MANAGEMENT OF DAMPING OFF OF VEGETABLE SEEDLINGS THROUGH SOME SELECTED CHEMICALS AND SOIL AMENDMENTS

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JUNE – 2007

MANAGEMENT OF DAMPING OFF OF VEGETABLES SEEDLINGS THROUGH SOME SELECTED CHEMICALS AND SOIL AMENDMENTS

A thesis

By

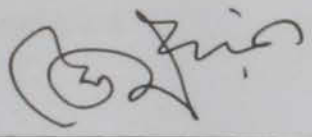
REGISTRATION NO. 27560/00723

SEMESTER: JANUARY-JUNE, 2006

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 (MS)
IN
PLANT PATHOLOGY

Approved by:



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This is to certify that the thesis entitled, ***"MANAGEMENT OF DAMPING OFF OF VEGETABLE SEEDLINGS THROUGH SOME SELECTED CHEMICALS AND SOIL AMENDMENT"*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the of* ***MASTER OF SCIENCE IN PLANT PATHOLOGY,*** *embodies the result of a piece of bonafide research work carried out by* ***MD. TOHIDUL ISLAM,*** *Registration No. 27560/00723, under my supervision and guidance. No part of the thesis has been submitted for any other degree in any other institutes.*

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

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MY BELOVED

PARENTS

ACKNOWLEDGEMENT

The author wishes to acknowledge the immeasurable grace and profound kindness of Almighty Allah the supreme Ruler of the Universe, Who has enabled him to carry out this research work and prepare the thesis.

The author feels proud to expresses his hear-felt gratitude, immense indebtedness and sincere appreciation to his respected teacher and supervisor Dr. Md. Rafiqul Islam, Professor, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for his scholastic guidance, valuable suggestions, constant encouragement, affectionate feelings, patience and advices throughout the research period and for completion of the thesis.

It is a great pleasure for the author to extend his deep sense of gratitude and indebtedness to his honorable teacher and co-supervisor Dr. F. M. Aminuzzaman, Assistant Professor, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for his creative suggestions, constructive criticism and sincere co-operation in completing the thesis.

The author desires to express his respect and deepest sense of gratitude to all the respectable teachers of the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for their valuable suggestion and kind co-operation during the period of the study.

The author pleased to convey cordial thanks to Abu Noman Faruk Ahmmed, Lecturer, Department of Plant Pathology, Mirja Hasanujjaman, Lecturer, Department of Agronomy, Md. Belal Hossain Lecturer, Department of Plant Pathology Sher-e-Bangla Agricultural University, Dhaka for their kind help and valuable advices during the research period and for preparation of the thesis.

The author desires to express his heartiest gratitude to Saila Yesmin, MS student, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for her inspiration and best co-operation during the research period and preparation of the thesis.

Cordial appreciation and thanks are extended to all the staff of Plant Pathology Laboratory and the farm workers of Sher-e-Bangla Agricultural University, Dhaka for their assistance and co-operation for conducting the research work.

Lastly the author expresses his indebtedness to his beloved parents, brothers, uncle and relatives for their blessings, love, and affection and well wishes.

The author

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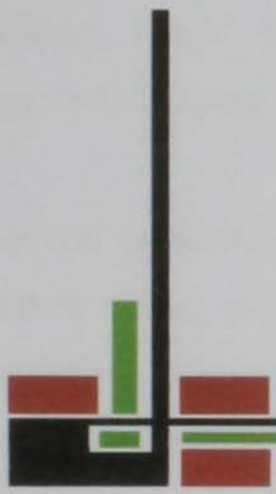
MANAGEMENT OF DAMPING OFF OF VEGETABLE SEEDLINGS THROUGH SOME SELECTED CHEMICALS AND SOIL AMENDMENTS

ABSTRACT

The effect of eleven selected treatments viz. Sawdust (T_1), Ash (T_2), Poultry waste (T_3), Kudepana (T_4), CaO (T_5), Formaldehyde (T_6), Furadan 5G (T_7), Ridomil gold (T_8), Bordeaux mixture (T_9), Soil solarization (T_{10}) and Control (T_{11}) were evaluated against *Sclerotium rolfsii*, *Fusarium* spp. *Rhizoctonia solani* and *Pythium* spp. causing damping off of vegetable seedlings (Eggplant, Tomato and Chilli). The efficacy of the treatments varied significantly in terms of increasing germination percentage and reducing percent damping off of vegetable seedlings in comparison to control (T_{11}). Soil application with Ridomil gold (T_8), Soil solarization (T_{10}), Poultry waste (T_3) and Formaldehyde (T_6) showed the remarkable effect in controlling damping off of vegetable seedlings increasing percent seed germination. An increased of 92.67% (18 DAS) seed germination in eggplant, 91.67% (13 DAS) in tomato and 90.33% (18 DAS) in chilli were recorded in case of Ridomil gold compared to control while reduction of damping off incidence were 1.67% (30 DAS), 1.00% (25 DAS) and 1.00% (30 DAS), respectively for eggplant, tomato and chilli seedlings.



Chapter 1
Introduction

INTRODUCTION

Vegetables are rich sources of minerals, vitamins and essential amino acids. They are considered as a cheap source of natural supplementary food and can be grown within a short duration. Vegetables in Bangladesh can be grouped into summer, winter and year round on the basis of growing season. About two thirds of the vegetables are grown in the winter season (November- Feb.). Major winter vegetables include tomato, eggplant, cabbage, radish, spinach, amaranth, bottle gourd etc. (Siddiqui, 1995).

Tomato and eggplant are important high value crops among vegetables in Bangladesh. They play vital role in human nutrition. Most of them supply carbohydrates, proteins, fats, vitamins and minerals. Our farmers may be able to get economic benefit when producing and marketing them early in the season. Eggplant is nutritious vegetable and has got multifarious use as a dish item (Bose and som, 1986 and Rashid, 1993). It is largely cultivated in almost all districts of Bangladesh. It can be grown at homestead area and kitchen garden because of its popularity especially for urban people. About 8 million farm families are involved in eggplant cultivation. (Islam, 2005). This gives small, marginal and landless farmers a continuous source of income and provides employment facilities for the rural people. For most of the time, except peak production period, market price of eggplant compared to other vegetables remains high which is in favour of the farmer's solvency. So, it plays a vital role to boost our national economy.

Eggplant (*Solanum melongena* L.) is the second most important vegetable crop next to potato in Bangladesh in respect of acreage and production (BBS, 2005). It belongs to the family solanaceae. The total area of eggplant cultivation is 60100 hectare where 22500 ha in kharif season and 37500 ha in Rabi season with total annual production of 358400 mt. and the average yield is 6.0 t/ha in 2003-04 (BBS, 2005). It is grown round the year both as winter (Rabi) and summer (Kharif) crops (Rashid, 1993).

The yield potential of eggplant is low in Bangladesh compared to other countries. Incidence of insect pests and diseases greatly hampered the production of eggplant. This crop suffers from the various diseases; about 13 different diseases so far recorded in Bangladesh (Das *et al*., 2000 and Rashid, 2000). Among the various pathogens, *Sclerotium rolfsii*, *Fusarium oxysporum* and *Rhizoctonia solani* causing damping off has been treated as the major constraints of eggplant cultivation in our country.

Tomato (*Lycopersicon esculentum* L.) is a commonly grown popular vegetable in the country. It belongs to the family solanaceae. In Bangladesh, tomato is cultivated mainly in homestead gardens as well as in fields during winter and in limited scale at summer season. Tomato was grown 17 thousand hectares of land in Bangladesh, the production being 67,416 tons in 2004-2005 (BBS, 2005). About 85% of total tomatoes are grown in six greater districts, namely Comilla, Dhaka, Jessore, Chittagong, Sylhet and Rajshahi. It contributes to 20% of the total vegetable grown in the country and plays a vital role in human nutrition having 15% vitamin and it is 100% edible (Gowda and Kaul, 1982).

The average yield of tomato in the world is 27 t/ha where as it is around 7 t/ha in Bangladesh. Diseases are the major constraints for lower yield of tomato in Bangladesh which cause about 30-40% yield loss of this crop annually (Anon, 1992). Among the various diseases, *Sclerotium rolfsii*, *Fusarium oxysporum* and *Rhizoctonia solani* causing damping off is the most prevalent throughout the tomato growing areas in Bangladesh. Outside Bangladesh the disease has been reported in many countries including India (Nene *et al.* 1996).

Chilli (*Capsicum annuum* L.) is one of the important spice crop in the world. It is the most important spice crops in Bangladesh under the family Solanaceae having nutritive value especially rich in vitamin C. It forms an indispensable adjunct in every house in the tropical and sub-tropical world (Bose and Som, 1990). It is specially liked for its spicy taste. Its green fruits as well as dried ripe fruits are used as spice for preparing curries salad etc. and also used in stuffing. Chilli is also a cash crop, grown in all seasons and all areas of Bangladesh.

In Bangladesh the total area of chilli plant cultivation is 65000 hectare where 23417 ha in kharif season and 41583 ha in Rabi season with total production of 52000mt. and average yield 0.08mt. in 2004-2005 (Anon., 2006). This yield is very low compared to other Chilli growing countries of the world. For the low yield of the crop, its annual production cannot meet the total requirement and as such large quantity is to be imported every year. There are many factors responsible for the low yield of the crop in our country; fungal diseases play a vital role. Chilli is known to suffer from as many as 83 different diseases, of which more than 40 are caused by fungi (Annon.,

1960; Anon., 1966; Rangswami, 1988). Among the fungal diseases, damping off caused by *Fusarium oxysporum, Sclerotium rolfsii, Pythium spp., Rhizoctonia solani* and *Phytophthora* sp. causing damping off is the most prevalent disease in Bangladesh.

