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EFFICACY OF NEMATICIDE, PLANT EXTRACT AND ORGANIC AMENDMENTS AGAINST ROOT KNOT (*Meloidogyne javanica*) OF BITTER GOURD AND TEASLE GOURD

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ABSTRACT

Khan MAI, Ahmad MU, Momen A (2014) Efficacy of nematicide, plant extract and organic amendments against root knot (*Meloidogyne javanica*) of bitter gourd and teasle gourd. *Int. J. Sustain. Crop Prod.* 9(3), 15-21.

Seven treatments comprising of non-treated control, dholkalmi plant extract, mustard oil cake, sawdust, ash, sawdust with ash and chemical Furadan 5G were evaluated against root knot (*Meloidogyne javanica*) disease of bitter gourd and teasle gourd. In both the vegetable crops, nematicide Furadan 5G improved plant growth characters and reduced nematode infestation. Comparatively, better efficacy was found with plant extract of dholkalmi followed by mustard oil cake and sawdust in plant growth and nematode development. Ash was found to be less effective against root knot disease.

Key words: *plant extract, nematode, root knot, bitter gourd, teasle gourd*

INTRODUCTION

Bitter gourd (*Momordica charantia* L.) and teasle gourd (*Momordica dioica* L.) are important and popular vegetable crops in Bangladesh and mostly grown in summer season. These are very nutritious vegetables containing lot of minerals and vitamins (Bosse and Som, 1986).

The subtropical climate of Bangladesh is very much favorable for root-knot nematode *Melodogyne javanica*. The nematode has a very wide host range Kishore (1969). Control of root-knot nematodes (*Meloidogyne* spp.) is of utmost importance to boost up economic production of both the vegetables. But no elaborate work on the specific control measure has yet been developed against this disease of bitter gourd and teasle gourd. The root-knot disease may be controlled by chemical, cultural and biological means. Presently, soil application of synthetic nematicides and addition of oil cakes and other organic amendments to the soil are the most dependable methods to control root-knot nematodes all over the world (Fassuliotis 1979). Chemical control is very costly and difficult task for the common farmers to determine the precise dose of the chemical for its application to the field. Chemical control of plant disease is discouraged all over the world.

Experimental reports so far available revealed that Furadan can control *Meloidogyne* spp.; reduction of root–knot incidence and increase of yield (Alam 1993; Azad 1995; Hassan 1995 and khan 1996). But the effectiveness of this chemical against root-knot nematode *Meloidogyne* spp. of bitter gourd and teasle gourd has not yet been studied thoroughly in Bangladesh. Various plant extracts have recently been reported to have nematicidal properties (Mahmood *et al*. 1982; Pathak *et al*. 1989; Ahmad and Karim, 1990). Dholkalmi (*Ipomoea fistulosa*) has also been found to be nematicidal (Alam 1993 and Sarker 1996) and it is commonly available in Bangladesh. Mustard oil cake, saw dust and ash are common sources of organic amendments in our country.

The present study was undertaken to evaluate the efficacy of Furadan 5G, plant extract of Dholkalmi (*Ipomoea fistulosa*), mustard oil cake, sawdust and ash either alone or in combination against root-knot of bitter gourd (*Momordica charantia* L.) and teasel gourd (*Trichosanthes dioica* L.) caused by *Meloidogyne javanica*.

MATERIALS AND METHODS

Preparation of soil and potting

At first, sandy loam soil, sand and well decomposed cowdung were taken at the ratio of 2:2:1 and mixed uniformly. Sandy loam soil was collected from the field of Bangladesh Agricultural University campus. Sand was collected from the river side of the Brahmaputra and well decomposed cowdung from the village Boyra. The mixed soil was sterilized with formalin at the rate of 30ml dissolved in 1000ml water per cubic feet soil. After 72 hours, the polythene sheet was removed and the sterilized soil was exposed to air drying for 48 hours in order to removed excess vapor of formalin. Earthen pots were provided with a small broken piece of earthen pot at the bottom and filled with 5kg sterilized and dried soil. Treatment of mustard oil cake, sawdust, ash and sawdust with ash were also mixed with soil separately at the rate of 122kg/acre and poured in seventy pots, thirty five for each vegetable crop. Treatments were applied only one for each vegetable crop.

Collection and surface sterilization of seed

Seeds of bitter gourd were collected from Mymensingh town and tubers of teasle gourd were collected from local farmers. Before sowing these seeds in the soil of earthen pots, surface sterilization was done with low concentration mercuric chloride solution (0.001%) for 1-2 minutes and subsequently rinsed thrice with sterilized distilled water.

