EFFECT OF NEMATICIDE AND SOME PLANT EXTRACTS AGAINST ROOT-KNOT (*Meloidogyne javanica*) OF BRINJAL

A Thesis

By

MD. SAZZAD KAMAL
Student No. 0705027
Session: 2007-2008
Semester: July-December 2008

MASTER OF SCIENCE (MS)

IN

PLANT PATHOLOGY

DEPARTMENT OF PLANT PATHOLOGY
HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY
UNIVERSITY, DINAJPUR

DECEMBER 2008

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Submitted to the

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Hajee Mohammad Danesh Science and Technology University, Dinajpur

in partial fulfillment of the requirements for the degree of

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DEDICATED
TO MY
BELOVED PARENTS

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''THE AUTHOR''

ABSTRACT

Four treatments viz. curaterr solution, standard (S) leaf extracts of neem (*Azadirachta indica*), marigold (*Tagetes erecta*) and dhalkalmi (*Ipomoea fistulosa*) with a control were tested against root-knot of brinjal caused by *Meloidogyne javanica*. Among the treatments, curaterr solution gave superior result followed by neem leaf extract (S) in plant growth as they had increased length of shoot and root as well as fresh weight of shoot and root and yield correspondingly with the lowest galling incidence. Better effect on plant growth characters with lower galling incidence observed with marigold leaf extract (S). Dhalkalmi leaf extract (S) was found effective in suppressing the nematode activities as evident with moderate growth of plants. Negative correlations between gall number with shoot and root length, shoot and root weight and fruit weight indicate the positive response of the treatments on brinjal against root-knot nematode (*Meloidogyne javanica*).

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CHAPTER 1

INTRODUCTION

Brinjal (*Solanum melongena* L.) is one of the most common, popular and cheap vegetable grown throughout the all seasons in Bangladesh and mostly available in winter season. It ranks as one of the top most vegetable in the tropics on the basis of production and economic importance. It is highly productive and usually finds its place as the poor man's crop. It has food and nutritive value; in 100g of edible part of brinjal which contains carbohydrate 2.2 g, protein 1.8 g, fat 2.9 g, vitamin 5.20 mg, iron 0.9 mg, calcium 28.0 g, water 92.4 g, ash 1.3 g, kilocalorie 42.0 μg, carotene 850 mg (Meah,2003).

As a vegetable crop, popularity of brinjal is increasing day by day in our country. But its total production in Bangladesh is low as compared to other tropical country. In Bangladesh, 22.5 thousand and 37.5 thousand hectare area were under its cultivation and the total production was 118.3 thousand and 240.1 thousand metric tons approximately in both kharif and rabi season, respectively (B.B.S., 2004).

Bangladesh lies in the sub-tropical region having hot and humid climate. On a global basis out of the approximately 35% crop losses annually caused by crop enemies; 12% is due to diseases caused by fungi, bacteria and viruses, 11% due to caused by nematodes, 7% is due to insects and 3% is due to weeds (Cramer, 1987). The annual loss of crops due to nematode is about 13% (R.S. Singh, 2005).

The soil and climatic condition of Bangladesh has made her an ideal abode for nematodes. Several hundred species of nematodes are known to feed on living plants as parasites causing a variety of plant diseases. From a preliminary survey, it is found that 15 genera of plant parasitic nematodes associated with

commercial crops in Bangladesh where root-knot nematode *Meloidogyne* spp. were the most abundant and wide spread (Timm and Ameen, 1960; Ahmad, 1977 and Mian, 1986). Considerable damage to the crops may occur due to the attack of root-knot nematode, *Meloidogyne* spp. (Singh & Sitaramaiah, 1973).

The root- knot disease is of economically significant to the growers of this country, In case of vegetable crops, the root-knot disease causing nematode predisposes the plants for further invasion by other micro-organisms (Chester, 1950). The nematode population in the soils of Bangladesh is increasing day by day (Chowdhury, 1976).

The disease can be controlled through integrated use of chemicals, cultural, biological and botanical means. Different chemicals are effectively used for controlling nematodes. These nematicides are very effective, useful and commercially applied in controlling nemic disease in developed countries. But such nematicides are very expensive and either not manufactured or available in Bangladesh. Besides, the farmers in our country are financially so incapable to afford above mentioned costly nematicides. Most of the farmers are incapable to determine the precise dose of the chemicals for field application. In addition their harmful effect is responsible for air, soil and water pollution (Alam, 1987). For these reasons, the extended use of chemicals in controlling plant pathogens including nematode has discouraged all over the world. A good number of nematicides are used in developed countries but in Bangladesh only a few of those are imported and marketed in small quantities and sold at high prices.

On the other hand, plant extracts are cheap, available and easy to prepare and also effective escaping the environmental pollution. Control of nematode disease of plant with extracts of leaves is relatively a new approach of disease control by biological means. Leaves, bark, fruits, flowers and seeds of many plants are also found to be toxic to plant parasitic nematode, especially to

root-knot nematode (Mian *et al.* 1982, Sartaj *et al.* 1986, Stephan *et al.*1989, Saifullah *et al.*1990 and Ahmad *et al.* 1991). Nemic population can be controlled applying various plant extracts, many plant extracts have been reported to have antifungal, antibacterial and anti-nematode properties (Irshad *et al.*1982 and Stephan *et al.* 1989).

In Bangladesh, particularly in northern region very limited work has been done regarding the use of plant extracts to control nematode. This is why the present investigation has been undertaken to use plant extracts as to see the nematicidal effect against root-knot (*Meloidogyne javanica)* of brinjal. A chemical named Curaterr was also taken in this research work to compare with the effectiveness of those plant extracts. Curaterr which is available in the market has been found effective to control root-knot nematodes and increase yield of various crops (Mian *et al.* 1991). It is commonly used as insecticide or nematicide.

To avoid environmental pollution and minimizing the production cost, the present research work has been undertaken with the following objectives:

- To see the effect of plant extracts (neem, marigold, and dholkalmi) and curaterr in controlling root-knot (*Meloidogyne javanica*) of brinjal

- To observe the comparative efficacy of neem, marigold, and dholkalmi extracts and curaterr on the control of root-knot (*Meloidogyne javanica*) of brinjal

CHAPTER 2

REVIEW OF LITERATURE

Control of nemic diseases of plant with chemical nematicides and plant extracts have been in practice both at home and abroad. Some important literature relating chemicals and plant extracts with failure and successes of research activities relevant to the control of nemic diseases of crops especially of root-knot caused by *Meloidogyne* spp. have been reviewed below:

Hameed (1970) reported that addition of decomposed leaves of *Chrysanthemum coronarium, Melia azadirachta, Tagetes patula, Datura fustuosa and Nerium indicum* as farmyard manure and pressmud to the soil reduced the incidence of *Meloidogyne* spp. in tomato and increased plant growth.

Ducusion and Davide (1972) reported that pot trials in the Philippines showed that inoculation of tomato (rainy season var. 2029) with *Meloidogyne incognita* eggmasses at planting gave 85.3% yield loss and 39.9% if inoculated at the flowering stage. Field trials of tomato growth after the addition of sawdust or chicken manure or planting with *Tagetes erecta*, showed reduced galling on plants treated with chicken manure and yield increases of 43% and 68% respectively. The other treatments had no effect. However, tomato root-galling was greatly reduced when *Tagetes erecta* was grown for several months before the tomatoes were planted. The effect of *Tagetes* and tomato root extracts at various dilutions on the hatching of *Meloidogyne incognita* is described.

Srivastava *et al.* (1972) practised with oil-cakes of neem, castor, linseed, mustard, groundnut, sawdust and mahua as organic amendments to the soil to evaluate their efficacy against *Meloidogyne javanica* on tomato and brinjal.

The sawdust at 1088.44 kg/acre closely followed by neem cake 486 kg/acre showed most effective in reducing the gall formation on the crops.

Khan *et al.* (1973) found the suppression of *Tylenchorhynchus brassicae, Hoplolaimus indicus, Helicotylenchus erythrinae and Meloidogyne incognita* in soil amended with oil-cakes of neem, groundnut and castor in tomato cultivation.

Khan *et al.* (1974 a) reported that amendments of soil with oil-cakes of neem, groundnut and castor significantly diminished the population of phytophagous nematodes such as *Tylenchorhynchus brassicae, Helicotylenchus erythrinae, Rotylenchulus reniformis* and the larvae of *M. incognita* in the rhizosphere of eggplant.

Khan *et al.* (1974 b) found that ammonia liberated as a result of the decomposition of oil-cake (mahua, castor, mustard, neem and groundnut) was found to be toxic to varying degrees to several species of plant parasitic nematodes.

Khan *et al.* (1974 c) tested water soluble fractions of 14 oil-cakes of which 7 were toxic to *Hoplolaimus indicus, Rotylenchulus reniformis and Tylenchorhynchus brassicae* and prevented larval hatch of *Meloidogyne incognita*. The bitter principles of neem, v12, nimbidin and thionimone also effectively suppressed the growth of fungi in culture media and were highly effective in killing the nematodes and inhibiting the larval hatch of *Meloidogyne incognita.*

Mishra and Prasad (1975) gave a trial with extracts of oil-cakes and neem cakes to control root-knot disease. Among them, extracts of neem cake were the most effective due to their toxicity to root-knot nematodes.

trial, addition of Temic (2 Ibs/a) or Furadan (2 Ibs/a) to Telone (16 g/a) treated plots did not further increased yields over Telone treatment alone.

Davide (1979) found that application of Temic -10G, Mocap-10G, Furadrn-3G, Vydate Nellite Hoe 2960-59 or Nemagon-20G, to tomato plants infested with *M. incognita* reduced nematode infection and increased yield significantly.

Perlaza *et al.* (1979) showed that application of Furadan at 6 kg a. i. /ha in carrot field were effective to control *M. incognita*, *M. hapla* and increased plant growth.

Koshy *et al.* (1979) reported that application of carbofuran at the rate of 2, 4 and 6 kg a. i. /ha controlled root-knot (*M. incognita*) and improved plant growth of *Elettaria cardomomum.*

Kartono (1980) stated that Temic 10G, Furadan 3G and Nemagon 20G reduced the population of *Meloidogyne* spp. in soil up to the 60th days. Temic 1OG appears to give better results than Furadan or Nemagon.

Rodriguez *et al.* (1981) obtained the reduction of larval population of *M. incognita* in potato with Furadan 10G at the rate of 4, 5 and 6 kg a. i. /ha.

Prot and Kornprobst (1983) observed that pre-treated with crude seed extracts of *Azadirachta indica, Hannoa undulata and H. klaineana* inhibited the penetration of *Meloidogyne javanica* juveniles into tomato roots.

Hussain *et al.* (1984) found that the root-dip treatment of *Solanum melongena* seedling with or Marigold leaf extract, Mustard cake considerately reduced the development of *Meloidogyne incognita* as compared to treatment with piperazine citrate, chenopodium oil and groundnut cake. They also observed that treatments with 'half standard' of *Artemisia maritina* were better for plant

growth improvement, but for disease control, 'standard' concentration was more effective.

Grewal *et al.* (1985) found that oil cakes of mustard, sesame and cotton each at 20 and 30 q/ha and aldicarb, carbofuran and phorate at 1.5 3.0 kg/ha were applied before sowing groundnut in a field heavily infested with *Meloidogyne* spp. Aldicarb, carbofuran and mustard oil cake were most effective in reducing the nematode population and root gall index and increasing the pod yields. Nematicides were generally more effective than the oil cakes.

Jagdale *et al.* (1985) observed that Carbofuran applied in the soil at 1.5 kg a. i. /ha had shown to reduced population of *M. incognita* and number of galls on betel leaf.

Khan and Alam (1985) reported that aldicarb carbofuran at 100and 1000 ppm were highly toxic to *Meloidogyne incognita* and inhibited larval hatching when applied to infested tomato seedlings.

Sharma *et al.* (1985) used powders of 9 plants (leaf at 5.0, 7.5 and 10.0 g/kg soil) which were applied to *Cucumis melo* in pots for control of *Meloidogyne incognita.* Lowest population after 45 days was found in soil treated with *Tagetes* or *Xanthium* leaf powders, followed by *Verbesina* and *Artemisia.*

Mani *et al.* (1986) reported the effect of extracts of the following plant spp. (dried and powered), *Agemone maxicana, Azadirachta indica, Calotropis gigantea, Gleome viscosa, Datura stramonium, Eucalyptus globulus and Tagetes erecta* on the mortality of nematode. The standard leaf extract 'S' was prepared and from which 1 and 5% solutions were also prepared and applied on second stage juveniles of *Tylenchulus semipenetrans* in petridish. Juvenile mobility decreased as the concentration of extract and the exposure periods increased.

Guzman and Saxena (1987) observed that derivatives from the neem tree (*Azadirachta indica.* A. Juss) namely neem oil, neem extract and neem cake showed high nematicidal activity against the root-knot nematode (*Meloidogyne incognita) Chitwood* in both laboratory and greenhouse tests. In vitro test showed a progressive significant increase in mortality of second stage larvae in the different neem treatments and they were observed to undergo protoplasmic vacuolation in contrast to motile, healthy larvae in the untreated control treatments. In pot experiment, inhibitory effects on production of galls in tomato plants were evident when applied with of 4 to 5 part of neem cake.

