T_1)	34.00 a	27.94 a	6.06 a	4.39 a	0.320 a	0.280 a	0.036 a	4.72 a
T_{12} (T_{10} + T_2)	32.67 b	27.53 ab	5.13 b-d	4.00 b	0.280 b	0.240 b	0.030 b	4.28 b
T_{13} (T_{10} + T_3)	30.80 c-f	26.03 cd	4.77 d-f	3.48 cd	0.223 f	0.213 c d	0.024c-e	3.71 cd
T_{14} (T_{10} + T_4)	31.27 cd	25.90 c-e	5.37 bc	3.63 c	0.213 g	0.210 c-e	0.028 b-d	3.85 c
T_{15} (T_{10} + T_5)	29.87 e-i	25.25 c-f	4.62 e-h	3.52 cd	0.237 e	0.210 c-e	0.019e-h	3.76 cd
T_{16} (T_{10} + T_6)	30.40 d-g	25.83 c-e	4.57 f-h	2.86 h	0.243 d	0.200 d-g	0.021e-g	3.10 gh
T_{17} (T_{10} + T_7)	29.57 f-i	25.03 c-f	4.53 f-h	2.98 gh	0.203 h	0.177 hi	0.023d-f	3.18 gh
T_{18} (T_{10} + T_8)	30.97 c-e	26.15 c	4.82d-f	3.38 de	0.203 h	0.203 c-f	0.022e-g	3.58 de
T_{19} (T_{10} + T_9)	29.77 e-i	24.92 c-f	4.850 d-f	2.96 gh	0.203 h	0.243 b	0.024c-e	3.16 gh
T_{20} (Untreated Control)	26.87 j	23.08 g	3.78 i	1.71 k	0.133 m	0.103 k	0.011 i	1.85k
LSD (p=0.05)	1.168	1.273	0.358	0.202	0.0053	0.0165	0.0053	0.195

4.1.12. Effect of different treatments on different growth characters of egg-plant seedlings

The effect of *Trichoderma harzianum* and some selected soil amendment on different growth characters of eggplant seedlings was showed significant variation except dry root weight (Table 10). The seedling height of eggplant seedling ranged from 16.87cm to11.43cm where the highest count was recorded in T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*) followed by T_{12} (Seed treatment with *T. harzianum* +Poultry Waste) and lowest count was recorded in T_{20}. In case of shoot length, the highest shoot length was recorded in T_{11} followed by T_{12} and lowest shoot length was recorded in T_{20} . The root length of eggplant seedling varied 5.80 to 2.50 cm where the highest root length was recorded in T_{11} and lowest in T_{20}. The highest fresh shoot weight and fresh root weight was recorded in T_{11} which was closely followed by T_{12}. The highest dry root weight was recorded in T_{11}. The highest fresh shoot weight and biomass was recorded in T_{11} which was closely followed by T_{12}. The lowest growth characters were recorded in control seed bed where no treatments were used. Vermicompost also showed better performance than other soil amendment in terms of all growth characters of chilli seedlings. Sawdust, khudepana, cocodust and cowdung showed significantly similar effect on growth characters of eggplant seedlings. From this experiment, it was found that all the growth characters were recorded higher when seeds were sown in different soil amendment applied seed bed after treated with *Trichoderma harzianum* than only soil application with different soil amendment.

Table: 10 Effect of different treatments on some growth characters of eggplant seedlings

Treatments	Seedling height (cm)	Shoot length (cm)	Root length (cm)	Fresh shoot weight (gm)	Fresh root weight (gm)	Dry shoot weight (gm)	Dry root weight (gm)	Biomass (gm)
T_1 (Soil application with *Trichoderma harzianum*)	15.23 b	10.77 ab	4.47 cd	0.867 b	0.062 bc	0.0743 c	0.008ab	0.95 b
T_2 (Soil application with Poultry Waste)	14.13 d	9.90d-g	4.23 de	0.729 cd	0.0567 cd	0.063 de	0.006cd	0.79 cd
T_3 (Soil application with Cocodust)	13.03 j	9.167 hi	3.87 ef	0.7003 c-e	0.0350 f-h	0.0527 g-i	0.004 ef	0.74 c-e
T_4 (Soil application with Vermicompost)	13.97d-f	9.93 c-g	4.03 ef	0.655 d-f	0.0450 e	0.055 f-h	0.005 de	0.70d-f
T_5 (Soil application with Ash)	13.48g-i	9.52 e-i	3.97 ef	0.565 f-h	0.0370 fg	0.052 g-i	0.003 f	0.60 f-h
T_6 (Soil application with Sawdust)	13.38g-j	9.98 c-f	3.40 gh	0.648 d-g	0.0363 f-h	0.051 hi	0.004 ef	0.68 d-g
T_7 (Soil application with Khudepana)	13.23h-j	10.14 b-e	3.09 h	0.553 gh	0.034 gh	0.049 i	0.004 ef	0.59 gh
T_8 (Soil application with Cowdung)	13.55f-h	10.38 b-d	3.17 h	0.658 d-f	0.040 ef	0.0523 g-i	0.003 f	0.70 d-f
T_9 (Soil application with Solarized Sand)	13.07 ij	9.77 d-h	3.30 gh	0.543 h	0.0330 gh	0.048 i	0.003 f	0.58 h
T_{10} (Seed treatment with *T. harzianum*)	12.50 k	9.47 f-i	3.03 h	0.446 i	0.03067 h	0.042 j	0.003 f	0.48 i
T_{11} (T_{10} + T_1)	16.87 a	11.07 a	5.80 a	1.080 a	0.076 a	0.092 a	0.009 a	1.16 a
T_{12} (T_{10} + T_2)	15.43 b	10.17 b-e	5.27 b	0.9303 b	0.0663 b	0.084 b	0.007 bc	1.00 b
T_{13} (T_{10} + T_3)	13.40g-j	9.30 g-i	4.10 de	0.723 cd	0.04467 e	0.057 e-g	0.005 de	0.76 c-e
T_{14} (T_{10} + T_4)	14.67 c	10.02 c-f	4.65 c	0.766 c	0.059 c	0.066 d	0.006 cd	0.82 c
T_{15} (T_{10} + T_5)	13.80d-g	9.60 e-h	4.20 de	0.688 c-e	0.043 e	0.060 ef	0.004 ef	0.73 c-e
T_{16} (T_{10} + T_6)	14.07de	9.97 c-f	4.10 de	0.711 c-e	0.04067ef	0.057 f-h	0.005 de	0.75c-e
T_{17} (T_{10} + T_7)	13.67e-h	10.30 b-d	3.37 gh	0.6103 e-h	0.045 e	0.056 f-h	0.006 cd	0.66 e-h
T_{18} (T_{10} + T_8)	14.20d	10.57 a-c	3.63 fg	0.724 cd	0.0517 d	0.060 ef	0.005 de	0.78 cd
T_{19} (T_{10} + T_9)	13.93d-f	10.03 c-f	3.90 ef	0.725 cd	0.0447 e	0.056 f-h	0.005 de	0.77 cd
T_{20} (Untreated Control)	11.43	8.93 i	2.50 i	0.384 i	0.0197 i	0.038 j	0.001 g	0.40 i
LSD (p=0.05)	0.391	0.558	0.369	0.091	0.005	0.005	0.002	0.091

