

## MANAGEMENT OF ROOT-KNOT NEMATODE INFECTING BRINJAL BY BIOPESTICIDES, CHEMICALS, ORGANIC AMENDMENTS AND BIO-CONTROL AGENT

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### Abstract

The potential of bio-pesticides, chemical pesticides, organic amendments and bio-control agent was studied in controlling the root-knot nematode *Meloidogyne incognita* on brinjal "cv" Dilnasheen in two greenhouse experiments. In first experiment bio-pesticides (Abamectin and Azadirachtin) and a chemical pesticide Lorsban were tested alone and in combination with a bio-control agent *Pasteuria penetrans* for the management of root-knot disease. The best control (61 %) in root galling was recorded in pots treated with Azadirachtin + *P. penetrans* followed by Abamectin + *P. penetrans* (52 %), Abamectin and *P. penetrans* (48 %), Lorsban + *P. penetrans* (42 %), Azadirachtin (36 %) and Lorsban (21%) compared with unamended control. All the treatments showed significant reduction in egg-masses compared with untreated control; however, maximum decrease (66 %) in egg-masses was recorded in Azadirachtin + *P. penetrans* treatment while lowest reduction (45 %) was observed where Lorsban was applied. In another experiment bio-pesticides (Abamectin and Emamectin) and organic amendments (saw dust and kanair leaves) and a chemical (Furadan) were evaluated in controlling the root-knot disease. Abamectin proved to be the best in reducing root galling (62 %) and egg-masses (79 %) followed by Furadan while other treatments showed intermediary effects compared to untreated inoculated control.

Plant parasitic nematodes cause global losses of crop plants with an estimated loss of \$125 billion per year (Chitwood, 2003). In particular root-knot nematodes (*Meloidogyne* spp.) are very common in tropical and sub-tropical agriculture having wide host range and attacks more than 3000 plant species (Abad *et al.*, 2003). So far 81 species of this destructive pest have been identified (Karssen, 2002). Four species viz., *M. incognita*, *M. javanica*, *M. arenaria* and *M. hapla* are among the most important pests of vegetable crops in Pakistan. Out of these four species, *M. incognita* (Kofoid & White) Chitwood is of major importance causing yield and quality losses especially in tomato, brinjal, okra and cucurbits. It has been reported to cause severe yield losses ranging between 17-20 % on egg plant, 18-33 % on melon and 24-38 % on tomato (Sasser, 1979). Lamberti (1979) reported 30-60 % losses in egg plant and 50 % on cantaloupe and watermelon in Southern Italy. In Pakistan damages to plants by plant parasitic nematodes are more serious and complex due to many factors such as sub-tropical location of the country, sandy and warm soils and mono cropping system / intensive cropping pattern (Shahid *et al.*, 2007).

Current control of plant parasitic nematodes is inadequate and the use of environmentally hazardous nematicides still remain the major option for the management of plant parasitic nematodes on numerous crops world wide (Atkinson *et al.*, 2003). Also presently available nematicides have higher cost of application and lack broad spectrum activity (Chitwood, 2002).

Efforts have been made in search for safer and eco-friendly control alternatives whereby biodegradable compounds of bacterial origin viz., Abamectin and Emamectin and of plant origin Azadirachtin have shown great potential as an alternative to the use of chemicals. *Pasteuria penetrans*, an obligate parasite of phytonematodes possesses some attributes required for a successful bio-control agent, like adaptability to adverse environmental conditions, compatibility with agro-chemicals and standard farm practices.

Although the use of organic amendments for effective nematode control is limited by the large quantities needed, they can reduce nematode population densities to different degrees (Muller & Gooch, 1982). In addition to their suppressive effects on nematode density, organic amendments provide better media for plants to grow, result in better soil texture, increase water holding capacity, supply the nutrients to deficient soil and stimulate microbial populations of actinomycetes, bacteria and fungi, elements of which might be antagonistic to nematodes (Rodriguez-Kabana, 1986). Organic soil amendments have been used successfully as effective alternative, environment friendly methods for controlling the root knot nematodes (Akhtar & Malik, 2000). Plant parts are also reported to possess nematicidal as well as nematostatic properties and their incorporation to soil has shown potential to reduce root-knot nematode (Tariq & Siddiqui, 2005). Oil cakes saw dust and bagasse have been used with some success (Sikora *et al.*, 1973; Khan *et al.*, 2004).

The present studies were therefore carried out to evaluate the efficacy of biopesticides (Abamectin, Emamectin & Azadirachtin), a bio-control agent (*P. penetrans*), chemical pesticides (Lorsban & Furadan) and organic amendments (Kanair leaves & saw dust) for the management of root-knot nematode, *M. incognita* infecting brinjal under greenhouse conditions.

