THE EFFECTS OF BIOCONTROL FUNGUS, *Paecilomyces lilacinus* AND FOSTHIAZATE ON ROOT KNOT (*Meloidogyne* spp.) AND YIELD OF EGGPLANT

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THE EFFECTS OF BIOCONTROL FUNGUS, *Paecilomyces lilacinus* AND FOSTHIAZATE ON ROOT KNOT (*Meloidogyne* spp.) AND YIELD OF EGGPLANT

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CERTIFICATE

This is to certify that thesis entitled, **"THE EFFECTS OF BIOCONTROL FUNGUS, *Paecilomyces lilacinus* AND FOSTHIAZATE ON ROOT KNOT (*Meloidogyne* spp.) AND YIELD OF EGGPLANT"** 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 **JEBUNNESA SHAMMI, Registration No. 10- 04218** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: 20. 09. 2012
Place: Dhaka, Bangladesh

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The Author

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ABSTRACT

The fungal biocontrol agent *Paecilomyces lilacinus* and chemical nematicide fosthiazate were evaluated to asses biocontrol potency of *P lilacinus* against root knot nematode *Meloidogyne* spp. in eggplant. The treatments were biocontrol fungus *P. lilacinus*, *P. lilacinus* + Fosthiazate, Fosthiazate, blank control (without any inoculation) and negative control (only nematode inoculation). In *P. lilacinus* and Fosthiazate combination the dose of chemical was reduced to one half in pot experiment. In the field experiment the treatments were biocontrol fungus *P. lilacinus*, *P. lilacinus* + Fosthiazate, Fosthiazate and untreated control. In pot experiment *P. lilacinus*, Fosthiazate and their combination reduced 53.86%, 82.05%, 92.28% gall index respectively over control in variety Singnath and 63.86%, 71.99%, 91.88% gall index respectively over control in variety Khotkhotia. In the field *P. lilacinus*, Fosthiazate and their combination reduced 44.56%, 69.7%, 81.25% gall index respectively over control in variety Singnath and 35.7%, 68.8%, 78.4%gall index respectively over control in variety Islampuri. 11.00 t/ha, 13.94 t/ha and 14.05 t/ha yield were recorded in *P. lilacinus*, Fosthiazate alone and their combination in Shingnath variety and 13.99 t/ha, 14.90 t/ha and15.56 t/ha were recorded in *P. lilacinus*, Fosthiazate and their combination in Islampuri variety. In most of the parameters the effect of chemical nematicide and nematicide biocontrol fungus combinations the result was statistically similar. So *P. lilacinus* may be useful either alone or in combination with fosthiazate to reduce the doses of chemical nematicide in controlling root knot nematode. *Meloidogyne* spp with increasing growth parameters of eggplant. *P lilacinus* is compatible with Fosthiazate.

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LIST OF ABBREVIATED TERMS

ABBREVIATION	FULL WORD
AEZ	Agro-Ecological Zone
et al.	And others
BARI	Bangladesh Agricultural Research Institute
Cm^3	Centimeter cube
CV.	Cultivar
°C	Degree centigrade
etc.	Et-cetera
Ed.	Edited
Edn	Edition
g	gram
J.	Journal
MP	Murate of Potash
N	Nitrogen
No.	Number
NS	Non-Significant
PDA	Potato Dextrose Agar
LSD	Least Significant Difference
PDA	Potato Dextrose Agar
%	Percent
RCBD	Randomized Completely Block Design
R	Replication
Res.	Research
SAU	Sher-e-Bangla Agricultural University
t/ha	Ton per hectare
TSP	Triple Super Phosphate
Viz.	Namely

Var.	Variety

INTRODUCTION

Eggplant (*Solanum melongena*) is one of the most popular vegetables in Bangladesh. It is a plant of the family Solanaceae and genus *Solanum*. It bears a fruit of the same name, commonly used in cooking. It is widely grown in Bangladesh, China, India, Pakistan and Philippines. It is also popular in other countries like Balkan area, France, Indonesia, Italy, Japan, Mediterranean, Turkey and United states (Bose and Som, 1986).

"Begoon" (Eggplant or Eggplant) is a very common and favorite vegetable in Bangladesh. It is one of the most popular vegetables in the country and it grows in an area of about 29,132 ha producing about 1,87,705 m tons of fruits. The total area of eggplant cultivation is 60100 hectare where 22500 ha in Kharif season and 37500 ha in Rabi season of the year with total annual production of 358400 mt. and the average yield is 6.0 t/ha in 2003-04 (BBS, 2005). The yield potential eggplant is low in Bangladesh compared to other countries.

Incidence of insects, pests and diseases generally 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; Rashid, 2000). Among those diseases root knot of eggplant has been treated as one of the major constrains in eggplant cultivation in the country. Root-knot nematodes are plant-parasitic organism of the genus *Meloidogyne* spp. About 2000 plants are susceptible to infection by root-knot nematodes *Meloidogyne* spp.

Root-knot caused by *Melodoigyne* spp. is widely distributed important disease in the country (Talukder, 1974; Ahmed and Hossain, 1985; Mian, 1986). In Bangladesh root knot may cause as much 27.2% loss in fruit yield of eggplant (Bari, 2001). Eggplant cultivation in Bangladesh is severly

impaired by three important wilt causing pathogens viz. *Pseudomonas solanacearum*, *Fusarium oxysporum* and *Meloidogyne* spp. the causal agent of Bacterial wilt, *Fusarium* wilt Nemic wilt, respectively and caused considerable damage of eggplant (Talukder, 1974., Ahmed and Hossain, 1985., Mian, 1986; Ali *et al*. 1994). These are also the major limiting factors for eggplant production throughout the world (Hinata, 1986). Infection of roots by nematodes alter uptake of water and nutrients and interferes with the translocation of minerals and photosynthates (Williamson and Hussey, 1996). Such alterations change the shoot: root ratio (Anwar and Van Gundy, 1989) and expose the plants to other pathogens. For example, nematode root infection increases the incidence and severity of Fusarium wilt diseases on a variety of crops (Martin *et al.* 1994), which can negatively influence yield (Orr and Robison, 1984). Vegetable yield reductions have reached as high as 30% for susceptible genotypes in the presence of plant parasitic nematodes in some production areas (Anwar *et al.* 2009a).

The control of plant parasitic nematode is a difficult task has mainly depended on chemical nematicide for remarkable reduction of nematode population has been achieved (Jatala, 1985). Fosthiazate is a nematicide. It provides a good and stable control of root-knot cyst, root lesion and free living nematodes in a wide range of crops such as eggplants, potatoes, tomatoes, bananas and other vegetables (Minton *et al*. 1993. Lawrence and McLean 1995. Ingham *et al*. 2000., Hafez and Sundararaj 2006., Kim *et al*. 2002). It is an organophosphate and very much effective in controlling root-knot nematode (Giannakou *et al.* 2005). But nematicide has been too expensive for use in developing countries, where their application has been limited to few crops (Hague and Gowen, 1987). Due to its hazardous effects it has led to an increased interest in biological control in its widest sense, in order to achieve environmentally safe method of reducing the nematode damage (Davise *et al*. 1991 Kiewnick and Sikora 2004,

Thomason, 1987). Biocontrol seems to be the most relevant and practically damaging approach for the control of root knot nematodes.

P. lilacinus is an excellent biocontrol agent in tropical and subtropical agricultural soils. *P. lilacinus* has been reported to reduce nematode population densities and is considered as one of the most promising and practicable biocontrol agent for the management of plant parasitic nematodes (Jatala. 1986., Morgan *et al*. 1984., Lara *et al.* 1996; Siddiqui *et al*. 2000., Eapen *et al.* 2005., Atkins *et al*. 2005., Kiewnick *et al.* 2011). Information from several countries indicated that this fungus adapts well in varied climatic conditions and is effective in controlling root knot nematodes (Holland *et al*., 2003., Oduor and Waudo, 1996., Usman and Siddiqui 2012., Jatala., 1986). In the past, *P. lilacinus* was applied to soil using various organic materials such as oil cakes, leaf residue, wheat bran and gram seeds as carrier (Cannayane and Sivakumar. 2001). Five formulations: alginate pellets were prepared with spores of *P. lilacinus* and diatomaceous earth granules (granules), wheat grain, soil, and soil plus chitin. Higher numbers of fungus-infected egg masses occurred in plots treated with pellets (32%) than in those treated with chitin-amended soil (24%), wheat (16%), granules (12%), or soil (7%). *P. lilacinus* YES -2 strains is an important nematophagus egg parasitic fungus is isolated from root-knot nematode egg and applied to soil in alginate pellet form with various doses. Various mechanisms of action have been suggested for the biological activity of *P. lilacinus* against plant parasitic nematodes. The main mechanism is direct infection of sedentary stages in particular the egg stage. The production of leucinotoxins, chitinases, proteases, and acetic acid by *P. lilacinus* has been associated with the infection process (Djian *et al.* 1991., Lopez- llorca *et al.* 2008., Cabanillas *et al.* 1989., Khan *et al*. 2003, 2004, 2006, Kiewnick and Sikora 2006., Anastasiadis *et al.* 2007). The fungus directly penetrated all stages of the nematode after formation of appressoria.

For the management of such important disease of eggplant evidence of research work exists in the world. The use of chemicals for controlling root-knot nematode is very costly for the growers. Besides *P. lilacinus* has been reported to reduce nematode population densities and is considered as one of the most promising and practicable biocontrol agent for the management of plant parasitic nematodes. Thus the experiment was undertaken with the target to replace the use of chemical nematicide fosthiazate by the nematophagous fungus *P. lilacinus* to establish a ecofriendly management of root-knot nematode with the following objectives.

1. To study the effect of biocontrol fungus *P. lilacinus* either alone or in combination with nematicide Fosthiazate on growth parameter and root knot (*Meloidogyne* spp.) development of eggplant in greenhouse.
2. To determine the effect of biocontrol fungus *P. lilacinus* either alone or in combination with nematicide Fosthiazate on root knot (*Meloidogyne* spp.) development and yield of eggplant in the field.

REVIEW OF LITERATURE

Cabanillas *et al.* (1989) isolated of 13 *P. lilacinus* isolates from various geographic regions as biocontrol agents against *Meloidogyne incognita*. The best control of *M. incognita* was provided by an isolate from Peru or a mixture of isolates of *P. lilacinus*. As soil temperatures increased from 16◦C to 28◦C, both root-knot damage caused by *M. incognita* and percentage of egg masses infected by *P. lilacinus* increased. The greatest residual *P. lilacinus* activity on *M. incognita* was attained with a mixture of fungal isolates. These isolates effected lower root-galling and necrosis, egg development, and enhanced shoot growth compared with plants inoculated with *M. incognita* alone.

Cabanillas and Barker (1989) conducted a microplot experiment to evaluate the inoculam level and time of application of *P. lilacinus* on the protection of tomato against *M. incognita*. They observed that *P. lilacinus* applied into soil 10 days before planting and again in planting resulted was increased yield with the improvement of plants compared with the nematode alone plots.

Mittal *et al.* (1995) evaluated *P. lilacinus*, a rhizospherc inhabiting nematophagous fungus, along with chitin in sterilized soil for the suppression of *Meloidogyne incognita*, causal agent of root-knot disease in *Solanum melongena, Lycopersicon esculentum* and *Cicer arietinum*. The plant growth after 30, 60 and 90 days was assessed in terms of shoot and root length, shoot and root fresh and dry weight. and number of galls/g root fresh weight. Combination of fungus with chitin enhanced suppression of *Meloidogyne incognita* more than using them alone.