4.1.13. Effect of different treatments on different growth characters of cabbage seedlings

The effect of *Trichoderma harzianum* and some selected soil amendment on different growth characters of cabbage seedlings was showed significant variation except dry root weight (Table 11). The seedling height of potato seedling ranged from 18.23cm to11.30cm where the highest count was recorded in T_{12} followed by T_{11} and lowest count was recorded in T_{20}. In case of highest shoot length was recorded in T_{12} followed by $T_{11}$and lowest shoot length was recorded in T_{20} which was statistically similar withT_{10}. The root length of eggplant seedling varied 3.12 to 1.87 cm where the highest root length was recorded in T_{12} and lowest in T_{20}. The highest fresh shoot weight and fresh root weight was recorded in T_{12} which was closely followed by T_2 $T_{11}$and T_{14}. In case of dry root weight, the highest dry root weight was recorded in T_{12}. The highest fresh shoot weight and biomass was recorded in T_{12} which was closely followed by T_{11}. The lowest growth characters were recorded in control seed bed where no treatments were used. Vermicompost also showed better performance than other soil amendment in terms of all growth characters of cabbage seedlings. Sawdust, khudepana, cocodust and cowdung showed significantly similar effect on growth characters of cabbage seedlings. From this experiment, it was found that all the growth characters were recorded higher when seeds were sown in different soil amendment applied seed bed after treated with *Trichoderma harzianum* than only soil application with different soil amendments.

Table: 11 Effect of different treatments on some growth characters of cabbage seedlings

Treatments	Seedling height (cm)	Shoot length (cm)	Root length (cm)	Fresh shoot weight (gm)	Fresh root weight (gm)	Dry shoot weight (gm)	Dry root weight (gm)	Biomass (gm)
T_1 (Soil application with *Trichoderma harzianum*)	15.50 ab	12.70bc	2.80 bc	2.58c-f	0.077 f-h	0.172g	0.016g-j	2.65d-g
T_2 (Soil application with Poultry Waste)	16.52 ab	13.56 b	2.96 ab	2.86 bc	0.103 b	0.217 c	0.030 c	2.99 bc
T_3 (Soil application with Cocodust)	13.45 bc	11.15 de	2.30 e-g	2.57 c-f	0.049 k	0.139 j	0.011 jk	2.61d-g
T_4 (Soil application with Vermicompost)	14.05 bc	11.57 c-e	2.48de	2.83 c	0.062 j	0.158 hi	0.026 cd	2.89cd
T_5 (Soil application with Ash)	13.73 bc	11.49 c-e	2.24 e-g	2.27 f-h	0.068 i	0.129 k	0.024de	2.33 g-i
T_6 (Soil application with Sawdust)	14.19 bc	12.01 cd	2.18fg	2.21 gh	0.037 l	0.134 jk	0.014h-j	2.24 hi
T_7 (Soil application with Khudepana)	13.89 bc	11.79 cd	2.10 gh	2.35 e-h	0.075 gh	0.155 i	0.012 ij	2.42 f-i
T_8 (Soil application with Cowdung)	13.70 bc	11.53 c-e	2.17 fg	2.17 gh	0.047 k	0.162 h	0.013 h-j	2.22 hi
T_9 (Soil application with Solarized Sand)	14.08 bc	11.95 cd	2.14 g	2.18 gh	0.057 j	0.163 h	0.015 g-j	2.23 hi
T_{10} (Seed treatment with *T. harzianum*)	12.50 bc	10.38 ef	2.12 g	2.06 hi	0.047 k	0.132 k	0.011 i-k	2.09 i
T_{11} ($T_{10}+T_1$)	16.47 ab	13.54 b	2.92 a-c	2.89 bc	0.099 bc	0.208 d	0.022d-f	2.99 bc
T_{12} ($T_{10}+T_2$)	18.63 a	15.52 a	3.12 a	3.63 a	0.152 a	0.279 a	0.060a	3.78 a
T_{13} ($T_{10}+T_3$)	16.03 ab	13.53 b	2.50 de	2.76 c	0.092 de	0.204 de	0.021d-g	2.85 cd
T_{14} ($T_{10}+T_4$)	15.00abc	12.31b-d	2.69 cd	3.17 b	0.097 cd	0.230 b	0.038 b	3.27 b
T_{15} ($T_{10}+T_5$)	14.57 bc	12.12 cd	2.45 de	2.41 d-g	0.098 bc	0.175 g	0.038 b	2.50 e-h
T_{16} ($T_{10}+T_6$)	14.33 bc	11.98 cd	2.35 e-g	2.37 d-h	0.090 e	0.156 i	0.018e-h	2.47 e-h
T_{17} ($T_{10}+T_7$)	14.83 abc	12.35 b-d	2.48 de	2.64c-e	0.081 f	0.202e	0.016 g-j	2.73 c-f
T_{18} ($T_{10}+T_8$)	14.10 bc	11.78 cd	2.32 e-g	2.42 d-g	0.073 hi	0.201 e	0.017 f-i	2.49 e-h
T_{19} ($T_{10}+T_9$)	14.48 bc	12.08 cd	2.40 ef	2.71 cd	0.079 fg	0.192 f	0.017 f-i	2.78 c-e
T_{20} (Untreated Control)	11.30 c	9.43 f	1.87h	1.76 i	0.027 m	0.124 l	0.006 k	1.79 j
LSD (p=0.05)	3.42	1.14	0.228	0.301	0.005	0.005	0.005	0.301

