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Studies on the bio-efficacy of botanicals against rice root-knot nematode, *Meloidogyne graminicola* development

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Abstract
Triclosan (TCS) has been widely used as an antibacterial and antifungal agent in household cleaning and personal care products. The widespread use of TCS in the cleaning products poses a potential risk to the ecological system and human health due to its release into sediments, wastewater and ground water resources causing chronic toxicity to aquatic organisms. Therefore, it is necessary to develop a fast, simple, and efficient method for monitoring TCS in the environment. In this article the studies of detection methods for TCS in the environmental samples in recent years are reviewed.
Bio-efficacy of botanicals like Neem (Azadiracta indica), Turmeric (Curcuma longa), Zinger (Zingiber officinale) and Eucalyptus (Eucalyptus globules) was studied against rice root-knot nematode, Meloidogyne graminicola under pot conditions. The decomposed leaves of each plants @ 5,10 and 15 g/kg soil was well mixed in the soil rice seeds were sown directly in the soil. At harvest, the observations on the plant height, root length, plant weight, number of galls, nematode population on root and soil, eggs/plant, total nematode population and multiplication factor were recorded. The observations revealed that the Plant growth parameters (plant height, root length, plant weight) and nematode reproduction parameter (Number of galls, nematode population on root and soil, eggs/plant, total nematode population and multiplication factor) increased significantly over the control. The highest plant growth parameters were observed in inoculated check. The per cent reduction in the plant growth parameters over Uninoculated check was 20.61, 23.80, 28.59, 17.23, 20.42, 22.85, 16.46, 17.50, 22.53, 17.42, 1947 and 22.97 per cent in plant height,59.13, 71.72, 83.04, 48.26, 58.69, 74.34, 55.43, 66.30, 77.61, 42.39, 50.00 and 45.65 percent in root length 10.19, 15.19, 21.66, 10.83, 17.20, 29.93, 12.74, 16.56, 23.57, 10.19, 14.01, and 17.83, percent in plant weight,54.98, 58.96, 65.33, 92.98, 57.76, 62.54, 50.19, 53.38, 63.56, 43.42, 49.80 and 59.36 percent in number of gall/ plant, 60.23, 72.56, 81.11, 53.08, 66.60, 76.73, 52.68, 62.22, 73.16, 45.72, 56.85 and 69.78 percent in root population, 72.68, 80.68, 86.06, 70.47, 76.81, 82.14, 67.79, 73.16, 81.25, 60.31 and 78.90 percent in eggs population/plant, 57.39, 62.07, 69.12, 56.14, 67.78, 55.34, 60.62, 66.63, 47.63, 35.15, and 57.04 percent in soil population, 68.66, 75.12, 81.01, 66.11, 72.25, 77.85, 63.96, 69.37, 76.87, 56.37, 65.35 and 72.37 percent in total nematode, 68.72, 75.08, 81.09, 66.07, 72.26, 77.91, 63.95, 69.43, 76.85, 56.36, 65.37 and 72.44, percent in multiplication factor.

Keywords: Rice root-knot nematode, *Meloidogyne graminicola*, Nematode Management, Organic amendaments, Eco-friendly nematode management

Introduction
Rice-Wheat cropping system is the major cropping system of India contributing 200.44 MT production of wheat and rice from 73.85 Mha. Area out of the total cropped area of the country. Both rice and wheat crops are known to suffer from many nematode pests, out of them *Meloidogyne graminicola* is known to be the serious common nematode pest of both the crops. More than 300 nematode species belonging to 30 genera have been reported to infected rice and wheat, among them *Meloidogyne graminicola* is known to be a most distractive pest for rice-wheat cropping system and reduce crop yield up to 21% in rainfed and well drained soils throughout the country (Prasad *et al*., 1987). Therefore need for a sophisticated and ecologically safe management system to reduce *Meloidogyne graminicola* population. The use of organic amendments for reducing population of *Meloidogyne graminicola* is although a time taking, coastally and sometime practically not feasible, but ecologically safe and maintain the biological health of the soil. Looking to the benefits of the organic amendments application in the soil and their bio-efficacy in reducing nematode population, Scientists also emphasized their use for the management of important nematode pest (Nanjegowda *et al*. 1998; Steffen *et al*. 2008; Mukesh and Sobita, 2013; Mukesh and Simon, 2013) [5, 9]. Accordingly studies on the bio-efficacy of botanicals against rice root-knot nematode, *Meloidogyne graminicola* in rice and wheat was initiated.