Lee (1987) reported that *Melia azadirach* leaf and seed extracts inhibited hatching of root-knot nematode (*Meloidogyne incognita*) eggs (associated with a delay in embryonic development) reduced nematode motility and killed the larvae. Four months old *Paulownia taiwaniana* saplings treated with extracts had significantly greater height and fewer root-knots suggesting that inter planting *P. taiwaniana* with *Melia azadirach* might help to control the nematode.

Rossner and Zebitz (1987) studied the influence of ground neem leaves and seed kernels (1% v/v) on the growth of tomatoes (var. Hellfrucht) and on the populations of *Pratylenchus penetrans* and *Meloidogyne arenaria* in pots in the greenhouse. The initial growth of tomatoes in soil treated with neem was retarded but subsequently and strikingly favoured compared with the untreated control. The size of plants, number of leaves and weight of shoots, roots and fruits increased. The number of root galls caused by *M. arenaria* was highest on plants growing in untreated soil (index 4.2) and lower in soil treated with ground neem leaves (index 3.1) and lowest in soil treated with ground neem seed kernels (index 2.5). There was a significant reduction in the number of *P. penetrans* extracted from the roots (control 2318 nematodes per g of roots; ground leaves, 453; and ground seed kernels, 536). In a field experiment, in which an additional treatment with extracted seed kernels was included, the

result of the greenhouse experiment was confirmed in principle. The growth of tomato plant was obviously improved by neem products, but there was no significant difference in the numbers of some nematodes species in the soil. However, among treated and untreated soils the majority was extracted from the roots of plants in untreated soil. The experiment confirmed in principle that tomato growth can be improved by neem products. In addition, the reduction of certain nematode species may contribute to the good plant growth in neem treated soil.

Scramin *et al.* (1987) reported about extracts of 14 plants species in laboratory for their nematicidal and namatode inhibiting properties. The extracts were obtained by fractioning with different organic solvents and were then bioassayed with *M. incognita*. The results revealed potential activity in some extracts of the following plants *Tagetes minuta, T. patula, Alomia fastigita* and *Ageratum conyzoides*.

Siddiqui and Alam (1987) reported that seeds of tomatoes, aubergines and okra (*Hibiscus esculentus*) were coated with water soluble extracts of *Azadirachta indica* and *Melia azedirach* and the resultant seedlings were inoculated with different doses of *M. incognita* and *R. reniformis*. Both seed treatments significantly reduced galling and *R. reniformis* population build up. The effect was more pronounced in plants grown from seed coated with fruit extract of leaves, flowers, bark or with gum.

Stephen *et al.* (1989) observed that Fenamiphos 40% EC at 10 ml/m^2 , Miral 10% G at 25 g/ m^2 and Carbofuran 3% G at 15 g/m^2 were significantly effective against *Meloidogyne javanica* on eggplant.

Zaki and Bhatti (1989) observed the nematicidal effects of leaves of three species (*Calotropis procera, Ricinus communis and Azadirachta indica*) and of

their paired combinations on the growth of tomato (height and weight). In all treated plants there was reduction in the nematode population.

Alam (1990) reported that neem (*Azadirachta indica*) had good properties in controlling plant parasitic nematodes.

Darekar *et al.* (1990) tested the effect of neem (*Azadirachta indica*), karanj (*Pongamia glabra*), mahua (*Madhuca indica*) and castor (*Ricinus communis*) oil seed cakes in a field experiment in furrows and for control of *M. incognita* on tomato. All treatments at 400 kg/ha reduced *M. incognita* populations and gall index with neem and karanj cake being the most effective.

Ahmad and Karim (1991) reported that standard (S) and half standard (S/2) solutions of Dholkalmi (*Ipomoea fistulosa*) suppressed the activity of *M. javanica* with significant lower galling incidence and corresponding higher significant shoot and root length, fresh weight of shoot and root of brinjal.

Ahmad *et al.* (1991) noted that leaf extracts of *Azadirachta indica, Melia azedirach, Datura alba* and *Ricinus communis* were highly toxic to *M. incognita. A. indica* gave maximum (100%) inhibition of egg hatching and larval mortality followed by *M. azedirach*, *Datura alba* and *R. communis*. Inhibition of egg hatch and larval mortality were significantly affected by the concentration of the leaf extracts and the exposure time.

Goswami and Meshram (1991) evaluated the comparative efficacy of mustard and karanj oil seed cakes with Carbofuran at 2 kg a. /ha for control of *M. incognita* in pot experiments. Both the cakes reduced root penetration of *M. incognita* by almost 50% compared with untreated control and were as effective as the carbofuran treatment. Plant growth was also increased in all treatments.

Ganai *et al.* (1992) investigated in-vitro the effect of leaf extracts of Neem *Azadirachta indica, Mentha piperita and Parthenium hysterophorus on Ditylenchus myceliophagus*. All extracts caused significant nematode mortality with the maximum occurring with *A. indica.*

Murthy and Rao (1992) observed that aldicarb, carbofuran and phorate all at 3.75, 6.25 and 8.75 kg a. i. /ha and the oil cakes of neem (*Azadirachta indica*), castor, til and coconut at 100 or 200 kg N/ha were effective in suppressing the effect of *M. incognita* and improving the yield of betel vine (Peper bettle) in pot experiments. Neem was the most effective treatment.

Mukhtar *et al.* (1994) observed that leaf extracts of *Azadirachta indica, Melia azadirach, Datura alba (Datura metal)* and *Ricinus communis* were applied to tomato plants inoculated with *M. incognita* in a pot trial. All extracts except *R. communis* enhanced plant growth and reduced disease severity with *A. indica* extract being the most effective.

Hassan (1995) carried out research with Furadan 5G and Miral 3G against root-knot of brinjal in granular and liquid forms of application, either alone or in combination. The two chemicals in higher concentration and combination in both types of application gave superior responses on plant growth characters with corresponding lower number of galls, adult females and eggmasses. Larval population was more suppressed by Furadan 5G.

Devappa *et al.* (1997) observed the effect of carbofuran at 2 kg a. i. /ha, neem cake (*A. indica*) at 2.5 t/ha and Pasteuria penitrans at 924 g of inoculum/m^2 either singly or in combination, for the management of *M. incognita* infecting sunflower, under field conditions. A combination of carbofuran, neem cake and *P. penetrans* significantly increased the plant growth characteristics like shoot height, shoot weight, root length, root weight and grain yield, and reduced the nematode population in soil and root galling.

Byomakesh *et al.* (1998) conducted an experiment to evaluate the comparative efficacy of 3 neem products (neem bitter 0.5%, repolin 1%, and neem seed extracts 2.5%) against *M. incognita* infecting tomato. Application by seed treatments, bare root dipping of seedling and foliar spraying proved that all the neem products were effective in reducing the root-knot disease incidence and increasing growth of plants.

Mohammad and Akhtar (2000) reported that the symptoms of root-gall caused by *M. incognita* were significantly reduced by the bare-root-dip treatment of tomato seedling in a neem based commercial product and in an aqueous extract of neem seeds. Treatments with all concentrations at various periods of dipping time reduced root-knot development. It is also investigated that improvement in plant weight and height were correlated to reduction in nematode infestation.

Siddiqui and Alam (2001) conducted an experiment to evaluate the nematicidal effects of fresh floral parts and decomposed flowers decomposed fruits (seeds) leaves and bark of neem (*Azadirachta indica*). Three week old seedlings of tomato were inoculated with 5000 freshly hatched L_2 juveniles of *M. incognita*. Root knot development on tomato was significantly inhibited by all treatments and the growth of tomato also significantly improved by all treatments. It is also observed that decomposed materials were more effective than fresh floral parts in controlling nematodes and increasing plant growth.

Hassan *et al.* (2003) showed the effect of marigold *(Tagetes patina),* turmeric and dhalkalmi on the incidence of root-knot disease caused by *Meloidogyne javanica* of aubergine and lady's finger. The dilution of plant extracts at S/2, S/10 and S/100 were prepared in 6 cm Petri dishes separately to see the effect on the mortality of juveniles of the nematode. Dead and surviving nematodes were counted after 12, 24,

48 and 96 hours. Marigold extract was more lethal to the juveniles in the mortality test compared to turmeric and dhalkalmi extracts.

Hassan *et al.* (2005 a) found to evaluate the efficacy of four indigenous plant extracts against the root-knot of okra. Marigold extract was found to be more lethal to the juvenile in the mortality test of *Meloidogyne javanica* compared to the dholkalmi, turmeric and thunkuni extract. Better plant growth with corresponding lower number of galls were recorded with extract of marigold used.

CHAPTER 3

MATERIALS AND METHODS

3.1. Experimental site:

The experiments were conducted both in the laboratory and research field of the Department of Plant Pathology, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur. The field falls under agro-ecological zone (AEZ-1), Old Himalayan piedmont plain. The land type was medium high with loamy soil texture and low in organic matter.

3.2. Duration of the experiment:

The experiments were conducted during December, 2007 to May, 2008.

3.3. Collection of seeds:

Seed samples of brinjal (*Solanum melongena* L), cv. Singhnath were collected from local market.

3.4. Surface sterilization of brinjal seeds:

Two hundred healthy, mature and disease free brinjal seeds of Singhnath variety were taken. Before sowing these seeds in the soil of seedbed, surface sterilization was done with low concentration of Mercuric chloride solution (0.001%) for 1-2 minutes. Subsequent washings of those seeds with sterilized distilled water were done thrice.

3.5. Preparation of seed bed:

Seed bed was prepared by mixing proper amount of sand and cow dung with seedbed soil. The length and breath of seedbed was maintained 3m and 1m respectively.

3.6. Sowing of seed:

Seeds were sown in the seedbed at 1 to 2 cm depth of soil. After seed sowing optimum soil moisture was maintained.

3.7. Land preparation:

The soils of experimental plot were opened with tractor in December 08, 2007. Weeds and other rubbishes were removed. The final plowing and laddering was done using country plough. The plot was then prepared according to experimental design in December 12, 2007.

3.8. Application of manures and fertilizers:

The requisite quantities of manures and fertilizers were applied and well incorporated in the soil as per Fertilizer Recommendation Guide of BARC (Anon. 2004).

3.9. Preparation of curaterr solution:

Forty milligram (40 mg) curaterr was taken in a conical flask containing 100ml distilled water. Then the flask was shaken gently in order to dissolve granular chemical. The flask was retained for 24 hours without disturbance. Thus, curaterr solution was prepared.

3.10. Preparation of neem leaf extract:

Neem leaf was collected from the HSTU campus. Twenty gram of neem leaves were macerated in an electric blender and soaked separately in 100 ml distilled water in several conical flasks. Then these were filtered. These filtrates were termed as standard (S) concentration of neem leaf extract.

3.11. Preparation of marigold leaf extract:

Marigold leaf was collected from the HSTU campus. Twenty gram of marigold leaves were macerated in an electric blender and soaked separately in 100 ml

distilled water in several conical flasks. Then these were filtered. These filtrates were treated as standard (S) concentration of marigold leaf extract.

3.12. Preparation of dholkalmi leaf extract:

Dholkalmi leaf was collected from the HSTU campus. Twenty gram of dholkalmi leaves were macerated in an electric blender and soaked separately in 100 ml distilled water in several conical flasks. Then these were filtered. These filtrates were termed as standard (S) concentration of dholkalmi leaf extract.

3.13. Root dipping of the seedlings with curaterr solution:

A beaker was taken for curaterr solution. The beaker was surface sterilized with methylated spirit before placing brinjal seedlings for treating with aforesaid solution. The seedlings were thoroughly dipped in the curaterr solution (720ml) within the beaker for 30 minutes. The treated seedlings were placed in a cool and shady place and the seedlings were transplanted in the field on the same day in the afternoon of the 2nd January, 2008.

3.14. Root dipping of the seedlings with standard (S) neem leaf extract:

A beaker was taken for standard (S) neem leaf extract. The beaker was surface sterilized with methylated spirit before placing brinjal seedlings for treating with aforesaid solution. The seedlings were thoroughly dipped in the neem leaf extract (720ml) within the beaker for 30 minutes. The treated seedlings were placed in a cool and shady place and the seedlings were transplanted in the field on the same day in the afternoon of the 2nd January, 2008.

3.15. Root dipping of the seedlings with standard (S) marigold leaf extract:

A beaker was taken for standard (S) marigold leaf extract. The beaker was surface sterilized with methylated spirit before placing brinjal seedlings for treating with aforesaid solution. The seedlings were thoroughly dipped in the marigold leaf extract (720ml) within the beaker for 30 minutes. The treated

seedlings were placed in a cool and shady place and the seedlings were transplanted in the field on the same day in the afternoon of the 2nd January, 2008.

3.16. Root dipping of the seedlings with standard (S)dholkalmi leaf extract:

A beaker was taken for standard (S) dholkalmi leaf extract. The beaker was surface sterilized with methylated spirit before placing brinjal seedlings for treating with aforesaid solution. The seedlings were thoroughly dipped in the dholkalmi leaf extract (720ml) within the beaker for 30 minutes. The treated seedlings were placed in a cool and shady place and the seedlings were transplanted in the field on the same day in the afternoon of the 2nd January, 2008.