4.1.14. Effect of different treatments on different growth characters of cauliflower seedlings

The effect of *Trichoderma harzianum* and some selected soil amendment on different growth characters of cauliflower seedlings was showed significant variation except dry root weight. (Table 12). The seedling height of cauliflower seedling ranged from 19.75cm to14.35cm where the highest count was recorded in T_{12} followed by T_2 and T_{14} and lowest count was recorded in T_{20}. In case of shoot length, the highest shoot length was recorded in T_{12} followed by T_{14} and lowest shoot length was recorded in T_{20}. The root length of eggplant seedling varied 2.91 to 2.08 cm where the highest root length was recorded in T_{12} and lowest in T_{20}. The highest fresh shoot weight and fresh root weight was recorded in T_{12} which was closely followed by T_{11}. In case the highest dry root weight was recorded in T_{12}. The highest fresh shoot weight and biomass was recorded in T_{12} which was closely followed by T_{11}. The lowest growth characters were recorded in control seed bed where no treatments were used. Vermicompost also showed better performance than other soil amendment in terms of all growth characters of cauliflower seedlings. Sawdust, khudepana, cocodust and cowdung showed significantly similar effect on growth characters of cauliflower seedlings. From this experiment, it was found that all the growth characters were recorded higher when seeds were sown in different soil amendment applied seed bed after treated with *Trichoderma harzianum* than only soil application with different soil amendment.

Table: 12 Effect of different treatments on some growth characters of Cauliflower seedlings

Treatments	Seedling height(cm)	Shoot length(cm)	Root length (cm)	Fresh shoot weight (gm)	Fresh root weight (gm)	Dry shoot weight (gm)	Dry root weight (gm)	Biomass (gm)
T_1 (Soil application with *Trichoderma harzianum*)	15.95 g	13.56 gh	2.39 f-h	1.73 c	0.025ef	0.1310 de	0.005d-f	1.76bc
T_2 (Soil application with Poultry Waste)	18.22 bc	15.53 bc	2.68 b	1.91 b	0.039 b	0.1337 cd	0.013 b	1.95 b
T_3 (Soil application with Cocodust)	16.92 ef	14.52 de	2.39 e-h	1.24 gh	0.017 gh	0.1207 g	0.004 ef	1.26 ij
T_4(Soil application with Vermicompost)	17.20 d-f	14.77 c-e	2.43 d-g	1.49 ef	0.018 gh	0.1230 fg	0.009b-e	1.51 d-h
T_5 (Soil application with Ash)	16.98 ef	14.50 d-f	2.32 g-j	1.28 gh	0.018 gh	0.1283 d-f	0.008b-e	1.413 e-i
T_6 (Soil application with Sawdust)	15.90 g	13.62 f-h	2.28 h-j	1.13 hi	0.016 g-i	0.1300 de	0.007b-f	1.36 g-i
T_7 (Soil application with Khudepana)	16.73 f	14.49 d-f	2.24 j	1.13 fg	0.021 fg	0.1273 ef	0.003 ef	1.35 hi
T_8 (Soil application with Cowdung)	16.92 ef	14.56 de	2.36 f-i	1.38 fg	0.018 gh	0.1267 ef	0.006c-f	1.40 e-i
T_9(Soil application with Solarized Sand)	17.40 c-f	15.00 c-e	2.40 e-h	1.38 fg	0.017 gh	0.1273 ef	0.007b-f	1.39 e-i
T_{10} (Seed treatment with *T. harzianum*)	15.62 g	13.34 h	2.27 ij	1.08 i	0.014 hi	0.1137 h	0.003 ef	1.09 j
T_{11} (T_{10} + T_1)	16.82 f	14.27 e-g	2.55 cd	1.90 b	0.035 bc	0.1430 b	0.009b-e	1.93 b
T_{12} (T_{10}+ T_2)	19.75 a	16.84 a	2.91 a	2.19 a	0.063 a	0.1793 a	0.075 a	2.26 a
T_{13} (T_{10}+ T_3)	17.75 b-e	15.14 c-e	2.61 bc	1.36 fg	0.020 f-h	0.1187 gh	0.009b-e	1.38 f-i
T_{14} (T_{10} +T_4)	18.57 b	16.05 ab	2.52 cd	1.68 cd	0.032 cd	0.1393 b	0.011 bc	1.71 cd
T_{15} (T_{10} + T_5)	17.58 c-f	15.20 b-e	2.39 f-i	13.8 fg	0.032 cd	0.1383 bc	0.011b-d	1.513d-h
T_{16} (T_{10} + T_6)	16.95 ef	14.49 d-f	2.46 d-f	1.27 gh	0.028 de	0.1383 bc	0.010b-d	1.42 e-i
T_{17} (T_{10}+ T_7)	17.25 d-f	14.78 c-e	2.47 d-f	1.41 fg	0.029 c-e	0.1403 b	0.007b-f	1.58c-g
T_{18} (T_{10} + T_8)	17.75 b-e	15.36 b-d	2.39 e-h	1.57 de	0.033 cd	0.1427 b	0.008b-e	1.60 c-f
T_{19} (T_{10}+ T_9)	17.87 b-d	15.35 b-d	2.51 c-e	1.59 c-e	0.022 fg	0.1437 b	0.013 b	1.62 c-e
T_{20} (Untreated Control)	14.35 h	12.27 i	2.08 k	0.897 j	0.010 i	0.1057 i	0.0013 f	0.907k
LSD (p=0.05)	0.758	0.796	0.104	1.48	0.0053	0.0053	0.0053	0.189