Oduor and Waudo (1996) evaluated *P. lilacinus, Phoma herbarum* and three isolates of *Fusarium oxysporum* in controlling root knot (*M. javanica*.) in eggplant. *P. lilacinus* and *Fusarium oxy*sporum-1 significantly ($p<0.05$) parasitized more than 70% eggs and female while *Fusarium oxysporum-3* parasitized less than 20%, control of *Meloidogyne incognita* on eggplant.

Siddiqui *et al.* (2000) studied the efficacy of *Pseudomonas aeruginosa* alone or in combination with *P. lilacinus* in control of root-knot nematode and root-infecting fungi under laboratory and field conditions. Ethyl acetate extract (1 mg/ml) of *P. lilacinus* and *P. aeruginosa*, respectively, caused 100 and 64% mortality of *Meloidogyne javanica* larvae after 24 h. In field experiments, biocontrol fungus and bacterium significantly suppressed soilborne root-infecting fungi including *Macrophomina phaseolina, Fusarium oxysporum, Fusarium solani, Rhizoctonia solani* and the root-knot nematode *Meloidogyne javanica*,. *P. lilacinus* parasitized eggs and female of *M. javanica*.

Rao and reddy (2001) used *Glomus mosseae* in combination with *P. lilacinus* and neem cake to control root knot nematode of eggplant. The parasitization of eggs of root-knot nematode was significantly increased by *P. lilacinus* and the transplants yielded significantly more fruit. Neem cake amendment in the nursery beds played a positive role in increasing the colonization of endomycorrhiza and the biocontrol fungus on the roots of transplants before and after transplanting. The combined effect of these three components facilitated the sustainable masnagement of *M. incogtia* on egg plant under field condition.

Oduor- owino (2003) used agrochemicals, organic matter and the antagonistic fungus *P. lilacinus* in natural field soil in controlling root knot nematode. He found that the smallest galling index, number of galls and nematode population were in soil treated with aldicarb in combination with *P. lilacinus*.

Kiewnick and Sikora (2004) conducted a greenhouse experiments to control root-knot nematodes *Meloidogyne incognita* and *M. hapla* on tomato using *P. lilacinus* 251 . All single or combination treatments tested decreased the gall index and the number of egg masses compared to the untreated control 12 weeks after planting. However, the combination of the seedling treatment with a pre- or at-planting application of *P. lilacinus* was necessary to achieve higher levels of control. They found that the above mentioned combination of pre-planting application plus the seedling and one post plant drench gave the best control and resulted in a significant fruit yield increase in concurrence with a decrease in number of galls per root.

Esphahani and Pour (2006) observed that *P. lilacinus* was effective in controlling root knot nematode on tomato and suppressing its population growth and effectively promoted the growth of plant.

Khan *et al.* (2006) described the mode and severity of infection of nematodes by a soil saprophyte *P. lilacinus* . Infection of stationary stages of nematodes by *P. lilacinus* was studied with three plant parasitic nematodes *Meloidogyne javanica, Heterodera avenae* and *Radopholus similis*. *P. lilacinus* infected eggs, juveniles and females of *M. javanica* by direct hyphal penetration. The early developed eggs were more susceptible than the eggs containing fully developed juveniles. *P. lilacinus* also infected immature cysts of *H. av*enae

including eggs in the cysts and the eggs of *R. similis* and the fungus was shown to infect mobile stages of all the plant-parasitic nematodes.

A total 455 fungul isolates belonging to 24 genera and 52 isolates of Actinomycetes were obtained from 28 samples by Sun *et al.* (2006) and they observed that *P. lilacinus* was highly pathogenic in controlling root knot nematode and it reduced tomato root gall index by 13.4- 58.9% compared to the no treatment control.

Kiewnick and Sikora (2006) mentioned that successful biocontrol of RKN depends on initial low nematode density in the soil. They used fungul biocontrol agent, *P. lilacinus* strain 251 (PL251), and evaluated for its potential to control the root-knot nematode *Meloidogyne incognita* on tomato. In growth chamber experiment, a pre-planting soil treatment reduced root galling by 66%, number of egg masses by 74% and the final nematode population in the roots by 71% compared to the inoculated control. They also mentioned that a single pre-plant application at a concentration of 1×10^6 CFU/g soil is needed for sufficient biocontrol of *Meloidogyne incognita* by PL251.

Anastasiadis *et al*. (2007) evaluated a formulated product (BioAct) is made up of the spores of the naturally occurring fungus *P. lilacinus*) containing spores of fungus *P. lilacinus*, strain 251, against root knot nematodes in pot and green house experiments. They observed that application of *P. lilacinus* and the bacteria *Bacillus fitmus*, significantly or together in pot experiments, provided

effective control of second stage juveniles, eggs or egg masses of root-knot nematodes.

In India Eapen *et al*. (2005) used 73 freshly collected fungal isolates and 76 isolates obtained from other sources. Fifty-nine isolates showe*d* 50- 90% inhibition in egg hatch of *Meloidogyne spp*.. *Pochonia chlamydospora*, *Verticillium lecanii*, *P. lilacinus*, and few isolates of *Trichoderma* spp. showed > 25% parasitism on root knot nematode eggs.

Singh (2007) examined root galls of rice caused by *Meloidogyne graminicola* for natural colonization by nematophagous fungi and observed that application of inocula of *A. dactyloides* and *D. brachophaga* in soil infested with *Meloidogyne graminicola*, respectively, reduced the number of root galls by 86%, and females by 94%, and eggs and juveniles by 94% . The application of these fungi to soil increased plant growth.

Lopez- llorca *et al.* (2008) observed the mode of action and interactions of nematophagous fungi and discussed types of recognition phenomena (e.g. chemotaxis and adhesion), signaling and differentiation, penetration of the nematode cuticle/ eggshell using mechanical, as well as enzymatic (protease and chitinase) means. They observed that *P. lilacinus* is an egg- and female-parasitic fungus and it infects nematode by it's appressoria. It produced chitinases enzymes and damage the eggshell and destroyed nematode.

Tobin *et al*. (2008) reported that nematophagous fungus *Pochonia chlamydosporia* provided similar levels of nematode population control as chemical nematicide fosthiazate.

Aminuzzaman (2009) used fungal pellet containing spores of nematophagous fungus *P. lilacinus* YES-2 in green house condition to assess its biocontrol potency against root knot of tomato and observed *P. lilacinus* significantly reduced the number of nematode population in soil and root and increased 20.75% tomato yield over untreated control. He mentioned that the effect of fosthiazate fungal pellet combinations to reduce nematode population in soil and plant roots. He observed that Fosthiazate and *P. lilacinus* pellet combinations was greater than the chemical alone.

Bhat *et al.* (2009) observed the interaction of fungus *P. lilacinus* and *Meloidogyne incognita* in bitter gourd at different time intervals. They found that *Meloidogyne incognita* induced large sized galls on the plants. The xylem and the pholeam exhibited abnormalities in structure near the giant cells. Abnormal vessel elements were occupying larger area near giant cells. The plants that were treated with fungus either one week before nematode inoculation or simultaneously, produced significantly (P= 0.01) small sized galls in comparison to untreated plants.

Kalele *et al.* (2010) worked with antagonistic fungus *P. lilacinus* strain 251 in controlling root-knot nematodes in tomato and cucumber. He applied *P. lilacinus* inoculum at different rates and different times. He found that pre-planting soil treatment reduced final nematode populations by 69% and 73% in the roots and soil, respectively, compared to the non-inoculated control in

tomato. However, soil treatment at planting recorded reduction level of 54% and 74% in the roots and soil respectively he described that PL251 was a promising potential that could be exploited in the management of *Meloidogyne* spp. in vegetable production systems.

Kiewnick *et al.* (2011) evaluated the fungal biocontrol agent, *P. lilacinus* strain 251 for its potential to control the root-knot nematode *Meloidogyne incognita* on tomato at varying application rates and inoculum densities. He demonstrated that a pre-planting soil treatment with the lowest dose of commercially formulated PL251 (2×10^5 CFU/g soil) was already sufficient to reduce root galling by 45% and number of egg masses by 69% when averaged over inoculum densities of 100 to 1,600 eggs and infective juveniles per 100 cm^3 of soil. A Real-time PCR revealed a significant relationship between egg mass colonization by PL251 and the dose of product applied to soil but no correlation was found between fungal density and biocontrol efficacy or nematode inoculum level. These results demonstrate that rhizosphere competence is not the key mode of action for PL251 in controlling *M. incognita* on tomato.

Aminuzzaman and Liu (2011) first reported the isolation and evaluation of biocontrol fungus *Paecilomyces lilacinus* recorded in Bangladesh. They collected galled roots of eggplant infected with *Meloidogyne* spp from farmers fields of Mymensingh district, Bangladesh. Eggs were collected and placed and smeared on PDA plates and incubated at 25◦ c. After detailed morphological examination, the fungal hyphae grown from eggs were identified as *P. lilacinus.* They mentioned that the fungus showed more than 80% egg parasitism and 52% juvenile mortality of *Meloidogyne* spp. They also

mentioned that the fungus increased shoot height, fresh shoot weight, root length and fresh root weight and also reduced root galling up to 63% and number of eggmass per root system up to 40 % when compared with control treatment.

P. lilacinus enhanced plant growth and reduced galling index and nematode population which was supported by Aminuzzaman *et al.* (2011). They mentioned that root galling index and final nematode population decreased up to 40.7% and 73.8% respectively for tomato and 55.6% and 66.9% respectively for brinjal of application of the biocontrol fungus. They also mentioned that *P. lilacinus* enhanced plant growth and reduced galling index with its increased doses.

Hashem and Abo-Elyousr (2011) tested the nematicidal effect of *Pseudomonas fluorescens*, *P. lilacinus*, *Pichia guilliermondii* and *Calothrix parietina* singly or in combination against root-knot nematode, *Meloidogyne incognita*. Treatments with *P. fluorescens* and *P. lilacinus* caused mortality of *M. incognita* as 45% and 30% of juveniles after 48 h of exposures, respectively compared to water control *in vitro*. Under greenhouse conditions, all treatments reduced the disease severity and enhanced plant growth compared to untreated control. Application of *P. fluorescens*, *P. lilacinus* and *P. guilliermondii* was more effective compared to *C. parietina*. Fresh and dry weight of shoots and roots of plants were significantly reduced as a result of infection with *M. incognita*, however application of biocontrol agents singly or in mix recovered this reduction. Moreover, they enhanced the growth parameters compared with the control. His results proved that application of different biocontrol agents (*P. fluorescens*, *P. lilacinus* and *P. guilliermondii*) not only has a lethal effect on nematode, but also enhances the plant growth,

supplying many nutritional elements and induction the systemic resistance in plants.

Usman and Siddiqui (2012) observed the effect of some fungal strains for the management of rootknot nematode (*Meloidogyne incognita*) on eggplant (*Solanum melongena.* They used two biocontrol fungal strains of *Trichoderma harzianum* and *Paecilomyces lilacinus* at 1g/pot and 2g/pot. Inoculation of fungus was done simultaneously along with 1000 second stage juveniles (J2) of *M. incognita.* Strains of *T. harzianum* were found to be most effective when treated at 2g/pot. *P. lilacinus* also gave almost similar results and enhanced all plant growth characters with the reduction in the root- knot infestation.

MATERIALS AND METHODS

In the present investigation nematophagous fungus *Paecilomyces lilacinus* and nematicide fosthiazate were used as experimental material. Pot experiment and field experiment were done to study the effects of biocontrol fungus *P. lilacinus* and fosthiazate on root knot (*Meloidogyne* spp.) and yield of eggplant.