3.17. Transplanting and aftercare of the seedlings:

At first, healthy and uniform sized seedlings of 30 days old were uprooted from the seed bed and then placed singly in every pit of the plot at the date of 2nd January, 2008. Special care was taken in uprooting the seedlings, so that the seedlings can receive minimum injury. Before uprooting the seedlings, the seed bed was moistened sufficiently for easy lifting of the seedling. Every brinjal seedling was watered uniformly for the establishment of the roots to the soil along with its vigorous growth and development. The seedlings were watered twice, every morning and afternoon for the first seven days after plantation. When the plants were established, recovering from the transplanting shock, the soil around the base of the plant was loosened with the help of khurpi (nirani). Adequate moisture content (18-20 % of the soil) in the plot was maintained by sprinkling water to the soil at every alternate day.

3.18. Intercultural operation:

Intercultural operations such as irrigation, weeding etc. were uniformly done in all plots. Irrigation was given at the time of vegetative growth period at 15DAS, 30DAS and 45DAS.

3.19. Experimental Design and Layout:

Five sets of experiments were carried out in the field. Two sets of experiments were completed with curaterr solution, standard leaf extracts of neem, marigold and dholkalmi applied after 7 days of transplantation and another two sets of experiments were done with the same treatments applied just after 21 days of transplantation for soil drenching and foliar application. The rest set of experiment was conducted with same treatments for root dipping method. The plots were arranged in Randomized Block Design on the field of Hajee Mohammad Danesh Science & Technology University, Dinajpur. Altogether 5 treatments with curaterr solution, standard leaf extracts of neem, marigold and dholkalmi including control were maintained in the experiment. Each treatment was replicated 3 times.

3.20. Inoculam preparation and Inoculation of the plants:

For inoculation, ten (10) reddish brown mature, eggmasses were placed in each plant in two (2) holes (2.5 cm deep), five eggmasses on each side of the plant. Inoculation was done to the whole plot plants after 14 days of transplantation.

3.21. Application of curaterr solution and standard extracts of neem, marigold and dholkalmi leaf:

30 ml of plant extracts of neem, marigold and dholkalmi leaf and 0.4 % of Curaterr solution were applied for each plant after 7 and 21 days of transplantation in soil drenching and foliar spray excluding the control where simple water was used.

3.22. Recording of temperature, humidity and soil moisture:

Data on average air temperature was recorded daily. The moisture of the soil was determined by oven drying of the soil and making difference in the weight of the soil. Average air temperature 25.8^{0}C and relative humidity (RH) 76.45% were recorded in the experimental area during the experimental period.

3.23. Different parameters studied in relation to plant growth:

After 60 and 90 days of inoculation plants were uprooted carefully to study the following characters:

- Shoot length (cm)
- Root length (cm)
- Shoot weight (g)
- Root weight (g)
- Gall number / g fresh root
- Fruit number / plant
- Fruit weight (g) / plant

3.24. Measurement of shoot and root length, fresh weight of shoot and root:

At first the soil of the field was watered to make it moist for easy uprooting of the plant. Then the whole plant along with the soil attached to its root was lifted from the field and dipped in a bucket of water. Then the roots were separated from the soil with gradual movement of roots in water. It was further cleaned under gently running tap water and carefully washed out. The length of shoot was measured from the base of the stem to the growing point of the youngest leaf after separating the root portion from the base of the stem. Similarly, length of the root was measured from the starting point of root to the longest available lateral root apex. The shoot and root portions were blotted dry with five tissue papers and fresh weight was recorded by electrical balance before the materials could get desiccated.

3.25. Counting of galls:

After washing, the roots were preserved in 5% formation solution. The roots were cut into small pieces of 1 cm size and randomly 1 g of root was taken from the bulk to count the number of galls formed.

3.26. Statistical analysis:

Data on the length of shoot and root, fresh weight of shoot and root and number of galls/g of root, number of fruit per plant, weight of fruit per plant were analyzed statistically to find out the level of significance. The means for all the treatments were counted and the analysis of the variance was studied by F-test for treatment means and replication means. The mean difference was evaluated at P = 0.05 level by Duncan's New Multiple Range Test (DMRT).

CHAPTER 4

RESULTS

4.1. Field experiment:

Effect of different treatments [curaterr solution and standard leaf extracts of neem, marigold and dholkalmi] on plant growth, galling incidence and yield of Brinjal after 60 and 90 days of inoculation with root-knot nematode (*Meloidogyne javanica*)

Four treatments with extracts including control were used in this experiment to see their effect on different parameters of plant growth, galling incidence and yield of brinjal inoculated with root-knot nematode (*Meloidogyne javanica*). After 60 and 90 days of inoculation, treatments effect was found to be significant (P=0.05) on the different growth parameters, galling incidence and yield of brinjal due to root-knot disease caused by *M. javanica* (Tables 1, 2, 3, 4, 5, 6, 7, 8, 9 and10).

4.2. Effect of root dipping with curaterr solution and standard leaf extracts for 30 minutes on growth and galling incidence of brinjal plant after 60 days of inoculation with *Meloidogyne javanica*

4.2.1. Effect on shoot length

Treatment T_1 was found to give the highest 52.53 cm shoot length. Significantly higher and identical shoot length was observed in T_3, T_2 and T_4 having 45.00 cm, 44.63 cm and 43.93 cm, respectively. The control treatment T_0 was recorded with lower response having 38.60 cm shoot length (Table 1).

4.2.2. Effect on root length

The highest root length 31.53 cm was found in T_1. The treatments T_2, T_4 and T_3 gave higher and identical response with 22.63 cm, 22.03 cm and 21.47 cm root length, respectively. Significantly the lowest root length was observed in control treatment T_0 with 12.87 cm (Table 1).

4.2.3. Effect on shoot weight

Treatment T_1 was observed with the highest 87.00 g shoot weight. Higher as well as identical shoot weight was found with the treatments T_2, T_3 and T_4 having 79.43 g, 77.20 g and 77.20 g shoot weight, respectively. Treatment T_0 was found to give the lowest 62.53 g shoot weight (Table 1).

4.2.4. Effect on root weight

The highest as well as statistically similar effect was found among the treatments T_1, T_4, T_2 and T_3 having 42.87 g, 39.83 g, 39.63 g and 37.77 g root weight, respectively. The control treatment T_0 was found to give lower 33.20 g fresh weight of root (Table 1).

4.2.5. Effect on the galling

In respect of galling, T_0 (control) was appeared to give the highest 16.33 galls per g of fresh root followed by statistically similar response in T_4 and T_3 treatments having 14.33 galls and 14.00 galls per g of fresh root, respectively. Lower effect on the galling was noted with T_2 having 10.67 galls. The treatment T_1 was observed with the lowest 6.33 galls per g of fresh root (Table 1).

4.2.6. Effect on fruit setting

The highest 7.33 fruits number was noted with the treatment T_1. The treatments T_4, T_3, and T_2 were found to give lower but statistically similar response with 3.33, 3.33 and 2.33 number of fruits, respectively. The lowest response was found in the treatment T_0 with 1.22 number of fruits (Table 1).

4.2.7. Effect on fruit weight

The treatment T_1 was observed with the highest 66.63 g fruit weight. Higher as well as similar response was obtained with the treatments T_4 and T_2 having 25.37 g and 23.57 g fruit weight, respectively. Treatment T_3 was appeared to give lower response with 10.63 g fruit weight. The lowest fruit weight was found in the treatment T_0 with 6.06 g (Table 1).

Table 1. Effect of root dipping with curaterr solution and standard leaf extracts for 30 minutes on growth and galling incidence of brinjal plant after 60 days of inoculation with *Meloidogyne javanica*

Treatments	Shoot length (cm)	Root length (cm)	Shoot weight (g)	Root weight (g)	Gall number /g of root	Fruit no./ plant	Fruit weight (g)/ plant
T_0	38.60 d	12.87 c	62.53 c	33.20 c	16.33 a	1.22 c	6.06 d
T_1	52.53 a	31.53 a	87.00 a	42.87 a	6.33 c	7.33 a	66.63 a
T_2	44.63 b	22.63 b	79.43 b	39.63 ab	10.67 b	2.33 b	23.57 b
T_3	45.00 b	21.47 b	77.20 b	37.77 b	14.00 a	3.33 b	10.63 c
T_4	43.93 bc	22.03 b	77.20 b	39.83 ab	14.33 a	3.33 b	25.37 b
LSD	2.90	3.39	4.242	3.69	2.77	1.11	8.47

Each value is an average of 3 (three) replications. In a column, values having same letter do not differ significantly at P = 0.05 level.

T_0 = Control (without extract)

T_1 = Curaterr solution

T_2 = Neem leaf extract (S)

T_3 = Marigold leaf extract (S)

T_4 = Dholkalmi leaf extract (S)

4.3. Effect of root dipping with curaterr solution and standard leaf extracts for 30 minutes on growth and galling incidence of brinjal plant after 90 days of inoculation with *Meloidogyne javanica*

4.3.1. Effect on shoot length

Treatment T_1 was appeared to give the highest 82.87 cm shoot length. Higher 76.50cm shoot length was noted with T_2 followed by T_3 with 72.57 cm shoot length. Treatment T_4 appeared to give lower 69.03 cm shoot length. The lowest 63.40 cm shoot length was recorded with the control treatment T_0 (Table 2).

4.3.2. Effect on root length

The highest 56.80 cm root length was found in treatment T_1. Higher 49.47cm root length was noted with T_2 followed by T_3 with 44.40 cm. Treatment T_4 was appeared to give lower 39.70 cm root length. The lowest 35.20 cm root length was recorded with the control treatment T_0 (Table 2).

4.3.3. Effect on shoot weight

Treatment T_1 exhibited the highest 145.30 g shoot weight. Higher 133.10 g shoot weight was noted with T_2 followed by T_3 with 127.80 g. Treatment T_4 was found to give lower 119.90 g shoot weight. The lowest 106.60 g shoot weight was recorded with the control treatment T_0 (Table 2).

4.3.4. Effect on root weight

The highest 78.20 g root weight was obtained with T_1. Treatment T_2 gave higher root weight with 71.87 g followed by T_3 with 67.07 g. Lower 61.30 g root weight was found with T_4. The control treatment T_0 gave the lowest 54.87 g root weight (Table 2).

4.3.5. Effect on the galling

T_0 (control) was appeared to give the highest 20.33 galls per g of fresh root. Higher 16.00 galls were found in treatment T_3 followed by T_4 having 13.67 galls. T_2 was found to give lower 11.33 galls per g of fresh root. The lowest effect on the galling was in the treatment $T_1$with 7.33 galls per g of fresh root (Table 2).

4.3.6. Effect on fruit setting

The highest as well as statistically similar response was found with the treatments T_2 and T_3 with 2.67 and 2.33 fruits number, respectively. Treatment T_1 was appeared to give lower response with 1.67 fruits number followed by T_4 with 1.67 fruits number. The lowest 1.00 fruit number was noted with the treatment T_0 (Table 2).

4.3.7. Effect on fruit weight

T_1 was found to give the highest 118.80 g fruit weight. Higher 87.73 g fruit weight was observed with the treatment T_2. Treatment T_3 resulted the lower response with 77.50 g fruit weight followed by T_4 with 67.07 g. The lowest 26.80 g fruit weight was found in control treatment T_0 (Table 2).

Table 2. Effect of root dipping with curaterr solution and standard leaf extracts for 30 minutes on growth and galling incidence of brinjal plant after 90 days of inoculation with *Meloidogyne javanica*

Treatments	Shoot length (cm)	Root length (cm)	Shoot weight (g)	Root weight (g)	Gall number /g of root	Fruit no./ plant	Fruit weight (g)/ plant
T_0	63.40 e	35.20 e	106.60 e	54.87 e	20.33 a	1.00 c	26.80 e
T_1	82.87 a	56.80 a	145.30 a	78.20 a	7.333 e	1.67 b	118.80 a
T_2	76.50 b	49.47 b	133.10 b	71.87 b	11.33 d	2.67 a	87.73 b
T_3	72.57 c	44.40 c	127.80 c	67.07 c	16.00 b	2.33 a	77.50 c
T_4	69.03 d	39.70 d	119.90 d	61.30 d	13.67 c	1.67 b	67.07 d
LSD	1.46	1.19	2.92	2.19	0.47	0.43	1.89

Each value is an average of 3 (three) replications. In a column, values having same letter do not differ significantly at P = 0.05 level.

T_0 = Control (without extract)

T_1 = Curaterr solution

T_2 = Neem leaf extract (S)

T_3 = Marigold leaf extract (S)

T_4 = Dholkalmi leaf extract (S)

4.4. Effect of soil drenching with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 7 days of transplantation and at 60 days after inoculation with *Meloidogyne javanica*

4.4.1. Effect on shoot length

Treatment T_1 exhibited the highest 72.20 cm shoot length. Higher but similar response in shoot length was noted in the treatments T_4, T_3, and T_2 with 61.23 cm, 60.50 cm and 60.20 cm shoot length, respectively. But the control treatment T_0 was recorded with the lowest 48.87 cm shoot length (Table 3).