### Materials and Methods

**Nematode inoculum:** *Meloidogyne incognita* root-knot nematode originally isolated from brinjal and maintained on the same susceptible host in greenhouse of Plant Pathology Section, Ayub Agricultural Research Institute, Faisalabad, was used as inoculum. Brinjal plants were uprooted; roots were washed gently with tap water and cut into 1-2cm pieces. The roots were shaken vigorously for five minutes in a Coffee Jar containing 200 ml Sodium hypochlorite solution (1%

NaOCl) to facilitate the release of eggs from egg-masses (Hussey & Barkar, 1973). Eggs collected in the fine sieve were poured on extraction dish containing tap water and incubated at 28 °C in an incubator to collect juveniles (J<sub>2s</sub>) for inoculations on brinjal seedlings.

**Integrated management of root knot nematode *M. incognita* attacking brinjal:** The potential of three bio-chemicals (Abamectin, Lorsban and Azadirachtin) alone and in combination with a bio-control agent (*Pasteuria penetrans*) for the management of root knot disease was studied in the greenhouse at 30 ± 5 °C. Brinjal seedlings were transplanted singly in earthen pots (15 cm diameter) containing 1-kg sterilized soil. *P. penetrans* inoculum, was mixed in the soil @ 30 mg of *P. penetrans* infested dried tomato root powder (10<sup>4</sup> spores) per pot in treatments (4-7) prior to transferring the seedlings. After ten days of transplanting, 1000 freshly hatched juveniles of *M. incognita* in 9 ml of nematode water suspension were pipetted into three equidistant 2.5 cm deep holes surrounding the root-zone of each plant. The holes were then filled with sterilized soil and pots were watered immediately to moisten the soil. Eight treatments were replicated tetra fold and arranged in a completely randomized design. The chemicals were drenched one day after inoculation as; Abamectin (1.8 EC) @ 1.0 ml / pot, Lorsban (40 EC) @ 0.5 ml / pot and Azadirachtin (0.3 EC) @ 0.5 ml / pot. Pots with nematodes only were kept as control to compare the nematode infestation on plants. The experiment was conducted during kharif season and was harvested in last week of May.

The experiment was terminated after six weeks of inoculation and data of root galling and egg mass production was recorded. Root galling was rated on a 0-10 Scale (Bridge & Page, 1980). The roots were stained with Pheloxin B (Southey, 1986) and egg-masses per root system of plant were counted. The data was analyzed by using Analysis of Variance (ANOVA) procedure. The significance of differences within treatments was tested by using Least Significant Difference (LSD) test at 5 %.

**Management of root knot nematode *M. incognita* by bio-pesticides, chemical and organic amendments:** The effects of three chemicals (Abamectin, Emamectin and Furadan) and two organic amendments (Saw dust and Kanair leaves) were compared to suppress the root-knot disease caused by *M. incognita* on brinjal. For organic amendments individual pots of each treatment (3 and 4) were treated by taking out the soil in a sterilized enamel tray, required quantity of particular organic material @ 10 g / pot was thoroughly mixed into the sterilized soil and then pots were refilled. This activity was carried out 15 days prior to transfer of brinjal seedlings so that plant material could be decomposed. Chemicals were drenched one day after nematode inoculation as; Abamectin (1.8 EC) @ 1.0 ml / pot, Emamectin (1.9 EC) @ 0.5 ml / pot and Furadan (3-G) @

0.0123 g / pot. All the experimental conditions and procedures were same as mentioned in the experiment No.1, except this experiment was conducted in Rabi season and harvested in mid March.

### Results

**Integrated management of root-knot nematode *M. incognita* attacking brinjal:** The highest reduction in root galling (61 %) caused by root-knot nematode *M. incognita* was observed in plants grown in pots treated with Azadirachtin + *P. penetrans* followed by the plants treated with Abamectin + *P. penetrans* (52 %) compared with untreated inoculated plants. Abamectin and *P. penetrans* when applied alone were at par 48% followed by Lorsban + *P. penetrans* (42%) while the influence of other treatments; Azadirachtin and Lorsban was found less effective (36 & 22 %) in reducing root galling. Similarly, Azadirachtin + *P. penetrans* proved the best (66 %) in reducing number of egg masses per plant produced by the females of *M. incognita* followed by Abamectin + *P. penetrans* (63 %), Abamectin (59 %), *P. penetrans* (58 %), Lorsban + *P. penetrans* (57 %), Azadirachtin (52 %) while the Lorsban proved the least effective(45 %) as compared to un-amended inoculated control (Table 1).

**Management of root-knot nematode by bio-pesticides and organic amendments:** The highest reduction in root galling (62 %) caused by root-knot nematode *M. incognita* on brinjal roots was observed in plants grown in pots treated with Abamectin followed by the plants treated with Furadan (53 %) compared with untreated plants while other treatments showed intermediate response in reducing root galling. Similarly, Abamectin proved the best in reducing number of egg masses per plant produced by the females of *M. incognita* (78.8 %) followed by Furadan (68 %), Emamectin (56 %) and Kanair leaves (50 %) and Saw dust (42 %) compared to un-amended inoculated control (Table 2).