The experiment was carried out during the period from October 2010 to May 2012.

3.1 Pot experiment

The experiment was conducted in greenhouse of department of Plant Pathology, Sher-e-Bangla Agricultural University.

3.1.1 Eggplant variety used

Eggplant varieties Singnath and Khotkhtoa were used for the experiment.

3.1.2 Collection of seeds

Healthy, mature and disease free seeds of Singnath variety was collected from BARI and Khotkhotia variety from BADC.

3.1.3 Seedlings raising

Plastic trays were filled with sterilized and fertile soil. Seeds of eggplant cultivars were soaked in water for 1 night and treated with NaOCl for 1 minute and washed with distilled

water for three minutes. Then the seeds were sown in the plastic tray. Then the trays were covered with polyethylene sheet and kept in sunlight for raising seedlings. Seedlings were observed regularly and watering was done as per necessity up to transplanting in poly bag. After emergence of seedlings they are transfer to poly bag containing same soil.

3.1.4 Preparations of pots

Soil was collected from the field without root-knot nematode infestation and mixed with sand at 7:3. Soil was sterilized with formalin then soil was dispensed into each pot. Then the pots were arranged according to experimental design.

3.1.5 Nematode culture

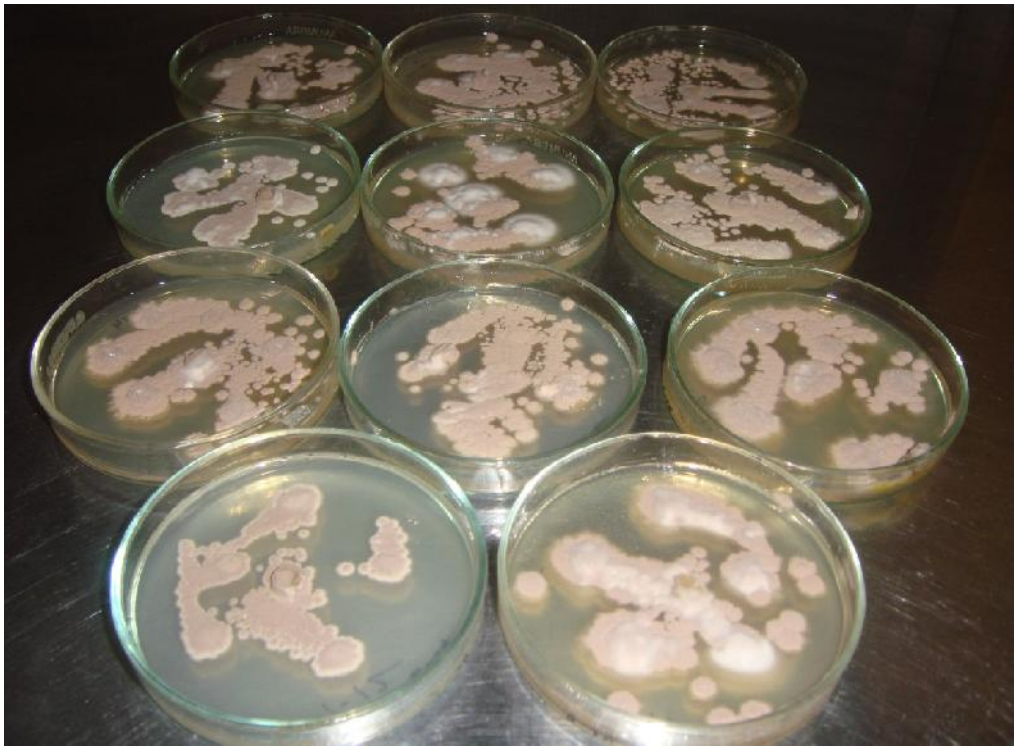
Nematode samples (*Meloidogyne* spp.) were collected from nematode infected eggplant root (Plate- 1). Egg masses were picked up and inoculated in young seedlings of eggplant. Sub-culturing were done subsequently by inoculating new eggplant seedling with egg masses.

3.1.6 Fungus culture

Paecilomyces lilacinus was grown on Potato Dextrose Agar (PDA) medium at 25^0 C temperatures for 15 days (Photograph- 1). The fungus was collected from the Department of Plant Pathology, Sher- e- Bangla Agricultural University.

3.1.7 Design and layout of the experiment

The experiment was laid out in a Randomized Complete Block Design with seven replications (pots).



Photograph1. Pure culture of biocontrol fungus *Paecilomyces lilacinus.*

3.1.8 Treatments of the experiment

There were five treatments in the experiment.

T_1= Biocontrol fungus *Paecilomyces lilacinus*

T_2= *Paecilomyces lilacinus* + Nematicide (Fosthiazate)

T_3= Fosthiazate

T_4= Blank control (without any inoculation)

T_5= Negative control (only nematode inoculation)

3.1.9 Transplanting of seedlings

After preparation of pot in the greenhouse 30 days old seedlings were uprooted carefully from the poly bag and transplanted in the experimental pot. Initial root and shoot weight were measured before transplanting. Each pot contains 800 g sterilized soil and only one plant was transplanted to each pot. Sufficient irrigation was given just after transplantation. Watering was continued till the seedlings were established.

3.1.10 Inoculation of *Paecilomyces lilacinus*

After sporulation (15 days) the plates were put into the laminar air flow chamber. Then sterile water was added and the spore masses scraped away with sterile brush. Then the harvested spores were filtered through sterilized cheesecloth. The plate harvested more than two times. The spore suspension was collected and were counted with a hemacytometer and adjusted to a concentration of 6×10^7 conidial/ml solution. Then the inoculation was done @ 18×10^7 spore/plant in each pot with micropipette. Spores were mixed thoroughly to the soil. It was done on the time of transplanting.

3.1.11 Application of nematicide Fosthiazate

Fosthiazate was applied @ 0.3 g/plant before transplantation by mixing properly with the soil. For Fosthiazate and *Paecilomyces lilacinus* combination the dose of Fosthiazate was reduced to half i. e. 0.15 g/plant.

3.1.12 Inoculation of *Meloidogyne* spp.

Mature eggmass of nematode (*Meloidogyne* spp) was collected from severely galled roots of eggplants (Photograph -2). The no. of egg mass per egg mass were counted. Each plant was inoculated with 5000 eggs at the time of transplanting (Photograph -3).

3.1.13 Intercultural operations

After transplantation of seedlings weeding and irrigation were done. The plants were observed regularly. General sanitation was maintained throughout the growing period. Insecticide named marshal was sprayed 5 times at 15 days intervals to protect the crop from aphid, shoot borer infestation.

3.1.14 Harvesting and data recording

After two months of transplanting plants were harvested and data were recorded. The following parameters were considered for data collection.

Root length

Shoot length

Root weight (fresh and dry)

Shoot weight (fresh and dry)

Gall index (0 – 10)

Number of egg mass per root

Number of egg per egg mass

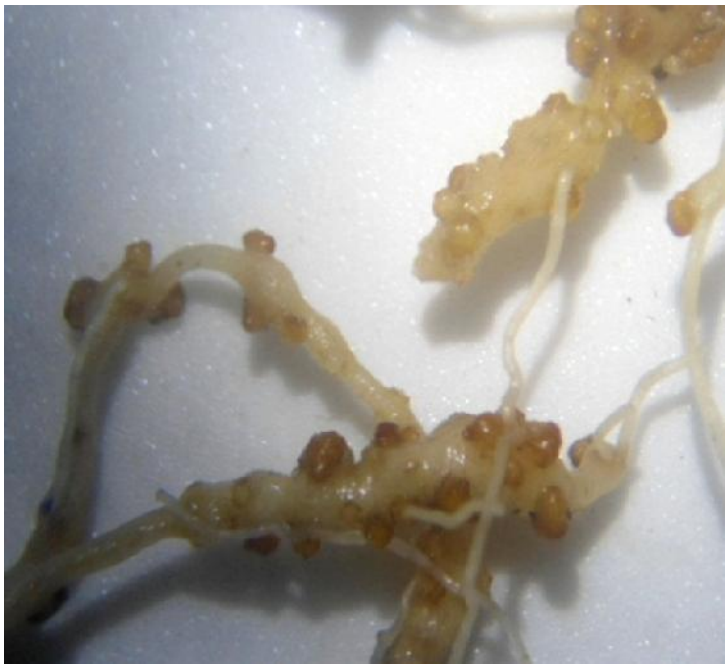
Number of egg per root system

Number of juvenile per g soil

Reproduction factor

% Egg mass colonized by *P. lilacinus*

Soil colonization by *P. lilacinus* (CFU/g soil)



Photograph 2: Light photograph showing eggmasses of *Meloidogyne* spp.

Photograph 3. Inoculation of egg suspension of nematode (*Meloidogyne* spp.)

3.1.15 Data collection

Shoot length was measured before harvest. The shoot height was measured from the base of the plant to the growing point of the youngest leaf. Then the roots are harvested. Roots were carefully separated from soil and collected in different polybag that were leveled according to different treatments. Then the roots were cleaned gently with water and length was taken. The length of root was measured from the growing point of root to the longest available lateral root apex. For fresh weight of root and shoot the portion was blotted dry and the weight was recorded.

3.1.16 Counting of nematode galls

Number of egg mass/root system was counted following Holbrook *et al.* (1983). The roots were soaked in Phloxine-B for 13 min (Photograph- 4). The roots were observed and egg mass were counted with a magnifying glass (Photograph- 5). Then eggmasses were picked with forcep and the eggs were separated from viscus materials carefully by using two sterile needles (Sun *et al.* 2006). on a slide then observed under microscope and eggs were counted. Egg per root system was counted; Juvenile was collected following white head tray method. Pot soil was mixed thoroughly and 100 g soil was weighted and put it on the sieve that was on a bowl filled with water (Photograph- 6). On the sieve there was tissue paper that was touched the water level in the bowl. After 3 days the water from the bowl and juveniles were counted under microscope.