4.4.2. Effect on root length

The highest 44.53 cm root length was recorded with T_1. Treatments T_2, T_4 and T_3 exhibited higher but statistically similar response having 38.57 cm, 37.53 cm and 37.40 cm root length, respectively. The lowest 21.87 cm root length was found in the treatment T_0 (Table 3).

4.4.3. Effect on shoot weight

The treatment T_1 was observed with the highest 127.90 g shoot weight. Higher and similar response of shoot weight was found with the treatments T_2 and T_4 with 114.90 g and 114.60 g shoot weight, respectively. The treatment T_3 gave the lower 107.90 g shoot weight. But the lowest 87.47 g shoot weight was found with the control treatment T_0 (Table 3).

4.4.4. Effect on root weight

The highest 68.20 g root weight was recorded with the treatment T_1. The treatment T_2 resulted higher root weight with 53.53 g. Lower and statistically similar type of root weight was in T_3 and T_4 with 46.87 g and 46.50 g, respectively. Treatment T_0 exhibited the lowest 38.33 g root weight (Table 3).

4.4.5. Effect on the galling

In respect of galling, treatment T_0 was appeared to give the highest 15.67 number of galls per g of fresh root. Lower and statistically similar response was found among the treatments T_3, T_4 and T_2 with 12.67, 12.33 and 11.67 number of galls per g of fresh root, respectively. T_1 was noted with the lowest effect on the galling having 5.33 galls (Table 3).

4.4.6. Effect on fruit setting

The highest fruit number was found in the treatment T_1 with 6.33 number of fruits. Treatment T_4 resulted higher response with 4.33 number of fruits. Lower number of fruits was found in the treatment T_2 with 3.33 followed by T_3 with 2.67 number of fruits. The control treatment T_0 was appeared to give the lowest 1.80 number of fruits (Table 3).

4.4.7. Effect on fruit weight

Treatment T_1 exhibited the highest 73.53 g fruit weight. Higher fruit weight was found in the treatment T_2 having 57.73 g. Treatment T_4 was found to give lower response having 33.30 g fruit weight followed by T_3 with 25.73 g, respectively. The lowest 13.03 g fruit weight was found in the control treatment T_0 (Table 3).

Table 3. Effect of soil drenching with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 7 days of transplantation and at 60 days after inoculation with *Meloidogyne javanica*

Treatments	Shoot length (cm)	Root length (cm)	Shoot weight (g)	Root weight (g)	Gall number /g of root	Fruit no./ plant	Fruit weight (g)/plant
T_0	48.87 c	21.87 c	87.47 d	38.33 d	15.67 a	1.80 e	13.03 e
T_1	72.20 a	44.53 a	127.90 a	68.20 a	5.33 c	6.33 a	73.53 a
T_2	60.50 b	37.40 b	114.90 b	53.53 b	11.67 b	3.33 c	57.73 b
T_3	60.20 b	37.53 b	107.90 c	46.87 c	12.67 b	2.67 d	25.73 d
T_4	61.23 b	38.57 b	114.60 b	46.50 c	12.33 b	4.33 b	33.30 c
LSD	3.30	3.11	4.51	2.86	1.19	0.48	5.29

Each value is an average of 3 (three) replications. In a column, values having same letter do not differ significantly at P = 0.05 level.

T_0 = Control (without extract)

T_1 = Curaterr solution

T_2 = Neem leaf extract (S)

T_3 = Marigold leaf extract (S)

T_4 = Dholkalmi leaf extract (S)

4.5. Effect of soil drenching with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 7 days of transplantation and at 90 days after inoculation with *Meloidogyne javanica*

4.5.1. Effect on shoot length

Treatment T_1 was appeared to give the highest 83.67 cm shoot length. Higher 77.60 cm shoot length was noted with T_2 followed by T_3 with 73.53 cm. Treatment T_4 resulted lower shoot length with 69.63 cm. The lowest 64.30 cm shoot length was recorded with the control treatment T_0 (Table 4).

4.5.2. Effect on root length

The highest root length was observed in the treatment T_1 with 60.67 cm. Treatment T_2 resulted higher 50.90 cm root length followed by T_3 with 46.30cm. Lower 43.20 cm root length was found with treatment T_4.The control treatment T_0 resulted the lowest 35.97 cm root length (Table 4).

4.5.3. Effect on shoot weight

Treatment T_1 exhibited the highest 147.30 g shoot weight. Higher 134.00 g shoot weight was noted with T_2 followed by T_3 with 127.80 g shoot weight. Treatment T_4 was appeared to give lower shoot weight with 119.90 g. The lowest 106.70 g shoot weight was recorded with the control treatment T_0 (Table 4).

4.5.4. Effect on root weight

The highest 80.33 g root weight was obtained with T_1. Treatment T_2 exhibited higher root weight with 71.87 g followed by T_3 with 67.07 g root weight. Lower 61.30 g root weight was found with T_4. The control treatment T_0 resulted the lowest 55.93 g root weight (Table 4).

4.5.5. Effect on the galling

T_0 (control) was appeared to give the highest 21.33 number of galls per g of fresh root. Higher 15.33 number of galls were found with the treatment T_3 followed by T_4 with 12.33 galls. Treatment T_2 resulted lower effect with 11.67 galls. The lowest effect on the galling was found in the treatment T_1 with 7.33 galls per g of fresh root (Table 4).

4.5.6. Effect on fruit setting

The highest 5.33 fruits number was noted with the treatment T_1. Treatment T_2 was appeared to give higher response with 3.33 number of fruits. Lower and statistically identical response was found in T_4 and T_3 treatment with 2.33 and 2.00 number of fruits, respectively. Treatment T_0 was appeared to give the lowest 1.90 numbers of fruit (Table 4).

4.5.7. Effect on fruit weight

Treatment T_1 exhibited the highest 220.00 g fruit weight. Higher response was observed in the treatment T_2 with 177.90 g fruit weight. Treatment T_4 and T_3 resulted lower but similar response with 143.20 g and 126.90 g fruit weight, respectively. The control treatment T_0 gave the lowest 122.90 g fruit weight (Table 4).

4.6. Effect of soil drenching with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 21 days of transplantation and at 60 days after inoculation with *Meloidogyne javanica*

4.6.1. Effect on shoot length

Treatment T_1 was found to give the highest 72.20 cm shoot length. Higher 60.50 cm shoot length was noted with the treatment T_2. Treatments T_4 and T_3 resulted lower and statistically similar effect on shoot length having 56.23 cm and 56.20 cm, respectively. The lowest 49.53 cm shoot length was noted with the treatment T_0 (Table 5).

4.6.2. Effect on root length

The highest 45.53 cm root length was recorded with T_1. Treatments T_2, T_4 and T_3 gave higher and statistically similar response with 37.53 cm, 37.43 cm and 37.37cm root length, respectively. While the lowest 23.30 cm root length was noted with T_0 (Table 5).

4.6.3. Effect on shoot weight

Treatment T_1 resulted the highest 127.90 g shoot weight. Higher 114.90 g shoot weight was found with the treatment T_2. Treatments T_3 and T_4 exhibited lower and statistically similar effect with 108.50 g and 105.90 g shoot weight, respectively. The lowest 93.80 g shoot weight was found in the treatment T_0 (Table 5).

4.6.4. Effect on root weight

The highest 68.53 g root weight was obtained with the treatment T_1. Treatment T_2 was found to give higher root weight with 54.20 g. Lower and statistically identical response was observed with the treatments T_3 and T_4 having 47.30 g and 46.63 g root weight, respectively. Treatment T_0 resulted the lowest 39.33 g root weight (Table 5).

4.6.5. Effect on the galling

In respect of galling, treatment T_0 was found to give the highest 15.67 number of galls. Higher but and statistically similar response was found with the treatments T_3, T_2 and T_4 with 12.67 galls, 11.67 galls and 11.67 galls per g of fresh root, respectively. The lowest response was found with the treatment T_1 with 6.33 galls per g of fresh root (Table 5).

4.6.6. Effect on fruit setting

The highest 6.00 number of fruits was found with treatment T_1. Treatment T_4, T_3 and T_2 gave higher as well as similar response with 4.67, 3.33 and 3.00 number of fruits, respectively. The lowest effect was found in the control treatment T_0 with 1.50 number of fruits (Table 5).

4.6.7. Effect on fruit weight

Treatment T_2 resulted highest 81.43 g fruit weight. Higher and statistically similar fruit weight was recorded in T_4 and T_1 with 53.27 g and 53.00 g, respectively. Treatment T_3 gave lower fruit weight with 46.57 g. The lowest 17.53 g fruit weight was found with the treatment T_0 (Table 5).

Table 5. Effect of soil drenching with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 21 days of transplantation and at 60 days after inoculation with *Meloidogyne javanica*

Treatments	Shoot length (cm)	Root length (cm)	Shoot weight (g)	Root weight (g)	Gall number /g of root	Fruit no./ plant	Fruit weight (g)/ plant
T_0	49.53 d	23.30 c	93.80 d	39.33 d	15.67 a	1.50 d	17.53 d
T_1	72.20 a	45.53 a	127.90 a	68.53 a	6.33 c	6.00 a	53.00 b
T_2	60.50 b	37.53 b	114.90 b	54.20 b	11.67 b	3.00 c	81.43 a
T_3	56.20 c	37.37 b	108.50 c	47.30 c	12.67 b	3.33 bc	46.57 c
T_4	56.23 c	37.43 b	105.90 c	46.63 c	11.67 b	4.67 ab	53.27 b
LSD	3.15	3.78	5.68	3.50	1.14	1.47	5.00

Each value is an average of 3 (three) replications. In a column, values having same letter do not differ significantly at P = 0.05 level.

T_0 = Control (without extract)

T_1 = Curaterr solution

T_2 = Neem leaf extract (S)

T_3 = Marigold leaf extract (S)

T_4 = Dholkalmi leaf extract (S)

4.7. Effect of soil drenching with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 21 days of transplantation and at 90 days after inoculation with *Meloidogyne javanica*

4.7.1. Effect on shoot length

T_1 was appeared to give highest 88.83 cm shoot length. Higher 83.20 cm shoot length was noted with T_2 followed by T_3 with 79.40 cm shoot length. Treatment T_4 resulted lower 77.00 cm shoot length. The lowest 71.63 cm shoot length was recorded with the control treatment T_0 (Table 6).

4.7.2. Effect on root length

The highest 61.33 cm root length was found in the treatment T_1. Treatment T_2 resulted higher 51.43 cm root length followed by T_3 with 46.97cm. Lower response was observed in T_4 having 43.57cm root length. Treatment T_0 was found to give the lowest 36.53 cm root length (Table 6).

4.7.3. Effect on shoot weight

Treatment T_1 exhibited the highest 147.30 g shoot weight. Higher 142.50 g shoot weight was noted with T_2 followed by T_3 with 127.80g shoot weight. Treatment T_4 resulted lower 119.90 g shoot weight. The lowest 106.70g shoot weight was recorded with the control treatment T_0 (Table 6).

4.7.4. Effect on root weight

The highest 80.33 g root weight was obtained with T_1. Treatment T_2 was recorded with higher 75.63 g root weight followed by T_3 with 67.07 g root weight. Lower 61.30 g root weight was found with T_4. The control treatment T_0 gave the lowest 55.93 g root weight (Table 6).

4.7.5. Effect on the galling

T_0 (control) was appeared to give the highest 24.33 number of galls per g of fresh root. Higher 15.33 number galls were found in T_3 followed by T_4 having 13.33 galls. Treatment T_2 gave lower 10.67 number of galls. The lowest 7.33 galls were found with T_1 per g of fresh root (Table 6).

4.7.6. Effect on fruit setting

The highest number of fruits was found in the treatment T_1 with 4.33. Treatment T_2 was appeared to give higher 3.33 number of fruits. Lower and statistically identical fruit numbers were found with the treatments T_3 and T_4 each with 2.0 numbers of fruits. Treatment T_0 exhibited the lowest 1.50 numbers of fruits (Table 6).

4.7.7. Effect on fruit weight

Treatment T_1 and T_2 resulted the highest and similar response with 118.00 g fruit weight in each case. Higher fruit weight was found in T_4 with 100.60 g. T_3 gave lower response with 84.40 g fruit weight. The lowest 77.00 g fruit weight was found with the treatment T_0 (Table 6).

Table 6. Effect of soil drenching with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 21 days of transplantation and at 90 days after inoculation with *Meloidogyne javanica*

Treatments	Shoot length (cm)	Root length (cm)	Shoot weight (g)	Root weight (g)	Gall number /g of root	Fruit no./ plant	Fruit weight (g)/ plant
T_0	71.63 e	36.53 e	106.70 e	55.93 e	24.33 a	1.50 d	77.00 d
T_1	88.83 a	61.33 a	147.30 a	80.33 a	7.33 e	4.33 a	118.00 a
T_2	83.20 b	51.43 b	142.50 b	75.63 b	10.67 d	3.33 b	118.00 a
T_3	79.40 c	46.97 c	127.80 c	67.07 c	15.33 b	2.00 c	84.40 c
T_4	77.00 d	43.57 d	119.90 d	61.30 d	13.33 c	2.00 c	100.60 b
LSD	1.38	1.70	2.37	2.11	0.43	0.46	2.35

Each value is an average of 3 (three) replications. In a column, values having same letter do not differ significantly at P = 0.05 level.

