World Journal of Agricultural Research, 2014, Vol. 2, No. 1, 1-4
Available online at http://pubs.sciepub.com/wjar/2/1/1

DOI:10.12691/wjar-2-1-1

Comparative Studies on the Performances of Some Plant Cakes and Synthetic Chemicals Against Nematodes in Tea in Bangladesh

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Received December 04, 2013; Revised December 12, 2013; Accepted December 26, 2013

Abstract A comparative study was undertaken to evaluate the performances of plant cakes and synthetic chemicals against nematodes infesting tea at Bangladesh Tea Research Institute (BTRI) during March 2012 to June 2012. The indigenous plants i.e. Bishkatali (Polygonum hydropiper), Mahogani (Swietenia mahagoni) and Neem (Azadirachta indica) and synthetic chemicals i.e. Carbofuran (Furadan 5G), Fipronil (Goolee 3GR) and Rynaxypyr (Ferterra 0.4G) were considered as treatments. The dose of tested plant cakes @ 50g/pot and synthetic chemicals i.e. Furadan 5G @ 35g/pot, Fipronil 3GR @ 35g/pot and Rynaxapyr 0.4G 15g/pot were used in this experiment. Soil samples are regularly collected at weekly interval and samples were analyzed for nematode count at Entomology Laboratory through Baermann funnel method. Result revealed that all the treatments had showed the toxic effect on nematodes and significantly reduced nematode population from the soil. The nematode population in the soil treated with Rynaxypyr 0.4G was the lowest due to the highest mortality of nematodes (85.80%) followed by Fipronil 3G (82.00%), and Carbofuran 5G (81.71%) which was satisfactory. Among the plant cakes, Mahogani cake showed the highest (79.89%) mortality of nematodes in the treated soil. The cakes of Bishkatali (74.82%) and Neem (71.57%) also reduced the nematode population significantly. Rynaxapyr and Mahagani Cake can be used as soil treatments for the management of nematodes to get nematode free soil or safe soil with less nematode for establishing tea nursery. Crude plant cakes of P. hydropeper, S. mahagoni and A. indica can effectively be utilized beside the use of chemical nematicides as safer nematicidal products in integrated pest management of nematodes in tea in Bangladesh.

Keywords: *plant cakes, chemicals, nematodes, tea, Bangladesh*

Cite This Article: M.S.A. Mamun, M. Ahmed, I. Ahmad, M.S. Uddin, and S.K. Paul, "Comparative Studies on the Performances of Some Plant Cakes and Synthetic Chemicals Against Nematodes in Tea in Bangladesh." *World Journal of Agricultural Research* 2, no. 1 (2014): 1-4. doi: 10.12691/wjar-2-1-1.

1. Introduction

Plant-parasitic nematodes are recognized as one of the greatest threat to crops throughout the world. Nematodes alone or in combination with other soil microorganisms have been found to attack almost every part of the plant including roots, stems, leaves, fruits and seeds. Plant parasitic nematodes cause significant economic loses to a wide variety of crops. Crop losses due to nematodes range from 8 to 20% on major crops around the world [1]. Nematodes are a serious problem in the tea nursery now-a-days. Because, more attention is generally paid by the planters to the foliar pests, which are often responsible for immediate damage to tea crop but nematodes go unnoticed for years before. Besides, cultural, mechanical and physical controls of nematodes were not highlighted. It is a serious pest in tea nursery and attacks young roots of seedlings up to the age of 9 months which, cause poor or stunted growth and even death to the nursery plants. The eelworm population in varying degrees have been observe in the affected nurseries of many tea estates. Globally, 82 species of nematodes are associated with tea plants [2]. More than 40 species of plant parasitic nematodes, belonging to 20 genera have been recorded in different tea growing countries of the world [3,4,5]. In Bangladesh tea, 10 species of nematodes have been recorded [6]. Among them, Root lesion nematode, *Pratylenchus loosi*, Spiral nematode, *Helicotylenchus* spp. and Root knot nematode, *Meloidogyne* spp. are mostly associated to tea plants in Bangladesh [7]. The occurrence of *Pratylenchus loosi* and *Meloidogyne* spp. is the maximal in the soil of the tea gardens [8].