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 oxysporum, Sclerotium rolfsii, Phytophthora sp.* and *Rhizoctonia solani* etc. (Singh, 1984).

The fungi *Fusarium oxysporum, Sclerotium rolfsii* and *Rhizoctonia solani* are soil inhabiting pathogen with wide host range and therefore, very difficult to control them. (Rangswami, 1988; Talukder, 1974; Singh, 1984; Elango, 1986; Das, 1984; Martin and Torres, 1989).

The damping off occurs in two phases of plant growth, namely pre-emergence damping off and post-emergence damping off. In pre-emergence damping off, the young seedlings are killed before they emerged from the soil while in post emergence damping off the infected seedlings are topple down due to infection in the collar region after the emergence from the soil.

There are several methods for controlling damping off disease. Numerous fungicides inhibit the germination of sclerotia or mycelial growth of the causal fungi. Many of them effectively control the disease of various crops in the field (Mukhopadhyay and Thakur, 1971; Agnihotri and Srivastava, 1975; Backman and Rodriguez Kabana; 1975; Hass, 1976; Diomande and Beute, 1977; Brown and Hendrix, 1980; Punja *et al.*, 1982). The major

limitation in the control of this fungal disease is the widespread use of fungicides in large quantity. In case of cultural control, several methods are suggested to minimize the inoculum of *S. rolfsii, F. oxysporum* and *R. solani* in the soil. Infact most of the methods are not effective unless used in conjunction with fungicide or fertilizer applications. (Gurkin and Jenkins, 1985; Punja *et al.*, 1985).

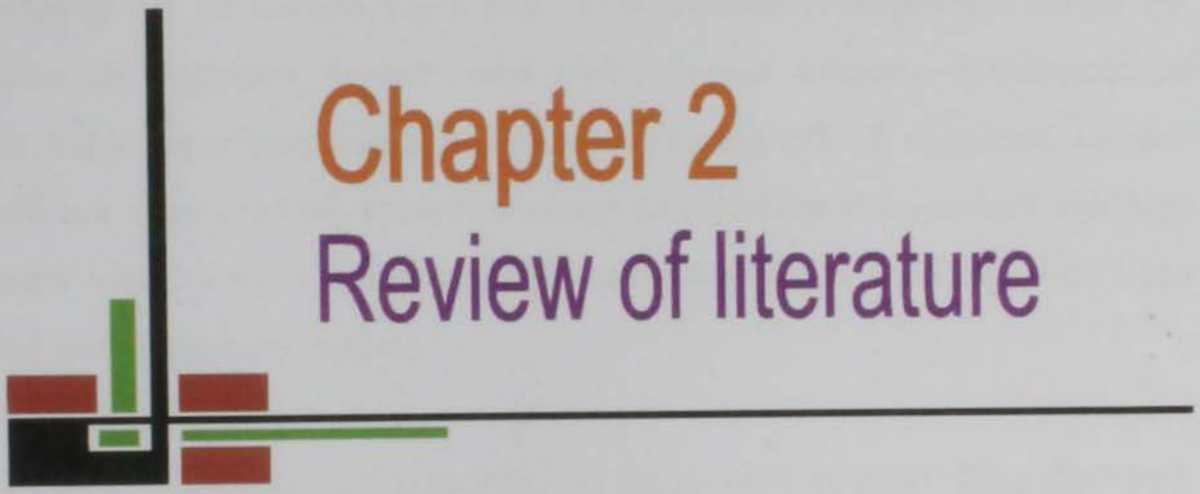
Other control measures like host resistance has not yet become a viable control measure. No resistant variety has yet been developed and released against these soil borne pathogens causing damping off of eggplant, tomato and chilli at seedlings stage in our country and also in the neibouring countries (India, Pakistan, Srilanka etc.). Recently, soil solarization has been shown to be successful in controlling several soil-borne pests and weeds which are extensively used in different parts of the world especially in Israil (Dey, 2005; Islam, 2005; Mihail and Alcorn, 1984; Chen and Katan, 1980; Elad *et al.*, 1980; Katan *et al.*, 1980; Grinstein *et al.*, 1979 and Katan *et al.*, 1976).

Among the different chemicals, Ridomil gold and formalin are effective against damping off of seedlings. (Taha *et al.*, 1988; Abdel-Rahim and Abu-Surrieh, 1991; Ayub *et al.*, 1998). Organic soil amendment is another important option and eco-friendly approach for controlling soil borne pathogen by developing suppressive soil such as poultry waste and saw dust (Patil and Katan, 1997 and Singh and Sitaramaiah, 1971).

Under the scenario discussed above, identification of the components for management of damping off of eggplant, tomato & chilli is an urgent demand. But there exists a few evidence of research work for management of damping off of eggplant, tomato and chilli in Bangladesh. Hence the present investigation was undertaken to achieve the following objectives:

- To evaluate the efficacy of soil amendments against damping off of vegetable (Eggplant, Tomato and Chilli) seedlings.

-To evaluate the efficacy of fungicides against damping off of vegetable (Eggplant, Tomato and Chilli) seedlings.



Chapter 2
Review of literature

REVIEW OF LITERATURE

Seedlings of eggplant, tomato and chilli are frequently attacked by damping off disease in seed bed. A number of soil borne 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 of tomato seedlings. This disease is important threat for production of eggplant, tomato and chilli in our country. Evidences of research work regarding management of damping off of eggplant, tomato and chilli are very limited. However some available and important findings on various aspects for management of damping off of seedlings has been compiled and presented below:

Fahim *et al.* (1988) screened a number of fungicides in controlling damping off of sugarbeet incited by *Sclerotium rolfsii* both *in vitro* and *in vivo* as seed treatment. In vitro, Homai-80, Captan and carboxin + Thirum completely inhibited the growth of *Sclerotium rolfsii* and they also reduced greatly pre-emergence damping off when used as seed treatment.

Taha *et al.* (1988) tested fungicides against *Fusarium solani*, *Pythium aphanidermatum* and *Rhizoctonia solani* on tomato. Homai [thiophanate-methyl + thiram] and Benlate [benomyl] were the most effective under laboratory conditions. Ridomil [metalaxyl], Vitavax [carboxin]-thiram and thiophanate-methyl + thiram were used as seed treatments and soil drenches to control damping off. They were also used as soil drenches and root dips to

control root rot. Benomyl and thiophanate-methyl + thiram gave good control and metalaxyl selectively inhibited *P. aphanidermatum*.

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 mycelial 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 day, the longest period tested.

Dharam *et al.* (1989) reported that Difolatan [captafol], Emisan (2-methoxyethylmercury chloride), Blitox-50 (copper oxychloride) and Topsin-M [thiophanate-methyl] and their combinations were used as seed treatments for the control of damping-off of tomatoes and chilli (*Capsicum frutescens*) caused by *Rhizoctonia bataticola* [*Macrophomina phaseolina*], *Fusarium* and *Pythium aphanidermatum*. 2-Methoxyethylmercury chloride at 1 g/kg seed or in combination with copper oxychloride (1+1 g/kg seed) was the best fungicide in controlling the disease on both the crops. However, a combination of thiophanate-methyl with 2-methoxyethylmercury chloride and copper oxychloride was also very effective.

Premature death of potato seedlings caused by *Rhizoctonia*, *Fusarium* and *Erwinia* spp. were identified in the costal valleys of peru (Torres, 1989). Four field trials were carried out in LaMolins from 1984-1987 with fungicides, Metalaxyl 5g, Talclofos Methyl and PCNB + Benomyl in combinations with or without a pre-planting application of Basamid+ Tolclofos Methyl and pre-planting fumigants and plastic cover during one month were more efficient than the other treatments.

Cubeta and Echandi (1991) reported that control of cucumber damping-off caused by *R. solani* and *Pythium* spp. requires an integrated approach and can be achieved using the bi-nucleate *Rhizoctonia* sp. isolate 232-CG combined with the fungicide metalaxyl. This treatment protected cucumber from *Rhizoctonia* and *Pythium* damping-off as effectively as the recommended fungicide captan.

Abdel-Rahim and Abu-Surrieh (1991) tested 9 fungicides such as Bavistin [carbendazim], Benlate [benomyl], Topsin M [thiophanate-methyl], Miltox special, Dithane M-45 [mancozeb], Dithane S-60, Ridomil 5-G [metalaxyl], Rovral [iprodione] and Captan 50 against damping off of cucumber. Metalaxyl followed by iprodione and Captan 50 gave the best control of *P. debaryanum* on potato dextrose agar medium. Metalaxyl also stopped oospore germination at 500 mg/litre a.i. *in vitro* and reduced cucumber damping off under greenhouse conditions.

El-Shami *et al.* (1993) reported that applications of Enide [diphenamid] or Devrinol [napropamide] as pre-emergence herbicides were not effective in minimizing damping off disease incidence. Vitavax [carboxin]-thiram or

Vitavax-captan, applied as seed treatment, were effective in controlling damping off disease. However, sowing date affected the efficiency of these fungicides. Vitavax-captan gave better disease control than Vitavax-thiram during October, while the opposite was observed during July and August Application of Enide enhanced the efficacy of Vitavax-thiram against *Fusarium* in October while Devrinol enhanced the potency of Vitavax-captan during August. The efficacy of these combined treatments against *Rhizoctonia* did not greatly differ from the effect of each fungicide alone. However, they enhanced its efficiency against the mixture of both pathogens. Pesticide application also affected the growth of tomato plants.

