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Performance of some plant cakes against plant parasitic nematodes in tea

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Abstract
An experiment was conducted to study the performance of some indigenous plant cakes against plant parasitic nematodes in tea at Entomology Laboratory, Bangladesh Tea Research Institute (BTRI), Srimangal, Moulvibazar during August 2014 to November 2015. Indigenous crude plant cakes of Marigold (*Tagetes* sp.) (leaves, flowers and stems), Karanja (*Pongamia pinnata)* (leaves and fruits), Chirota (*Swertia chirayaita*) (leaves and stems), Neem (*Azadirachta indica*) (leaves) and Mahagoni (*Swietenia mahogani*) (seeds) were selected for the study. Each treatment was replicated thrice. Soil samples were analyzed in the Nematology Laboratory, Entomology Division for the counting of the nematodes. Extraction was done by Baermann Funnel Method with slight modification. Then nematodes were counted through Stereoscopic microscope. The result revealed that the treatment differences were found to be statistically significant ($P<0.05$). All the treatments showed the toxic effect in reducing nematode populations significantly from the soil. Among them, Marigold plant cake showed the highest (78.80%) mortality of nematodes in the treated soil followed by Mahogani (77.08%) and Neem (75.40%). It is concluded that the tested plant cakes may effectively be utilized as the safer nematicidal products in integrated management of nematodes in tea.

Keywords: Plant Cakes, Tea, Plant Parasitic Nematodes, IPM

1. Introduction
Nematodes have been found to attack almost every part of the plant including roots, stems, leaves, fruits and seeds. Plant parasitic nematodes are found in the soil affect the root system of the plant. Plant parasitic nematodes are recognized as one of the greatest threat to crops throughout the world. But most of them have no positive evidence of pathogenicity [1]. However, infestation of root-knot nematodes *Meloidogyne incognita*, *M. hapla* and *M. javanica* are very destructive to young tea plants in the nursery in India and Bangladesh. Plant parasitic nematodes cause significant economic losses to a wide variety of crops. Crop losses due to nematodes range from 8 to 20% on major crops around the world [2]. 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. 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 [3]. The eelworm populations in varying degrees have been observed in the affected nurseries of many tea estates. Globally, 82 species of nematodes are associated with tea plants [4]. More than 40 species of plant parasitic nematodes, belonging to 20 genera has been recorded in different tea growing countries of the world [1, 5, 6]. In Bangladesh tea, 10 species of nematodes have been recorded. 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 [1]. The critical value of nematodes in tea soil is 7.00/10g of soil [9]. Nematode free soils are not available to establish tea nursery or to fill up poly bag for vegetative propagation.

Recently, Guatemala and Citronella are recommended to use as soil rehabilitation crops to suppress nematode population below the critical level (<7.00) for establishing a nematode free tea nursery [10]. 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 [11]. Chemical nematicides have been used for a long time for controlling nematodes in tea, but have serious drawbacks, such as direct toxicity to beneficial insects, fishes and human being, pesticide induced resistance [12].

Botanicals are biodegradable, systemic, eco-friendly and non-toxic to mammals and are thus considered safe [13]. 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 against plant parasitic nematodes [14]. These botanical materials can be used as an alternative to chemical pesticides. This will in turn help in controlling the major pests of tea such as *Helopeltis*, Red spider mite, Thrips, Flushworm, Termites, Nematodes etc. [15].

So far, there is no report on the efficacy of plant cakes for the management of notorious tea garden nematode pests. Therefore, the present research was designed to test the efficacy of cakes prepared by different types of plants on nematode pests.

2. Materials and Methods

An experiment was undertaken to evaluate the performances of plant cakes for the control of nematodes infesting tea plant at Entomology Laboratory, Bangladesh Tea Research Institute (BTRI), Srimangal, Moulvibazar during the period from August 2014 to November 2015. 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 Test Plants

The indigenous plants namely, Neem (*Azadirachta indica*), Mahagoni (*Swietenia mahagoni*), Karanja *(Pongamia pinnata)*, Marigold (*Tagetes* sp.) and Chirota (*Swertia chirayaita*) were collected from the different locations of both Jahangirnagar University (JU) campus, Savar and Bangladesh Tea Research Institute (BTRI), Srimangal, Moulvibazar, Bangladesh. Details of the plants, their scientific names, family names and plant parts utilized in the experiment are given below (Table 1).