Chapter 5
Discussion

CHAPTER V

DISCUSSION

The present study was carried with twenty different treatments to evaluate their efficacy in controlling damping-off disease caused by *Fusarium oxysporium, Sclerotium rolfsii, Rhizoctonia solani* and *Pythium spp* .in vitro. The main objective of this study was to find out a suitable and eco-friendly control measure of damping – off disease and their growth contributing characters of selected six winter vegetable seedlings.

Effect of different treatments on seed germination, damping-off disease and growth characters of potato seedlings

From the experimental findings different treatments showed the remarkable effect against the damping-off pathogen, increased the seed germination and influence the growth characters. In case of seed germination, the highest seed germination at 13DAS was recorded on T_{11} (94.33%) followed by T_1 (80.00%) and T_{12} (77.00%) respectively, where the lowest seed germination at 13DAS was recorded on T_{20} (34%).

In case of percent damping-off of potato (TPS) seedlings, the highest percent damping-off at 25DAS was observed on T_{20} (28.67%) followed by T_{10} (22.00%) which was statistically identical with T_6 (21.33%) and T_8 (21.00%), whenever the lowest percent damping-off at 25DAS was observed on T_{11} (2.33%) preceded by T_1(7.00%).

In case of growth characters of potato seedlings, the highest seedling height (16.30 cm), shoot length (12.65 cm), root length (3.65 cm), fresh shoot weight (1.22 g), fresh root weight (0.73 g), dry shoot weight (0.084 g), dry root weight (0.009 g) and biomass (1.29 g) were observed on $T_{11.}$ The lowest growth characters were observed on T_{20} against these parameters. The present finding were supported previous research report Kavi *et al.* (2001). Kavi *et al.* (2001) found that efficacy of *Trichoderma viride*, *T. harzianum*, and *T. hamatum* as hyperparasites of *R. solani* was investigated in the laboratory.

Effect of different treatments on seed germination, damping-off disease and growth characters of chilli seedlings

From the results, different treatments showed the remarkable effect against the damping-off pathogen, increased the seed germination and influence the growth characters. In case of seed germination, the highest seed germination at 13DAS was recorded on T_{11} (86.67%) followed by T_{14} (77.33%) and T_{12} (76.00%) respectively, where the lowest seed germination at 13 DAS was recorded on T_{20} (58.67%).

In case of percent damping-off of chilli seedlings, the highest percent damping-off at 30 DAS was observed on T_{20} (18.67%) followed by T_8 (14.67%). whenever the lowest percent damping-off at 30DAS was observed on T_{11} (2.00%) preceded by T_1(4.67%).

In case of growth characters of chili seedlings, the highest seedling height (21.40 cm), shoot length (15.17 cm), root length (6.23 cm), fresh shoot weight (2.83 g), fresh root weight (.295 g), dry shoot weight (0.817 g), dry root weight (.050 g) and biomass (3.12 g) were observed on $T_{12.}$ The lowest growth characters were observed on T_{20} against these parameters. The present findings were supported previous research report Faruq and Islam (2007). They stated that the highest seedlings population 78.00% at 12 DAS, 82.67% at 15 DAS, 90.00% at 18 DAS was recorded under the treatment poultry refuse where seed germination was increased 43.57%, 24.63%, and 34.82% over control respectively. Poultry refuse reduced the damping-off incidence by 100% at 20DAS, 94.1% at 25 DAS, 89.46% at 30DAS over control. Seedlings growth characters like shoot length, root length, fresh shoot weight fresh root weight of chilli enhanced by poultry refuse.