Nematode infestation is a gradual process; the plants react with visible symptoms only when an appreciable part of the root system has been destroyed or ceases to function. Stagnation of growth followed by yellowing and wilting of leaves are the earliest signs of nematode attack. In severe cases, die-back and death may occur. The nature of nematode damage may be mechanical, chemical or

physiological or combination of these. The crop loss is estimated to be about 15-20% plant injury and 350-500 kg of made tea per hectare per year in Sri Lanka [9]. The critical value of nematodes in tea soil is 7.00/10g of soil [10]. In Bangladesh tea soil, nematode free soils are not available to establish tea nursery or to fill up poly bag for vegetative propagation. Recently, Guatemala and Citronella are being used as soil rehabilitation crops to suppress nematode population below critical level (<7.00) in field condition to get nematode free or soil with less nematode for establishing tea nursery [11]. It is well known fact that once nematodes are introduced into a field, it cannot be eradicated thereafter. Like many other tea growing countries, Carbofuran (a systemic nematicide) i.e. Furadan 5G @ 165g/m^3 of soil is only the widely useful remedy to reduce nematode population from the tea soil in Bangladesh [12]. Chemical pesticides have been used for a long time, but have serious drawbacks [13], such as direct toxicity to beneficial insects, fishes and human [14], pesticide induced resistance [15], health hazard [16] and increased environmental and social costs [17].

Botanical antimicrobials derived from plants are currently recognized as biodegradable, systemic, eco-friendly and non-toxic to mammals and are thus considered safe [18]. Some plant based antimicrobials (e.g. neem products, pyrethroids and essential oils) are already used to manage pest populations on a large scale. Botanical pesticides are extracted from various plant parts (leaves, stems, seeds, roots, bulbs, rhizomes, unripe fruits and flower heads etc.) of different plant species. Some plants have been scientifically tested and have been found to have good pesticidal properties. Botanicals like Bonkalmi (*Ipomoea maxima*), Bazna *(Zanthoxylum rhetsa)*, Bishkatali (*Polygonum hydropiper*), Datura (*Datura stramonium*), Durba (*Cynodon dactylon*), Eucalyptus (*Eucalyptus globulus*), Ghora-neem *(Melia sempervirens)*, Hijal *(Barringtonia acutangula)*, Karanja *(Pongamia pinnata)*, Mahogoni *(Swietenia mahagoni)*, Marigold (*Tagetes erecta*), Neem *(Azadirachta indica)*, Nishinda (*Vitex negundo*) and Pithraj (*Aphanamixis polystachya*) may be grown by farmers with minimum cost and extracted by indigenous methods [19]. These botanical materials can be used as an alternative to chemical pesticides. It will help in controlling major pests of tea such as *Helopeltis*, Red spider mite, Thrips, Flushworm, Termites, Nematodes etc. The potential indigenous plants described by [20] may be used as biopesticides for the control of insect pests of tea.

The present experiment was undertaken to evaluate the performances of three botanicals namely, Bishkatali (*Polygonum hydropiper*), Mahogani (*Swietenia mahagoni*) and Neem (*Azadirachta indica*) and three novel nematicides namely, Carbofuran (Furadan 5G), Fipronil (Goolee 3GR) and Rynaxypyr (Ferterra 0.4G) against nematodes in tea in Bangladesh. The objectives of the present research work are as follows:

- To determine the toxic effect of plant cakes against soil nematodes in tea.
- To observe the mortality rate of nematodes due to some novel nematicides.
- To compare the performances between plant cakes and nematicides against nematodes in tea.

2. Materials and Methods

An experiment was undertaken to evaluate the performances of plant cakes and synthetic chemical pesticide for the control of nematodes infesting tea plant at Entomology Laboratory, Bangladesh Tea Research Institute (BTRI), Srimangal, Moulvibazar during the period from April 2012 to June 2012. The nematodes were cultured in a pot with sufficient cowdung at the Entomology Laboratory, BTRI, at 27°C to 30°C temperature and 70-80% relative humidity.