Balardin *et al.* (1994) tested the effect of sand covering, sawdust covering and methyl bromide on percentage and speed of emergence, and percentage pre- and post-emergence in relation to damping off (known to be predominantly caused by *Pythium debaryanum*, *Rhizoctonia solani*, *Phytophthora spp.* and *Fusarium* spp.) control in lettuce, sugarbeet and cabbage. The results showed that sand was the best inert material and confirmed the possibility of a good alternative control of damping off in the nursery on cabbage and sugarbeet. However, the inert materials had a negative effect on lettuce seedling emergence.

Mani and Marimuthu (1994) conducted an experiment where decomposed coirpith gave comparable results with *Trichoderma hamatum* and *T. viride* str. 2 giving 16.3 and 11.5% post emergence damping off in *Capsicum annuum* caused by *Pythium aphanidermatum* compared with 75% in the untreated inoculated controls, in a series of pot experiments. Decomposed coirpith alone and in combination with *T. harzianum* str. 2 gave the best

survival of plants 60 d after sowing. The best control of pre-emergence damping off was given by copper oxychloride. The best control of *Macrophomina phaseolina* in *Vigna mungo* was given by carbendazim (92.2% plant stand), followed by *T. harzianum* 2 + decomposed coirpith (90.6%). It is concluded that coconut coirpith is available in large quantities in Tamil Nadu, offering great potential for use in soil improvement and the management of soil borne diseases.

Wahab *et al.* (1995) investigated the effects of seed dressings (2g/kg) of quintozene (as Brassicol), thiophanate-methyl (as Topsin-M), carboxin (as Vitavax) and benomyl (as Benlate) on *Fusarium* damping off of *Citrus aurantium* and seed germination and reported that Seed germination was highest (82%) with thiophanate-methyl treatment, followed by quintozene (63%). Quintozene was the most effective in controlling damping off.

Hundoo and Dwivedi (1997) reported that Jkstein and Vitavax were the most effective and inhibited the linear growth of the damping off pathogen completely on an agar medium at concentrations of 10 µg/ml, followed by Emisan-6 (20 µg/ml). Captan and Shield-75 were totally ineffective at 10, 20 and 40 µg/ml, but captan controlled mycelial growth at higher concentrations. Shield-75 was the least effective in controlling growth. Foltaf and Kavach controlled growth by 88.8 and 50.0%, respectively, at 200 µg/ml. In in vivo studies, all the fungicides gave some degree of control. The % disease control tended to increase as the concentration of chemical increased. A 3 mg/g concentration of all fungicides gave good protection of the seedlings against damping-off. Jkstein was the most effective and significantly superior (P=0.05) to the other fungicides in protecting the

seedlings against the disease followed by Foltaf, captan and Emisan-6. Jkstein was also non-phytotoxic to aubergine seedlings at 50, 100, 200 and 400 µg/ml concentrations.

Harender-Raj *et al.* (1997) reported that soil solarization with transparent polyethylene mulch (25 micro m) controlled damping off pathogens of different vegetable crops in the nursery. Nursery-bed soil was flood irrigated and then covered with transparent polyethylene sheet for 40 days. Mulching with polyethylene resulted in 13.5 degrees C higher temperature at 8 cm soil depth with an average maximum temp. of 49.7 degrees . Soil solarization for 40 days killed the *Pythium* spp. and *Fusarium* spp. up to 30 cm soil depth. A nursery of 10 different vegetable crops raised later in solarized beds recorded 18.3 to 42.0% higher seed germination, lower incidence of post-emergence damping off and had better seedling vigour.

Ayub *et al.* (1998) reported that Ridomil (Metalaxyl) at all concentrations effectively controlled the damping off disease of tomato. Captan was effective only at higher concentration. The number of leaves, and root and shoot lengths of tomato were significantly reduced by all the fungicides [Ridomil (metalaxyl), captan (captan) and dithane M-45 (mancozeb), each at 3 different concentrations]. To minimize production costs and produce healthy and vigorous seedlings, Metalaxyl at the rate of 12 and 16 mg a.i/L, and Captan at 1.75 g a.i/L were recommended for control of seed rot and damping-off in vegetable nurseries.

Hickman and Michailides (1998) reported that untreated fallow field soil, solarized soil, methyl bromide treated soil and metalaxyl soil drench treatments were all effective against damping off (caused by *Pythium aphanidermatum*) of cucumber.

Ioannou *et al.* (1999) also found the effect of solarization in two field trials, have been carried out at Paralimni, Cyprus, during 1984-85 and 1985-86 for tomato production. Solarization treatments were applied in 80 cm wide stripes for 7 to 8 weeks in July-August, using transparent polyethylene sheets for soil mulching. Tomato (cv. marmande) seedlings were transplanted in the centre of solarized stripes in mid September and grown in the open till March. In both trials, solarization raised the maximum temperature by 10 to 11°C, reduced the population density of *Fusarium* [*F. oxysporum* f. sp. *Lycopersici*] and *Verticillium* [*V. dahliae*] wilt diseases on tomato. It also controlled weeds (species of Malva, *amaranthus*, Chrysanthemum, *Chenopodium* and *Calendula arvensis*, *Lolium rigidum* and *Utica urens*) by 90%, improved tomato plant growth, and increased fruit yield by 60 to 135% compared with the untreated control.

Salerno *et al.* (1999) found that the soil solarization that have been carried out at 3 Eucalyptus forest nurseries in Argentina for production of disease free seedling of eucalyptus that damaged by *Fusarium* spp. and *Pythium* sp. caused damping off. Soil temperatures reached during solarizarion at the 3 nurseries were 44, 45 and 49°C, respectively. The soil-borne pathogens were controlled within 4 weeks using a single layer in one of the nurseries and using a double layer in the other two. Although the temperatures generated in the soil were not very high, they suggest that the antagonistic micro-flora

present in the native virgin soils in argentina and or biological processes may have contributed to the control of these pathogens.

Karthikeyan *et al.* (2000) evaluated in a field trail in 1995 [place not given] using the several viz. treatments: 4 g talc formulation of *Trichoderma viride*/kg seed (T1), 4 g talc formulation of *T. harzanium*/kg seed (T2), 1 g *Paecilomyces lilacinus* culture/kg seed (T3), 10 g Diafuran 3G/kg seed (T4), 8 g Ridomil MZ-72 [metalaxyl]/kg seed (T5), 8 g Ridomil MZ-72/kg seed + 10 g Diafuran 3G/kg seed (T6) and 4 g Aureofungin/kg seed (T7) for the management of *P. aphanidermatum-Meloidogyne incognita* disease complex in chilli and brinjal. Seed treatment with Diafuran 3G + Ridomil MZ-72, significantly reduced the incidence of damping-off followed by seed treatment with Ridomil MZ-72, *T. viride*, *T. harzianum* and *P. lilacinus* treatments. There was an increase in dry shoot and root weight of both crops when *T. viride* was used as seed treatment followed by *P. lilacinus* and *T. harzianum*. The nematode gall-index was highly reduced in Diafuran 3G + treatment followed by P. lilacinus and Diafuran 3G-Ridomil MZ-72 treatments.

Swamy *et al.* (2000) conducted an experiment in Shimoga, Karnataka, India during the kharif season of 1997 against damping off (*Pythium aphanidermatum*) in an FCV tobacco nursery. Treatments consisted of freshly-chopped leaves of *Gliricidia maculata*, *Pongamia pinnata*, *Azadirachta indica* or *Eupatorium odoratum* [*Chromolaena odorata*] at 3 kg/m2, neem or pongamia oilseed cakes at 400 g/m2, and/or 0.2% Ridomil MZ [mancozeb + metalaxyl] 72 WP or 0.5% Bordeaux mixture. Soil solarization was common to all treatments except the untreated control. The

integration of neem or pongamia cake and soil solarization for 4 weeks followed by 2 sprays of Ridomil MZ 72 WP or Bordeaux mixture at 10-day intervals reduced the disease incidence and yielded the highest number of transplantable seedlings.

Islam *et al.* (2000) conducted an experiment and was during 1995-96 and 1996-97 in Bangladesh on true potato seed (FPS). The treatments were soil moisture at 40, 60, and 80% field 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 MZ 72 (0.2%), Apron 35SD (0.2%) and Captan (0.2%) at 5 litres a.i./m2. three soil-borne 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.

Hegde *et al.* (2001) conducted an experiment where seeds of chilli, sown in pots in a glasshouse, treated with biological control agents, namely *Pseudomonas fluorescens, Bacillus subtilis, Trichoderma viride* and *T. harzianum* at 108 cfu/ml, and fungicides Captan and Thiram at 3 g/kg. After one month of sowing observations were recorded for per cent seedling mortality. Treatments differed significantly with respect to per cent mortality of chilli seedlings. The least per cent mortality (10.13) was observed in captan-treated seeds, which was on par with *P. fluorescens* (11.12) and

thiram (12.34). The maximum per cent mortality (63.25) was recorded in the control.

Patricio *et al.* (2002) evaluated naturally infested soil for controlling damping off of melon, cucumber, cabbage and tomato seedlings caused by *P. aphanidermatum*. This soil, collected from chrysanthemum or gypsophila fields was mixed with oatmeal (20 g/litre of soil) and placed around the stems of recently emerged seedlings. Treatments applied immediately after (either in g or ml/100 litres of water) consisted of: propamocarb hydrochloride (100), propamocarb hydrochloride (150), propamocarb hydrochloride (200), propamocarb hydrochloride (100)+carbendazim (100), propamocarb hydrochloride (150)+carbendazim (150), propamocarb hydrochloride (100)+flutolanil (100), metalaxyl+mancozeb (300), and pentachloronitrobenzene (PCNB) [quintozene] (600). Three to seven days after the treatments, seedlings that survived damping off were counted. All the treatments, except PCNB for melon, PCNB and metalaxyl+mancozeb for tomato, reduced damping off. The highest rates of propamocarb hydrochloride and metalaxyl+mancozeb were the best treatments for cucumber seedlings. All treatments, except the mixture of propamocarb hydrochloride with carbendazim and PCNB controlled cabbage seedling damping off.