T_0 = Control (without extract)

T_1 = Curaterr solution

T_2 = Neem leaf extract (S)

T_3 = Marigold leaf extract (S)

T_4 = Dholkalmi leaf extract (S)

4.8. Effect of foliar spray with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 7 days of transplantation and at 60 days after inoculation with *Meloidogyne javanica*

4.8.1. Effect on shoot length

The highest 77.20 cm shoot length was found in T_1. Treatments T_3, T_2 and T_4 resulted higher and statistically similar response with 63.87 cm 62.97 cm and 60.67 cm shoot length, respectively. Lower 50.20 cm shoot length was observed with T_0 (Table 7).

4.8.2. Effect on root length

T_1 was found to give the highest response with 45.53 cm root length. Higher and identical response was found with the treatments T_2 and T_3 with 38.40 cm and 34.30 cm root length, respectively. Treatment T_4 resulted lower 26.30 cm root length. The lowest response was found with the treatment T_0 with 22.00 cm root length (Table 7).

4.8.3. Effect on shoot weight

The highest 127.30 g shoot weight was recorded with T_1. No significance difference was found among the treatments T_2, T_3 and T_4 having 115.30 g, 109.20 g and 104.90 g shoot weight, respectively. The lowest 95.47 g shoot weight was observed with the treatment T_0 (Table 7).

4.8.4. Effect on root weight

Treatment T_1 resulted the highest 77.87 g root weight. Higher response was found with the treatment T_2 with 69.57 g root weight. Treatment T_3 and T_4 exhibited lower and identical response with 64.87 g and 64.53 g shoot weight, respectively. The lowest 42.20 g root weight was found with T_0 (Table 7).

4.8.5. Effect on the galling

The highest 28.33 number of galls were found with the treatment T_0 (control). Treatment T_3 was recorded with higher 25.67 number of galls. Lower and identical effect was found with T_2 and T_4 having 22.67 galls and 22.00 galls, respectively. T_1 resulted the lowest 17.33 galls per g of fresh root (Table 7).

4.8.6. Effect on fruit setting

Treatment T_1 exhibited the highest 6.33 number of fruits. Higher and similar response was found with treatments T_4, T_2 and T_3 with 4.67, 3.67 and 3.33 number of fruits, respectively. Treatment T_0 was found to give the lowest 1.27 number of fruits (Table 7).

4.8.7. Effect on fruit weight

The highest 77.9 g weight of fruit was found with the treatment T_1. Treatment T_4 was found to give higher fruit weight with 57.87g. Lower and identical response was found with the treatments T_2 and T_3 with 54.20 g and 52.20 g fruit weight, respectively. T_0 gave the lowest 18.00 g fruit weight (Table 7).

Table 7. Effect of foliar spray with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 7 days of transplantation and at 60 days after inoculation with *Meloidogyne javanica*

Treatments	Shoot length (cm)	Root length (cm)	Shoot weight (g)	Root weight (g)	Gall number /g of root	Fruit no./ plant	Fruit weight (g)/ plant
T_0	50.20 c	22.00 d	95.47 d	42.20 d	28.33 a	1.27 d	18.00 d
T_1	77.20 a	45.53 a	127.30 a	77.87 a	17.33 d	7.33 a	77.90 a
T_2	62.97 b	38.40 b	115.30 b	69.57 b	22.67 c	3.67 bc	54.20 c
T_3	63.87 b	34.30 b	109.20 bc	64.87 c	25.67 b	3.33 bc	52.20 c
T_4	60.67 b	26.30 c	104.90 c	64.53 c	22.00 c	4.67 b	57.87 b
LSD	4.17	4.55	7.73	4.43	1.37	1.39	3.55

Each value is an average of 3 (three) replications. In a column, values having same letter do not differ significantly at P = 0.05 level.

T_0 = Control (without extract)

T_1 = Curaterr solution

T_2 = Neem leaf extract (S)

T_3 = Marigold leaf extract (S)

T_4 = Dholkalmi leaf extract (S)

4.9. Effect of foliar spray with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 7 days of transplantation and at 90 days after inoculation with *Meloidogyne javanica*

4.9.1. Effect on shoot length

Treatment T_1 was appeared to give the highest 89.83 cm shoot length. Higher 82.33 cm shoot length was noted with T_2 followed by T_3 with 79.40 cm. Treatment T_4 found with lower 76.73 cm shoot length. The lowest 73.23 cm shoot length was recorded with the control treatment T_0 (Table 8).

4.9.2. Effect on root length

The highest 60.77 cm root length was noted with the treatment T_1. Treatment T_2 resulted higher 52.07 cm root length followed by T_3 with 46.40 cm. Lower 43.57cm root length was found with the treatment T_4. Treatment T_0 observed with the lowest 36.20 cm root length (Table 8).

4.9.3. Effect on shoot weight

Treatment T_1 exhibited the highest 152.30 g shoot weight. Higher 142.50 g shoot weight was noted with T_2 followed by T_3 with 127.80 g shoot weight. Treatment T_4 was appeared to give lower 119.90 g shoot weight. The lowest 107.60 g shoot weight was recorded with the control treatment T_0 (Table 8).

4.9.4. Effect on root weight

The highest 81.33 g root weight was obtained with T_1. Treatment T_2 gave higher 67.07 g root weight followed by T_3 with 67.07 g. Lower 62.67 g root weight was found with T_4, while the control treatment T_0 resulted the lowest 55.40 g root weight (Table 8).

4.9.5. Effect on the galling

T_0 (control) was appeared to give the highest 27.33 galls per g of fresh root. Higher and statistically similar number of galls were found with the treatments T_3 and T_4 having 20.67 galls. Treatment T_2 gave lower effect with 18.33 galls. The lowest effect was found in the treatment T_1 with 16.33 galls per g of fresh root (Table 8).

4.9.6. Effect on fruit setting

The highest fruits number was found with the treatment T_1 with 3.33. Both the treatments T_2 and T_4 were found to give higher and statistically similar number of fruits with 3.00. Lower number of fruits was observed in T_3 with 2.00. The control treatment T_0 gave the lowest 1.33 number of fruits (Table 8).

4.9.7. Effect on fruit weight

Both the treatments T_1 and T_2 resulted highest as well as statistically similar response with 118.00 g fruit weight. Higher fruit weight was in T_4 with 110.00 g. T_3 gave lower response with 95.53 g fruit weight. The lowest 56.40 g fruit weight was found with the control treatment T_0 (Table 8).

Table 8. Effect of foliar spray with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 7 days of transplantation and at 90 days after inoculation with *Meloidogyne javanica*

Treatments	Shoot length (cm)	Root length (cm)	Shoot weight (g)	Root weight (g)	Gall number/ g of root	Fruit no./ plant	Fruit weight (g)/ plant
T_0	73.23 e	36.20 e	107.60 e	55.40 e	27.33 a	1.33 d	56.40 d
T_1	89.83 a	60.77 a	152.30 a	81.33 a	16.33 d	3.33 a	118.00 a
T_2	82.33 b	52.07 b	142.50 b	77.30 b	18.33 c	3.00 b	118.00 a
T_3	79.40 c	46.40 c	127.80 c	67.07 c	20.67 b	2.00 c	95.53 c
T_4	76.73 d	43.57 d	119.90 d	62.67 d	20.67 b	3.00 b	110.00 b
LSD	1.67	1.70	2.15	2.37	0.46	0.26	2.94

Each value is an average of 3 (three) replications. In a column, values having same letter do not differ significantly at P = 0.05 level.

T_0 = Control (without extract)

T_1 = Curaterr solution

T_2 = Neem leaf extract (S)

T_3 = Marigold leaf extract (S)

T_4 = Dholkalmi leaf extract (S)

4.10. Effect of foliar spray with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 21 days of transplantation and at 60 days after inoculation with *Meloidogyne javanica*

4.10.1. Effect on shoot length

The highest 56.87 cm shoot length was found in T_1. Treatments T_2, T_3 and T_4 resulted higher as well as similar response with 49.87 cm, 48.53 cm and 46.53 cm shoot length, respectively. The lowest response was found with the treatment T_0 with 42.00 cm shoot length (Table 9).

4.10.2. Effect on root length

T_1 was found to give the highest response with 35.77 cm root length. Higher as well as statistically similar response was found with the treatments T_2 and T_3 having 26.57 cm and 24.27 cm root length, respectively. Similarly, no significant difference was found between the treatments T_3 and T_4. T_0 was appeared to give lower 16.53 cm root length (Table 9).

4.10.3. Effect on shoot weight

The highest 106.20 g shoot weight was recorded with T_1. The treatments T_2, and T_4 resulted higher and statistically identical response with 85.87 g, and 85.20 g shoot weight, respectively. No significant differences were found between T_3 and T_2 as well as T_3 and T4. Lower shoot weight was noted in T_0 with 76.24 g (Table 9).

4.10.4. Effect on root weight

Treatment T_1 resulted the highest 68.20 g root weight. Higher response was found with the treatment T_2 with 53.53 g root weight. Treatment T_3 and T_4 gave lower and identical response with 46.87 g and 45.20 g root weight, respectively. Lower root weight was observed in T_0 with 35.20 g (Table 9).

4.10.5. Effect on the galling

The highest 27.67 galls were found with the treatment T_0. Treatment T_3 was recorded with higher 25.33 number of galls. Lower and statistically similar effect was found with T_2 and T_4 having 20.33 and 20.67 number of galls, respectively. T_1 resulted the lowest effect on the galling with 16.33 galls per g of fresh root (Table 9).

4.10.6. Effect on fruit setting

Treatment T_1 exhibited the highest 6.33 fruits number. Higher response was found in treatment T_4 with 3.33 fruits number. Treatments T_2 and T_3 gave lower as well as identical response with 2.33 and 1.70 fruits number, respectively. The lowest 1.00 number of fruit was found with the treatment T_0 (Table 9).

4.10.7. Effect on fruit weight

The highest 66.83 g fruit weight was obtained with T_1. Treatment T_4 was found to give higher 40.60 g fruit weight followed by T_2 with 32.53 g. Lower 26.87 g fruit weight was found with T_0. The treatment T_3 gave the lowest 15.97 g fruit weight (Table 9).

Table 9. Effect of foliar spray with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 21 days of transplantation and at 60 days after inoculation with *Meloidogyne javanica*

Treatments	Shoot length (cm)	Root length (cm)	Shoot weight (g)	Root weight (g)	Gall number /g of root	Fruit no./ plant	Fruit weight (g)/ plant
T_0	42.00 d	16.53 d	76.24 d	35.20 d	27.67 a	1.00 d	15.97 e
T_1	56.87 a	35.77 a	106.20 a	68.20 a	16.33 d	6.33 a	66.83 a
T_2	49.87 b	26.57 b	85.87 b	53.53 b	20.33 c	2.33 c	32.53 c
T_3	48.53 bc	24.27 bc	84.53 bc	46.87 c	25.33 b	1.70 c	26.87 d
T_4	46.53 bc	25.30 c	85.20 b	45.20 c	20.67 c	3.33 b	40.60 b
LSD	3.53	2.09	4.26	3.63	1.03	0.97	2.30

Each value is an average of 3 (three) replications. In a column, values having same letter do not differ significantly at P = 0.05 level.

T_0 = Control (without extract)

T_1 = Curaterr solution

T_2 = Neem leaf extract (S)

T_3 = Marigold leaf extract (S)

T_4 = Dholkalmi leaf extract (S)

4.11. Effect of foliar spray with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 21 days of transplantation and at 90 days after inoculation with *Meloidogyne javanica*

4.11.1. Effect on shoot length

Treatment T_1 was appeared to give the highest 89.83 cm shoot length. Higher 82.33 cm shoot length was noted with T_2 followed by T_3 with 79.30 cm. Treatment T_4 resulted lower 76.07 cm shoot length. The lowest 73.23 cm shoot length was recorded with the control treatment T_0 (Table 10).

4.11.2. Effect on root length

The highest 60.77 cm root length was found with the treatment T_1. Treatment T_2 gave higher 52.07cm root length followed by T_3 with 47.07cm root length. Lower root length was observed in T_4 having 44.23cm. Treatment T_0 gave the lowest 36.20 cm root length (Table 10).

4.11.3. Effect on shoot weight

Treatment T_1 exhibited the highest 152.30 g shoot weight. Higher 142.50g shoot weight was noted with the treatment T_2 followed by T_3 with 133.50g shoot weight. Treatment T_4 exhibited lower 119.90 g shoot weight. The lowest 107.60g was recorded with the control treatment T_0 (Table 10).

4.11.4. Effect on root weight

The highest 81.33 g root weight was obtained with T_1. Treatments T_2 and T_3 were appeared to give higher and statistically identical response with 77.30 g and 67.07 g root weight, respectively. Lower 62.67 g root weight was found with T_4. The control treatment T_0 gave the lowest 55.40 g root weight (Table 10).