2.1. The Test Plants

The indigenous plants namely, Bishkatali (*Polygonum hydropiper*), Mahogoni (*Swietenia mahogani*) and Neem (*Azadirachta indica*) were collected from the different locations of both Shahjalal University of Science and Technology (SUST) campus, Sylhet and Bangladesh Tea Research Institute (BTRI), Srimangal, Moulvibazar, Bangladesh.

Table 1. Plants evaluated for nematicidal activities against nematodes

Scientific name	Common name	Family	Plant parts used
Polygonum hydropiper	Bishkatali	Polygonaceae	Whole plant
Swietenia mahagoni	Mahogoni	Meliaceae	Leaves and seeds
Azadirachta indica	Neem	Meliaceae	Leaves and seeds

2.2. The Test Chemicals

The available synthetic chemicals of different chemistry i.e. Carbofuran (Furadan 5G), Fipronil (Goolee 3GR) and Rynaxapyr (Ferterra 0.4G) were used in this experiment those were collected from the local agent of FMC International, USA; ACI Formulations Limited; and Petrochem (Bangladesh) Limited respectively.

2.3. Preparation of Plant Cake

Fresh leaves, succulent stems, seeds of Bishkatali (*Polygonum hydropiper*), Mahogani (*Swietenia mahagoni*) and Neem (*Azadirachta indica*) were collected locally from nearby areas of SUST, Sylhet and BTRI main farm, Srimangal, Moulvibazar. Each plant material was dried under shade and powdered by using electric grinder and pass through a 20 mesh sieve and kept in a 1 kg capacity polypropylene bag. 300 g of each powdered plant material were taken into a 1 litre capacity conical flask and 500 ml of distilled water was added to it and then kept it for 24 h. After 24hrs the water soaked powder was dried in sunlight for 1 hr to make cake form.

2.4. Pot Experiment

The experiment was designed in Completely Randomized Design (CRD) with three replications at the Entomology Laboratory, BTRI in pot experiment (Plate 1). Soils were collected from nematode cultured plots of Entomology Division. 5 kg of such soil was taken into 20 cm dia plastic pot. Thereafter the tested plant cakes @

50g/pot and synthetic chemicals i.e. Furadan @ 35g/pot, Fipronil 3GR @ 35g/pot, and Rynaxapyr 0.4G @ 15g/pot were applied. Plant cakes and chemical nematicides were mixed thoroughly with pot soils. All pots were kept moist by sprinkling tap water as when required. Untreated pot was considered as Control. Pretreatment was done by counting nematodes before application. Second round application of the treatments were done after 2 weeks of the 1st application.

Plate 1. Pot experimental view on nematode control by chemicals and plant cakes

2.5. Counting of Nematodes

Soil samples are regularly collected randomly by inserting soil sampling auger in to the soil up to 0-9″ (23cm) from the respective pot at weekly interval. Each sample was composite of 5 soil cores from each pot. Soil sample was analyzed at the Entomology Laboratory. Extraction was done by "Baermann Funnel Method" with slight modification [21]. Ten grams of soil sample were taken into 50 ml beaker and covered with muslin cloth and kept in the glass funnel (10 cm diameter) in reverse for overnight and nematodes were decanting and sieving into a slide. A rubber tube of 15 cm long was fitted with each stem of each funnel. The rubber tube was closed with a pinch clamp. Tap water was poured in to the funnel until the level is 2.5 cm below the funnel rim. The active nematodes moved through muslin cloth leaving the soil. They were concentrated at the bottom of the rubber tube. Nematodes were collected in a glass slide by releasing the pinch clamp along with small quantity of water. Then nematodes were counted through Stereoscopic microscope.

Performance of the treatments in suppressing nematode population was calculated by using Henderson & Tilton formula [22]:

$$\text{Corrected percent mortality} = \left(1 - \frac{cbxta}{caxtb}\right) \text{ x } 100$$

Where,

cb = No. of insect population in control before treatment
ca = No. of insect population in control after treatment
tb = No. of insect population in treated before treatment
ta = No. of insect population in treated after treatment

2.6. Statistical Analysis

The experimental data were statistically analyzed by Completely Randomized Design (factorial CRD) using MSTAT statistical software in a microcomputer. The results are expressed as Mean and data were statistically analyzed by ANOVA, with the level of significance set at $p<0.05$. The mean values adjusted by Duncan's Multiple Range Test (DMRT) [23].