Ali *et al.* (2002) conducted an experiment during 1995-97 to determine an 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

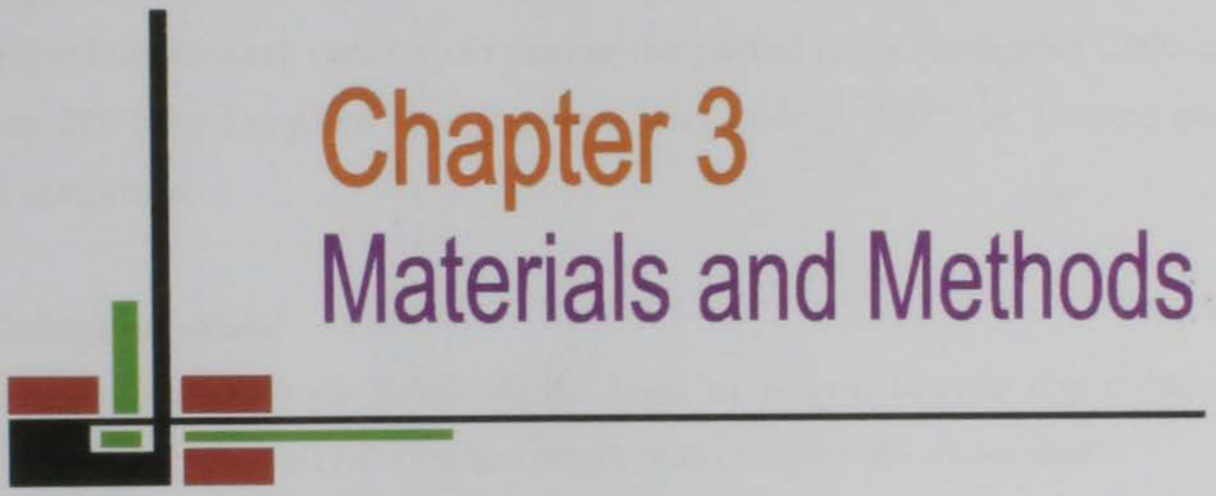
capacity; application of formalin; and application of fungicides such as Vitavax 200 [carboxin+thiram], Ridomil [metalaxyl], captan and Apron [metalaxyl]. All the treatments showed better control of the disease compared to the control. Application of formalin resulting in the lowest mean disease incidence (8.77%) followed by Vitavax 200 (10.38%).

Rahman *et al.* (2003) conducted an field experiment in Andhra Pradesh, India during the summer and kharif seasons of 1997-98 and 2000-01, soil solarization with white polythene sheet for 30 days during the peak of summer resulted in the lowest incidence of damping-off in tomato (3.9%), aubergine (1.5%) and chilli (1.3%) caused by *Pythium, Fusarium* and *Phytophthora*, followed by seed treatment with Captan. Among the fungal antagonists, *Trichoderma viride* recorded the lowest incidence of damping-off (5.7% in tomato, 4.7% in aubergine and 4.7% in chilli) followed by seed treatment with *Pseudomonas fluorescens, T. harzianum* and *Azotobacter chroococcum* which were at par with each other. The results indicate that the occurrence of damping-off disease in nurseries can be effectively controlled by soil solarization of nursery beds during the peak of summer or seed treatment followed by soil application with *Trichoderma viride*.

Lakra (2003) conducted an experiment on true potato seedlings during 1998/99 and 1999/2000 in Haryana, India, to determine the efficacy of bio-agents (*Trichoderma viride* and *Bacillus subtilis*) and captan against damping off (*Pythium aphanidermatum*). The treatments comprised talc-based formulations of bio-agents *T. viride* and *B. subtilis* applied at 4 g/kg of seed (before sowing) and broadcasted on the soil at 5 g/m2 (before sowing); seed and soil treatments of Captan at 4 g/kg and 5 g/m2, respectively. The

pre-emergence damping-off was 35.9, 27.1 and 4.8% when the seeds were treated with *B. subtilis*, *T. viride* and Captan, respectively. The incidence of post-emergence damping-off was minimum (5.5%) when the seed and soil were treated with captan followed by *T. viride* seed + soil treatment (13.5%) and *B. subtilis* seed + soil treatment (22.2%). The post-emergence damping-off in the control was 42.6%. The number of tuber and tuber yield/m2 were also highest with captan seed + soil treatment followed by *T. viride* seed + soil treatment and *B. subtilis* seed + soil treatment.

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.



Chapter 3
Materials and Methods

MATERIALS AND METHODS

3.1 Experimental site

The experiments were conducted in the Department of Plant Pathology, Sher-e-Bangla Agricultural University. A temporary made polythene shed house was used for the pot experiments.

3.2 Experimental Period

The experiments were carried out during the period from November 2006 to January 2007 for Eggplant seedlings and May to July, 2007 for Tomato and Chilli seedlings.

3.3 Collection of soil

Soil was collected from Horticultural farm of Sher-e-Bangla Agricultural University. Surface soil of 6 inches depth was used for the experiment.

3.4 Variety used

Eggplant variety 'BARI Begon 5', Tomato variety 'BARI Hybrid tomato 3' and Chilli variety 'Banglalanka' were used for the experiment.

3.5 Treatments of the experiment

In this study eleven (11) treatments with three replication were used as designated by T_1, T_2, T_3, T_4. T_5, T_6, T_7, T_8, T_9, T_{10} and T_{11} which were as follows:

T_1= Saw dust

T_2= Ash

T_3= Poultry waste

T_4= Kudepana

T_5= CaO

T_6= Formaldihyde

T_7= Furadan 5G

T_8= Ridomil gold

T_9= Bordeaux mixture

T_{10}= Soil Solarization

T_{11}= Control

3.6 Preparation of soil:

Soil, sand and cowdung were mixed in 2:1:1 ratio and kept for 15 days. Then the soil for individual treatments were treated with treatment materials and then kept for 15 days for the necessary action. Soil for treatment T_{10} (Soil solarization) was kept open sunlight for solarization.

3.7 Collection of seeds

The seeds were collected from Bangladesh Agricultural Research Institute, Joydebpur, Gazipur.

3.8 Collection of test materials

Furadan 5G, Formaldehyde, Ridomil gold, Bordeaux mixture, CaO and Poultry waste were purchased from the market. Sawdust was collected from the Mohammadpur sawmill and Khudepana was collected from the pond of Sher-e-Bangla Agricultural University.

3.9 Application of Khudepana

Fresh khudepana was collected from pond of SAU campus and placed on soil for 15 days and then mixed with experimental soil

3.10 Application of Formaldehyde

15 ml formalin was mixed in 60 ml water and that solution was used for 12 kg soil. (Dashgupta, 1988). After treating with formaldehyde, the treated soil was covered with polythene for 48 hrs. Then the soil was exposed and pulverized before sowing.

3.11 Application of Furadan 5G

As per recommended dose 15 g Furadan 5G was mixed with 12 kg for the experiment.

3.12 Application of Ridomil gold

As per recommended dose, 4 g Ridomil gold was mixed with 2 lit water that was used for 12 kg soil.

3.13 Application of Bordeaux mixture

18.16 g $CuSO_4$ and 18.16 g CaO was dissolved in 2 liter water and that solution was thoroughly mixed with 12 kg experimental soil

3.14 Application of other treatments

Sawdust, Ash, Poultry waste, Kudepana (compost) was mixed at 1:3 ratio with Experimental soil.

3.15 Details of the chemicals used in the experiment

Trade name	Chemical name	Active ingredient	Mode of action
Furadan 5G	Carbamic acid, methyl-2,3-dihydro-2,2-dimethyl11-7-benzofuranyl ester	Carbofuran	Systemic
Ridomil gold	N-(2,6 dimethyl phenyl)-N-(metoxyacetyle)-D-alanin methyl ester($C_{14}H_2NO_4$)	Metalxyl	Systemic
Bordeaux mixture	$CaO.CuSO_4.5H_20$	5:5:50	Systemic
Formalin	Formaldehyde	40% Formaldehyde	

(Rashid, 2000)

3.16 Isolation and identification of the causal organisms of damping off

To identify the pathogen, the diseased plants were collected from the pot and were taken to the laboratory. The diseased plant was cut into small pieces (about 0.5-1 cm) and surface sterilized by dipping in 10% sodium Hypochlorite solution for 2-3 minutes or $HgCl_2$ solution (0.01%) for 30

second. The cut pieces were then washed in sterilized water at three times and were placed into PDA media in sterilized petridish with the help of sterile forceps and incubated at 25±1°c for 7-10 days. Then the organism that grew freshly into culture were isolated by means of hyphal tip culture method aseptically and were cultured again in PDA to have pure culture. The PDA plate was incubated at 25±1°c for a week and identified. The color of the culture is found white. Then a slide was prepared from that culture and observed under compound microscope and the fungus was identified as *Fusarium oxysporum*.

3.17 Data collection

Data were recorded on germination percentage at different days of sowing (7, 10, 12 DAS for tomato and 12, 15, 18 DAS for eggplant and chilli) and damping off percentage at different days (15, 20, 25 DAS for tomato and 20, 25, 30 DAS for eggplant and chilli) after sowing.