### Discussion

The effectiveness of Abamectin, Emamectin, Lorsban and Furadan in reducing the root knot disease suggests that these chemicals possess some nematicidal properties. These results are in agreement with Abbas *et al.*, (2008) who reported significant control of root-knot nematode *M. incognita* with chemicals; Chlorpyrifos, Talstar, Abamectin and Emamectin under greenhouse condition. These chemicals are recommended for use as insecticides against insects, but their potential as nematicides was not known. Biopesticides (Abamectin, Emamectin & Azadirachtin) showed their potential in reducing root-knot disease and these results are encouraging in the sense that these synthetic bio-pesticides are safer to human and could be potential candidates for chemically controlling phytonematodes.

**Table 1. Efficacy of chemicals alone and in combination with a biocontrol agent on the root-knot disease caused by *M. incognita*.**

Treatments	Root galling (0-10)	% decrease over control	No. of egg-masses / plant	% decrease over control
T <sub>1</sub> =Abamectin 1.8 EC (Avermectin) @ 1.0 ml/pot	4.25 cde	48.49	82.25 cd	59.19
T <sub>2</sub> =Lorsban 40 EC (Chlorpyrifos) @ 0.5 ml/pot	5.50 b	21.22	110.00 b	45.41
T <sub>3</sub> =Azadirachtin 0.3 EC @ 0.5 ml/pot	5.25 bc	36.37	96.75 bc	51.99
T <sub>4</sub> = <i>P. penetrans</i> @ 30 mg root powder (10 <sup>4</sup> spores) per pot	4.25 cde	48.49	84.00 bcd	58.32
T <sub>5</sub> =Abamectin 1.8 EC @ 1.0 ml/pot + <i>P. penetrans</i> @ 30 mg root powder (10 <sup>4</sup> spores) / pot	4.00 de	51.52	74.00 cd	63.28
T <sub>6</sub> = Lorsban 40 EC (Chlorpyrifos) @ 0.5 ml/pot + <i>P. penetrans</i> @ 30 mg root powder (10 <sup>4</sup> spores) per pot	4.75 bcd	42.43	87.25 bcd	56.70
T <sub>7</sub> =Azadirachtin 0.3 EC @ 0.5 ml/pot + <i>P. penetrans</i> @ 30 mg root powder (10 <sup>4</sup> spores) / pot	3.25 e	60.61	68.00 d	66.26
T <sub>8</sub> =Control (Nematode alone)	8.25 a	-	201.50 a	-
LSD	1.173		27.15	-

**Table 2. Effect of different controlling agents on the root-knot disease caused by *M. incognita*.**

Treatments	Root galling (0-10)	% decrease over control	No. of egg-masses	% decrease over control
T <sub>1</sub> = Abamectin @ 1.0 ml / pot.	3.25 d	61.77	21.5 d	78.82
T <sub>2</sub> = Emamectin @ 0.5 ml / pot.	4.50 bc	43.75	44.25 bc	56.41
T <sub>3</sub> = Sawdust @ 10.0 g / pot.	5.00 b	41.12	59.00 b	41.88
T <sub>4</sub> = Kanair leaves @ 10.g / pot.	5.75 b	32.36	50.75 b	50.00
T <sub>5</sub> = Furadan @ 0.0123 g / pot.	4.00 cd	52.95	32.25 cd	68.23
T <sub>6</sub> = Nematode alone (Control).	8.50 a	-	101.50 a	-
LSD	0.959	-	15.64	-

The variation in the efficacy of Abamectin in controlling root-knot disease in two experiments could be due to different temperatures during the study. The temperature range during kharif experiment was 25 – 48°C while in Rabi it was 10 - 32°C which might have affected the efficacy of Abamectin. Moreover, this

efficacy variation could be due to different experimental factors such as manual operations like watering of pots or soil type used or other environmental factors.

*P. penetrans* has proved effective in reducing root-knot disease alone and when integrated with other chemicals. These results are in agreement with other workers (Daudi & Gowen, 1992, Tzortzakaskis & Gowen, 1994) who reported that *P. penetrans* alone or in combination with various nematicides brought about considerable reduction in nematode infection. Azadirachtin and *P. penetrans* when applied together proved most effective in reducing root galling and egg mass production by the root knot nematode. The reason could be as both *P. penetrans* and Azadirachtin retard nematode movement in soil, juveniles if encumbered heavily with spores of *P. penetrans* can not move while Azadirachtin has nematostatic effect. Neem products have been shown to have an effect on juvenile behaviour resulting in a reduction in nematode invasion (Akhtar, 2000)

The use of organic soil amendments is the cheapest and effective way for the control of plant diseases caused by nematodes. Organic amendments (Saw dust & Kanair leaves) showed some potential in controlling the root-knot disease. The compounds present in the plant material are either nematicidal or nematostatic in nature (Pandey *et al.*, 2000) or the end products of decomposed plant material are responsible for antinematic activity. These effects may also have resulted from the release of phenolic compounds, NH<sub>3</sub> and nitrite (Stirling, 1991). The reduction in nematode severity may also be caused by the microbes decomposing these specific plant materials releasing substances which are nematicidal / nematostatic or these microbes themselves attack on phytonematodes.

The present study suggested that the effective and rational management of root-knot nematode is very much feasible if integrated strategy is applied rather applying single remedy.

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