Gall index

Root galls were indexed on a 0-10 scale (Bridge and Page; 1980)

Scales	Specification
0	No gall

1	Few small gall, difficult to find
2	Small gall only, clearly visible, main root clean
3	Some larger galls visible, main root clean
4	Larger galls predominant but main root clean
5	50% of the roots infected, galling on some main roots, reduced root system
6	Galling on main roots
7	Majority of the main roots galled
8	All main roots including tap roots galled, few clean roots visible
9	All roots severely galled, plants usually dying.
10	All roots severely galled, no root system

Photograph 4. Galled roots treated by Phloxine-B

Photograph 5. Phloxine-B treated eggmass in root system

Photograph 6. Extraction of Meloidogyne *spp. From soil by Bangladeshi plate method (Modified White Head and Hemming Method, 1965).*

3.1.17 % Eggmass colonization by *Paecilomyces lilacinus*

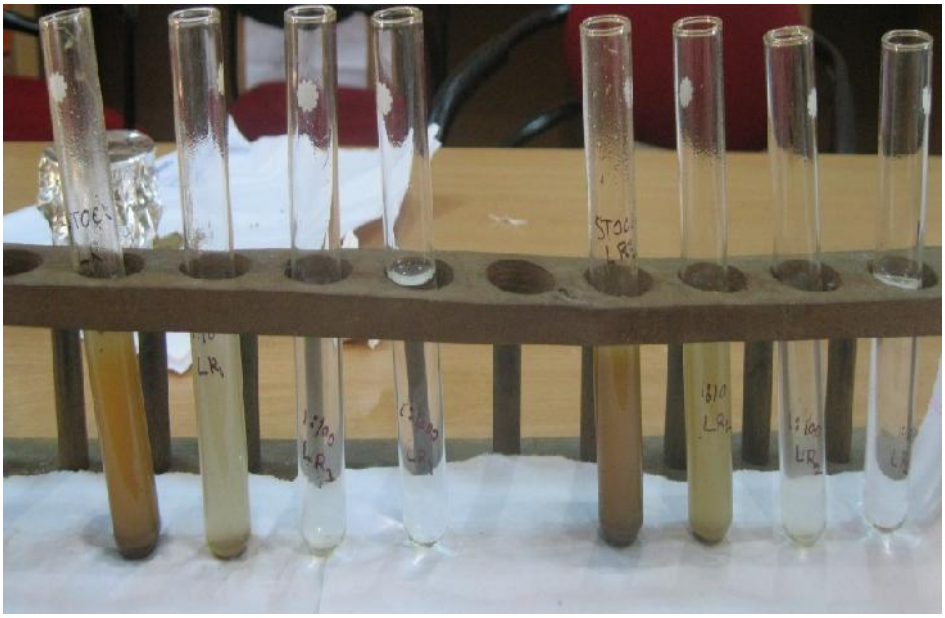
Eggmasses were collected per treatment from the eggplant roots, washed with water and disinfected with a solution of Clorox and put on PDA media in petridish. The number of colonized eggmasses was determined after 5 days of incubation.

3.1.18 Soil colonization by *Paecilomyces lilacinus* (CFU/g soil)

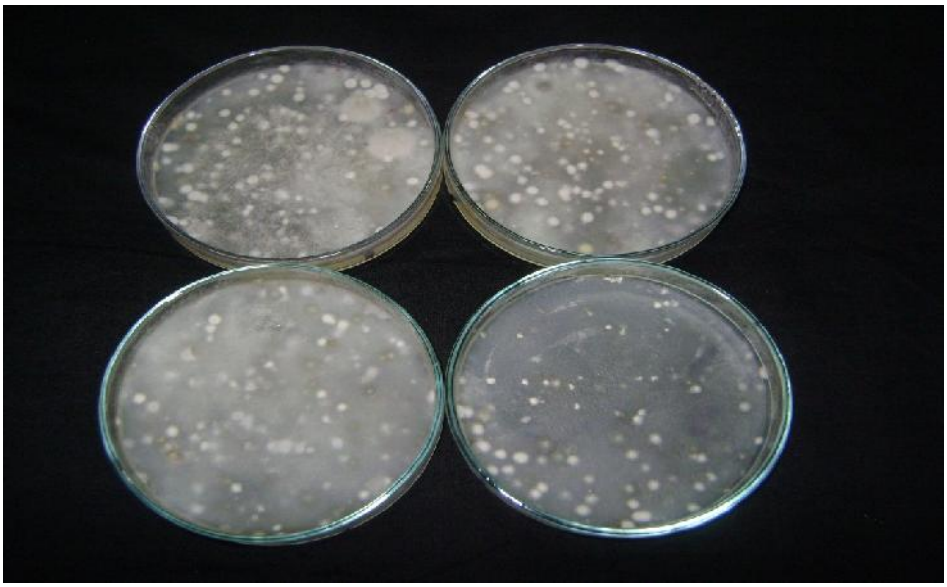
Samples of 100 g soil were collected two months after fungul inoculation from around the root zone. The number of spores per gram soil was evaluated using the plating dilution soil method.

3. 1.19 Analysis of data

The data were statistically analyzed using analysis of variance to find out the variation of results from experimental treatments. Treatment means were compared by LSD. Data were analyzed by MSTAT software.



Photograph 7. Stock solution and several soil dilutions for soil dilution plate.



Photograph 8. Colony growth of *P. lilacinus* on PDA (soil dilution plate technique**).**

3.2 Field experiment

The experiment was conducted in the Field Laboratory allotted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka-1207.

3.2.1 Soil type

The soil of the experimental plot was loam to clay loam in texture belonging to the Madhupur Tract (AEZ-28). The soils of the site was non-calcareous with loam to clay loam in texture. The description of the Agro Ecological Zone (UNDP and FAO, 1988) of the experimental site is sited below:

Agro Ecological Region : Madhupur Tract (AEZ-28)

Land Type : Medium high land

General soil type : Non-Calcareous

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.

3.2.2 Climate

The climate of the experimental area was of sub-tropical in nature characterized by high temperature associated with heavy rainfall during Kharif season (April to September) and scanty rainfall with moderately low temperature during Rabi season (October to March).

3.2.3 Eggplant variety used

Eggplant varieties Singhnath and Islampuri were used for the experiment.

3.2.4 Collection of seeds

Healthy, mature and disease free seeds of eggplant varieties were collected from BARI and BADC.

3.2.5 Seedling rising

Plastic trays were filled up with sterilized and fertile soil. Seeds of eggplant cultivars were soaked in water for 1 night and sterilized with NaOCl for 1 minute and washed with distilled water for three times. Then the seeds were sown in plastic trays containing sterilized soil. The trays were covered with polyethylene sheet. Trays were kept in sunlight for raising seedlings. Seedlings were observed regularly and watering was done as per necessary up to transplanting in poly bag. After emergence of seedlings they were transplanted to poly bag for adaptation.

3.2.6 Land Preparation

Land was firstly ploughed with a power tiller and prepared using well decomposed cowdung and left exposed to sunlight for 7 days. Then the land was ploughed and cross ploughed by a country plough until the soil had a good tilth. It required six times ploughing and every ploughing was followed by several laddering. After each ploughing weeds and rubbish were removed to obtain desirable tilth. Finally spade was used to prepare plots and drains.

3.2.7 Application of manure and fertilizers

Manure and fertilizers were applied as per standard recommendation. The following doses are used for carrying out the field experiment (Anonymous, 1998).

Fertilizers and manures used in the experimental field.

Fertilizers and manures	Rate (kg/ha)
Urea	250.00
TSP	240.00
MP	200.00
Cowdung	18500.00

A half of total amount of cowdung and TSP were applied during final land preparation and remaining half was applied in pits before transplanting. Urea and MP were applied in two installments as ring dressing after 15 and 35 days of transplanting.

3.2.8 Treatments

There were four treatments in this experiment which were as follows :

T_1: Biocontrol fungus *Paecilomyces lilacinus*

T_2: *Paecilomyces lilacinus* + Nematicide (Fosthiazate)

T_3: Fosthiazate

T_4: Untreated control

3.2.9 Fungus culture

Paecilomyces lilacinus was grown on PDA (Potato Dextrose Agar) medium at 25◦ C temperature for 15 days.

3.2.10 Inoculation of *Paecilomyces lilacinus*

After sporulation (10-15 days) the plates were put into the laminar air flow chamber. Then add sterile water and the spore masses scraped away with sterile brush. Then the harvested spore are filtered through sterilized cheesecloth. The plate harvested more than two times. Then the suspension was collected and made a volume. Then the spores were counted with a hemacytometer (magnification 1040) concentration 6×10^7 conidial/ml solution. Then the inoculation was done (18×10^7 spore/plant) at the root zone with micropipette. Spores were mixed thoroughly to the soil. It was done on the time of transplanting.

3.1.11 Application of nematicide Fosthiazate

Fosthiazate was applied @ 1.4 g/plant before transplantation by mixing properly with the soil. For Fosthiazate and *P. lilacinus* combination the dose of Fosthiazate was reduced to half i. e. 0.7 g/plant.

3.2.12 Design and layout of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. The whole field was divided into two blocks for two varieties. Each blocks containing 16 plots of 3m × 1.75 m size. Each of the treatment put once at each block. The space kept between the block was 1 m wide and between plots it was 0.5 m. Plant to plant distance was maintained 60 cm and row to row distance was 70 cm.

3.2.13 Transplanting of seedlings

After preparation of plot 30 days old seedlings were uprooted from the poly bag and transplanted in the experimental field. Two hours before transplanting the seedlings were watered before removing the seedlings from poly bag to minimize root damage. A sufficient irrigation was given just after transplantation. Shedding was provided to protect transplanted seedlings from the sunlight. Shading and watering was continued till the seedlings were established in the field.

3.2.14 Intercultural operation

After transplantation gap filling was done in case of seedling died. In 15 to 20 days after planting (DAP) weeding was done which followed split dose urea application. First split application was done on 15 days after transplanting (DAT) and the second split application was done at 50 DAT. After weeding and fertilizer application flood irrigation was given by filling the drains surrounding the plots by pumping water in those drains with a water pump. After soaking the plots excess water was allowed to be drained out. The plants were observed regularly. General field sanitation was maintained throughout the growing period. Insecticide named marshal was sprayed at 15 days intervals to protect the crop from aphid, shoot borer infestation.

3.2.15 Harvesting and data recording

At the end of the season following data were recorded:

Gall Index (0-10)

Number of Egg mass/ root

Number of egg/egg mass

Number of fruit/plant

Nematode population/ plant

Yield (g/plant)

Yield (t/ha)

After washing the roots galls were indexed on a 0-10 scale (Bridge and Page; 1980) as described in pot experiment. To count the number of fruit per plant and weight of fruit per plant there were four harvests was done. When the fruits were harvested then weight was taken in the field and data were recorded. Then the roots were uprooted carefully and kept in separate polybags that were leveled according to treatments. Root gall, number of egg mass per root and number. of egg per root system were recorded. Number of eggmass/root system was recorded following (Holbrook et al. 1983) as described in pot experiment.

3.2.16 Analysis of data

The data were statistically analyzed using analysis of variance to find out the variation of results from experimental treatments. Treatment means were compared by LSD. Data were analyzed by MSTAT software.

RESULTS

Root knot (*Meloidogyne* spp.) is a destructive pathogen of vegetable (Photograph 9). The present investigation was carried out to study the effects of biocontrol fungus *Paecilomyces lilacinus* and Fosthiazate on root knot (*Meloidogyne* spp) and yield of eggplant. The results have been presented and discussed and possible interpretations have been given under the following headlines.

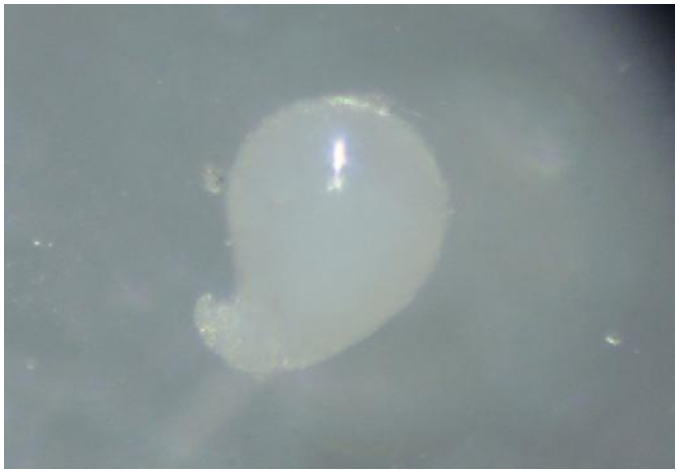
4.1 Pot experiment

In pot experiment two varieties of eggplant namely Singnath and Khotkhotia were used (Photograph 10 and Photograph 11)

4.1.1 Effect of biocontrol fungus *Paecilomyces lilacinus* and Fosthiazate on growth parameters of eggplant Var. Singnath.