Effect of different treatments on seed germination, damping-off disease and growth characters of tomato seedlings

The effect of different treatments showed the remarkable effect against the damping-off pathogen, increased the seed germination and influence the growth characters of tomato seedlings. In case of seed germination, the highest seed germination at 13DAS was recorded on T_{11} (92.00%) followed by T_1 (82.67%) and T_{12} (82.00%)

Effect of different treatments on seed germination, damping-off disease and growth characters of chilli seedlings

From the results, different treatments showed the remarkable effect against the damping-off pathogen, increased the seed germination and influence the growth characters. In case of seed germination, the highest seed germination at 13DAS was recorded on T_{11} (86.67%) followed by T_{14} (77.33%) and T_{12} (76.00%) respectively, where the lowest seed germination at 13 DAS was recorded on T_{2} (58.67%).

In case of percent damping-off of chilli seedlings, the highest percent damping-off at 30 DAS was observed on T_{20} (18.67%) followed by T_{1} (14.67%) whenever the lowest percent damping-off at 30DAS was observed on T_{11} (2.00%) preceded by T_{1}(4.67%).

In case of growth characters of chilli seedlings, the highest seedling height (21.40 cm), shoot length (15.17 cm), root length (6.23 cm), fresh shoot weight (2.83 g), fresh root weight (.295 g), dry shoot weight (0.817 g), dry root weight (.050 g) and biomass (3.12 g) were observed on T_{11}. The lowest growth characters were observed on T_{2} against these parameters. The present findings were supported previous research report Farug and Islam (2007). They stated that the highest seedlings population 78.00% at 12 DAS, 82.67% at 15 DAS, 90.00% at 18 DAS was recorded under the treatment poultry refuse where seed germination was increased 43.57%, 24.63%, and 34.82% over control respectively. Poultry refuse reduced the damping-off incidence by 100% at 20DAS, 94.1% at 25 DAS, 89.40% at 30DAS over control. Seedlings growth characters like shoot length, root length, fresh shoot weight fresh root weight of chilli enhanced by poultry refuse.

Effect of different treatments on seed germination, damping-off disease and growth characters of tomato seedlings

The effect of different treatments showed the remarkable effect against the damping-off pathogen, increased the seed germination and influence the growth characters of tomato seedlings. In case of seed germination, the highest seed germination at 13DAS was recorded on T_{11} (92.00%) followed by T_{1} (82.67%) and T_{12} (82.00%)

respectively, where the lowest seed germination at 13DAS was recorded on T_{20} (61.00%).

In case of percent damping-off of tomato seedlings, the highest percent damping-off at 25DAS was observed on T_{20} (24.33%) followed by T_{10} (19.67%). whenever the lowest percent damping-off at 25DAS was observed on T_{11} (2.67%) preceded by T_1(767%).

In case of growth characters of tomato seedlings, the highest seedling height (34.00 cm), shoot length (27.94 cm), root length (6.06 cm), fresh shoot weight (4.39 g), fresh root weight (0.320 g), dry shoot weight (0.280 g), dry root weight (0.036 g) and biomass (4.72 g) were observed on $T_{11.}$ The lowest growth characters were observed on T_{20} against these parameters. The present findings were supported previous research report Jayaraj *et al.* (2006). They reported that the Seed treatment with *T. harzianum* formulations reduced the incidence of damping-off disease of tomato by up to 74% and enhanced plant biomass under greenhouse and field (Tamil Nadu, India) conditions.

Effect of different treatments on seed germination, damping-off and growth characters of egg-plant seedlings

From the results, different treatments showed the remarkable effect against the damping-off pathogen, increased the seed germination and influence the growth characters egg-plant seedlings. In case of seed germination, the highest seed germination at 13DAS was recorded on T_{11} (94.33%) followed by T_{12} (86.00%) and T_{14} (85.00%) respectively, where the lowest seed germination at 13 DAS was recorded on T_{20} (62.33%).

In case of percent damping-off of egg-plant seedlings, the highest percent damping-off at 30 DAS was observed on T_{20} (21.00%) followed by T_{10} (18.33%). whenever the lowest percent damping-off at 30DAS was observed on T_{11} (1.67%) preceded by T_1(4.33%).

In case of growth characters of egg-plant seedlings, the highest seedling height (16.87 cm), shoot length (11.07 cm), root length (5.8 cm), fresh shoot weight (1.08 g), fresh root weight (0.076 g), dry shoot weight (0.92 g), dry root weight (.009 g) and biomass (1.16 g) were observed on T_{11}. The lowest growth characters were observed on T_{20} against these parameters. The present findings were supported previous research report Faruq and Islam (2007). They reported that poultry refuse reduced damping-off incidence by 90.56% (30 DAS) in eggplant and 84.81 % (25 DAS) in tomato seedlings over control and increased seedlings growth characters like shoot length, root length, seedling height, fresh shoot weight, fresh root weight and fresh seedling weight of egg-plant and tomato. They also reported that application of neem compost and vermicompost also showed promising effect against damping-off disease and also enhanced seed germination and growth characters of eggplant and tomato seedlings.

Effect of different treatments on seed germination, damping-off and growth characters of cabbage seedlings

From the experimental findings different treatments showed the remarkable effect against the damping-off pathogen, increased the seed germination and influence the growth characters of cabbage seedlings. In case of seed germination, the highest seed germination at 13DAS was recorded on T_{11} (88.00%) followed by T_1 (81.67%) and T_{12} (80.00%) respectively, where the lowest seed germination at 13DAS was recorded on T_{20} (54.00%).

In case of percent damping-off of cabbage seedlings, the highest percent damping-off at 25DAS was observed on T_{20} (28.67%) followed by T_{10} (17.33%). whenever the lowest percent damping-off at 25DAS was observed on T_{11} (2.33%) preceded by T_1(5.67%).