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Sowing of seeds and after care of seedlings

Two uniform sized bitter gourd and teasle gourd seeds per pot were sown. After 10 days, the cotyledon leaves emerged from the soil. After germination of seeds, regular and uniform watering of the pots was done for proper establishment of the roots within the sterilized soil. Only one healthy seedling per pot was allowed to grow. When the plants were well established, one support with bamboo stick was given in pot soil for vine nature of both the vegetable crop.

Design of experiment

Two sets of pot experiment were set up in the glasshouse. Each set contained 35 plants, one for bitter gourd and other for teasle gourd. In both the sets, plant extracts, mustard oil cake, sawdust, ash, sawdust with ash and Furadan 5G were used as treatments. Altogether, seven treatments including control were maintained in the following way: T_1 = Control, T_2 = 10ml leaf extract of Dholkalmi, T_3 = 25g Mustard oil cake, T_4 = 25g Sawdust, T_5 = 25g Ash, T_6 = 12.5g + 12.5g Sawdust ash, T_7 = 0.5g Furadan 5G/plant.

Each treatment was replicated five times. Each set had 35 pots and each pot with single plant was arranged in glasshouse properly with random arrangement for the study of different growth characters like, galling incidence and the number of the nematodes at different growth stages of the plants.

Preparation of inoculum and inoculation

Eggmasses were collected from the roots of brinjal cv. Singhnath which were previously inoculated individually with single eggmass of *Meloidogyne javanica*. For inoculation, six reddish brown mature eggmasses were placed in each pot around the standing plant in 2 holes three eggmasses on each side of the plant. Inoculation was done on the 28th April, 1999.

Preparation of mustard oil cake

At first, 250g of mustard oil cake was taken in a bucket and mixed with required amount of water until it comes to a melting condition. Mustard oil cake paste thus prepared had been allowed to rot for 7 days keeping in a bucket.

Preparation of Dholkalmi extract

Mature green leaves of Dholkalmi (*Ipomoea fistulosa*) were collected from different places of Bangladesh Agricultural University campus. The collected leaves were chopped after cleaning in running tap water. Then 25 g of leaves were macerated in a blender and soaked separately in 100 ml of distilled water. After two hours, sample were centrifuged and filtered. The filtrates were regarded as standard solution (S).

Application of Dholkalmi extract

Half standard(S/2) solution of the plant extract was used in ten pots, five for each set in both the experiments. The treatment was repeated three times during the experimental period at 10 days interval.

Application of Furadan 5G granular

Furadan 5G was used in ten plots, five for each set in both the experiments at the rate of 500 mg/pot. Treatment was applied only once as side dressing for each vegetable crop.

Different parameters studied

After 60 days of inoculation, plants were uprooted carefully to study the characters: i) Plant height ii) weight of shoot iii) Length of root iv) weight of root v) Number of galls/g fresh root vi) Number of adult male or female nematode, eggmasses, L_2, L_3 and L_4 stages in 10 galls per treatments.

Counting of galls

After washing, the roots were preserved in 5% formalin 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.

Statistical analysis

Data on the length of plant and root, fresh weight of shoot and root, and number of galls/g of fresh root and number of adult male or female, eggmass, L_2 L_3 and L_4 stage in 10 galls/treatment were analysed statistically to find out the level of significance. The means for all the treatments were counted and the analysis of variance was studied by F-test for the treatment means and replication means. The mean differences were evaluated at P = 0.05 level by Duncan's New Multiple Range Test. Linear Correlation Co-efficient and regression equations were calculated with a standard statistical method.

RESULTS AND DISCUSSION

Experiment no. 1 (bitter gourd)

Seven treatments consisted of five organic materials of Plant origin and a nematicide (Furadan 5G) including control were used in this experiment to evaluate their efficacy against root-knot disease and effect on other parameters like plant growth, galling incidence, eggmass, adult female and larval development in bitter gourd.

Effect on plant height

The highest plant height (267.8 cm) was observed with Furadan 5G followed by Dholkalmi, Mustard oilcake, Saw dust and Saw dust + ash (Table 1). Comparatively lower response was found with ash untreated control. Only Furadan 5G had significantly higher effect as compared to control.