Table 1: Plants evaluated for nematicidal activities against nematodes in tea

Scientific Name	Common Name	Family	Plant Parts Used
Azadirachta indica	Neem	Meliaceae	Leaves
Swietenia mahagoni	Mahagoni	Meliaceae	Seeds
Pongamia pinnata	Karanja	Fabaceae	Leaves and fruits
Tagetes sp.	Marigold	Asteraceae	Leaves, flower and stem
Swertia chirayaita	Chirota	Gentianaceae	Leaves and Stems

2.2 Preparation of Plant Cake

Fresh leaves of Neem (*Azadirachta indica*), seeds of Mahagoni (*Swietenia mahagoni*), leaves and fruits of Karanja *(Pongamia pinnata)*, leaves, flower and stem of Marigold (*Tagete* sp.) and leaves and stems of Chirota (*Swertia chirayaita*) were collected locally from nearby areas of Jahangirnagar University, Savar and BTRI main farm, Srimangal, Moulvibazar (Fig. 1). 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. 500 g of each powdered plant material were dissolved in 1lit distilled water and kept it for 24 hrs. After 24hrs the water soaked powder was dried in sunlight for 1 hr to make cake form.

2.3 Pot Experiment

The experiment was designed in a Completely Randomized Design (CRD) with three replications at the Entomology Laboratory, BTRI in a pot experiment (Fig. 1). Soils were collected from nematode cultured plots of Entomology Division. 5 kg of such soil was taken into 1 ft^3 tin pot. Thereafter the tested plant cakes @ 50g/pot 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 was done after 2 weeks of the 1st application.

2.4 Counting of Nematodes

Soil samples were 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 samples were analyzed in the Nematology Laboratory, Entomology Division for the counting of the nematodes. Extraction was done by Baermann Funnel Method with slight modification [16]. 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 on a glass slide by releasing the pinch clamp along with a small quantity of water. Then nematodes were counted through Stereoscopic microscope. Performance of the treatments in suppressing the nematode population was calculated by using Henderson & Tilton formula [17]:

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

Where,

cb = No. of nematode population in untreated field before treatment

ca = No. of nematode population in untreated field after treatment

tb = No. of nematode population in treated field before treatment

ta = No. of nematode population in treated field after treatment

2.5 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).

Plate 1. Leaves of Marigold (*Tagetes* sp.)

Plate 2: Seeds of Mahagoni (*Swietenia mahagoni*)

Plate 3: Leaves of Karanja (*Pongamia pinnata*)

Plate 4: Leaves,flowers and stems of Chirota (*Swertia chirayaita*)

Plate 5: Leaves of Neem (*Azadirachta indica*)

Plate 6: Pot experiment with different plant cakes

Fig 1: Some indigenous plants used in the experiment and experimental pot

3. Results and Discussion

The effects of different plant cakes of Neem (*Azadirachta indica*), Mahagoni (*Swietenia mahagoni*), Karanja (*Pongamia pinnata*), Marigold (*Tagetes* sp.) and Chirota (*Swertia chirayaita*) against nematodes in are presented in Table 2.

Table 2: Percent effectiveness of different plant cakes against nematodes in tea garden soil sylhet, Bangladesh