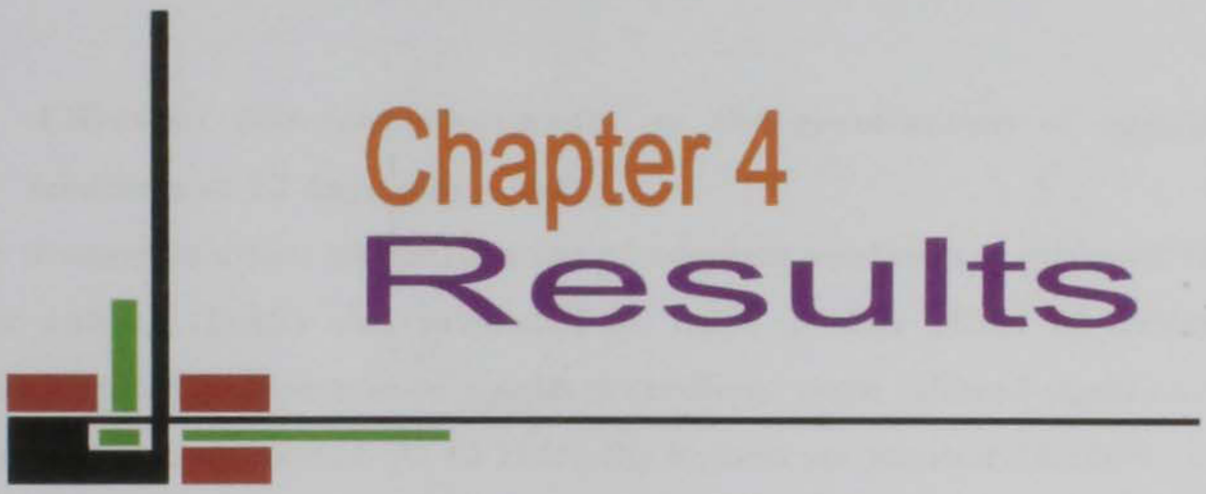
3.18 Analysis of data

The data were statistically analyzed using computer package program. Treatments means were compared by DMRT (Duncan's Multiple Range Test).

Plate 1. Showing experimental pot of eggplant seedlings

Plate 2. Pure culture of *Fusarium oxysporum* on PDA medium

Plate 3. Macro and micro conidia of *Fusarium oxysporum* (40x)



Chapter 4
Results

RESULTS

The results obtained from the present study on the effect of eleven different treatments viz. saw dust, ash, poultry waste, kudepana, CaO, formaldehyde, Furadan 5G, Ridomil gold, Bordeaux mixture, soil solarization and control (un-treated) for the management of damping off of vegetable (Eggplant, tomato and chilli) seedlings are presented below.

4.1 Effect of different treatments on the germination of eggplant seedlings at 12 days after sowing

The treatments effect on germination of eggplant seedlings at different days after sowing (DAS) was presented in Table 1. The effect of different treatments on germination of eggplant seedlings were differed significantly in comparison to control. At 12 DAS, the highest germination (82.00%) was observed in T_8 (Ridomil gold) and the lowest germination (55.67%) was observed in T_{11} (Control). The second highest germination (79.00%) at same days after sowing was observed in T_{10} (Soil solarization). The effect of poultry waste on germination at 12 DAS was statistically similar with the effect of formaldehyde. The effect of sawdust on germination at 12 DAS was also statistically similar with the effect of Bordeaux mixture.

4.2 Effect of different treatments on the germination of eggplant seedlings at 15 days after sowing

A remarkable effect was observed among the treatments on the germination at 15 DAS of eggplant seedling. The effect of different treatments on germination of eggplant seedlings were differed significantly in comparison

to control. At 15 DAS, the highest germination (88.00%) was observed in T_8 (Ridomil gold) and the lowest germination (58.33%) was observed in T_{11} (Control). The second highest germination (85.33%) at 15 DAS was observed in T_{10} (Soil solarization). The effect of poultry waste on germination at 15 DAS was statistically similar with the effect of formaldehyde. The effect of sawdust on germination at 15 DAS was also statistically similar with the effect of Bordeaux mixture.

4.3 Effect of different treatments on the germination of eggplant seedling at 18 days after sowing

The effect of different treatments on germination of eggplant seedlings was differed significantly in comparison to control. At 18 DAS, the highest germination (92.67%) was observed in T_8 (Ridomil gold) and the lowest germination (62.00%) was observed in T_{11} (Control). The second highest germination (88.67%) at 18 DAS was observed in T_{10} (Soil solarization). The effect of poultry waste on germination at 18 DAS was statistically similar with the effect of formaldehyde. The effect of sawdust on germination at 18 DAS was also statistically similar with the effect of Bordeaux mixture.

Table 1. Effect of different treatments on the germination of eggplant seedlings at different days after sowing (DAS)

Treatments	%Germination		
	12 DAS	15 DAS	18 DAS
T_1	71.00 d	76.00 d	82.00 d
T_2	68.00 e	72.00 e	78.33 e
T_3	76.00 c	82.33 c	86.33 c
T_4	60.00 g	61.00 g	66.67 g
T_5	65.33 f	71.00 e	76.33 e
T_6	74.33 c	81.33 c	84.67 c
T_7	65.00 f	65.33 f	71.00 f
T_8	82.00 a	88.00 a	92.67 a
T_9	71.00 d	77.33 d	81.67 d
T_{10}	79.00 b	85.33 b	88.67 b
T_{11}	55.67 h	58.33 h	62.00 h
% CV	1.69	1.52	1.55

T_1= Sawdust
T_2= Ash
T_3= Poultry waste
T_4= Khudepana
T_5= CaO
T_6= Formaldehyde
T_7= Furadan 5G
T_8= Ridomil gold
T_9= Bordeaux mixture
T_{10}= Soil solarization
T_{11}= Control

4.4 Effect of different treatments on damping off of eggplant seedlings at 20 days after sowing

Treatments effect was differed significantly in respect of damping off percentage at 20 days after sowing (Table 2). Significantly the highest percent damping off was recorded in control (4.67 %) which was statistically similar with kudepana (4.33%), CaO (4.33%) and Furadan (4.00%) at 20 DAS. The second highest percent damping off at same DAS was observed in sawdust (3.33%) and ash (3.33%) which was statistically similar with formaldehyde (2.67%). No damping off was noticed in case of Ridomil gold which was statistically similar with soil solarization. Poultry waste also gave the remarkable performance in reducing damping off where percent damping off was 1.67%.

4.5 Effect of different treatments on damping off of eggplant seedlings at 25 days after sowing

A remarkable effect was observed among the treatments in controlling damping off disease of eggplant at 25 days after sowing (Table 2). The treatments effects were differed significantly in terms of damping off percentage. The highest effect against damping off was observed in case of Ridomil gold which was statistically similar with soil solarization where percent damping off was 0.67% and 2.33% respectively. The second lowest percent damping off (5.00%) was observed in poultry waste which was statistically similar with formaldehyde (5.67%), ash (6.33%) and sawdust (6.67%). Significantly the highest percent damping off was recorded in control (15.33%) followed by Furadan 5G (11.33%) which was statistically identical with khudepana (11.00%) and CaO (10.00%).

4.6 Effect of different treatments on damping off of eggplant seedlings at 30 days after sowing

The effect of the treatments on damping off percentage of eggplant seedlings at 30 days after sowing (DAS) was presented in Table 2. All the treatments were differed significantly in terms of damping off percentage. The highest percent damping off was observed in control (23.00%) followed by Furadan (16.67%) which was statistically identical with Khudepana (16.33%) and CaO (14.67) at 30 DAS. The lowest percent damping off at 30 DAS was recorded in Ridomil gold (1.67%) which was statistically identical with soil solarization (3.33%).

Table 2. Effect of different treatments on damping off of eggplant seedlings at different days sowing (DAS)

Treatments	% Damping off		
	20 DAS	25 DAS	30 DAS
T_1	3.33 b-d	6.67 cd	9.67 c
T_2	3.33 b-d	6.33 cd	10.33 c
T_3	1.67 ef	5.00 d	8.33 c
T_4	4.33 ab	11.00 b	16.33 b
T_5	4.33 ab	10.00 b	14.67 b
T_6	3.00 cd	5.67 cd	9.33 c
T_7	4.00 a-c	11.33 b	16.67b
T_8	0.00 g	0.67 e	1.67d
T_9	2.67 de	7.33 c	10.33c
T_{10}	0.67 fg	2.33 e	3.33 d
T_{11}	4.67 a	15.33 a	23.00 a
%CV	21.82	20.87	27.68

T_1= Sawdust
T_2= Ash
T_3= Poultry waste
T_4= Khudepana
T_5= CaO
T_6= Formaldehyde
T_7= Furadan 5G
T_8= Ridomil gold
T_9= Bordeaux mixture
T_{10}= Soil solarization
T_{11}= Control

4.7 Effect of different treatments on the germination of tomato seedlings at 7 days after sowing

The treatments effect on germination of tomato seedlings at different days after sowing (DAS) was presented in Table 3. The effect of different treatments on germination percentage of tomato seedlings at 7 DAS were differed significantly in comparison to control. At 7 DAS, the highest germination (81.33%) was observed in T_8 (Ridomil gold) which was statistically similar with T_{11} (Soil solarization) and the lowest germination (54.00%) was observed in T_{11} (Control). The second highest germination (80.33%) at same DAS was observed in T_6 (Formaldehyde) which was statistically identical with Poultry waste (76.67%). The third highest germination was recorded in Ash (73.33%).