Table 1. Effect of different soil amendments, plant extract and nematicide on the growth and galling incidence of bitter gourd inoculated with *Meloidogyne javanica*

Treatments	Plant height (cm)	Root length (cm)	Shoot weight (g)	Root weight (g)	Number of galls/g root
T_1 (Control)	155.6 b	11.0c	25.4 b	2.30 c	31.4 a
T_2 (Plant extract of Dholkalmi)	210.2 ab	17.6 b	35.4 b	5.57 b	21.0 cd
T_3 (Mustard oil cake)	208.8 ab	15.8 b	35.8 b	4.46 be	21.8 cd
T_4 (Saw dust)	196.8 ab	15.4 bc	30.8 b	3.62 bc	23.2 bcd
T_5 (Ash)	164.2 b	14.2 bc	29.6 b	3.14 bc	27.2 ab
T_6 (Saw dust + Ash)	198.6 ab	15.4 bc	31.4b	3.36 bc	25.6 bc
T_7 (Furadan 5G)	267.8a	22.6a	73.4a	8.37a	18.8d
SE (±)	10.62	0.78	4.41	0.45	0.93
LSD	75.04	4.53	30.23	4.66	5.40

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

Effect on root length

The highest root length (22.6 cm) was found with the treatment T_7 (Table 1). Comparatively higher response was observed with the treatments T_2 and T_3. This was followed by T_4, T_5 and T_6 having. They were found to be identical in response, while the treatment T_1 had the lowest (11.0 cm) root length (Table 1).

Effect on the weight of shoot

Significant variation was found among the treatments with respect to fresh weight of shoot. The highest fresh weight 73.4g of shoot was recorded with T_7 followed by T_1, T_2, T_3, T_4, T_5 and T_6 having (Table 1).

Effect on root weight

Plants treated with Furadan 5G (T_7) gave the highest (8.37g) root weight (Table 1). Higher root weight was found with T_2. This was followed by T_3, T_4, T_5 and T_6. Statistically they were similar. The lowest root weight (2.3g) was observed in T_1. Other than T_7, all the treatment gave significantly lower identical response in root weight.

Effect on the galling

With respect to galling, control treatment T_1 had the highest (31.4) number of galls (Table 1). This was followed by T_5. Comparatively higher galling was noted with the treatments T_6 and T_4 respectively. Treatments T_2 and T_3 gave significantly lower and identical galling incidence with 21.8 and 21.0 galls/g of root, respectively. The lowest (18.8) no. of galls/g root was achieved with T_7 (Furadan 5G).

Effect on the development of adult female

Significant variation in number of adult females was found in different treatments. The highest (25.80) number of adult females was found in the control treatment T_1 (Table 2). Higher number of adult female was observed in treatment T_5. Moderately higher number 14.2 of adult females was recorded with T_6 followed by T_4 and T_3 respectively. The lowest number of adult female/10 galls were noted with the treatments T_2 and T_7, respectively.

Effect on the eggmass

In respect to eggmass, the highest (13.4/10 galls) no. of galls was recorded with T_1, while the lower no. was found in T_2 and T_7 respectively (Table 2). Higher no. of eggmases were noted in treatments T_5 and T_6, respectively. Comparatively, lower no. was found with the treatment T_4 and T_3.

Table 2. Effect of different soil amendments, plant extract and nematicide on the number of adult female, eggmass, L_2, L_3, and L_4 stages of *Meloidogyne javanica* in bitter gourd

Treatments	Number of adult female/ 10 galls	Number of eggmass/ 10 galls	Number of L_2 stage/ 10 galls	Number of L_3 stage/ 10 galls	Number of L_4 stage/ 10 galls
T_1 (Control)	25.80 a	13.40 a	3.40 a	4.40 a	13.00 a
T_2 (Plant extract of Dholkalmi)	4.40 e	2.00 e	1.20 de	1.20 cd	2.60 d
T_3 (Mustard oil cake)	8.60 d	6.40 d	1.40 cde	1.80 bc	6.40 c
T_4 (Saw dust)	10.80 d	8.40 c	2.00 bcd	2.20 b	7.00 c
T_5 (Ash)	18.80 b	11.20 b	2.60 ab	3.60 a	12.00 a
T_6 (Saw dust + Ash)	14.20 c	10.00 b	2.20 bc	2.60 b	10.00 b
T_7 (Furadan 5G)	2.00 e	1.40 e	0.60 e	0.80 d	1.40 e
SE (±)	1.36	0.74	0.18	0.22	0.72
LSD	2.74	1.38	0.86	0.80	1.19

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

Effect on the larval development

Larval development varied significantly in different treatments (Table 2). All the treatments reduced the larval development as compared to control. The most effective treatment to reduce larval development was Furadan followed by Dholkalmi extract, mustard oil cake and saw dust.

Experiment no. 2 (teasle gourd)

Results obtained in teasle gourd are presented in Table 3 and 4.