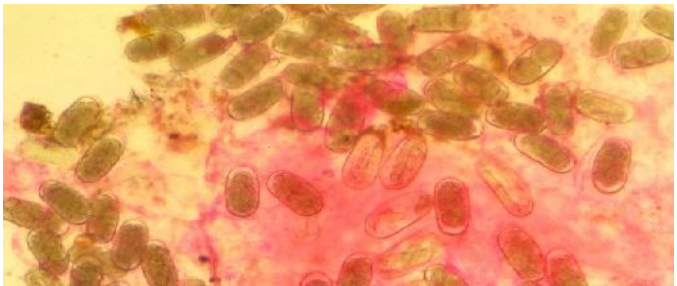
Application of *P. lilacinus* and nematicide Fosthiazate reduced the damage caused by *Meloidogyne* spp. and the effect of the treatments on growth characteristics of eggplant viz. shoot length, shoot fresh weight, shoot dry weight, root length, root fresh weight and root dry weight studied were presented in Table 1and Photograph 12and Photograph 13

The highest shoot length (44.11cm) was recorded in the treatment T_3 (Fosthiazate) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate), T_4 (Blank control) and T_1 (*P. lilacinus*). The lowest shoot length (40.34) was observed in T_5 (negative control) which was statistically similar with T_1 (*P. lilacinus*). It was observed that application of Fosthiazate and inoculation with *P. lilacinus* + Fosthiazate showed good performance among the treatments. (Table 1).



A

B



C

Photograph 9. Microphotographs showing adult female (A), second stage larvae (B), and eggs (C) of *Meloidogyne* spp.

Photograph 10. A set of pot experiment of eggplant variety singnath

Photograph 11. A set of pot experiment of eggplant variety khotkhotia

The highest fresh weight of shoot (34.09g) was recorded in T_3 (Fosthiazate) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate), T_4 (Blank control), T_1 (*P. lilacinus*). The lowest result (22.33 g) was observed T_5 (negative control) which was statistically similar with T_1 (*P. lilacinus*). Among different treatments the highest dry weight of shoot (7.98 g) was recorded in T_3 (Fosthiazate) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate), T_4 (Blank control), T_1 (*P. lilacinus*). But the lowest dry weight of shoot (3.98 g) was observed in T_5 (negative control).

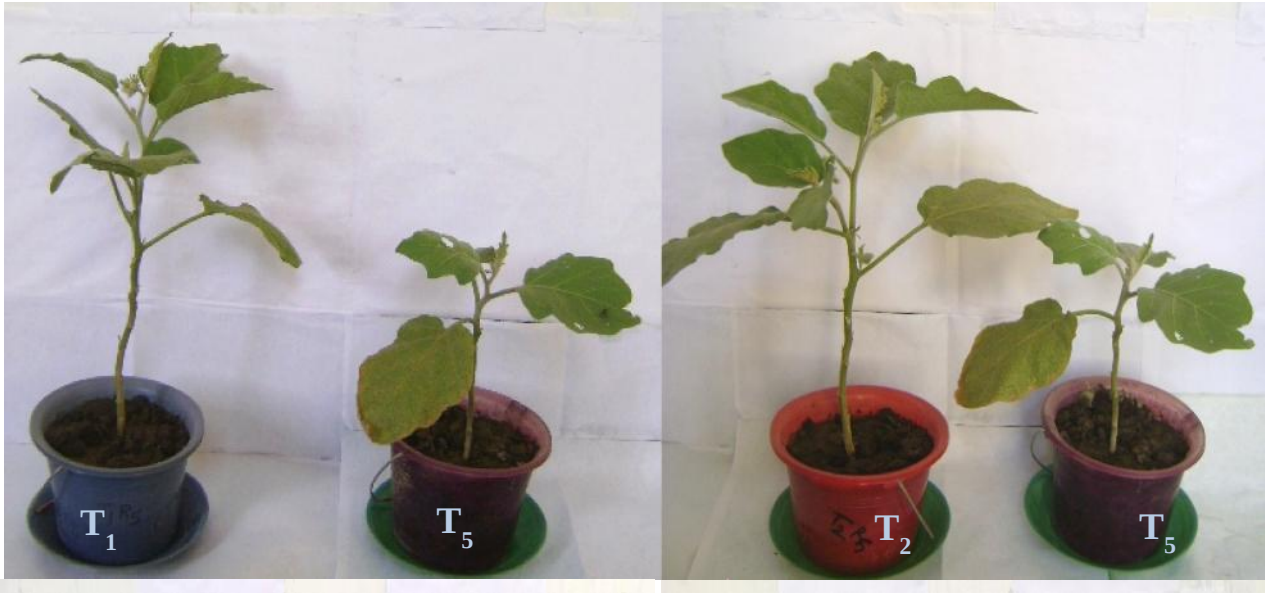
It was observed that application of Fosthiazate and inoculation with *P. lilacinus* + Fosthiazate showed good results among the treatments Table 1. In terms of length of root, treatments effect differed significantly among themselves. Maximum root length (27.67 cm) was observed in T_2 (*P. lilacinus* + Fosthiazate) which was statistically similar with T_3 (Fosthiazate), T_4 (Blank control), T_1 (*P. lilacinus*). The lowest result (17.11 cm) was observed in T_5 (negative control) which was statistically similar with T_1 (*P. lilacinus*). Considering fresh weight of root, the highest weight (30.77g) was recorded in T_4 (Blank control) followed by T_1 (*P. lilacinus*), T_2 (*P. lilacinus* + Fosthiazate), T_3 (Fosthiazate). The lowest result (11.97 g) was observed in T_5 (negative control).

Among different treatments the highest dry weight of root (7.34 g) was recorded in T_3 (Fosthiazate) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate), T_4 (Blank control). But the lowest dry weight of shoot (3.80 g) was observed in T_5 (negative control) and T_1 (*P. lilacinus*). The best result was recorded in in T_3 (Fosthiazate) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate).

Table 1. Effect of biocontrol fungus *Paecilomyces lilacinus* and Fosthiazate on growth parameters of eggplant Var. Singnath.

Treatments	Shoot length (cm)	Shoot weight (g)		Root length (cm)	Root weight (g)	
		Fresh weight	Dry weight		Fresh weight	Dry weight
T_1= *P. lilacinus*	40.34 ab	30.23 ab	7.10 a	23.45 ab	22.33 b	5.35 b
T_2= *P. lilacinus* + Fosthiazate	43.99 a	31.45 a	7.58 a	27.67 a	30.27 a	7.31 a
T_3= Fosthiazate	44.11 a	34.09 a	7.98 a	25.41 a	29.89 a	7.34 a
T_4= Blank control	43.63 a	32.41 a	7.01 a	25.69 a	30.77 a	7.14 a
T_5= Negative control	34.11 b	22.33 b	3.98 b	17.11 b	11.97 c	3.80 b
LSD (0.10)	8.33	8.23	2.41	7.70	7.28	1.63

Data represent the mean values of 7 replications; in a column means having similar letter(s) are statistically similar at 0.1% level of significance by LSD.


T1
T5
T2
T5

Photograph 12. Photograph showing the effect of *Paecilomyces lilacinus* , Fosthiazate and their combination on plant growth of eggplant var. singnath in comparison to control.

T_1 = *Paecilomyces lilacinus*

T_2 = *Paecilomyces lilacinus* + Fosthiazate

T_3 = Fosthiazate

T_4 = Blank control (without any inoculation)

T_5 = Negative control (only nematode inoculation)

4.1.2 Effect of biocontrol fungus *Paecilomyces lilacinus* and Fosthiazate on gall index, number of eggmass/root, number of egg/ egg mass and number of juveniles/ g soil at harvest of eggplant var. Singnath.

The treatment effects against gall formation egg mass, eggs and juvenile production was presented in Table 2. Significant variations were observed among different treatments. Lowest gall index (0.43) was recorded in treatment T_3 (Fosthiazate) (Photograph 13 and Photograph 14). This was statistically similar in T_2 (*P. lilacinus* + Fosthiazate), T_4 (Blank control) and followed by T_1 (*P. lilacinus*). The highest gall index (5.57) was recorded in T_5 (Negative control) which is significantly differ from all other treatments. In terms of number of egg mass per root, treatments effect differed significantly among them. Maximum number of egg mass (543.7) was recorded in T_5 (Negative control). The Lowest number of egg mass per root (11.57) was observed in T_3 (Fosthiazate) that was statistically similar with T_2 (*P. lilacinus* + Fosthiazate) and followed by T_1 (*P. lilacinus*). Considering number of eggs per egg mass, the highest value (409.9) was recorded in T_5 (negative control) and the lowest value (75.00) was recorded in T_3 (Fosthiazate). In terms of number of

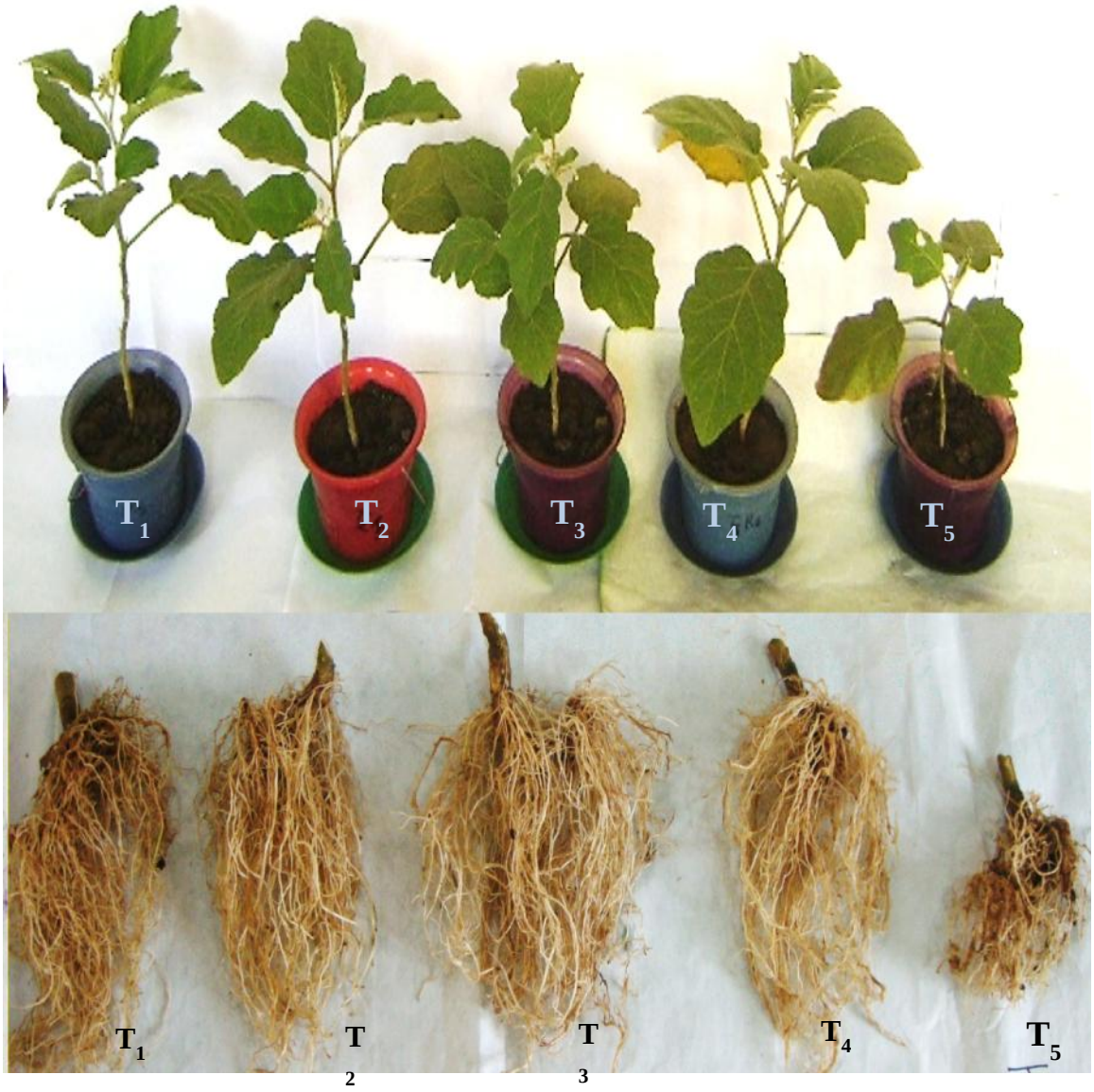
juvenile/g soil, treatments effect differed significantly among them. Maximum number of juvenile (242.9) was observed in T_5 (Negative control). The lowest number of juvenile was observed in T_3 (Fosthiazate) which was statistically similar to T_2 (*P. lilacinus* + Fosthiazate) followed by T_1 (*P. lilacinus*).