4.8 Effect of different treatments on the germination of tomato seedlings at 10 days after sowing

A remarkable effect was observed among the treatments on the germination at 10 DAS of tomato seedlings (Table 3). The effect of different treatments on germination percentage of tomato seedlings were differed significantly in comparison to control. At 10 DAS the highest germination (86.67%) was observed in T_8 (Ridomil gold) which was statistically identical with Soil solarization (86.67%) and Formaldehyde (85.33%). The lowest germination (57.33%) was recorded in T_{11} (Control). The second highest germination (83.67%) was recorded at same DAS was observed in T_3 (Poultry waste).

4.9 Effect of different treatments on the germination of tomato seedlings at 13 days after sowing

The effect of different treatments on germination percentage of tomato seedlings at 13 DAS was differed significantly in comparison to control (Table 3). At 13 days after sowing (DAS), the highest germination (91.67%) was observed in T_8 (Ridomil gold) which was statistically similar with Soil solarization (89.33%). The lowest germination (59.33%) was observed in T_{11} (Control). The second highest germination (89.00%) at same days after sowing was observed in T_6 (Formaldehyde). The third highest germination (85.67%) was recorded in Poultry waste.

Table 3. Effect of different treatments on the germination of tomato seedlings at different days after sowing

Treatments	%Germination		
	07 DAS	10 DAS	13 DAS
T_1	66.00 e	72.33 e	75.00 f
T_2	73.33 c	79.00 c	82.00 d
T_3	76.67 b	83.67 b	85.67 c
T_4	62.33 f	68.00 f	70.67 g
T_5	59.33 g	64.00 g	66.33 h
T_6	78.00 b	85.33 ab	89.00 b
T_7	60.00 g	62.00 g	63.33 i
T_8	81.33 a	86.67 a	91.67 a
T_9	69.33 d	75.67 d	78.33 e
T_{10}	80.33 a	86.67 a	89.33 ab
T_{11}	54.00 h	57.33 h	59.33 j
%CV	1.84	1.75	1.82

T_1= Sawdust
T_2= Ash
T_3= Poultry waste
T_4= Khudepana
T_5= CaO
T_6= Formaldehyde
T_7= Furadan 5G
T_8= Ridomil gold
T_9= Bordeaux mixture
T_{10}= Soil solarization
T_{11}= Control

4.10 Effect of different treatments on damping off of tomato seedlings at 15 days after sowing

Treatments effect was differed significantly in respect of damping off percentage at 15 DAS (Table 4). Significantly the highest percent damping off was recorded in control (5.67%) which was statistically similar with Khudepana (5.33%) at 15 DAS. The second highest percent damping off at same DAS was observed in Furadan 5G (4.67%) which was statistically similar with CaO (4.33%). No damping off was noticed in case of Ridomil gold which was statistically similar with Formaldehyde (0.67%). The second lowest percent damping off (1.67%) was observed in soil solarization which was statistically identical with poultry waste (1.67%).

4.11 Effect of different treatments on damping off of tomato seedlings at 20 days after sowing (DAS)

A remarkable effect was observed among the treatments in controlling damping off of seedlings of tomato at 20 days after sowing (Table 4). The treatments effect was differed significantly in terms of damping off percentage. The highest effect against damping off was observed in case of Ridomil gold which was statistically similar with formaldehyde where percent damping off were 0.33% and 1.67% respectively. The second lowest percent (2.67%) damping off was observed in poultry waste which was statistically similar with soil solarization (4.00%). Significantly the highest percent damping off was recorded in control (12.67%) that was statistically identical with khudepana (11.33%).

4.12 Effect of different treatments on damping off of tomato seedlings at 25 days after sowing

The effect of the treatments on damping off of tomato seedlings at 25 days after sowing was presented in Table 4. The treatments effect was differed significantly in terms of damping off percentage. The highest percent damping off was observed in control (24.67%) at 25 DAS. The second highest percent damping off (19.67%) was recorded at same DAS in Kudepana which was statistically similar with Furadan 5G (18.33%). The lowest percent damping off at 25 DAS was recorded in Ridomil gold (1.00%) which was statistically identical with formaldehyde (3.33%). Soil solarization also gave the better performance where percent damping off recorded 4.67%.

Table 4. Effect of different treatments on damping off of tomato seedlings at different days after sowing

Treatments	% Damping off		
	15 DAS	20 DAS	25 DAS
T_1	3.67 de	9.33 bc	15.67 cd
T_2	2.67 f	5.67 d	9.00 e
T_3	1.67 g	2.67 ef	4.67 fg
T_4	5.33 ab	11.33 ab	19.67 b
T_5	4.33 cd	10.00 bc	16.67 cd
T_6	0.67 h	1.67 fg	3.33 gh
T_7	4.67 bc	10.33 bc	18.33 bc
T_8	0.00 h	0.33 g	1.00 h
T_9	3.33 ef	8.33 c	14.00 d
T_{10}	1.67 g	4.00 de	6.67 ef
T_{11}	5.67 a	12.67a	24.67 a
%CV	18.25	19.66	15.34

T_1= Sawdust
T_2= Ash
T_3= Poultry waste
T_4= Khudepana
T_5= CaO
T_6= Formaldehyde
T_7= Furadan 5G
T_8= Ridomil gold
T_9= Bordeaux mixture
T_{10}= Soil solarization
T_{11}= Control

4.13 Effect of different treatments on the germination of chilli seedlings at 12 days after sowing

The treatments effect on germination of chilli seedlings at different days after sowing (DAS) was presented in Table 5. The effect of different treatments on germination of chilli seedlings at 12 DAS were differed significantly in comparison to control. At 12 DAS, the highest germination (80.33%) was observed in T_8 (Ridomil gold) which was statistically similar with T_6 (Formaldehyde) where germination recorded 78.67%. The lowest germination (54.33%) was observed in T_{11} (Control) at 12 DAS. The second highest germination (76.33%) at same DAS was observed in T_{10} (Soil solarization). The third highest germination was recorded in poultry waste (73.67%) which was statistically similar with Bordeaux mixture where germination recorded 71.67%.

4.14 Effect of different treatments on the germination of chilli seedlings at 15 days after sowing

A remarkable effect was observed among the treatments on the germination at 15 DAS of chilli seedlings (Table 5). The effect of different treatments on germination percentage of chilli seedlings were differed significantly in comparison to control. At 15 DAS, the highest germination (87.33%) was observed in T_8 (Ridomil gold). The lowest germination (56.33%) was observed in T_{11} (Control) at same DAS. The second highest germination (82.67%) at 15 DAS was observed in T_{10} (Soil solarization).

4.15 Effect of different treatments on the germination of chilli seedlings at 18 days after sowing

The effect of different treatments on germination percentage of chilli seedlings at 18 DAS were differed significantly in comparison to control (Table 5). At 18 DAS, the highest germination (90.33%) was observed in T_8 (Ridomil gold). The lowest germination (63.00%) was observed in T_{11} (Control) at 18 DAS. The second highest germination (86.33%) at same DAS was observed in T_6 (Formaldehyde) which was statistically similar with soil solarization where germination recorded 85.00%.

Table 5. Effect of different treatments on the germination of chilli seedlings at different days after sowing

Treatments	%Germination		
	12 DAS	15 DAS	18 DAS
T_1	65.00 e	71.00 f	74.00 f
T_2	68.67 d	74.33 e	77.33 e
T_3	73.67 c	80.33 c	83.33 c
T_4	62.00 f	66.00 h	68.33 g
T_5	61.00 fg	68.33 g	72.33 f
T_6	78.67 ab	84.67 b	86.33 b
T_7	58.67 g	64.33 h	69.00 g
T_8	80.33 a	87.33 a	90.33 a
T_9	71.67 c	77.67 d	80.67 d
T_{10}	76.33 b	82.67 b	85.00 bc
T_{11}	54.33 h	56.33 i	63.00 h
%CV	2.11	1.70	1.95

T_1= Sawdust

T_2= Ash

T_3= Poultry waste

T_4= Khudepana

T_5= CaO

T_6= Formaldehyde

T_7= Furadan 5G

T_8= Ridomil gold

T_9= Bordeaux mixture

T_{10}= Soil solarization

T_{11}= Control

4.16 Effect of different treatments on damping off of chilli seedlings at 20 days after sowing (DAS)

Treatments effects were differed significantly in respect of damping off percentage at 20 days after sowing (Table 6). At 20 DAS, significantly the highest percent damping off was recorded in control (5.67%) which was statistically identical with Kudepana and CaO where percent damping off recorded 4.67% and 4.67 respectively. The second highest percent damping off at same DAS was observed in Furadan 5G (4.00%) which was statistically similar with Ash (3.67%). The lowest percent damping off (0.33%) was recorded in Ridomil gold which was statistically similar with Soil solarization (Percent damping off 0.67%), formaldehyde (Percent damping off 1.00%) and poultry waste (Percent damping off 1.33%).

4.17 Effect of different treatments on damping off of chilli seedlings at 25 days after sowing

A remarkable effect was observed among the treatments in controlling damping off disease of chilli at 25 days after sowing (Table 6). The treatments effect was differed significantly in terms of damping off percentage. The highest effect against damping off was observed in case of Ridomil gold where percent damping off 0.33 which was statistically similar with soil solarization (Percent damping off 1.67%). The second lowest percent damping off was recorded in formaldehyde. (Percent damping off 2.33%) which was statistically similar with poultry waste (Percent damping off 3.00%). Significantly the highest percent damping off was recorded in control (16.67%) followed by CaO (12.33%) which was statistically identical with khudepana (11.67%).