Treat Ments	Dose/m³ soil	Pre-treatment data (No. of nematodes/ 10 g of soil)	Effectiveness of plant cakes against nematodes in tea soil (%)								Overall mean (%)
			1st Application				2nd Application				
			Aug 15		Sep 15		Oct 15		Nov 15		
			1st quart	2nd quart	1st quart	2nd quart	1st quart	2nd quart	1st quart	2nd quart	
T_1	50g	20	79.01	75.51	72.79	70.61	82.42	77.14	75.16	70.54	75.40c
T_2	50g	23	88.34	74.49	70.52	67.35	87.18	81.51	76.71	70.54	77.08b
T_3	50g	25	78.93	70.05	65.18	64.98	80.15	72.68	67.74	65.41	70.64d
T_4	50g	22	86.39	73.81	68.25	65.71	89.74	85.88	82.61	78.01	78.80a
T_5	50g	24	77.04	66.52	66.27	66.07	64.74	80.88	75.54	72.94	71.25d
T_6	-	26	31	37	43	49	54	58	62	67	-

T_1= Neem, T_2= Mahogani, T_3= karanja, T_4= Marigold, T_5= Chirota and T_6= Control
Mean of 3 replications. Figures with different letters are statistically different from each other by DMRT (p>0.05)

Result revealed that the treatment differences were found to be statistically significant (P<0.05). All the treatments showed the toxic effect on nematodes and significantly reduced nematode population from the soil. Among the plant cakes, Marigold cake showed the highest (78.80%) mortality of nematodes in the treated soil followed by Mahogani (77.08%), Neem (75.40%), Chirota (71.25%) and Karanja (70.64%) treated soil (Fig. 2).

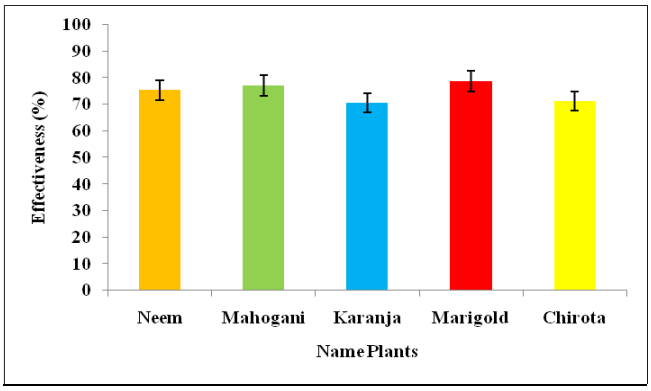

Fig 2: Performance of indigenous plant cakes for controlling nematodes in tea

The nematicidal potential of baker tree (*Milletia ferruginea*), Bitter leaf (*Vernonia amygodalina*), parthenium (*Parthenium hysterophorus*), lantana (*Lantana camara*), Mexican marigold (*Tagetes minuta*), Mexican tea (*Chenopodium ambrosioides*), Neem (*Azadira chtaindica*) and Pyrethrum (*Chrysanthemum cineraria folium*) against *M. incognita* was assessed on tomato under field conditions [18]. The study revealed that lantana and Mexican marigold leaves extract at 5% concentration reduced root-knot nematode infestation and increased the number of fruits and total tomato yield and can be used effectively for the management of root-knot nematode in tomato and they can be used as a component of integrated root-Knot nematode managements. The similar trends of result were obtained by the authors [19, 20].

Among the plant cakes Marigold cake showed the highest toxic effect on nematodes. Similar trend of results using plant cakes against nematodes in tea were obtained by the researchers [21]. The nematode population in the soil treated with Rynaxypyr 0.4G was the lowest due to high 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 a tea nursery.

4. Conclusion

Use of indigenous plant extracts *i.e.* botanicals is safe, cost effective and ecofriendly control option under integrated pest management (IPM). Crude plant cakes of Marigold (*Tagetes* sp.), Karanja *(Pongamia pinnata)*, Chirota (*Swertia chirayaita*), Neem (*Azadirachta indica*) and Mahagoni (*Swietenia mahogani*) can effectively be utilized beside the use of chemical nematicides as safer nematicidal products in integrated pest management of nematodes in tea in Bangladesh. Planters can use the products for the control of nematodes in the tea nursery. These plants are easily available in and surrounding the tea gardens and planters can prepare the plant cakes by easy methods. Previous works revealed that the effectiveness of chemical nematicides performs well than plant cakes. However, plant cakes are eco-friendly, safe and can be made with minimum cost. It may be recommended from the findings that Marigold 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 a tea nursery.

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