Table 2. Effect of biocontrol fungus *Paecilomyces lilacinus* and Fosthiazate on gall index, number of eggmass/root, number of egg/ egg mass and number of juveniles/ g soil at harvest.

Treatments	Gall Index (0-10)	Number of eggmass/ root	Number of egg/egg mass	Number of juvenile/g soil
T_1= *P. lilacinus*	2.57 b	263.4 b	223.0 b	74.29 b
T_2= *P. lilacinus* + Fosthiazate	1.00 c	32.86 c	136.3 bc	45.71 bc

T_3= Fosthiazate	0.43 c	11.57 c	75.00 cd	11.43 c
T_4= Blank control	0.00 c	0.00 c	0.00 d	0.00 c
T_5= Negative control	5.57a	543.7a	409.9 a	242.9 a
LSD (0.10)	1.16	199.1	94.24	53.38

Data represent the mean values of 7 replications; in a column means having similar letter(s) are statistically similar at 0.1% level of significance by LSD.



Photograph13. Photograph showing effect of *Paecilomyces lilacinus* , Fosthiazate and their combination on disease and plant growth of eggplant var. singnath in comparison to control.

T_1 = *Paecilomyces lilacinus*

T_2 = *Paecilomyces lilacinus* + Fosthiazate

T_3 = Fosthiazate

A

B

C

Photograph 14. Fresh root (A), Galled root (B) and highly galled root (C) of eggplant.

4.1.3 Effect of biocontrol fungus *Paecilomyces lilacinus* and Fosthiazate on nematode population, reproduction factor, % egg mass colonized by fungus *P. lilacinus* and soil colonization by *P. lilacinus* at harvest of eggplant Var. Singnath.

The highest nematode population (445.1×10^3) was recorded in Negative control (Table 3). The lowest nematode population (11.97×10^3) was recorded in T_3 (Fosthiazate) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate), T_4 (Blank control) and T_1 (*P. lilacinus*). It was observed that T_3 (Fosthiazate) and T_2 (*P. lilacinus* + Fosthiazate) gave good performance among the treatments. Reproductions of *Meloidogyne* spp were suppressed most by the application of Fosthiazate (reproduction factor 2.40) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate) and T_1 (*P. lilacinus*). The highest reproduction factor (91.76) was recorded in T_5 (Negative control). Among different treatments the % of egg mass colonized by fungus (57.14 %) was recorded in T_1 (*P. lilacinus*) and the % of egg mass colonized by fungus (50.00 %) was recorded in T_2 (*P. lilacinus* + Fosthiazate). Soil colonization (CFU/g soil) was observed higher (71.4) in T_1 (*P. lilacinus*) and CFU/g soil was lower (43.71) in T_2 (*P. lilacinus* + Fosthiazate). From the above findings it was concluded among different treatments application of Fosthiazate showed best result but it was similar to T_2 (*P. lilacinus* + Fosthiazate) and followed by T_1 (*P. lilacinus*).

Table 3. Effect of biocontrol fungus *Paecilomyces lilacinus* and Fosthiazate on nematode population, reproduction factor, % egg mass colonized by fungus *P. lilacinus* and soil Colonization by *P. lilacinus* at harvest of eggplant Var. Singnath.

Treatments	Nematode population/ plant ($\times 10^3$)	Reproduction factor (RF)	% egg mass colonized by fungus	Soil colonization (CFU/g soil)
T_1= *P. lilacinus*	104.4 b	21.83 b	57.14 a	71.43a
T_2= *P. lilacinus* + Fosthiazate	41.18 b	8.20 bc	50.00 a	43.71 b
T_3= Fosthiazate	11.97 b	2.40 bc	0.00 b	0.00 c
T_4= Blank control	00.00 b	0.00 c	0.00 b	0.00 c
T_5= Negative control	445.1a	91.76a	0.00 b	0.00 c
LSD (0.10)	101.7	19.51	25.01	11.20

Data represent the mean values of 7 replications; in a column means having similar letter(s) are statistically similar at 0.1% level of significance by LSD.

4. 1. 4 Effect of biocontrol fungus, *Paecilomyces lilacinus* and Fosthiazate on growth parameters of eggplant Var. Khotkhotia.

Inoculation of *P. lilacinus* and nematicide Fosthiazate reduced the damage caused by *Meloidogyne* spp. and significant variations were observed among different treatments in respect of shoot length, shoot weight, and shoot dry weight, root length, root weight, root dry weight of eggplant variety Khotkhotia in Table 4 and Photograph 15.

The highest shoot length (31.40 cm) was recorded in T_1 (*P. lilacinus*) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate), T_3 (Fosthiazate), T_4 (Blank control), and also T_5 (negative control) (Table 4).

Application of Fosthiazate gave the highest fresh weight of shoot (19.93 g) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate) and followed by T_1 (*P. lilacinus*). The lowest result (14.47 g) was observed in case of T_5 (negative control) which was statistically similar with T_1 (*P. lilacinus*) and T_4 (Blank control). Among different treatments the highest dry weight of shoot (10.96g) was recorded in T_3 (Fosthiazate) which was statistically similar with T_1 (*P. lilacinus*), T_2 (*P. lilacinus* + Fosthiazate) and T_4 (Blank control), But the lowest dry weight of shoot (7.20 g) was observed in T_5 (negative control) (Table 4). In terms of root length, treatments effect did not differed significantly among them. Maximum root length (14.37 cm) was observed in T_1 (*P. lilacinus*) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate), T_3 (Fosthiazate), T_4 (Blank control), and also T_5 (negative control) Table 4. Considering fresh weight of root, the highest weight (8.689g) was recorded in T_2 (*P. lilacinus* + Fosthiazate). The lowest result (5.40 g) was observed in T_5 (negative control). Among different treatments the highest dry weight of root (3.71 g) was recorded in T_3 (Fosthiazate) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate), T_4 (Blank control) and T_5 (negative control). No differences in root dry weight were found compared to both treated and untreated control (Table 4).

Table 4. Effect of biocontrol fungus *Paecilomyces lilacinus* and Fosthiazate on growth parameters of eggplant Var. Khotkhotia.

	Shoot	Shoot weight	Root	Root weight

Treatments	length (cm)	(g)		length (cm)	(g)	
		Fresh weight	Dry weight		Fresh weight	Dry weight
T_1= *P. lilacinus*	31.40a	18.27 abc	9.03 ab	14.37 a	7.77ab	3.37a
T_2= *P. lilacinus* + Fosthiazate	31.33a	18.91 ab	9.27 ab	13.20 ab	8.68a	3.66a
T_3= Fosthiazate	30.34a	19.93 a	10.96 a	13.76 ab	7.90ab	3.71a
T_4= Blank control	28.50a	15.07 bc	8.69 ab	12.61 ab	6.76ab	2.81a
T_5= Negative control	27.79a	14.47 c	7.20 b	9.76 a	5.40 b	1.74 a
LSD (0.10)	NS	3.88	3.03	4.22	2.54	NS

Data represent the mean values of 7 replications; in a column means having similar letter(s) are statistically similar at 0.1% level of significance by LSD.

NS = Not significant


T5
T4
T5
T3
T5
T2
T5
T1

Photograph 15. Photograph showing effect of *Paecilomyces lilacinus* , Fosthiazate and their combination on plant growth of eggplant var. Khotkhotia in comparison to control.
T_1 = *Paecilomyces lilacinus*
T_2 = Paecilomyces lilacinus + Fosthiazate
T_3 = Fosthiazate
T_4 = Blank control (without any inoculation)
T_5 = Negative control (only nematode inoculation)

4.1. 5 Effect of biocontrol fungus *P. lilacinus* and Fosthiazate on gall index, number of eggmass/root, number of egg/egg mass and number of juveniles/ g soil at harvest of eggplant Var. Khotkhotia.

The treatment effects against gall formation egg mass, eggs and juvenile production was presented in Table 5. Significant variations were observed among different treatments.

The highest effect was found in T_3 (Fosthiazate) and recorded the lowest gall index (Phograph- 16). This was statistically similar in T_4 (Blank control) and followed by T_1 (*P. lilacinus*), T_2 (*P. lilacinus* + Fosthiazate). The highest gall index (3.57) was recorded in T_5 (Negative control) which is significantly differ from all other treatments. In terms of number of egg mass per root, treatments

effect differed significantly among them. The highest number of egg mass (299.4) was recorded in T_5 (Negative control). The Lowest number of egg mass per root (6.29) was observed in T_2 (*P. lilacinus* + Fosthiazate) that was statistically similar with T_3 (Fosthiazate) and followed by T_1 (*P. lilacinus*). Application of Fosthiazate was effective in nematode suppression and here the lowest number of egg per egg mass (41.29) was recorded, which was statistically similar to T_2 (*P. lilacinus* + Fosthiazate) followed by T_1 (*P. lilacinus*). The lowest effect was observed in T_5 (negative control). Maximum number of juvenile (73.71) was recorded in T_5 (Negative control). The lowest number of juvenile was recorded in T_3 (Fosthiazate) which was statistically similar to T_1 (*P. lilacinus*), T_2 (*P. lilacinus* + Fosthiazate), T_4 (Blank control).

Table 5. Effect of biocontrol fungus *P. lilacinus* and Fosthiazate on gall index, reproduction of *Meloidogyne* spp, number of eggs/egg mass and number of juvenile/g soil at harvest of eggplant Var. Khotkhotia.

Treatments	Gall Index (0-10)	Number of egg mass/root	Number of egg/egg mass	Number of juvenile/g soil
T_1= *P.lilacinus*	1.29 b	48.71 b	143.9 b	6.29 b
T_2= *P. lilacinus* + Fosthiazate	1.00 b	29.86 b	67.14 c	5.14 b
T_3= Fosthiazate	0.29 c	6.29 b	41.29 cd	1.00 b
T_4= Blank control	0.00 c	0.00 b	0.00 d	0.00 b
T_5= Negative control	3.57a	299.4a	422.3 a	73.71a
LSD (0.10)	0.66	75.06	58.39	37.07
CV (%)	58.51	106.79	47.32	235.31

Data represent the mean values of 7 replications; in a column means having similar letter(s) are statistically similar at 0.1% level of significance by LSD.