4.18 Effect of different treatments on damping off of chilli seedlings at 30 days after sowing

The effect of the different treatments on damping off percentage of chilli seedlings at 30 days after sowing (DAS) was presented in Table 6. All the treatments were differed significantly in terms of damping off percentage of chilli. The highest percent damping off of chilli seedlings at 30 DAS were observed in control (25.00%). The second highest percent damping off (19.00%) was recorded at 30 DAS in CaO which was statistically similar with Khudepana (18.00%). The lowest percent damping off of chilli seedlings at 30 days after sowing was recorded in Ridomil gold (1.00%) The second lowest percent damping off was recorded in soil solarization (2.67%) which was statistically identical with formaldehyde (3.33%).

Table 6. Effect of different treatments on damping off of chilli seedlings at different days after sowing

Treatments	% Damping off		
	20 DAS	25 DAS	30 DAS
T_1	2.33 de	5.67 e	8.33 f
T_2	3.67 bc	9.00 c	13.33 d
T_3	1.33 ef	3.00 f	4.67 g
T_4	4.67 ab	11.67 b	18.00 b
T_5	4.67 ab	12.33 b	19.00 b
T_6	1.00 f	2.33 f	3.33 gh
T_7	4.00 bc	9.67 c	15.00 c
T_8	0.33 f	0.33 g	1.00 i
T_9	3.33 cd	7.33 d	10.33 e
T_{10}	0.67 f	1.67 fg	2.67 h
T_{11}	5.67 a	16.67 a	25.00 a
%CV	23.34	21.63	17.76

T_1= Sawdust
T_2= Ash
T_3= Poultry waste
T_4= Khudepana
T_5= CaO
T_6= Formaldehyde
T_7= Furadan 5G
T_8= Ridomil gold
T_9= Bordeaux mixture
T_{10}= Soil solarization
T_{11}= Control

Plate 4. Healthy seedlings of eggplant raised on Ridomil gold treated pot

Plate 5. Eggplant seedlings affected by damping off raised on control pot

Plate 6. Healthy seedlings of tomato raised on Ridomil gold treated pot

Plate 7. Tomato seedlings affected by damping off raised on control pot

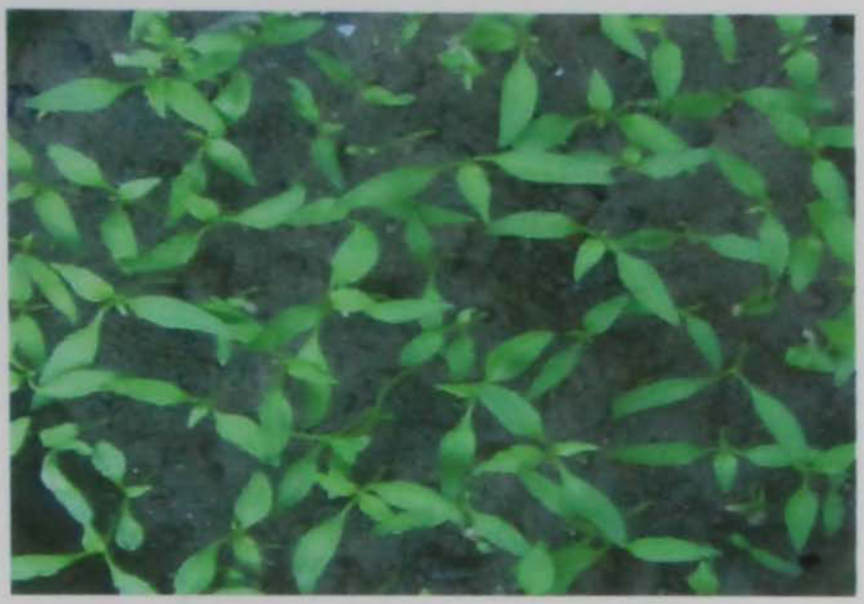


Plate 8. Healthy seedlings of chilli raised on Ridomil gold treated pot

Plate 9. Chilli seedlings affected by damping off raised on control pot

Chapter 5
Discussion

DISCUSSION

The present study was carried with eleven different treatments to evaluate their efficacy in controlling damping off caused by *Fusarium oxysporum, Sclerotium rolfsii, Rhizoctonia solani* and *Pythium* sp. in *in vitro*.

5.1 Effect of chemicals and soil amendments on germination and percent damping off of eggplant seedlings

From the experimental findings recorded on seed germination and percent damping off of eggplant seedlings at different DAS revealed that Ridomil gold, soil solarization and poultry waste had remarkable effect against damping off pathogen and increased seed germination. At 12 DAS, the highest germination (82.00%) was observed in T_8 (Ridomil gold) and the second highest germination (79.00%) was observed at same days after sowing in T_{10} (Soil solarization). At 15 DAS, the highest germination (88.00%) was observed in T_8 (Ridomil gold). The effect of poultry waste on germination at 15 DAS was statistically identical with the effect of formaldehyde. The effect of sawdust on germination at 15 DAS was also statistically identical with the effect of Bordeaux mixture. At 18 DAS, the highest germination (92.67%) was observed in T_8 (Ridomil gold) and second highest germination (88.67%) was observed in T_{10} (Soil solarization). From the present findings it is revealed that Metalyxyl (Ridomil gold) proved to be the best fungicide inhibiting the pre-emergence damping off and increased germination.

In case of percent damping off of eggplant seedlings at different DAS Ridomil gold, soil solarization, poultry waste and formaldehyde gave the better result. At 20 DAS, no damping off of eggplant seedlings was noticed in case of Ridomil gold which was statistically similar with soil solarization (0.67%). Poultry waste also gave the better performance in reducing damping off where percent damping off was 1.67%. At 25 DAS, the highest effect against damping off of eggplant seedlings was observed in case of Ridomil gold which was statistically similar with soil solarization where percent damping off was 0.67% and 2.33%, respectively. The second lowest percent damping off (5.00%) was observed in poultry waste which was statistically similar with formaldehyde (5.67%), ash (6.33%) and sawdust (6.67%). At 30 DAS, the lowest percent damping off was recorded in Ridomil gold (1.67%) which was statistically similar with soil solarization (3.33%). The present findings are keep in with the findings of Abdel-Rahim and Abu-Surrieh (1991), Balardin *et al* (1994), Harender-Raj *et al.* (1997) and Ayub *et al.* (1998) who reported that Ridomil (Metalaxyl) at all concentrations effectively controlled the damping off disease of tomato seedlings. Hickman and Michailides (1998) reported that untreated fallow field soil, solarized soil, methyl bromide treated soil and soil drenched with metalaxyl were effective against damping off caused by *Pythium aphanidermatum* of cucumber seedlings. Ioannou *et al.* (1999) reported that soil solarization reduced the population density of *Fusarium* sp. and controlled damping off seedlings in the seed bed.

5.2 Effect of chemicals and soil amendments on germination and percent damping off of tomato seedlings

The experimental findings for the management of damping off of tomato seedlings at different DAS showed that Ridomil gold and poultry waste had tremendous effect on germination and percent damping off. At 7 DAS, the highest germination of tomato seedlings (83.33%) was observed in T_8 (Ridomil gold). The second highest germination (78.00%) at same DAS was observed in T_6 (Formaldehyde) which was statistically similar with poultry waste (76.67%). At 10 DAS, the highest germination of tomato seedlings (86.67%) was observed in T_8 (Ridomil gold) which was statistically identical with soil solarization (86.67%) and formaldehyde (85.33%). At 13 days after sowing (DAS), the highest germination (91.67%) was observed in T_8 (Ridomil gold) which was statistically similar with soil solarization (89.33%). The present findings were supported by previous research reports (Taha *et al.*, 1988). They reported that Metalyxyl (Ridomil gold) inhibited the pre-emergence damping off of seedlings and increased germination.

In case of damping off, at 15 DAS, no damping off of tomato seedlings was noticed in case of Ridomil gold which was statistically similar with formaldehyde (0.67%). The second lowest percent damping off (1.67%) was observed in Soil solarization which was statistically similar with poultry waste (1.67%). At 20 DAS, the highest effect against damping off was observed in case of Ridomil gold which was statistically similar with formaldehyde where percent damping off were 0.33% and 1.67%, respectively. At 25 DAS the lowest percent damping off of tomato seedlings was recorded in Ridomil gold (1.00%) which was statistically similar with

formaldehyde (3.33%). Soil solarization also gave the better performance where damping off recorded 4.67%. The present findings are supported by the findings of Islam *et al.* (2000), Ali *et al.* (2002), Abdel-Rahim and Abu-Surrieh (1991), Ayub *et al* (1998) and Ali *et al.* (2002). Islam *et al.* (2000) reported that Formalin and Vitavax-200 appeared to be the most effective materials to minimize incidence of pre- and post-emergence mortality of True potato seedlings (TPS) when seed bed soil treated with those materials. Ali *et al.* (2002) while conducted an experiment against damping-off disease mostly caused by *Fusarium oxysporum, Sclerotium rolfsii* [*Corticium rolfsii*] and *Rhizoctonia solani*, in true potato seedlings cv. HPS-11/13 where 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], Captan and Apron [metalaxyl] found that all the treatments showed better control of the disease compared to non-treated ones. (Control), Application of formalin resulting in the lowest mean disease incidence (8.77%) followed by Vitavax 200 (10.38%).