4.11.5. Effect on the galling

T_0 (control) resulted the highest 25.67 galls per g of fresh root. Higher and statistically identical response was found with the treatments T_2 and T_3 with 17.33 number of galls. Treatment T_4 was found to give lower 16.67 galls. The lowest 15.67 galls were observed with the treatment T_1 (Table 10).

4.11.6. Effect on fruit setting

The highest 4.67 fruits number was found with the treatment T_1. Treatment T_4 resulted comparatively lower number of fruits with 2.67, but no significant differences were found between T_4 and T_2 as well as T_2 and T_3 treatments. The lowest 1.80 number of fruits was recorded with the treatment T_0 (Table 10).

4.11.7. Effect on fruit weight

Treatment T_1 and T_2 were found to give the highest and statistically identical response with 118.00 g fruit weight. Higher 109.30 g fruit weight was found in the treatment T_4. The treatment T_3 gave lower 97.20 g fruit weight while the lowest 84.40 g fruit weight was found with the treatment T_0 (Table 10).

Table 10. Effect of foliar spray with curaterr solution and standard leaf extracts on growth and galling incidence of brinjal plant after 21 days of transplantation and at 90 days after inoculation with *Meloidogyne javanica*

Treatments	Shoot length (cm)	Root length (cm)	Shoot weight (g)	Root weight (g)	Gall number /g of root	Fruit no./ plant	Fruit weight (g) /plant
T_0	73.23 e	36.20 e	107.60 e	55.40 e	25.67 a	1.80 d	84.40 d
T_1	89.83 a	60.77 a	152.30 a	81.33 a	15.67 d	4.67 a	118.00 a
T_2	82.33 b	52.07 b	142.50 b	77.30 b	17.33 b	2.33 bc	118.00 a
T_3	79.30 c	47.07 c	133.50 c	67.07 bc	17.33 b	2.00 c	97.20 c
T_4	76.07 d	44.23 d	119.90 d	62.67 d	16.67 c	2.67 b	109.30 b
LSD	1.83	1.94	2.13	2.23	0.46	0.44	2.48

Each value is an average of 3 (three) replications. In a column, values having same letter do not differ significantly at P = 0.05 level.

T_0 = Control (without extract)

T_1 = Curaterr solution

T_2 = Neem leaf extract (S)

T_3 = Marigold leaf extract (S)

T_4 = Dholkalmi leaf extract (S)

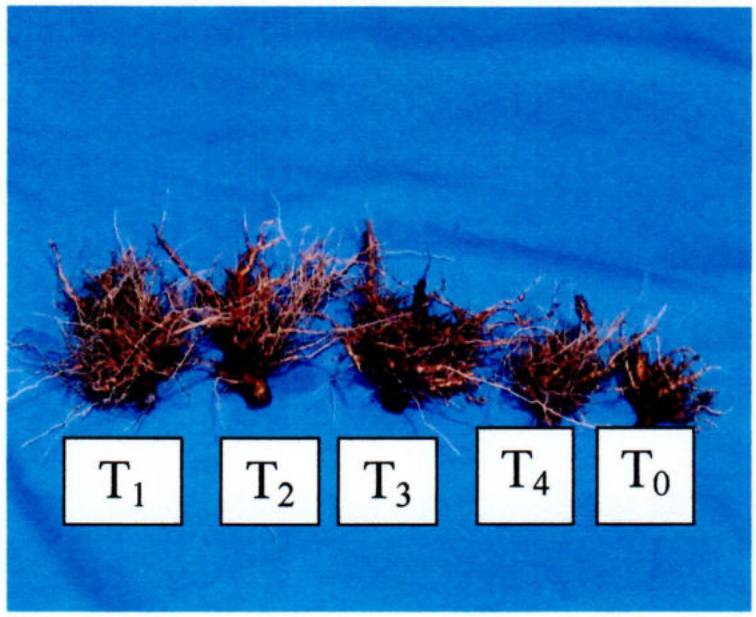

Plate 1. **Root growth and galling incidence of brinjal plant in soil drenching with treatments after 21 days of transplantation and at 60 days after inoculation with *Meloidogyne javanica***

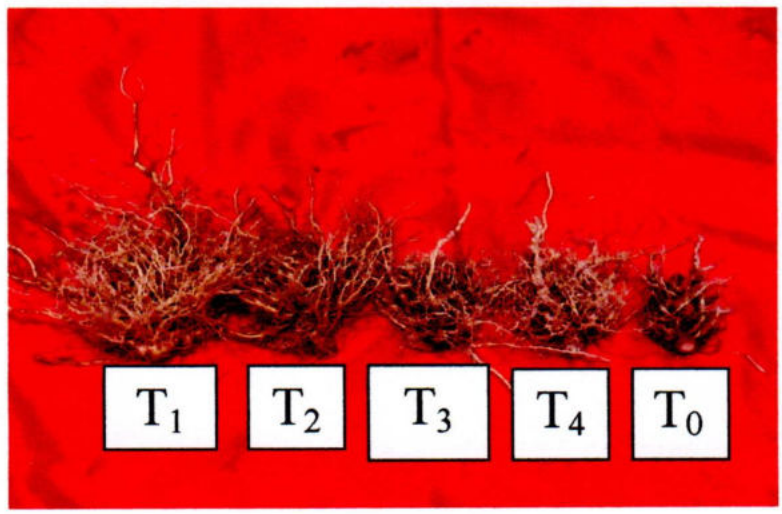

Plate 2. **Root growth and galling incidence of brinjal plant in foliar spray with treatments after 21 days of transplantation and at 90 days after inoculation with *Meloidogyne javanica***

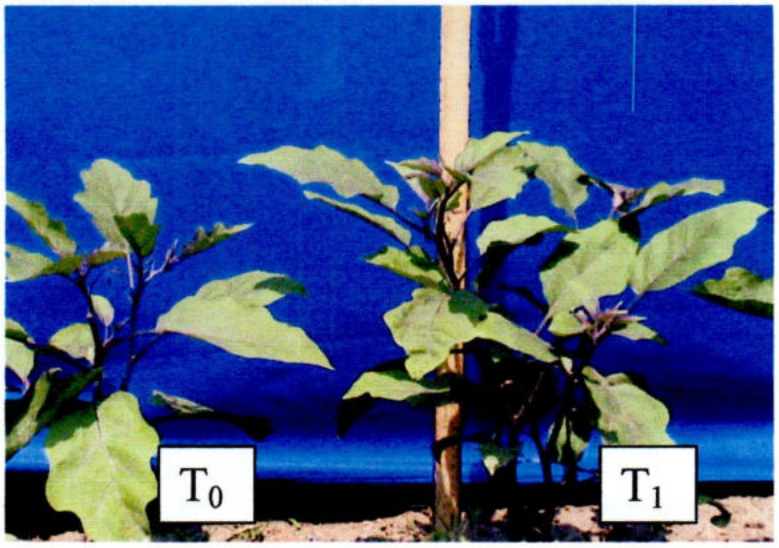

Plate 3. **Growth of brinjal plant in root dipping between control, T_0 and curaterr solution, T_1 after 60 days of inoculation with *Meloidogyne javanica***

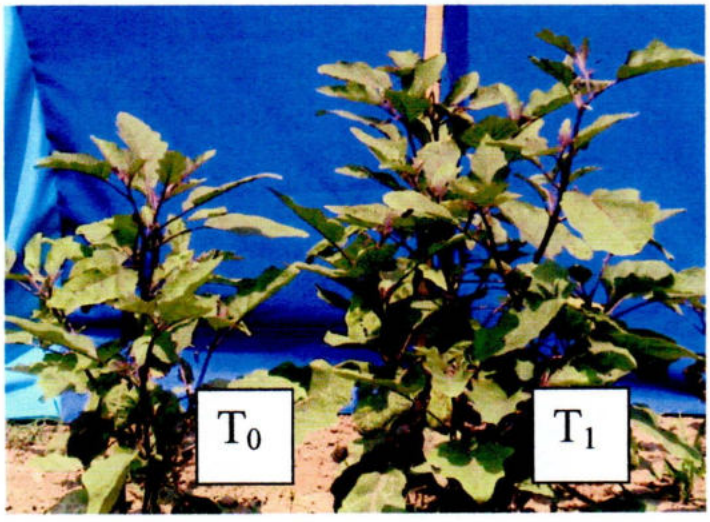

Plate 4. **Growth of brinjal plant in root dipping between control, T_0 and curaterr solution, T_1 after 90 days of inoculation with *Meloidogyne javanica***

Plate 5. **Growth of brinjal plant in soil drenching between control, T_0 and neem leaf extract, T_2 after 7 days of transplantation and at 60 days after inoculation with *Meloidogyne javanica***

Plate 6. **Growth of brinjal plant in soil drenching between control, T_0 and neem leaf extract, T_2 after 7 days of transplantation and at 90 days after inoculation with *Meloidogyne javanica***

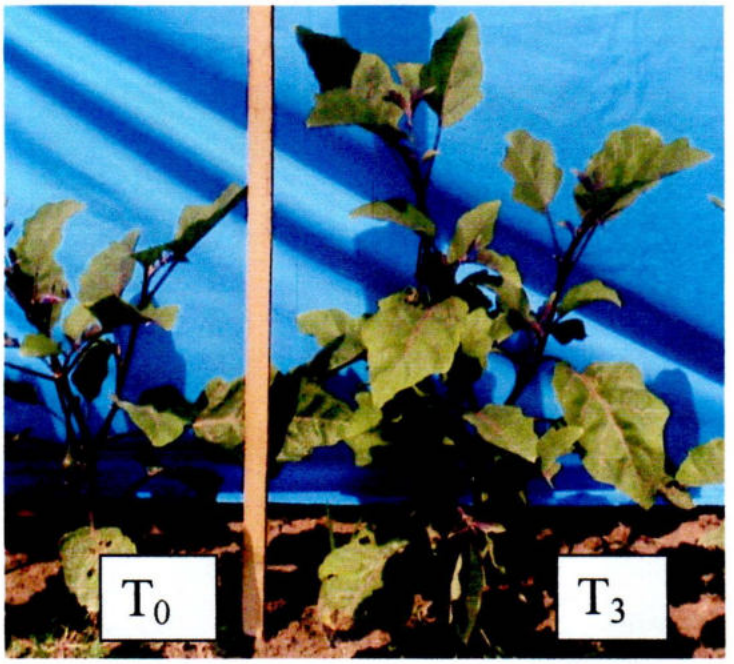

Plate 7. **Growth of brinjal plant in foliar spray between control, T_0 and marigold leaf extract, T_3 after7 days of transplantation and at 60 days after inoculation with *Meloidogyne javanica***

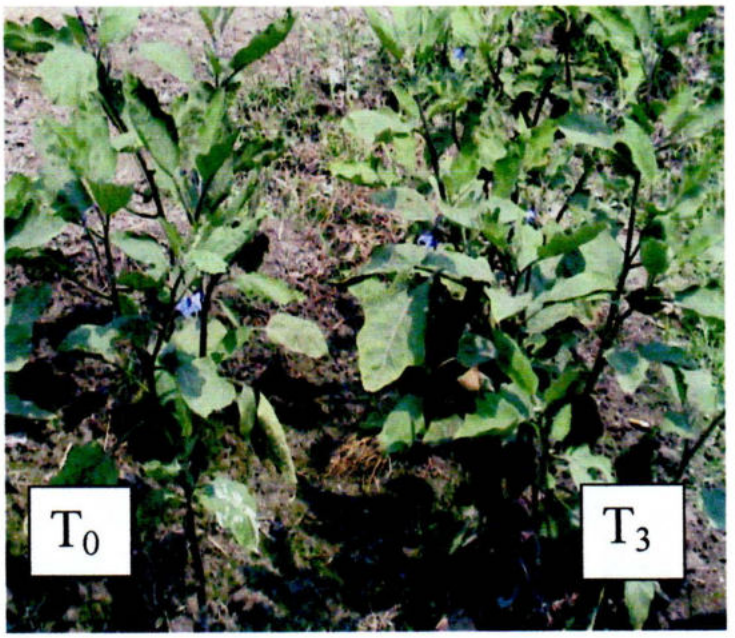

Plate 8. **Growth of brinjal plant in foliar spray between control, T_0 and marigold leaf extract, T_3 after 7 days of transplantation and at 90 days after inoculation with *Meloidogyne javanica***