Photograph 16. Photograph showing the effect of *Paecilomyces lilacinus*, Fosthiazate and their combination on plant growth of eggplant var. khotkhotia in comparison to control.

T_1 = *Paecilomyces lilacinus*

T_2 = *Paecilomyces lilacinus* + Fosthiazate

T_3 = Fosthiazate

T_4 = Blank control (without any inoculation)

T_5 = Negative control (only nematode inoculation)

4.1.6 Effect of biocontrol fungus *P. lilacinus* and Fosthiazate on nematode population, reproduction factor, % egg mass colonized by Fungus *P. lilacinus* and soil Colonization by *P. lilacinus* at harvest of eggplant Var. Khotkhotia.

The highest nematode population (276.7a $\times 10^3$) was recorded Negative control (Table 6). The lowest nematode population (2.07×10^3) was recorded in T_3 (Fosthiazate) which was statistically similar with T_1 (*P. lilacinus*), T_2 (*P. lilacinus* + Fosthiazate) and T_4 (Blank control). Reproductions factor was maximum (38.19) in Negative control. The lowest reproduction factor (0.32) was recorded in application of Fosthiazate which was statistically similar with T_1 (*P. lilacinus*), T_2 (*P. lilacinus* + Fosthiazate), T_4 (Blank control).

Among different treatments the highest % of egg mass colonized by fungus (17.86 %) was recorded in T_1 (*P. lilacinus*) and the lowest % of egg mass colonized by fungus (14.29 %) was recorded in T_2 (*P. lilacinus* + Fosthiazate). Soil colonization (CFU/g soil) was observed 56.86 in T_1 (*P. lilacinus*) and T_5 and CFU/g soil 33.71 was recorded in T_2 (*P. lilacinus* + Fosthiazate).

Table 6. Effect of biocontrol fungus *P. lilacinus* and Fosthiazate on nematode population, reproduction factor, % egg mass and soil colonization by *P. lilacinus* at harvest of eggplant Var. Khotkhotia.

Treatments	Nematode population/ plant ($\times 10^3$)	Reproduction factor (RF)	% egg mass colonized by fungus	Soil colonization (CFU/g soil)
T_1= *P. lilacinus*	15.04 b	3.01 b	17.86 a	56.86 a

T_2= *P. lilacinus* + Fosthiazate	5.40 b	1.13 b	14.29 a	33.71 b
T_3= Fosthiazate	2.07 b	0.32 b	0.00 b	0.00 c
T_4= Blank control	0.00 b	0.00 b	0.00 b	0.00 c
T_5= Negative control	276.7a	38.19a	0.00 b	0.00 c
LSD (0.10)	95.20	13.04	11.10	11.51

Data represent the mean values of 7 replications; in a column means having similar letter(s) are statistically similar at 0.1% level of significance by LSD.

4.2 Field experiment

In field experiment two varieties of eggplant namely Singnath and Islampuri were used.

4.2.1 Effect of biocontrol fungus *P.lilacinus* and Fosthiazate on gall index, reproduction of *Meloidogyne* spp and yield of eggplant var. Singnath in the field.

Inoculation of *P. lilacinus* and application of nematicide Fosthiazate reduced the damage caused by *Meloidogyne* spp and increased the yield of eggplant.

The lowest gall index (0.93) was recorded in Fosthiazate treated plot (T_3) This was statistically similar with T_2 (*P. lilacinus* + Fosthiazate) followed by T_1 (*P. lilacinus*). The highest gall index (4.96) was recorded in T_4 untreated control which was significantly differed from other treatments (Table 7).

In terms of number of egg mass per root, treatments effect differed significantly among them. Maximum number of egg mass per root (293.1) was recorded in untreated control. Lower number of egg mass per root (35) was recorded in Fosthiazate treated plant. It was observed that application of Fosthiazate and inoculation with *P. lilacinus* + Fosthiazate gave good results among the treatments (Table7). Considering number of egg per egg mass, the lowest count (154.2) was made in T_3 (Fosthiazate) which is statistically similar to T_2 (*P. lilacinus* + Fosthiazate) followed by T_1 (*P. lilacinus*). The highest count (403.7) was made in untreated control (Table 7).

The highest nematode population per plant (135.6×10^3) was recorded in untreated control plant. The lowest nematode population per plant (4.45×10^3) was recorded in Fosthiazate treated plot which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate), T_4 (untreated control) andT_1 (*P. lilacinus).*The highest number of fruit/plant (6.33) was recorded in T_3 (Fosthiazate) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate) followed by T_1 (*P. lilacinus*). The lowest number of fruit/plant (4.33) was recorded in untreated control plot.

The highest weight of fruit/plant (737.6 g) was recorded in T_3 (Fosthiazate) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate) followed by T_1 (*P. lilacinus*). The lowest number of fruit/plant (238.3g) was recorded in T_4 (untreated control) (Table 7).

The highest yield (14.05 t/ha) was recorded in T_3 (Fosthiazate) which was statistically similar with T2 (*P. lilacinus* + Fosthiazate) and followed by T_1 (*P. lilacinus*). The lowest result was observed in T_4 (untreated control).

Table 7. Effect of biocontrol fungus *P. lilacinus* and Fosthiazate on gall index, reproduction of *Meloidogyne* spp and yield of eggplant var. Singnath in the field.

Treatments	Gall Index (0-10)	Number of Egg mass/root	Number of egg/egg mass	Nematode population/ plant ($\times 10^3$)	Number of fruit/plant	Yield (g/plant)	Yield (t/ha)
T_1= *P. lilacinus*	2.75ab	164.4ab	278.6 b	48.81 b	5.16 b	577.6 b	11.00 b
T_2= *P. lilacinus* + Fosthiazate	1.50 ab	50.58 b	180.3 bc	11.28 b	6.08a	704.4a	13.94a
T_3= Fosthiazate	0.93 b	35.00 b	154.2 c	4.45 b	6.33a	737.6 a	14.05a
T_4= Blank control	4.96a	293.1a	403.7a	135.6 a	4.33 c	238.3 c	4.54 c
LSD (0.10)	3.40	170.7	115.5	76.34	0.66	83.06	1.32

Data represent the mean values of 4 replications; in a column means having similar letter(s) are statistically similar at 0.1% level of significance by LSD.

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4.2.2 Effect of biocontrol fungus *P. lilacinus* and Fosthiazate on gall index, reproduction of *Meloidogyne* spp and yield of eggplant var. Islampuri in the field.

Inoculation of biocontrol fungus *P. lilacinus* and application of nematicide Fosthiazate either alone or in combination reduced the damage caused by *Meloidogyne* spp. and increased the yield of eggplant, var. Islampuri.

Gall index was minimum (0.65) in Fosthiazate treated plot which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate) followed by T_1 (*P. lilacinus*). The highest gall index (3.02) was recorded in untreated control plot which was significantly differing from other treatments (Table 8).

Treatments effect differed significantly among them in terms of number of egg mass per root, Maximum number of egg mass per root (269.0) was recorded in untreated control which was statistically similar with T_1 (*P. lilacinus*). Lower number of egg mass per root (43.94) was observed in T_3 (Fosthiazate).

It was observed that application of Fosthiazate and inoculation with *P. lilacinus* + Fosthiazate gave good results among the treatments (Table 8). Considering number of egg per egg mass, the lowest count (132.3) was made in T_3 (Fosthiazate) which is statistically similar with T_1 (*P. lilacinus*), T_2 (*P. lilacinus* + Fosthiazate). The highest count (526.8) was made in untreated control (Table 8). The highest nematode population per plant (93.35×10^3) was recorded in T_4 (untreated control). The lowest nematode population per plant (6.76×10^3) was recorded in Fosthiazate treated plot which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate), T_4 (Blank control), T_1 (*P. lilacinus*) (Table 8). The highest number of fruits/plant (6.93) was recorded in T_3 (Fosthiazate) which was statistically similar with T_1 (*P. lilacinus*) and T_2 (*P. lilacinus* +

Fosthiazate). The lowest number of fruit/plant (4.92) was recorded in T_4 (untreated control).

Among different treatments the highest weight of fruit/plant (815.9 g) was recorded in T_3 (Fosthiazate) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate) and T_1 (*P. lilacinus*). The lowest number of fruit/plant (351.2 g) was recorded in T_4 (untreated control) (Table 8).

The highest yield (15.56 t/ha) was recorded in T_3 (Fosthiazate) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate) and T_1 (*P. lilacinus*). The lowest yield (6.69 t/ha) was reduced in T_4 (untreated control) (Table 8).

Table 8. Effect of biocontrol fungus *P. lilacinus* and Fosthiazate on gall index, reproduction of *Meloidogyne* spp and yield of eggplant var. Islampuri in the field.

Treatments	Gall Index (0-10)	Number of Egg mass/root	Number of egg/egg mass	Nematode population/ plant ($\times 10^3$)	Number of fruit/plant	Yield (g/plant)	Yield (t/ha)
T_1= *P. lilacinus*	1.94 b	213.9a	242.3 b	55.54ab	5.96ab	734.4a	13.99a
T_2= *P. lilacinus* + Fosthiazate	0.94 c	123.1 b	240.0 b	24.57 b	6.22ab	782.6a	14.90a
T_3= Fosthiazate	0.65 c	43.94 b	132.3 b	6.76 b	6.93a	815.9a	15.56a
T_4= Blank control	3.02 a	269.0a	526.8a	93.35 a	4.92 b	351.2 b	6.69 b
LSD (0.10)	0.68	79.24	128.0	51.70	1.43	311.1	5.924

Data represent the mean values of 4 replications; each replication was derived from plants per treatment; in a column means having similar letter(s) are statistically similar at 0.1% level of significance by LSD.

DISCUSSION

The experiment was conducted to study the use of nematophagous fungus *P. lilacinus* as a bio control agent against root-knot nematode (*Meloidogyne* spp) in eggplant grown in pot and under field condition. The pot experiment demonstrated the efficacy of biocontrol fungus *P. lilacinus* in controling the root knot nematode *Meloidogyne* spp. with reduction in galling and nematode population. *P. lilacinus* enhanced plant growth and reduced galling index and nematode population. In similar experiment Aminuzzaman *et al.* (2011) reported that pellets of *P. lilacinus* enhanced plant growth, reduced galling index and nematode population. They also mentioned that root galling index and final nematode population decreased up to 40.7% and 73.8% respectively for tomato and 55.6% and 66.9% respectively for brinjal. Ganaie and Khan (2010) reported that the growth parameters were improved by biological control agent *P. lilacinus* while it also reduced *M. javanica* reproduction on simultaneous and sequential inoculation. Walia *et al.* (1999) observed improved tomato plant growth parameter with simultaneous and sequential inoculations of *P. lilacinus* and *Meloidogyne* spp. Sun *et al.* (2006) observed that *P. lilacinus* was highly pathogenic to root knot nematode and it reduced tomato root gall index by 13.4- 58.9%. Present findings also supported by Oduor and Waudo (1996) who reported *P. lilacinus* and *Fusarium oxysporum*-1 significantly ($p<0.05$) parasitized more than 70% of eggs and female nematode on eggplant.