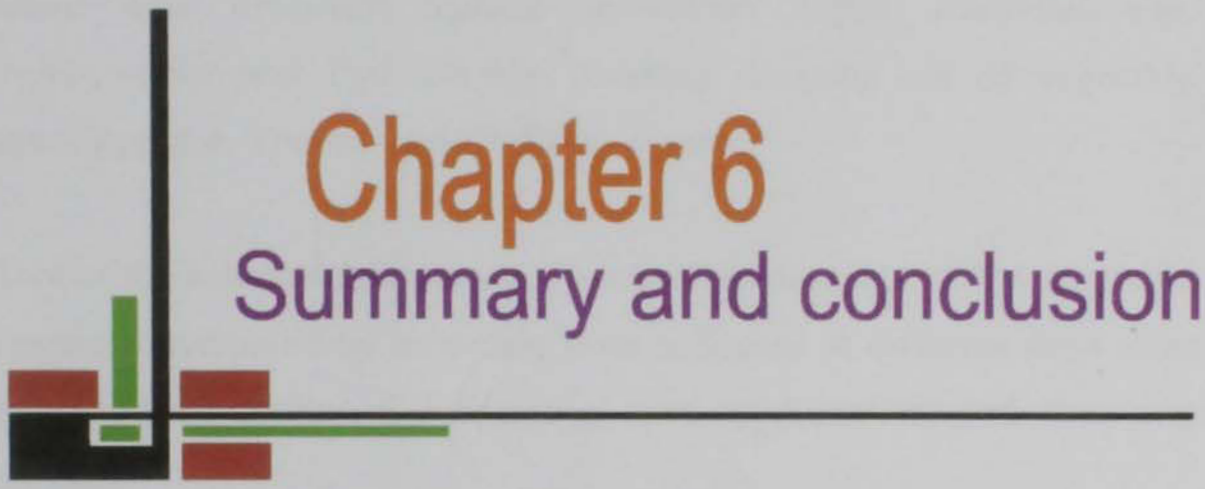
5.3 Effect of chemicals and soil amendments on germination and percent damping off of chilli seedlings

In case of germination at different days after sowing (DAS), all the treatments had significant effect. At 12 DAS the highest germination of chilli seedlings (80.33%) was observed in T_8 (Ridomil gold) which was statistically similar with T_6 (Formaldehyde) where germination recorded 78.67%. The second highest germination of chilli seedlings (76.33%) observed at same DAS in T_{10} (Soil solarization). At 15 DAS, the highest

germination of chilli seedlings (87.33%) was observed in T_8 (Ridomil gold). The second highest germination (82.67%) at 15 DAS was observed in T_{10} (Soil solarization). At 18 DAS, the highest germination of chilli seedlings (90.33%) was observed in T_8 (Ridomil gold). The second highest germination (86.33%) at same DAS was observed in T_6 (Formaldehyde) which was statistically similar with soil solarization where germination recorded 85.00%.

In case of percent damping off of chilli seedlings at different days after sowing (DAS), all the treatments had significant effects. At 20 DAS, the lowest percent damping off of chilli seedlings (0.67%) was recorded in Ridomil gold which was statistically similar with soil solarization (Percent damping off 0.67%), formaldehyde (Percent damping off 1.00%) and poultry waste (Percent damping off 1.33%). At 25 DAS, the highest effect against damping off of chilli seedlings was observed in case of Ridomil gold where where percent damping off 0.33% and that was statistically similar with soil solarization (Percent damping off 1.67%). Significantly the highest percent damping off was recorded in control (16.67%) followed by CaO (12.33%) which was statistically identical with khudepana (11.67%). At 30 DAS, The lowest percent damping off of chilli seedlings at 30 days after sowing was recorded in Ridomil gold (1.00%). The second lowest percent damping off was recorded in soil solarization (2.67%) which was statistically similar with formaldehyde (3.33%). The present findings are supported by the findings of Islam *et al.* (2000), Ali *et al.* (2002), Abdel-Rahim and Abu-Surrieh (1991), Ayub *et al* (1998), Ali *et al.* (2002), Dey, T.K. (2005) and Harender-Raj *et al.* (1997). Dey, (2005) reported that during soil solarization (for 20 days) of moist soil covered with transparent

white polythene trap, an increase in temperature more than 14°C than control was recorded at a depth of 6 cm and a considerable population of the soil organisms (*S. rolfsii*, *Fusarium* spp. *R. solani* and *Pythium* spp.) were eliminated. As a result significant reduction of damping off incidence was obtained. Harender-Raj *et al.* (1997) reported that Soil solarization with transparent polyethylene mulch (25 micro m) controlled damping off pathogens of different vegetable crops in the nursery. Mulching flood irrigated soil with polyethylene for 40 days resulted in 13.5 degrees C higher temperature at 8 cm soil depth with an average maximum temp. of 49.7 degrees and killed *Pythium* spp. and *Fusarium* spp. up to 30 cm soil depth and resulted in 18.3 to 42.0% higher seed germination, lower incidence of post-emergence damping off and better seedling vigor. Rahman, (2005) reported that application of mustard oil cake @ 3 ton/ha and half decomposed poultry manure @5 ton /ha 2 weeks before sowing seeds performed better in reducing incidence of collar rot of Chickpea.



Chapter 6
Summary and conclusion

SUMMARY AND CONCLUSION

Experiments were conducted to control damping off of vegetable seedlings through some selected chemicals and soil amendment. Four chemicals viz. Furadan 5G, Ridomil gold, Formaldehyde and Bordeaux mixture and five soil amendment viz. Sawdust, Ash, Poultry waste, Kudepana, CaO and soil solarization were evaluated against *Sclerotium rolfsii*, *Fusarium* spp. *Rhizoctonia solani* and *Pythium* spp. causing damping off of vegetable seedlings (Eggplant, Tomato and Chilli) in *in vitro*.

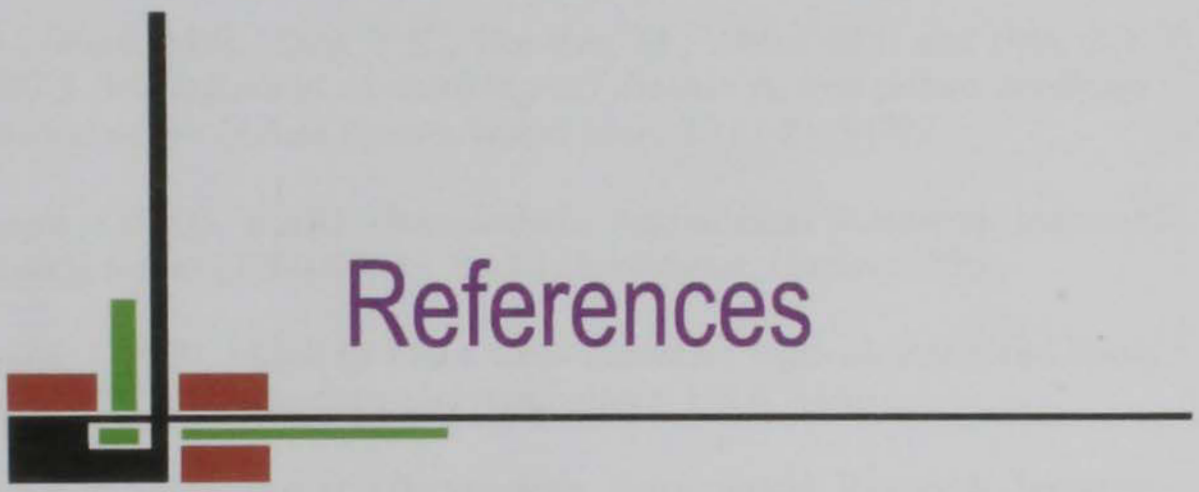
The effect of the selected treatments in controlling damping off of vegetable seedlings were evaluated by recording data collected at different days after sowing (DAS) in terms of increasing seed germination and reducing damping off.

At 12 DAS, 15 DAS and 18 DAS, the highest germination of eggplant seedlings was observed in T_8 (Ridomil gold) and the second highest germination at same days after sowing was observed in T_{10} (Soil solarization). The effect of poultry waste on germination at 15 DAS was statistically identical with the effect of formaldehyde. At 20 DAS, no damping off of eggplant seedlings was noticed in case of Ridomil gold which was statistically similar with soil solarization (0.67%). At 25 DAS and 30 DAS, the highest effect against damping off of eggplant seedlings was observed in case of Ridomil gold which was statistically similar with soil solarization.

In case of tomato seedlings the highest germination (83.33%) at 7 DAS was observed in T_8 (Ridomil gold). At 10 DAS, the highest germination of tomato seedlings (86.67%) was also observed in T_8 (Ridomil gold) which was statistically identical with soil solarization (86.67%) and formaldehyde (85.33%). At 13 days after sowing (DAS), the highest germination (91.67%) was observed in T_8 (Ridomil gold) which was statistically identical with soil solarization. At 15 DAS, no damping off of tomato seedlings was noticed in case of Ridomil gold which was statistically identical with formaldehyde (0.67%). At 20 DAS, the highest effect against damping off of seedlings was observed in case of Ridomil gold which was statistically similar with soil solarization. At 25 DAS the lowest percent damping off of tomato seedlings was recorded in Ridomil gold (1.00%) which was statistically similar with formaldehyde (1.67%).

In case of chilli seedlings the highest germination (80.33%) at 12 DAS was observed in T_8 (Ridomil gold) which was statistically similar with T_6 (Formaldehyde) where germination recorded 78.67%. At 15 DAS and 18 DAS, the highest germination of chilli seedlings (87.33%) was also observed in T_8 (Ridomil gold). At 20 DAS, 25 DAS and 30 DAS the lowest percent damping off of chilli seedlings was recorded in Ridomil gold which was statistically identical with soil solarization, formaldehyde and poultry waste.

Considering the overall performance of the treatments applied in the experiment in controlling damping off of vegetable seedlings, application of Soil solarization and Poultry waste could be used as eco-friendly approach and may be advised to the farmers for seedling production. The chemical fungicide Ridomil gold and formaldehyde could be used for controlling the disease as the last option. However, further study need to be carried out for consecutive years including more options in different Agro Ecological Zones (AEZs) of the country for searching better management option of damping off of vegetable seedlings.



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