Materials and Methods

Neem (*Azadiracta indica*), Turmeric (*Curcuma longa*), Zinger (*Zingiber officinale*) and Eucalyptus (*Eucalyptus globules*) leaf compost was prepared using NADEP method for the study. Pot soil were sterilized, mixed with leaf compost and filed in 9 inch earthen pots. All the treatments were prepared by mixing well decomposed leaves of various botanicals/ weed plants @ 5, 10 and 15g/kg soil containing 3 larvae/g. All the treatments were replicated four times with a control without adding leaves in 6 inch diameter earthen pots. The Seed of susceptible rice variety Sarju-52 was sown directly in the pots. The pots were left undisturbed for a period of 30 days, on expiry of the period, all the plants were uprooted, washed carefully and processed for recoding observations on, plant height, root length, fresh plant weight, number of J_2, J_3, J_4, mature females eggs and males / plant after staining the plant root system using the staining procedure of Byrd (1983) [2]. For determining the number of galls and nematode population in the roots, plants was uprooted carefully after expiry of the experimental period and washed for free of soil. The total numbers of galls and nematode population present on the roots were counted under stereoscopic binocular microscope.'

Results and Discussion

The observations on the management of rice root-knot nematode, M. graminicola with botanicals like Neem (Azadiracta indica), Turmeric (Curcuma longa) Eucalyptus (Eucalyptus globulus) Zinger (*Zingiber officinale*) @ 5, 10 and 15g/kg soil indicated that the all treatments was found effective in reducing the nematode population in comparison to the Uninoculated check and increased the plant growth parameters. The per cent reduction in the plant growth parameters over Uninoculated check was observed 20.61, 23.80, 28.59, 17.23, 20.42, 22.85, 16.46, 17.50, 22.53, 17.42, 1947 and 22.97 per cent in plant height,59.13, 71.72, 83.04, 48.26, 58.69, 74.34, 55.43, 66.30, 77.61, 42.39, 50.00 and 45.65 percent in root length 10.19, 15.19, 21.66, 10.83, 17.20, 29.93, 12.74, 16.56, 23.57, 10.19, 14.01, and 17.83, percent in plant weight,54.98, 58.96, 65.33, 92.98, 57.76, 62.54, 50.19, 53.38, 63.56, 43.42, 49.80 and 59.36 percent in number of gall/ plant, 60.23, 72.56, 81.11, 53.08, 66.60, 76.73, 52.68, 62.22, 73.16, 45.72, 56.85 and 69.78 percent in root population, 72.68, 80.68, 86.06, 70.47, 76.81, 82.14, 67.79, 73.16, 81.25, 60.31 and 78.90 percent in eggs population/plant, 57.39, 62.07, 69.12, 56.14, 67.78, 55.34, 60.62, 66.63, 47.63, 35.15, and 57.04 percent in soil population, 68.66, 75.12, 81.01, 66.11, 72.25, 77.85, 63.96, 69.37, 76.87, 56.37, 65.35 and 72.37 percent in total nematode, 68.72, 75.08, 81.09, 66.07, 72.26, 77.91, 63.95, 69.43, 76.85, 56.36, 65.37 and 72.44, percent in multiplication factor. The reduction in may be due to the presence of various types of chemicals present in the test plants. i.e.

Mukesh and Sobita (2013) conducted studies on Nematicidal activity of plant extracts against *Meloidogyne graminicola* including Neem (*Azadirachta indica*), Bael (*Aegle marmelos*), Jatrofa (*Jatropha curcas*), Eucalyptus (*Eucalyptus globus*), Sahjan (*Moringa oleifera*), Ber (*Ziziphus mauritiana*), Sarifa (*Annona reticulate*), Congress grass (*Parthenium argentatum*) and reported that the Neem, Bael, Jatropha, Eucalyptus and Congress grass leaf extracxts increased Shoot length, Root length (cm.) and Root weight (gm.) significantly.

Prasad *et al.* (2005) [6]. conducted studies on the effects of seed cakes of castor (*Ricinus communis*), neem (*Azadirachta indica*) and *Simarouba glauca* (*Quassia simarouba*) at 2.5 or 5.0 g/kg soil as soil treatments, and seed extracts of *S. glauca* at 2.5 or 5% as root dip or soil drench on the growth of rice and population of root-knot nematode (*M. graminicola*). The application of castor cake at 5 g/kg soil enhanced plant growth parameters (shoot weight and length, and root weight and volume) even in the presence of the nematode. The lowest number of egg masses of *M. graminicola* was recorded for neem cake applied to soil at 5 g/kg soil, root dip + soil drench with 5 and 2.5% of the seed extract of *S. glauca*, and soil application of *S. glauca* cake at 5 g/kg soil.

Steffen *et al.* (2008) [9] conducted studies on essential oils of medicinal plants i.e *Lavandula angustifolia, Cymbopagon citratus, Eucalyptus globulus, Mentha pilerita, Rosmarimus officinalis, Matricaria chamomilla, Ocimum basilicum, Achyrocline satureioides, Origunum vulgare and Foeniculum vulgare* and evaluated them were evaluated for the control of *Meloidogyne graminicola*. The nematicidal and nematostatic activity of these essential oils on the hatching and the mortality of the second stage juveniles were first evaluated *in vitro*. Thereafter, the essential oils that showed the higher nematode mortality percentage and Sixty five days after the inoculation, the effect of the oils on the *M. graminicola* showed smaller gall and egg numbers, resulting in 68% reduction of *M. graminicola* reproduction.