3. Results and Discussion

Plant parasitic nematodes or eelworms are associated with rhizosphere soils of tea plantation in the tea growing countries including Bangladesh. The effects of different plant cakes of Bishkatali (*Polygonum hydropiper*), Mahogani (*Swietenia mahagoni*), Neem (*Azadirachta indica*) and synthetic chemicals i.e. Carbofuran (Furadan 5G), Fipronil (Goolee 3GR) and Rynaxypyr (Ferterra 0.4G) against nematodes in are presented in Table 2.

Table 2. Effectiveness of Bishkatali, Mahogani, Neem, Carbofuran 5G, Fipronil 3GR and Rynaxypyr 0.4G against nematodes in tea

Treatments & Chemicals	Dose/m^3 soil	Pre-treatment observation (No. of nematodes/10 g of soil)	Performances of plant cakes and chemicals against nematodes in tea soil (%)				Overall mean (%)
			after 1st application		after 2nd application		
			1st wk	2nd wk	3rd wk	4th wk	
T_1 Bishkatali	50g	46	73.68	63.90	83.24	78.44	74.82d
T_2 Mahogani	50g	53	78.78	70.64	89.27	80.89	79.89c
T_3 Neem	50g	43	63.10	62.28	82.59	78.30	71.57e
T_4 Carbofuran 5G	165g	41	83.58	75.39	90.04	77.83	81.71b
T_5 Fipronil 3GR	165g	49	85.98	75.12	88.10	78.80	82.00b
T_6 Rynaxypyr 0.4G	70g	47	89.24	78.30	94.29	81.36	85.80a
T_7 Control (No. of nematodes)	-	38	46	57	65	73	-

Mean of 3 replications. Figures with different letters are statistically different from each other by DMRT (p>0.05.)

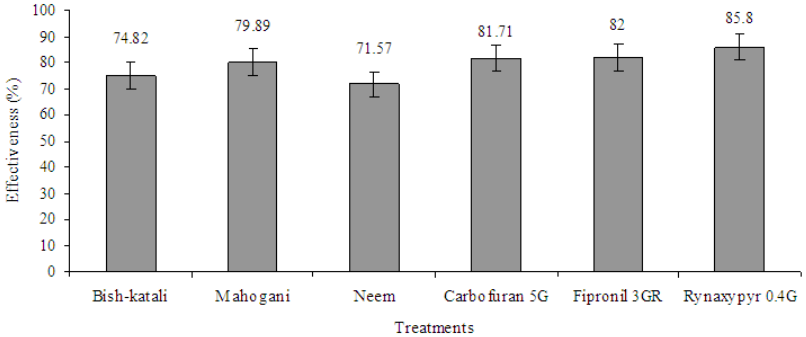

Figure 1. Performances od plant cakes and synthetic chemicals against nematodes in tea

Result revealed that the treatment differences were found to be statistically significant ($P<0.05$). All the treatments had showed the toxic effect on nematodes and significantly reduced nematode population from the soil. The nematode population in the soil treated with Rynaxypyr 0.4G was the lowest due to the highest mortality (85.80%) followed by Fipronil 3GR (82.00%), and Carbofuran 5G (81.71%). Among the plant cakes, Mahogani cake showed the highest (79.89%) mortality of nematodes in the treated soil followed by Bishkatali (74.82%) and Neem (71.57%) treated soil (Figure 1).

Among the chemicals Rynaxypyr showed the highest toxic effect on nematodes. Among the plant cakes Mahogani cake showed the highest toxic effect on nematodes. Similar trend of results were obtained by [24,25,26,27]. Planters can use the products for the control of nematodes in the tea nursery. It may be recommended from the findings that Rynaxapyr and Mahogani cake can be used as soil treatments for the management of nematodes to get nematode free soil or safe soil with less nematodes for establishing tea nursery. Crude plant cakes of *P. hydropiper*, *S. mahagoni* and *A. indica* can effectively be utilized beside the use of chemical nematicides as safer nematicidal products in integrated pest management of nematodes in organic tea estates as well as traditional tea estates in Bangladesh.

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