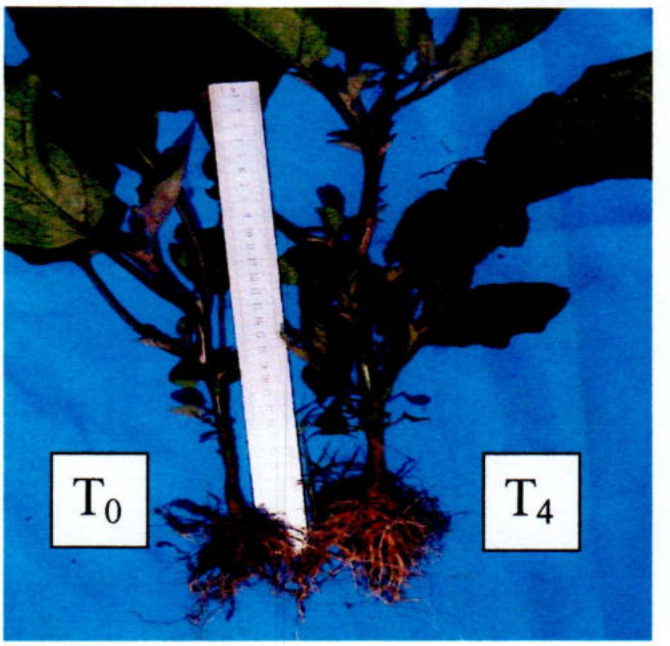

Plate 9. **Shoot & root growth of brinjal plant in root dipping between control, T_0 and dholkalmi leaf extract, T_4 after the 60 days of inoculation with *Meloidogyne javanica***

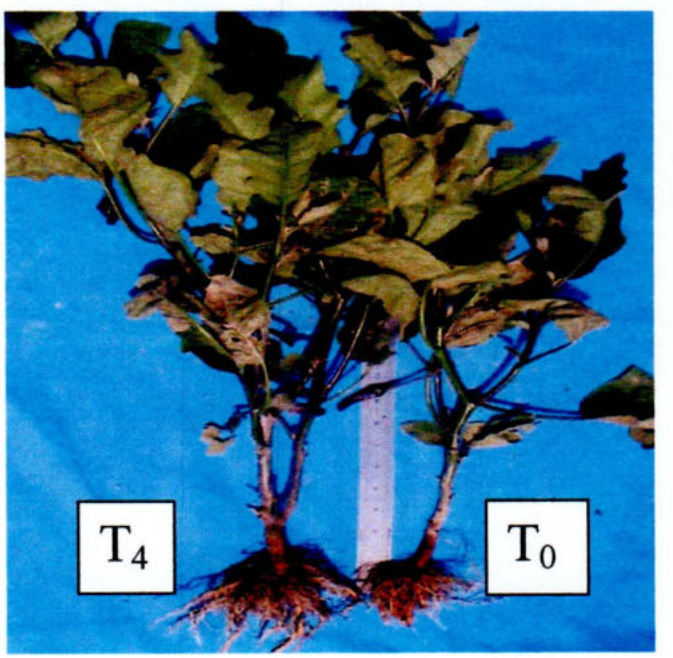

Plate 10. **Shoot & root growth of brinjal plant in root dipping between control, T_0 and dholkalmi leaf extract, T_4 after 90 days of inoculation with *Meloidogyne javanica***

Plate 11. **Treatment T_0 (control) showed severe infection on brinjal root caused by *Meloidogyne javanica* after 21 days of transplantation and at 90 days after inoculation in foliar spray method**

4.12. Correlation and regression study

Correlation and regression study was done to examine the relationship of shoot and root length and fruit weight with galling incidence under the treatments. It revealed negative and significant correlations between shoot and root length and fruit weight with gall number followed in the linear regression equations ($Y = 92.39 - 1.42x$, $r = -0.94^*$, $Y = 66.98 - 1.59x$, $r = -0.92^*$, $Y = 164.56-2.77x$, $r = -0.93^*$, $Y = 90.11 - 1.70x$, $r = -0.92^*$, $Y = 165.22 - 6.52x$, $r = -0.95^*$) in brinjal (Figures. 1, 2, 3, 4 and 5). The results indicated that the treatments were effective in increasing the growth characters and yield of brinjal by suppressing the nematode activities as evident with lower galling incidence in the treated plants over control treatment.

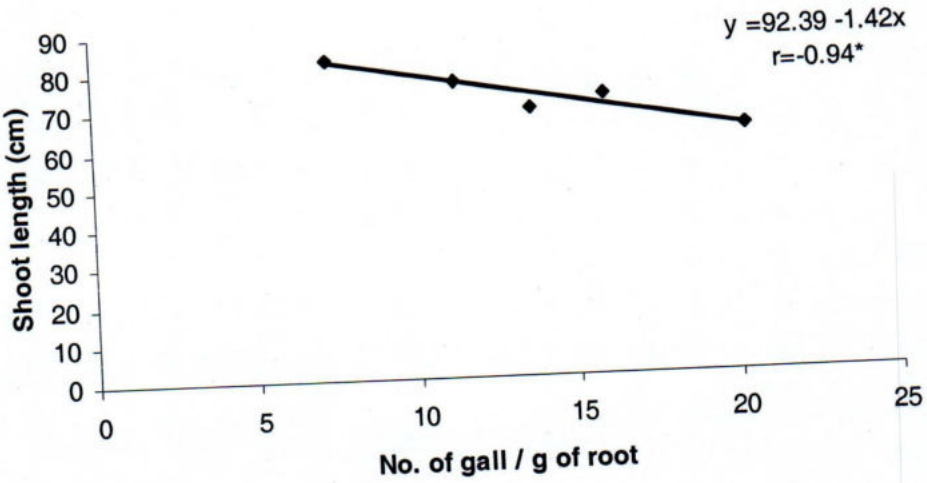

Figure 1. Relationship between shoot length (cm) and number of gall / g of root of brinjal in root dipping with curaterr solution and standard plant extracts for 30 minutes after 90 days of inoculation with *Meloidogyne javanica*

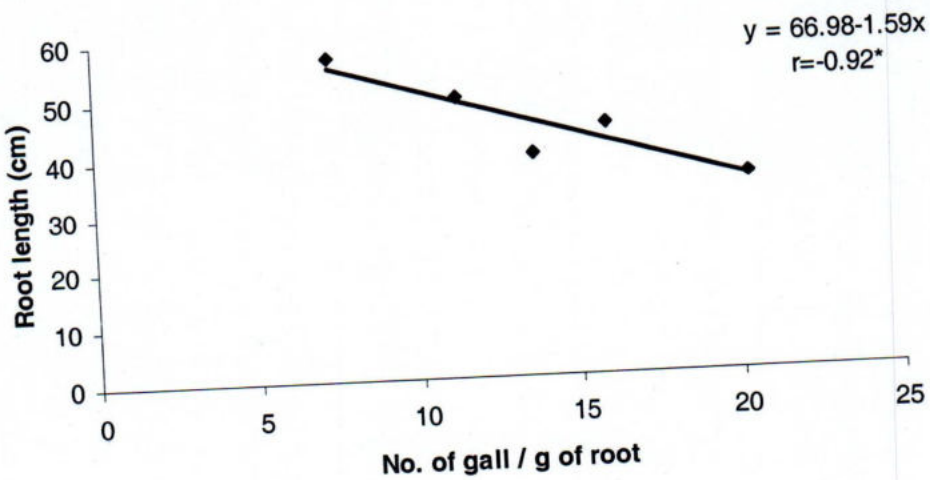

Figure 2. Relationship between root length (cm) and number of gall / g of root of brinjal in root dipping with curaterr solution and standard plant extracts for 30 minutes after 90 days of inoculation with *Meloidogyne javanica*

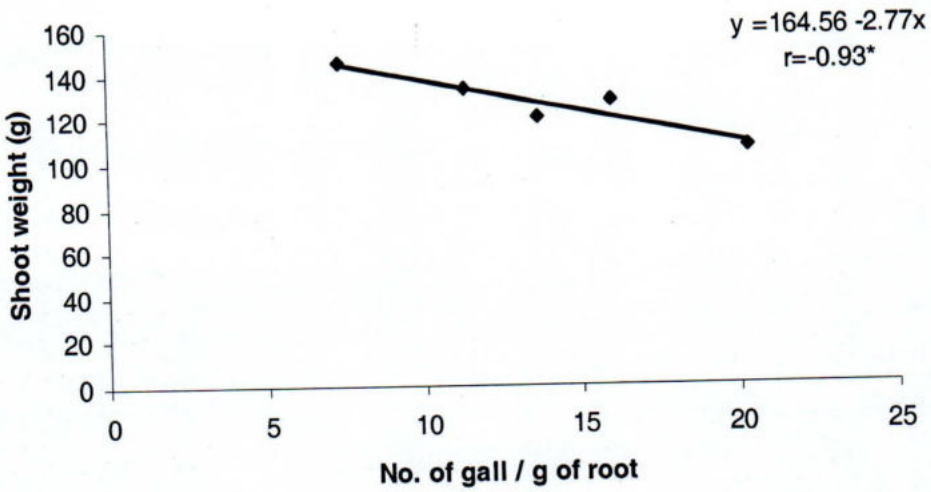

Figure 3. Relationship between shoot weight (g) and number of gall / g of root of brinjal in root dipping with curaterr solution and standard plant extracts for 30 minutes after 90 days of inoculation with *Meloidogyne javanica*

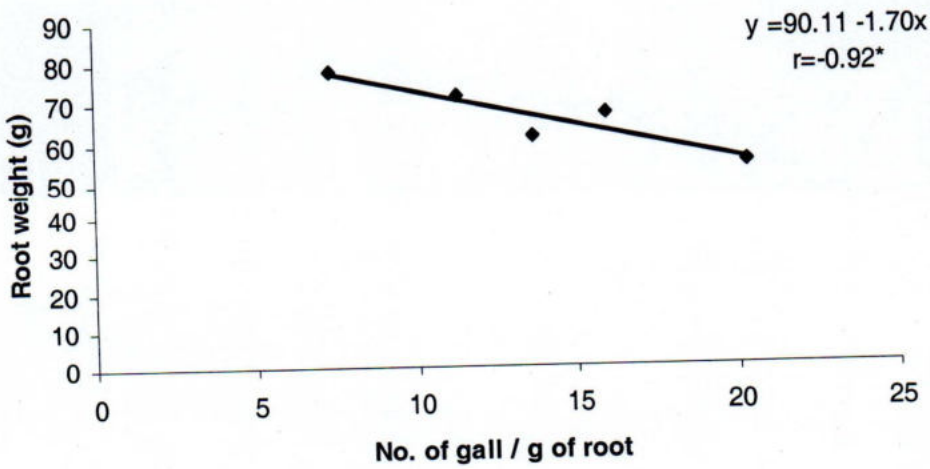

Figure 4. Relationship between root weight (g) and number of gall / g of root of brinjal in root dipping with curaterr solution and standard plant extracts for 30 minutes after 90 days of inoculation with *Meloidogyne javanica*

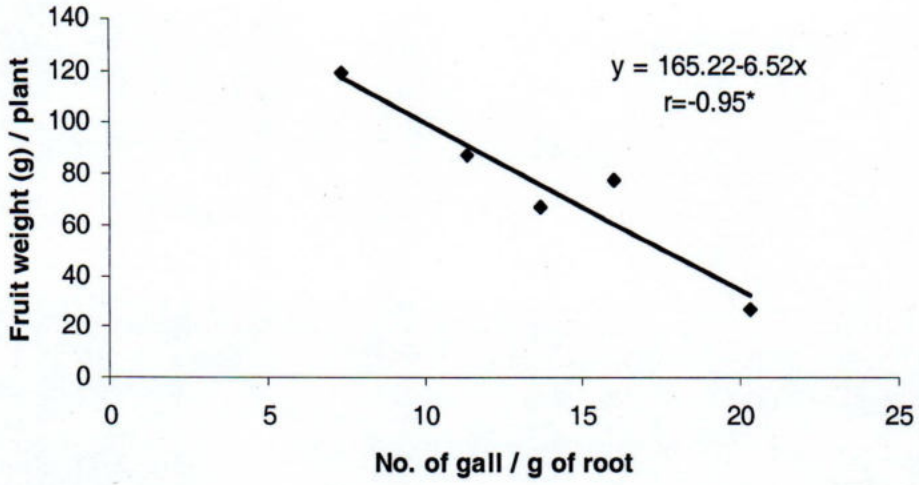

Figure 5. Relationship between fruit weight (g) / plant and number of gall / g of root of brinjal in root dipping with curaterr solution and standard plant extracts for 30 minutes after 90 days of inoculation with *Meloidogyne javanica*

CHAPTER 5

DISCUSSION

In the present study, effect of treatments with neem leaf extract, marigold leaf extract, dholkalmi leaf extract and curaterr solution against root-knot (*Meloidogyne javanica*) of brinjal was found highly significant (p=0.05) with respect to plant growth characters and suppression of nematode development within the brinjal plant.

Among the treatments curaterr gave superior response with significant growth of shoot and root as evident with the highest length of shoot and root, fresh weight of shoot and root and yield characters (Tables 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10). This might have happened due to significantly lower galling incidence in all the curaterr treated plants in comparison to the other treatments (Tables 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10). The highest value of the plant with curaterr in relation to shoot and root length, shoot and root weight is the indications of the better growth ability of the plants.