Effect on growth parameters

Significant variation in growth parameters were observed due to different treatments. Plant height, root length, shoot and root wt. of teasle gourd was increased due to application of the treatments as compared to control. Furadan was found to be the most effective treatment followed by Dholkalmi extract, mustard oil cake, saw dust, saw dust + ash as compared to untreated control (T_1). Only ash was the least effective treatment (T_5). Similar results were obtained in reducing the no. of galls in the roots. In this case Furadan was found to be the most effective treatment (T_7).

Table 3. Effect of different soil amendments, plant extracts and nematicide on the growth and galling incidence of teasle gourd inoculated with *Meloidogyne javanica*

Treatments	Plant height (cm)	Root length (cm)	Shoot weight (g)	Root weight (g)	Number of galls/g root
T_1 (Control)	139.2 d	8.8 d	27.4 d	1.5 e	7.6 a
T_2 (Plant extract of Dholkalmi)	229.4 ab	14.2 b	58.0 ab	4.3 b	2.0 d
T_3 (Mustard oil cake)	195.4 bc	13.6 bc	55.0 ab	3.48 c	2.6 cd
T_4 (Saw dust)	182.0 cd	12.4 bc	52.0 ab	2.76 cd	4.4 bc
T_5 (Ash)	174.6 cd	10.8 cd	35.0 cd	2.40 d	7.2 a
T_6 (Saw dust + Ash)	178.0 cd	12.0 bc	45.0 bc	2.66 d	6.4 ab
T_7 (Furadan 5G)	242.8 a	20.8 a	62.2 a	5.56 a	1.6 d
SE (±)	7.71	0.7	2.84	0.23	0.48
LSD	44.99	3.01	16.82	0.79	2.12

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

Effect on eggmass, adult female and larval development

Results on eggmass, adult female and various larval stages like L_2, L_3 and L_4 are presented in Table 4. All the treatments caused significant reduction in eggmass, development of adult female and various larval stages. The most effective treatment in reducing no. of adult female nematode per 10 galls was found to be Furadan 5G (2.00) followed by Dhlolkalmi extract, mustard oil cake, saw dust and saw dust + ash. Ash was found to be the least effective treatment (12.60) in comparison to untreated control. Almost identical results were obtained in case of eggmass and different larval stages (Table 4). Effect of Dholkalmi extract was very close to Furadan.

Table 4. Effect of different soil amendments, plant extracts and chemical on the number of adult female, eggmass, L_2, L_3, and L_4 stages of *Meloidogyne javanica* in teasle gourd

Treatments	Number of adult female/ 10 galls	Number of eggmass/ 10 galls	Number of L_2 stage/ 10 galls	Number of L_3 stage/ 10 galls	Number of L_4 stage/ 10 galls
T_1 (Control)	27.40 a	14.00 a	5.60 a	8.60 a	14.20 a
T_2 (Plant extract of Dholkalmi)	4.00 f	2.00 f	1.40 e	1.40 f	2.00 f
T_3 (Mustard oil cake)	8.40 e	4.40 e	2.60 d	2.40 e	5.40 e
T_4 (Saw dust)	12.60 d	7.60 d	3.80 c	3.40 d	7.60 d
T_5 (Ash)	23.80 b	12.60 b	4.80 b	7.60 b	10.80 b
T_6 (Saw dust + Ash)	16.80 c	9.00 c	4.00 c	5.40 c	8.80 c
T_7 (Furadan 5G)	2.00 f	1.20 f	0.40 f	1.00 f	1.20 f
SE (±)	1.56	0.81	0.31	0.49	0.75
LSD	2.21	1.31	0.79	0.82	0.82

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

Seven treatments comprising control (T_1), plant extract of dholkalmi (T_2), mustard oil cake (T_3), sawdust (T_4), ash (T_5), sawdust with ash (T_6) and Furadan 5G (T_7) were used against the root-knot (*Meloidogyne javanica*) of bitter gourd and teasle gourd in this study. The highest plant growth with respect to plant and root length, shoot and root weight with corresponding lower galling incidence were observed with the chemical treatment T_7 both in the bitter gourd and teasel gourd plants inoculated with *Meloidogyne javanica*. The highest galling incidence with corresponding the lowest plant growth in respect of plant and root length and shoot and root weight were observed with the control treatment T_1 (Tables 1 and 3). More or less, identical response in plant growth was found with the rest of the treatments in both bitter gourd and teasel gourd inoculated plants. In case of shoot weight with bitter gourd significantly lower effect was observed in all the treatments other than chemical treatment T_7. Comparatively, better response was obtained with dholkalmi extract followed by mustard oil cake, sawdust and sawdust with ash both in bitter gourd and teasel gourd treated plants (Tables 1 and 3).