Nanjegowda *et al.* (1998) [5] observed the efficacy of various neem (*Azadirachta indica*) products neem seed kernel, neem leaf, neem cake, Nimbecidine and a nematicide (carbofuran) were evaluated against *M. incognita* in a tomato nursery. All the neem products and carbofuran significantly reduced the nematode population and increased the plant growth compared to control. However, carbofuran was found to be more effective in reducing root galling and increasing plant growth, followed by neem leaf, seed kernel, cake and Nimbecidine. Mukesh and Simon (2013) experiment conducted on plant leaf extracts in pot including Neem, Bael, Jatropha, Eucalyptus and Congress grass leaf extracxts were found significantly increased shoot length, root length (cm.) and root weight (gm.) and reduced root gall in different concentration i.e 100% and 50%. The 100% plant leaf extracts of Neem and Bael showed highest increase in plant growth parameters i.e shoot length, root length, root weight and highest reduction of root gall as compared to treatment nematode alone.

Table 1: Effect of botanicals on plant growth parameter in rice root nematode infected plant**.**

Treatments	Plant height (cm's)	% Decrease over control	Root Length (cm)	% Decrease over control	Plant Weight/ Plant(g)	% Decrease over control	Galls/ Plant	% Decrease over control
AZ@5g	18.90	20.61	7.32	59.13	1.73	10.19	28.25	54.98
AZ@10g	19.40	23.80	7.9	71.72	1.82	15.92	25.75	58.96
AZ@15g	20.15	28.59	8.42	83.04	1.91	21.66	21.75	65.33
CL@5g	18.37	17.23	6.82	48.26	1.73	10.83	29.5	92.98
CL@10g	18.87	20.42	7.30	58.69	1.84	17.2	26.5	57.76

CL@15g	19.25	22.85	8.02	74.34	1.93	29.93	23.5	62.54
ZO@5g	18.25	16.46	7.15	55.43	1.77	12.74	31.25	50.19
ZO@10g	18.42	17.50	7.65	66.30	1.83	16.56	29.25	53.38
ZO@15g	19.20	2253	8.17	77.61	1.94	23.57	24.5	63.56
EG@5g	18.40	17.42	6.55	42.39	1.73	10.19	35.5	43.42
EG@10g	18.80	19.47	6.90	50.00	1.79	14.01	31.5	49.80
EG@15g	19.27	22.97	7.50	45.65	1.85	17.83	25.5	59.36
UC	15.67	-	4.60	-	1.57	-	62.75	-
IC								
CD value	0.39		0.34		0.023		2.53	

AZ-*Azadiracta indica*, CL- *Curcuma longa*, ZO-*Zingiber officinal*, EG-*Eucalyptus globules*, UC-Uninoculated Check, IC-Inoculated Check, MF-Multiplication Factor.

Table 2: Effect of botanicals on development of rice root knot nematode *M. graminicola* in rice plant

Treatments	Root Population/ Plant	% Decrease over control	Egg/Plant	% Decrease Over control	Soil Population /Plant	% Decrease Over control	Nematode Population/ Plant	% Decrease Over control	MF	%Decrease Over control
AZ@5g	50.00	60.23	3230.75	72.68	2137.5	57.39	5318.25	68.66	1.77	68.72
AZ@10g	34.50	72.56	2285.00	80.68	1902.75	62.07	4221.75	75.12	1.41	75.08
AZ@15g	23.75	81.11	1649.00	86.06	1548.75	69.12	3221.50	81.01	1.07	81.09
CL@5g	59.00	53.08	3492.75	70.47	2200	6.14	5751.75	66.11	1.92	66.07
CL@10g	42.00	66.60	2743.00	76.81	1924.25	61.64	4709.25	72.25	1.57	72.26
CL@15g	29.25	76.73	2112.5	82.14	1616.00	67.78	3757.75	77.85	1.25	77.91
ZO@5g	59.50	52.68	3809.75	67.79	2240.00	55.34	6109.25	63.96	2.04	63.95
ZO@10g	47.50	62.22	3174.25	73.16	1975.25	60.62	5197.00	69.37	1.73	69.43
ZO@15g	33.75	73.16	2217.75	81.25	1673.75	66.63	3925.25	76.87	1.31	76.85
EG@5g	68.25	45.72	4694.25	60.31	2642.25	47.32	7404.75	56.37	2.47	56.36
EG@10g	54.25	56.85	3476.00	70.61	2349.75	53.15	5880.00	65.35	1.96	65.37
EG@15g	38.00	69.78	2495.00	78.90	2155.00	57.04	4688.00	72.37	1.56	72.44
UC	125.75	-	11829.75	-	5016.50	-	16972.00	-	5.66	00.00
IC										
CD at 5%	9.09	-	378.67	-	29.40	-	-	-	-	-

AZ-*Azadiracta indica*, CL- *Curcuma longa*, ZO-*Zingiber officinal*, EG-*Eucalyptus globules*,UC-Uninoculated Check, IC-Inoculated Check, MF-Multiplication Factor.

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