Curaterr is systemic in nature; this chemical inhibited the growth and development of the nematode inside the plants by suppressing its activities. As a result, plant metabolism was less disturbed and allowed better growth of the plant

Rodriguez *et al.* (1981) reported that the larval population of *M. incognita* was decreased in potato with Furadan 10G at the rate of 4, 5 and 6 kg a.i. /ha. Similar report was also given by Zem *et al.* (1982). Hassan (1995) carried out research with Furadan 5G and Miral 3G against root-knot of brinjal in granular and liquid forms of application, either alone or in combination. The two chemicals in higher concentration and combination in both types of application gave superior responses on plant growth characters with corresponding lower

number of galls, adult females and eggmasses. Larval population was more suppressed by Furadan 5G. Results obtained by Hossain *et al.* (1989) and Poornima and Vadivelu (1990) also revealed that carbofuran was one of the most effective chemicals in checking development and reproduction of *M. incognita* in the roots of aubergine plant. In the present study, higher growth characters of brinjal with suppressing galling incidence as well as nematode development within the plants with the chemical treatment are in agreement with the findings of the above mentioned authors.

The control of root-knot disease caused by *Meloidogyne* sp. with plant products have been practiced by many authors. On decomposition of the plant products like leaves, oil cakes, seed extracts etc., on the soil toxic substances are released which are directly lethal or harmful to the nematodes. In the present study, treatment with neem leaf extract was found to give higher response by giving higher shoot and root length, fresh weight of shoot, root and fruit with corresponding lower galling incidence in brinjal. Mishra and Prasad (1975) gave a trial with extracts of oil-cakes and neem cakes to control root-knot disease. Among them, extracts of neem cake were the most effective due to their toxicity to root-knot nematodes. Alam (1990) reported that neem (*Azadirachta indica*) had good properties in controlling plant parasitic nematodes.

Among the treatments, marigold leaf extracts was found to give comparatively better effect in respect of plant growth characters with improved length of shoot and root and fresh weight of shoot and root correspondingly with reduced galling incidence. Siddiqui and Alam (1987) conducted pot experiments and showed that the mixed cultures of marigold (*Tagets erecta*) inhibited the root-knot development caused by *Meloidogyne incognita* on eggplant and tomato and the growth of all test plants were improved due to the marigold intercrop. The root exudates of *Tagets erecta* were also found to have nematicidal properties.

Treatment with dhalkalmi leaf extracts appeared to give more or less good effect with respect to length of shoot and root, fresh weight of shoot and root and reduced galling incidence and nematode population compared to the control treatment. Ahmad and Karim (1991) reported that standard (S) and half standard (S/2) solutions of dholkalmi (*Ipomoea fistulosa*) suppressed the activity of *M. javanica* with significant lower galling incidence and corresponding higher significant shoot and root length, fresh weight of shoot and root of brinjal.

From the over all study, it was revealed that the highest plant growth characters of brinjal in respect of length of shoot and root, fresh weight of shoot and root and reduced incidence of galling could be achieved by the use of curaterr. Among the three plant extracts which were used in this research work neem leaf extract was found effective in better growth of brinjal with reduced galling incidence and nematode development in it. Marigold leaf extract also showed good effect in controlling galling incidence. Very similar effect was found in dhalkalmi leaf extract as compared to marigold.

Further study with these leaves extracts along with curaterr needs to be carried out in the field level with brinjal before making any recommendation to the farmers.

Cramer, H. H. 1987. Plant Protection and Crop Protection. Transl from German by J. N. Edwards. Plantzenschutz Nachr. V, 20. Farbenfabriken Bayer AG. Leverkusen.

Darekar, K. S.; Mhase, N. L. and Shelke, S. S. 1990. Effect of placement of non-edible oil seed cakes on the control of root-knot nematodes on tomato. Int. Nematol. Network Newsl. 7(1): 5-7.

Davide, R. G. 1979. Effects of nematicides and *Tagets erecta* on the control of *Meloidogyne incognita* and yield of tomato. Philippine Phytopathol. 15 (2): 141-144.

Devappa, V.; Krishnappa, K. and Reddy, B. M. R. 1997. Management of root-knot nematode, *Meloidogyne incognita* in sunflower. Mysore J. Agril. Sci. 31 (2): 155-158.

Ducusion, A. R. and Davide. R. G. 1972. *Meloidogyne incognita* and its effect on tomato yield and some methods on control. Philippine Agriculturist 55: 261-281.

Egunjobi, 0. A. and Afolami, S. 0. 1976. Effect of neem (*Azadirachta indica*) leaf extracts on populations of *Pratylenchus brachyurus* and on the growth and yield of maize. Nematol.22(2): 125-132

Ganai, G. H.; Kaul, K. K. and Chhabra, K. K. 1992. Nematicidal action of leaf extracts of neem, mentha and parthenium against *Ditylenchus myceliophagus*. Plant Dis. Res. 7(2): 279-281.

Grewal, P. S.; Chhabra, H. K. and Kaul, V. K.1985. Control of *Meloidogyne arenaria* on groundnut with nematicides and oil cakes. J. Oil Seeds Res. 2:22-28.

Guzman-R. S. and Saxena, R. C. 1987. Nematicidal activity of neem and its derivatives. J. Res. (Philippines) 4(1-2): 40-44.

Hameed, S. F. 1970. "Note on the effect of some organic additives on the incidence of root-knot nematodes in tomato (*Lycopersicon esculentum* Mill)." Indian J. Agric. Sci. 40(3): 207-210.

Hassan, M. G. M.; Rhaman, M. S.; Kabir, M. A.; Hasan, M. R. and. Sarker, M.G.M. 2003. Effect of some plant extracts on the root-knot (*Mleloidogyne javanica)* of lady's finger and aubergine. Agril. Sci. Digest, 23 (1): 63-64.

Hassan, S. M. E. 1995. Comparative efficacy of granular and liquid application of Furadan 5G and Miral 3G against root- knot (*Meloidogyne javanica*) of brinjal. An M. S. thesis submited to the Department of Plant Pathology, BAU, Mymensingh.

Hassan, S. M. E.; Ahmad, M. U.; Sikdar, M. S. I.; Hasan, M. R. and Rahman, M. Sq. 2005. Effect of turmeric on root-knot of tomato. J. Sci. Tech. 2: 101-104.

Hossain, A. S.; Mian, L. H. and Tsuno, K. 1989. Efficacy of three nematicides and two oil cakes for control of root-knot nematodes (*Meloidogyne incognita*) on potato seedlings. J. Fac. Agric. Kyushu Univ. 34:115-121.

Hussain, S. I.; Kumar, R.; Khan, T. and Titow, A. 1984. Effect of root-dip treatment of eggplant seedling with plant extracts, nematicides, oil-cake extracts and anthelmintic drugs on plant growth and root-knot development. Pak.J. Nematol. 2(2): 79-83.

Irshad, M.; Saxena, S. K. and Zakiuddin 1982. Effect of certain plant extracts on the mortality of *Rotylenchulus reniformis* and *Meloidogyne incognita*. Bangladesh J. Botany 11(2): 154-157.

Jagdale, G. B.; Pawar, A. B. and Darekar, S. K. 1984. Control of root-knot nematode on betel vine with systemic nematicides. Int. Nematol. Network Newsl. 1: 4-5.

Kanaujia, R. S. and Mishra, R. R. 1978. Effect of foliar application of plant extracts. Bangladesh J. Botany 7(2): 13-19.

Kartono, G. 1980. Nematicidal control of nematodes on flue-cured tobacco varieties. Pemberitaan lembage Penelitian Tanarnali industri. Bogor Indonesia, 37: 81-88.

Khan, A. M.; Alam, M. M. and Ahmad, R. 1974 b. Mechanism of control of plant parasitic nematodes as a result of the application of oil-cake to the soil. Indian J. Nematol. 4(1): 93-96.

Khan, A. A. and Alam, M. M. A. 1985. Control of *Meloidogyne incognita* by chemical dips. Pakistan. J. Nematol. 3(2), 105-109.

Khan, M. W.; Alam, M. M.; Khan, A. M. and Saxena, S. K. 1974 c. Effect of water soluble oil-cakes and bitter principles of neem on some fungi and nematodes. Act. Bot. Ind. 2(2): 120-128.

Khan, M. W.; Khan, A. M. and Saxena, S. K. 1973. Influence of certain oil-cake amendments on nematodes and fungi in tomato field. Act. Bot. Ind. 1: 49-54.

Khan, M. W.; Khan, A. M. and Saxena, S. K. 1974. Rhizosphere fungi and nematodes of eggplant as influenced by oil-cake amendments. Indian Phytopathol. 27: 480-484.

Koshy, P. K.; Sundarajuand, P. and Wilson, K. L. 1979. Efficacy of certain systematic nematicides against *Meloidogyne javanica* in a cardamom nursery. Nematol. Mediterr. 7: 195-198.

Lee, M. J. 1987. The effect of extract of *Melia azadirachta* on *Meloidogyne incognita.* Quarterly J. Chinese Forestry 20 (4): 1-7.

Mani, A.; Ahmed, S. N.; Kameswar R. P. and Dakshina Murti, V. 1986. Plant produces toxic to the citrus nematode, *Tylenchulus semipenetrans,* Gbb. Int. Nematol. Network. Newsl. 3(2): 14-15.

Meah, B. H. 2003. Integrated Management of Eggplant Cultivation-1, USDA-Bangladesh Collaborative Research Project (Grant No. BG-ARS 106). IPM Laboratory, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh.

Mian, I. H.; Hossain, M. S and Ali, M. R. 1991. Efficacy of Furadan for control of root-knot in potato. Bang. J. Pl. Pathol., 7(1&2):1-3.

Mian, I. H.; Godoy, O; Shelby, R.A.; Rodriguez-Kabana, R. and Morgan-Jones, G. 1982. Chitin amendments for control of *Meloidogyne arenaria* in infested soil. Nematrop.12(1): 71-84.

Mian, I. H. 1986. Plant parasitic nematodes associated with some crop species in Bangladesh. Bangladesh J. Plant Pathol. : 73

Mishra, S. D. and. Prasad, S. K 1975. Effect of water extracts of oil-seed cake on the second-stage larvae of *Meloidogyne incognita* at different concentrations and exposure times. Indian J. Entom. 35:104-106.

Mohammad A. and Akhtar, M. 2000. Evaluation of the nematicidal effect of a neem based product on root-knot nematode of tomato. Plant Protection Department. Ins. Agril. Aligarh Muslim University, Aligarh, India, 42: 16-17.

Moussa, F. F.;.Osman, H. A. and Billah, M.E.1977. Control of *Meloidogyne incognita* on tomatoes with marigold and asparagus plants. Bulletin National Res.Centre, Cairo, Egypt, 2: 359-304.

Mukhtar, T.; Ahmad R.; Inamul Hoq, M. and Javed, N. 1994. Effect of extract of some plants on *M. incognita*. Pak. .J. Phytopathol. 6(1): 35-37.

Perlaza, F.; Lopez, R. and vargas, E. 1979. Chemical control of *Meloidogyne* spp. and *Alternaria* sp. in carrots. Escuela De Fitotecnia, Fac De Agron. Univ. De Costa-Rica.

Poornima, K. and Vadivelu, S. 1990. Comparative efficacy of nematicides, oil-cakes and plant extracts in the management of *Meloidogyne incognita*, *Pratylenchus delattrei* and *Rotylenchulus reniformis* on brinjal. Indian J. Nematology. 20 (2), 170-173.

Prot, J. C. and Kornprobst, J. M. 1983. Effect of *Azadirachta indica, Hannoa undulata and Hannoa klaineana* seed extracts on the ability of *Meloidogyne javanica* juveniles to penetrate tomato roots. Rev. – de-Nematol. 6(2): 330-332.

Rao, V. R. and Singh, D. B. 1978. Chemical control of root-knot in okra with the aid of nematicides. Indian J. Hort. 35: (2) 151-154.

Rodriguez-kabana, R.; King, P. S. and Pope, M. H. 1981. Control of root-knot nematodes and colorado potato beetle on potato with application of systemic nematicides. Nematrop.11 (1):17-25.

Rossner, J. and Zebitz, C. P.W. 1987. Effect of Neem products on nematodes and growth of tomato (*Lycopersicon esculentum*) plants. In Natural Pesticides from the Neem tree (*Azadirachta indica* A. Juss) and other tropical plants. Proceedings of the 3rd Int. Neem Conf. Nairobi, Kenya, 10-15 July 1986.

Saifullah, Z. M. and Gui, A. 1990. Organic amendments as control of root-knot nematodes. Int. Nematol. Network Newsl. 7(1): 22-24.

Sartaj. A.; Tiyagi, J. M. and Maskoor, M. 1986. Toxicity of an insect repellent plant to plant parasitic nematode. An M.Sc. thesis submitted to the Department of Plant Pathology. Bangladesh Agricultural University, Mymensingh.

Stephen, Z. A.; Michbass, A. H. and Shakir, C. W. 1989. Control of root-knot nematodes on eggplant by nematicides. Int. Nematol. Network Newsl. 6 (3):25-26.

Timm, R. W. and Ameen, M. 1960. Nematodes associated with commercial crops in East Pakistan. Agric. Pak. 11(3): 355-366.

Zaki, F. A. and Bhatti D. S. 1989. Phytotherapeutic effect of some plant leaves on *M. javanica* infecting tomato plants. Nemtol. Mediterr. 17 (2): 71-72.

Zem, A. C.; Zonon, J. I. and Lordello, L. G. E. 1982. Timing and dosage of carbofuran application for control of *M. javanica* on potato. Socie. Brasile. de Nemtol. 233-245.