The present study found fungus *P. lilacinus* is an effective soil-inhibiting opportunistic parasite of nematode eggs and this finding is in accordance with (Jatala *et al*. 1980., Villanueva and Davide, 1984., Davide and Zorilla, 1986). This fungus is currently used as a biological control agent against various plant parasitic nematodes (Brand *et al*. 2004). Similar results were found in tomato plant treated with *P. lilacinus* (Nasr esfahani and Ansari pour, 2006). Kalele *et al*. (2010) worked with antagonistic fungi *P. lilacinus* strain 251 in controlling root-knot nematodes in tomato and cucumber. They applied *P. lilacinus* inoculum at different rates and different times. They found that pre-planting soil treatment reduced final nematode populations by 69% and 73% in the roots and soil, respectively, compared to the non-inoculated control in tomato. They described that PL251 was a promising potential that could be exploited in the management of *Meloidogyne* spp in vegetable production systems.

Fosthiazate provided excellent control of root-knot nematodes and increased plant growth in the experiment. Kim *et al.* (2002) reported that fosthiazate pre-plant plus post-plant application reduced nematode population densities as much as 90 % and increased yield.

Findings of the present study also show that the combined effect of *P. lilacinus* and chemical nematicide fosthiazate gave better results in terms of controlling number of egg mass per root, number of egg per egg mass, number of juvenile per gram soil, nematode population and reproduction factor. These results are in accordance with previous findings concerning the efficacy of *P. lilacinus* in controling in *Meloidogyne* spp. Aminuzzaman (2009) reported that fungal pellets containing spores of nematophagous fungus *P. lilacinus* YES-2 significantly reduced the number of nematode population in soil and root and increased 20.75% tomato yield over untreated control. He also observed that combined effect of *P. lilacious* and fosthiazate reduced root knot index up to 85.71%. Results of the present study also demonstrated that *P. lilacinus* was compatible with fosthiazate and had tantamount effect in controlling nematode and such of *P. lilacinus* might be an effective alternative to chemical nematicide fosthiazate in controlling root knot disease.

In the present study high percentage of egg masses were infected by *P. lilacinus.* Esfahani and Pour (2006) reported that a high percentages (55%) egg masses were infected with *P. lilacinus* and infected eggs contained mycelium of *P. lilacinus*. They also observed that some juveniles of infected eggs showed various degrees of deformity and abnormal development and a number of juveniles that emerged from eggs were infected and showed mycelial growth over their body (Ganaie and Khan, 2010, Jatala, 1985, 1986 and Dunn *et al*. 1986).

In the present study when Fosthiazate was combined with biocontrol fungus *P. lilacinus* the dose of Fosthiazate was reduced to half. Chemical nematicide and nematicide biocontrol fungus combinations had statistically similar effect on most of the parameters. So *P. lilacinus* might be useful either alone or in combination with nematicide fosthiazate to reduce the hazardous effect of chemical nematicide in controlling root knot nematode.

In field experiment two varieties of eggplant namely singnath and islampuri were used and biocontrol potency of *P. lilacinus* in controlling root knot nematode were evaluated. Gall index, number of eggmass, number of eggs in eggmasses, nematode population were significantly decreased and yield were increased using the chemical and biological treatment and their integration over non treated control. The efficacy of biocontrol fungus *P. lilacinus* and fungus plus fosthiazate in controlling RKN were observed and it was found that *P. lilacinus* either alone or in combination with fopsthiazate reduced nematode populations in soil and plant roots, reduced root gall index and increased yield over untreated control. Cannayane and Rajendran (2001) also reported that *P. lilacinus* significantly reduced *M. incognita* population and increased yield. Khan *et al.* (2012) reported that the incorporation

of *P. lilacinus* into the soil significantly enhanced the yield by 14% over uninoculated eggplant. They also observed that *P. lilacinus* reduced the suppressive effect of the nematode that leading to a significant increase in the dry matter production and yield. Cabanillas and Barker (1989) delivered *P. lilacinus* into soil 10 days before planting and again in planting and observed that yield was increased with the improvement of plants growth.

The results of the experiment showed the compatibility of biocontrol fungus *P. lilacinus* with chemical nematicide fosthiazate. Use of *P. lilacinus in* combination with chemical nematicide also evaluated by other scientist around the world. Sivakumar *et al.* (1993) reported that integrated application of biocontrol fungus *P. lilacinus* and chemical nematicide carbofuran gave significantly better results than either treatment individually in the control of root knot nematode *M. aeranaria* in brinjal nursery. Woods *et al.* (1999) found *Pochonia chlamydosporia* compitable with fosthiazate to control potato cyst nematodes (*Globodera pallida*) in UK. Tobin *et al.* (2008) reported nematophagous fungus *Pochonia chlamydosporia* provided similar levels of nematode population control as chemical nematicide fosthiazate and increased yields. Integrated control of root knot was observed by Mittal *et al.* (1995) and they mentioned that *P. lilacinus*, in combination with chitin enhanced suppression of *Meloidogyne incognita* more than using them alone.

In the present study the responses of bio control fungus *P. lilacinus* either alone or in combination with chemical nematicide fosthiazate had similar effect on nematode control, growth parameter and yield of eggplant. In fine, *P. lilacinus* alone might be an ecofriendly tool to control root knot nematode or might be used in combination with chemical nematicide fosthiazate in a compatible manner for better control of root knot nematode as well as conservation of environment.

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SUMMARY AND CONCLUSION

The pot experiment was conducted in green house of the Department of Plant Pathology and field experiment was conducted in the field of Sher-e-Bangla Agricultural University. Dhaka. In the present investigation nematophagous fungus *P. lilacinus* and a chemical nematicide Fosthiazate were used as experimental material. Pot experiment and field experiment were done to study the effects of biocontrol fungus *P. lilacinus* in controlling root knot nematode (*Meloidogyne* spp.).

In the pot experiment the treatments were biocontrol fungus *P. lilacinus*, *P. lilacinus* + Fosthiazate, Fosthiazate, blank control and negative control. In *P. lilacinus* and Fosthiazate combination the dose of chemical was reduced to one half. Eggplant varieties Singnath and khotkhotia were used for the experiment. The experiment was laid out in Randomized Complete Block Design (RCBD) with 7 replications. Inoculation was done at the root zone of plant by drenching of spore suspension @ of 18000× 10^4 spore/plant with the help of micropipette. Mature eggmass of nematode (*Meloidogyne* spp) was collected from severely galled roots of eggplants. Then the egg mass picked and egg per egg mass counted. Each plant was inoculated with 5000 eggs on the time of transplanting. Data recorded at 60 days after transplanting (DAT). In singnath variety the highest shoot length (44.11cm), the highest fresh weight of shoot (34.09g), the highest dry weight of shoots (7.98 g), maximum root length (27.67cm), the highest dry weight of root (7.34 g) were recorded in T_3 (Fosthiazate) which were statistically similar with T_2 (*P. lilacinus* + Fosthiazate).The lowest shoot length (40.34cm), the lowest fresh weight of

shoot (22.33 g), the lowest dry weight of shoots (3.98 g), lowest root length (17.11 cm), the lowest dry weight of root (3.80g) were recorded in negative control. Besides *P. lilacinus,* Fosthiazate and their combination reduced 53.86%, 82.05%, 92.28% gall index, 51.5%, 93.9%, 97.8% egg mass/root, 45.5%, 66.7%, 81.7% egg/egg mass, 69.4%, 81.1%, 95.2% juvenile/g soil, 76.5%, 90.7%, 97.3% nematode population/ plant, 76.2%, 91.0%, 97.3% reproduction factor, respectively over control.

In khotkhotia variety the highest shoot length (30.34 cm), the highest fresh weight of shoot(19.93g), the highest dry weight of shoots (10.96 g) were recorded in T_3 (Fosthiazate), maximum root length (14.37cm) in *P. lilacinus* treated plant, the highest dry weight of root (8.68 g)in *P. lilacinus* + Fosthiazate. The lowest shoot length (27.79 cm), the lowest fresh weight of shoot(14.47g), the lowest dry weight of shoots (7.20 g), lowest root length (9.76 cm), the lowest fresh weight of root(5.40 g), the lowest dry weight of root (1.74 g) were recorded in negative control. Besides *P. lilacinus,* Fosthiazate and their combination reduced 63.8%, 71,9%, 91.8% gall index, 83.7%,90.0%, 97.8% egg mass/root, 65.9%, 84.1%, 90.2% egg/egg mass,67.42%, 93.1%, 98.6% juvenile/g soil, 94.5%, 98.0%, 99.2% nematode population/ plant and 92.1%, 97.0%,99.1% reproduction factor respectively over control.

In the field experiment the treatments were biocontrol fungus *P. lilacinus*, *P. lilacinus* + Fosthiazate, Fosthiazate and untreated control. The experiment was laid out in Randomized Complete Block Design (RCBD) with 4 replications. Eggplant varieties singhnath and islampuri were used for the experiment. Inoculation done at the root zone of plant by drenching of spore suspension

@ of 18000× 10^4 spore/plant with the help of micropipette and Fosthiazate was mixed thoroughly to the soil. After transplantation of seedlings weeding and irrigation were done. The plants were observed regularly. General sanitation was maintained throughout the growing period. Inoculation of biocontrol fungus *P. ilacinus* and application of nematicide Fosthiazate either alone or in combination reduced the damage caused by *Meloidogyne* spp. and increased the yield of eggplant, var. singnath. In the field *P. lilacinus,* Fosthiazate and their combination reduced 44.56%, 69.7%, 81.25%gall index,43.9%, 82.7%, 88.0% egg mass/root, 30.9%, 55.3%, 61.8% egg/ egg mass and 64.0%, 91.6%, 96.7% nematode population/plant respectively over control in variety singnath. It was observed that application of Fosthiazate and inoculation with *P. lilacinus* + Fosthiazate gave good results among the treatments; the lowest count was made in Fosthiazate and the highest count was made in untreated control. Among different treatments the highest weight of fruit/plant (737.6 g) was recorded in Fosthiazate treated plot which was statistically similar with *P. lilacinus* + Fosthiazate combined treated and *P. lilacinus* treated plot. The lowest number of fruit/plant (238.3 g) was recorded in untreated control. The highest yield (14.05 t/ha) was recorded in T_3 (Fosthiazate) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate) and T_1 (*P. lilacinus*). The lowest yield (4.54 t/ha) was reduced in untreated control.

Inoculation of biocontrol fungus *P. lilacinus* and application of nematicide Fosthiazate either alone or in combination reduced the damage caused by *Meloidogyne* spp. and increased the yield of eggplant, var. islampuri. In the field *P. lilacinus,* Fosthiazate and their combination reduced 35.7%, 68.8%, 78.4%gall index, 14.9%, 54.2%, 60.9%egg mass/root, 54.0%,54.4%, 74.8% egg/ egg mass and 40.5%, 73.6%, 92.7% nematode population/plant respectively

over control. Among different treatments the highest weight of fruit/plant (815.9 g) was recorded in Fosthiazate treated plot which was statistically similar with *P. lilacinus* + Fosthiazate combined treated and *P. lilacinus* treated plot. The lowest number of fruit/plant (351.2 g) was recorded in untreated control. The highest yield (15.56 t/ha) was recorded in T_3 (Fosthiazate) which was statistically similar with T_2 (*P. lilacinus* + Fosthiazate) and T_1 (*P. lilacinus*). The lowest yield (6.69 t/ha) was reduced in untreated control.

Considering the overall results it is concluded, that in most of parameters the effect of chemical nematicide and combinations of nematicide with biocontrol fungus, the result was statistically similar. So *P. lilacinus* might be useful either alone or in combination with nematicide Fosthiazate in controlling root knot nematode. *Meloidogyne* spp with increasing growth parameters and yield of eggplant. However, further experiment need to conduct including more vegetables available in the country at different agro-ecological zone in order to evaluate and use of biocontrol fungus *P. lilacinus* as supplementation of chemical nematicide.