In case of growth characters of potato seedlings, the highest seedling height (18.63 cm), shoot length (15.52 cm), root length (3.12 cm), fresh shoot weight (3.63 g), fresh root weight (0.152 g), dry shoot weight (0.028 g), dry root weight (0.06 g) and biomass (3.78 g) were observed on T_{12}. The lowest growth characters were observed on T_{20} against these parameters. The present finding was supported previous research Roy, *et al.* (1998). They found that Seed treatments of *Trichoderma viride, T. harzianum and T. koningii* reduced damping off of cabbage caused by *Rhizoctonia* root weight (0.076 g), dry shoot weight (0.92 g), dry root weight (.009 g) and biomass (1.16 g) were observed on T_{11}. The lowest growth characters were observed on T_{20} against these parameters. The present findings were supported previous research report Farug and Islam (2007). They reported that poultry refuse reduced damping-off incidence by 90.56% (30 DAS) in eggplant and 84.81 % (25 DAS) in tomato seedlings over control and increased seedlings growth characters like shoot length, root length, seedling height, fresh shoot weight, fresh root weight and fresh seedling weight of egg-plant and tomato. They also reported that application of neem compost and vermicompost also showed promising effect against damping-off disease and also enhanced seed germination and growth characters of eggplant and tomato seedlings.

Effect of different treatments on seed germination, damping-off and growth characters of cabbage seedlings

From the experimental findings different treatments showed the remarkable effect against the damping-off pathogen, increased the seed germination and influence the growth characters of cabbage seedlings. In case of seed germination, the highest seed germination at 13DAS was recorded on T_{11} (88.00%) followed by T_1 (81.67%) and T_{12} (80.00%) respectively, where the lowest seed germination at 14DAS was recorded on T_{20} (54.00%).

In case of percent damping-off of cabbage seedlings, the highest percent damping-off at 25DAS was observed on T_{20} (28.67%) followed by T_{16} (17.33%), whenever the lowest percent damping-off at 25DAS was observed on T_{11} (2.33%) preceded by T_1(5.67%).

In case of growth characters of potato seedlings, the highest seedling height (18.03 cm), shoot length (15.52 cm), root length (3.12 cm), fresh shoot weight (3.63 g), fresh root weight (0.152 g), dry shoot weight (0.028 g), dry root weight (0.06 g) and biomass (3.78 g) were observed on T_{11}. The lowest growth characters were observed on T_{20} against these parameters. The present finding was supported previous research Roy, *et al.* (1998). They found that Seed treatments of *Trichoderma viride*, *T. harzianum* and *T. koningii* reduced damping off of cabbage caused by *Rhizoctonia* *solani* in both sterilised and unsterilised soil. Treating cabbage seeds with a spore suspension of *T. viride and T. harzianum* separately was more effective than the application of antagonist to the soil at the inoculum rate of 2.0% (w/w). The combination of seed treatment and soil application with *Trichoderma spp.* further reduced the pre- and post-emergence damping off of cabbage in the nursery.

Effect of different treatments on seed germination, damping-off and growth characters of cauliflower seedlings

From the results different treatments showed the remarkable effect against the damping-off pathogen, increased the seed germination and influence the growth characters of cabbage seedlings. In case of seed germination, the highest seed germination at 13DAS was recorded on T_{11} (88.00%) followed by T_1 (81.67%) and T_{12} (80.00%) respectively, where the lowest seed germination at 13DAS was recorded on T_{20} (54.00%).

In case of percent damping-off of cabbage seedlings, the highest percent damping-off at 25DAS was observed on T_{20} (28.67%) followed by T_{10} (17.33%). whenever the lowest percent damping-off at 25DAS was observed on T_{11} (2.33%) preceded by T_1(5.67%).

In case of growth characters of potato seedlings, the highest seedling height (19.75 cm), shoot length (16.84 cm), root length (2.91 cm), fresh shoot weight (2.19 g), fresh root weight (0.063 g), dry shoot weight (0.179 g), dry root weight (0.075 g) and biomass (2.26 g) were observed on $T_{12.}$ The lowest growth characters were observed on T_{20} against these parameters. The present finding was supported previous research Rajappan and Ramaraj (1999). They found that the efficacy of 4 fungal biocontrol agents (*Trichoderma viride, T. harzianum, T. hamatum and Gliocladium virens*) were evaluated against the cauliflower wilt pathogen, *Fusarium moniliforme* [*Gibberella fujikuroi*] in vitro. Among the fungal bio-control agents, *T. harzianum* produced the maximum inhibition zone.

solum in both sterilised and unsterilised soil. Treating cabbage seeds, with a spore suspension of *T. viride* and *T. harzianum* separately was more effective than the application of antagonist to the soil at the inoculum rate of 2.0% (w/w). The combination of seed treatment and soil application with *Trichoderma* spp. further reduced the pre- and post-emergence damping off of cabbage in the nursery.

Effect of different treatments on seed germination, damping-off and growth characters of cauliflower seedlings

From the results different treatments showed the remarkable effect against the damping-off pathogen, increased the seed germination and influence the growth characters of cabbage seedlings. In case of seed germination, the highest seed germination at 13DAS was recorded on T_{11} (88.00%) followed by T_1 (81.67%) and T_{12} (80.00%) respectively, where the lowest seed germination at 13DAS was recorded on T_{20} (54.00%).

In case of percent damping-off of cabbage seedlings, the highest percent damping-off at 25DAS was observed on T_{20} (28.67%) followed by T_6 (17.33%), wherever the lowest percent damping-off at 25DAS was observed on T_{11} (2.33%) preceded by T_1(5.67%).