Darekar and Mhase (1988) reported similar results of lower galling incidence in bitter gourd along with other vegetable crops with carbofuran. Katalan-Gateva *et al.* (1979) reported that carbofuran reduced the number of *Meloidogyne incognita* in soil and in the roots and inhibited gall formation. Similar reports on the reduction of galling incidence and increase of growth and yield with many vegetable crops by the use Furadan 5G had been reported by Sitaramaiah *et al.* (1976), Siddiqui *et al.* (1993), Gupta and Sharma (1988) and Hassan (1995).

Plant extract of dholkalmi appeared to give higher plant and root length and shoot and root weight in both the vegetable crops (Tables 1 and 3). Similar result were also observed by Ahmad and Karim (1990) and Ahmad and Karim (1991).

Mustard oil cake appeared to have third position in the efficacy in reducing the nematode activity with respect to plant growth in the present study. Effective control of root-knot nematodes (*Meloidogyne javanica* and *Meloidogyne incognita*) and corresponding better plant growth and yield were stated by Zaiyd (1977), Hassan and Saxena (1979), Saifullah *et al.* (1990) and Khan (1996). Mian and Rodriguez-Kabana (1982) reported lower galling incidence with stimulated plant growth in squash. Also reported about toxic existence of biochemical substances that repel the plant parasitic nematodes along with root-knot nematode, *Meloidogyne* spp. Mustard oil cake used as treatment in this study might have given toxic response to the inoculated nematode whereby improved plant growth characters with suppressed galling incidence were recorded (Tables 1 and 3).

Treatment with sawdust appeared to have fifth position in response to plant growth characters and galling incidence. Amendments of soil with sawdust improved the soil condition as a result nematode could not thrive well under such improved condition having lower population that could not harm the plants to the extreme level as observed in this study (Tables 1 and 3). Similar observations were also made by Srivastava *et al.* (1972), Sitaramaiah *et al.* (1976) and Morale and Kurandker (1987).

Ash as a treatment gave the lowest response to plant growth characters along with higher galling incidence in both the vegetable crops (Tables 1 and 3). Morale and Kurandker (1987) reported that sawdust and wood ash reduced gall formation and root damage in aubergines in pot experiment. But in the present study ash alone could not give better effect might be due to variation in the source and nature of the ash used.

Like that of plant growth and galling incidence with treatment Furadan 5G which also appeared to suppress the development of adult females and eggmasses along with L_2, L_3 and L_4 larval stages as evident with the lowest number of all these stages of *Meloidogyne javanica* (Tables 2 and 4). Katalan-Gateva *et al.* (1979) similarly observed reduced nematode population of *Meloidogyne incognita* in the soil and in the roots inhibiting gall formation and nematode development (adult and larvae).

Extract of dholkalmi appeared to give more or less similar response in the development of adult females and eggmasses along with other stages of nematode development (Tables 2 and 4). Ahmad and Karim (1990) stated that extract of dholkalmi leaves was more toxic to juvenile mortality of *Meloidogyne javanica.* The same toxic principle might have worked in this study as a result lower number of adult females, eggmasses, L_2, L_3 and L_4 stages were recorded in dholkalmi plant extract treatment.

In case of mustard oil cake reduction in the number of adult females, eggmasses and different larval stages might be due to the toxic substances released in soil from its applicaiton as described earlier in plant growth and galling incidence (Tables 1, 2, 3 and 4). Hassan and Saxena (1979) reported that hatching of larvae of *Meloidogyne incognita* was inhibited by extract in soil amended with mustard and other oil cakes. Similarly Bora and Phukan (1983) observed significant reduction of *Meloidogyne incognita* population on jute (as judged by gall number and eggmasses/g root and by the nematode population in soil).

Sawdust and ash gave moderately higher number of adult females, eggmass and three larval stages in the present study (Tables 2 and 4) like that of plant growth characters and galling incidence (Tables 1 and 3). Statement given by Morale and Kurandkar (1987) in relation to reduced gall formation and root damage and reduced number of females and eggmasses with treatment of sawdust and wood ash corroborates with the present findings.

CONCLUSION

Results of the present study has revealed that Furadan 5G is very much effective in controlling root knot of nematode (*Meloidogyne javanica*) of bitter gourd and teasle gourd. Plant extract of dholkalmi and mustard oil cake is also very effective. Besides disease control these treatments also increased various growth parameters like plant height, root length, root and shoot wt.

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