In case of growth characters of potato seedlings, the highest seedling heigh (19.75 cm), shoot length (16.84 cm), root length (2.91 cm), fresh shoot weight (2.19 g), fresh root weight (0.063 g), dry shoot weight (0.179 g), dry root weight (0.075 g) and biomass (2.26 g) were observed on T_{11}. The lowest growth characters were observed on T_{20} against these parameters. The present finding was supported previous research Rajappan and Ramaraj (1999). They found that the efficacy of 4 fungal biocontrol agents (*Trichoderma viride*, *T. harzianum*, *T. hamatum* and *Gliocladium virens*) were evaluated against the cauliflower wilt pathogen, *Fusarium moniliforme* [*Gibberella fujikuroi*] in vitro. Among the fungal bio-control agents, *T. harzianum* produced the maximum inhibition zone.

Chapter 6

Summary and conclusion

CHAPTER VI

Summary and Conclusions

Vegetable are protective food rich in vitamins and minerals which are essential for maintaining good health. Vegetable crops assume great importance in view of widespread malnutrition that exists in Bangladesh. Pre-emergence and post-emergence damping-off is the most common and prevalent disease of seedlings of vegetable affecting seed germination and seedling survival. A number of soil borne pathogens are known to be associated with the disease. *Fusarium* spp., *Rhizoctonia solani*, *Pythium* spp., *Sclerotium rolfsii* and *Erwinia* spp. are predominant for causing the disease. The above stated damping-off pathogens are worldwide in distribution having wide host range and are well known as soil-borne pathogens. Application of fungicides against these pathogens may reduce the disease incidence but it is neither cost effective nor environmentally sound. In this experiment, soil application with poultry waste, cocodust, vermicompost, ash, sawdust, khudepana, cowdung, solarized sand, *Trichoderma harzianum* and or with seed treatment with *Trichoderma harzianum* were evaluated against damping-off, seed germination and growth characters of vegetable (tomato, potato, egg-plant, chilli, cabbage and cauliflower) seedlings in the seed bed.

Seed treatments with bio-agent were done by dipping the seeds in the spore suspension of bio-agent (*Trichoderma harzianum*) for 1 hour. After treatment, the seeds were allowed to dry up for 6 hours. . Soil application by *Trichoderma harzianum* were done by drenched with the spore suspension @ 3 lit/seed bed with the help of compressed air hand sprayer following pulverized the soil to mix up the *Trichoderma harzianum* spores throughout the soil. Different soil amendments were applied on seed bed soil and left for 15-30 days for proper decomposition, growing antagonistic microorganisms and developing suppressiveness. Seed germination, percent damping-off at different days after sowing and growth characters were recorded for every vegetable from the seed bed. In the seed bed, seed + soil treatment

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In Potato seedling, the highest germination in T_{11} (Seed treatment with *T. harzianum*+ Soil application with *T. harzianum*), 94.00% at 13 DAS and the lowest germination T_{20} (Un treated control), 34.00%. In T_{11} the seed treatment with *T. harzianum*+ Soil application with *T. harzianum* gave the best result at 15 DAS where no damping off disease observed. The highest damping-off observed as 28.67 % T_{20} (Untreated control). Seed treatment with *T. harzianum*+ Soil application with *T. harzianum* showed better growth character.

In chilli seedling, the highest germination was recorded in T_{11} treatment 86.67% at 18 DAS followed by T_1 treatment and the lowest germination was recorded T_{20} (Untreated control), 52.67 %. The seed treatment with *T. harzianum*+ Soil application with *T. harzianum* gave the best result at 20 DAS where no damping-off disease was observed. The highest damping-off disease was observed 18.67 % in T_{20} (Untreated control). Seed treatment with *T. harzianum* + Soil application with Poultry Waste showed better growth character.

In eggplant seedling, the highest germination was recorded , 94.33 % in treatment T_{11} at 18 DAS followed by T_1 (Soil application with *Trichoderma harzianum*) and the lowest germination (T_{20} Un treated control). (51.00%). The seed treatment with *T. harzianum*+ Soil application with *T. harzianum* gave the best result at 20 DAS no damping off disease observed. The highest damping-off disease was observed 21.00

% (T_{20} Untreated control). Seed treatment with *T. harzianum*+ Soil application with *T. harzianum* showed better growth character.

In tomato seedling, the highest germination in treatment, 92.00 % at 13 DAS followed by T_1 (Soil application with *Trichoderma harzianum*) and the lowest germination T_{20} (Untreated control), 54.00%. The seed treatment with *T. harzianum*+ Soil application with *T. harzianum* gave the best result at 15 DAS where no damping-off disease was observed. The highest damping-off observed 24.33 % T_{20} (Untreated control) 25 DAS. Seed treatment with *T. harzianum*+ Soil application with *T. harzianum* showed better growth character.

In cabbage seedling, the highest germination in treatment, 88.00 % at 13 DAS followed by T_1 (Soil application with *Trichoderma harzianum*) and the lowest germination T_{20} (Untreated control),43.33% .The seed treatment with *T. harzianum*+ Soil application with *T. harzianum* gave the best result at 15 DAS no damping off disease was observed. The highest damping-off was observed 23.00 % in T_{20} (Untreated control) at 25 DAS. The Seed treatment with *T. harzianum*+ Soil application with Poultry Waste showed better growth character.

In cauliflower seedling the highest germination in treatment T_{11}, 90.00 % at 13 DAS followed by T_1 (Soil application with *Trichoderma harzianum*) and the lowest germination T_{20} (Untreated control), 33.00%. The seed treatment with *T. harzianum*+ Soil application with *T. harzianum* gave the best result at 15 DAS lowest damping off disease observed (0.33%). The highest damping-off observed 25.00 % T_{20} (Untreated control) 25 DAS. The Seed treatment with *T. harzianum*+ Soil application with Poultry Waste showed better growth character.

The findings of the present study emphasized the possibility of using bio-agent and soil amendment in controlling damping-off disease with increasing seed germination and seedling growth of vegetable.

Considering the overall performance of the treatments applied in the experiment in controlling damping off of vegetable, sowing of *Trichoderma harzianum* treated seed in *Trichoderma harzianum* treated seed bed could be used as eco-friendly approach and may be advised to the farmers for profitable seedling production. However, further study need to be carried out for a consecutive years including more option as management practices in different Agro Ecological Zones (AEZ) of the country.

Chapter 7
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CHAPTER VII

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Appendices

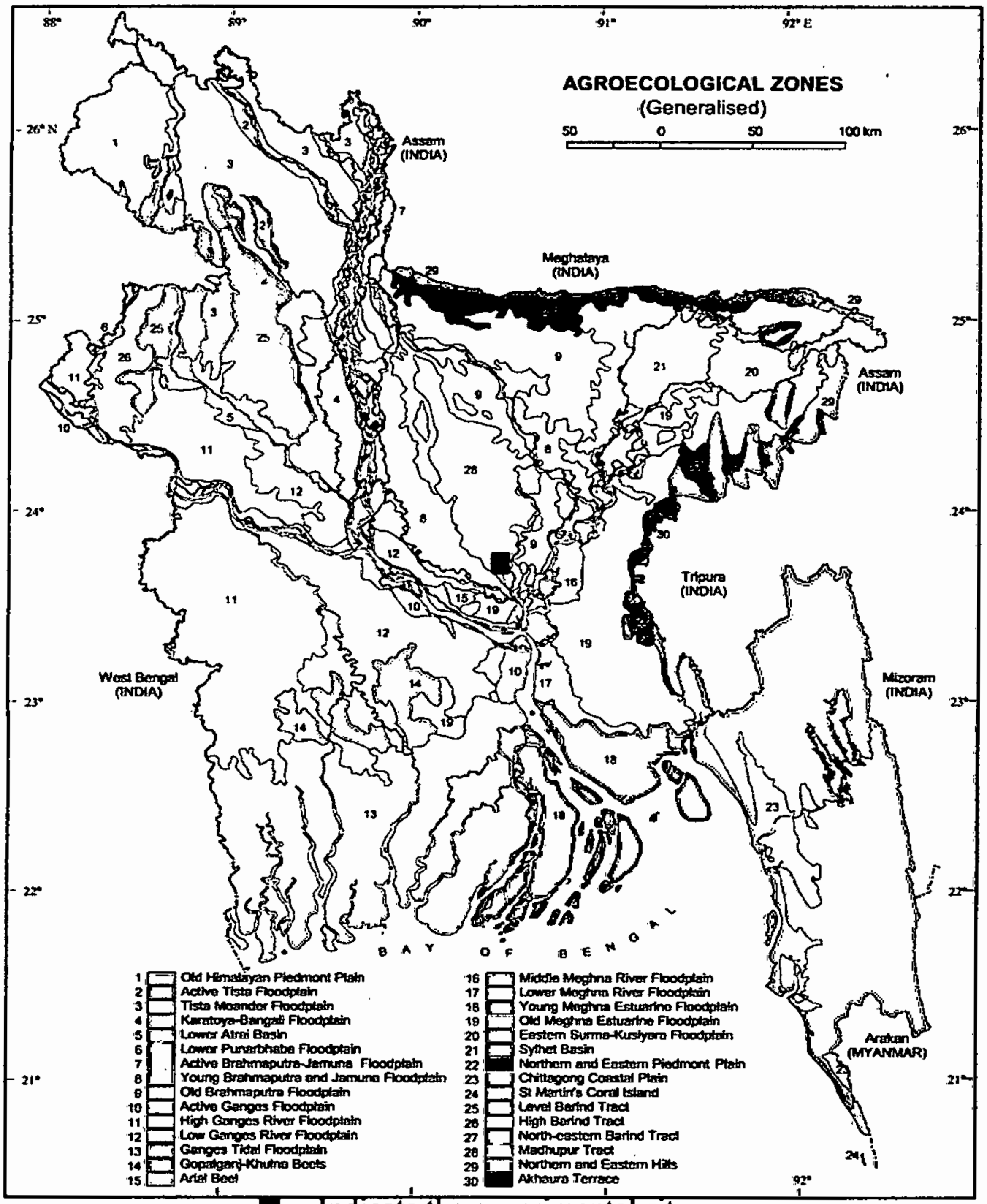
8. APPENDICES

Appendix I. Records of meteorological information (monthly) of the experimental site during the period from October 2008- February 2009.

Month (2008-09)	Average Temperature (° C)		Rainfall (mm.)	Relative humidity (%)
	Maximum	Minimum		
October, 2008	34.8	18.0	227	77
November, 2008	32.3	16.3	0	69
December, 2008	29.0	13.0	0	79
January, 2009	28.1	11.1	1	72
February, 2009	33.9	12.2	1	55

Source: Bangladesh Meteorological Department (Climate & Weather Division) Agargoan, Dhaka – 1207.

Appendix II. Map showing the location of experimental site



■ Indicate the experimental site

Source: www.fao.org.