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Eco-friendly management of root-knot nematode (*Meloidogyne graminicola*, Golden & Brichfield) on Wheat

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Abstract:

A total of seven treatments with four replications were taken up in RBD and the parameters observed were number of galls and larva per root system, root weight (g), shoot weight (g), root length and shoot length (cm) after thirty, sixty, ninety days of inoculation. Treatments comprised of Control (M. graminicola), (M. graminicola+FYM), (M. graminicola+Neem cake), (M. graminicola+Mustard cake), (M. graminicola+Nemola), (M. graminicola+Carbofuran 3G) and (plant alone without nematode). Second stage juveniles of M. gramincola @ 2250 J_2/ml of suspension were inoculated in the pots seven days after germination. The experimental results showed that the significantly increased of root weight (3.97 g), shoot weight (17.25 g), number of larvae (189) and number of seeds per ear head (42) in the treatment neem cake followed by plant alone, mustard cake, FYM, carbofuran 3G and nemola including with control (nematode inoculated plants). Whereas, maximum significantly increased the root length (15.25 cm) in the treatment carbofuran (3G) as compared with plant alone (15.15 cm), neem cake (15.06 cm), mustard cake (13.12 cm), nemola (13.12 cm), FYM (12.46 cm) and control (11.06 cm). While, a reduction of gall formation of soil nematodes density, and improvement of plants by amendments with cake of neem, mustard, nemola, Carbfuran (3G) and FYM.

Key words: *Meloidogyne gramincola*, Neem, Mustard, Nemola, Carbfuran 3G, FYM and Wheat plant.

Introduction

Wheat (*Triticum aestivum* L.) is a member of the family Poaceae, which includes major cereal crops such as sorghum, maize, wheat, rice, millet and barely (Briggle and Reitz, 1963). It is nutritious, easy to store and transport and can be processed into various types of food. Wheat provides 70-90% of all calories and 66-90% of the protein, 55% of the carbohydrate and 20% of the calories consumed globally in developing countries (Breiman and Graur, 1995). Wheat is cultivated under a wide range of climatic conditions. India, the world's second-biggest wheat grower, had produced a record 94.88 million tonnes of wheat in the 2011-12. Poor rains in 2012-13 lowered the output to 92.46 million tonnes. Wheat acreage remains higher in Uttar Pradesh at 9.94 million hectares, Madhya Pradesh at 5.78 million hectares and Rajasthan at 3 million hectares (Anonymous, 2013). Root-knot nematode, *Meloidogyne graminicola* is one of the major constraints to rice production and causes significant yield losses which vary from low to high depending on the severity of infestation (Golden *et al*., 1968; Padgham *et al*., 2004). The nematode infestation is manifested by root galling, yellowing, stunting and wilting of the plants. The rice root-knot nematode, *M. graminicola* completes its life cycle in 15 days at 27-37°C (Jaiswal and Singh, 2010). An adult female reproduces approximately 300 eggs mainly laid in the cortex (Singh *et al.,* 2006). The rice root-knot nematode, *M. graminicola* is widely distributed in upland, lowland, deepwater and irrigated rice growing areas of the world (Bridge and Page, 1982; Soriano and Reversal, 2003). The root-knot nematode is making its importance felt in almost all the rice growing areas. *M. triticoryzae* infecting both rice and wheat including some monocot weeds is also reported

from India (Gaur *et al*., 1993) and its occurrence is restricted to a few areas. *M. graminicola* is a serious pest of upland rice and nurseries world over in well drained soils (Rao *et al*., 1986). The nematode was reported on irrigated rice in Andhra Pradesh (Sharma and Prasad, 1995) and Karnataka (Prasad and Varaprasad, 2001). (Oteifa, 1952) reported that a high inoculum level of the *M. incognita* reduced shoot growth of Lima bean (*Phaseolus lunatus*) accompanied by a decrease in shoot-root ratio.

Organic manure is of paramount importance not only in augmenting the crop production but also for making the agriculture sustainable as an ecofriendly means of soil health management (Mishra and Nayak, 2004). The neem tree (*Azadirachta indica* A. Juss.) is a tropical evergreen tree (deciduous in drier areas) native to Indian sub-continent (Anonymous, 1985; Roxburgh, 1874). It has been used in Ayurvedic medicine for more than 4000 years due to its medicinal properties. Neem pesticides play a vital role in pest management and hence have been widely used in agriculture. Azadirachtin is the main ingredient used to manufacture bio pesticides. One of the most important advantages of neem-based pesticides and neem insecticides is that they do not leave any residue on the plant. Musabyimana and Saxena (1999) have reported that application of neem cake at 100 g/plant reduced the numbers of *Pratylenchus goodeyi* and *Meloidogyne* spp. in banana. The control of the root knot nematodes has been a major problem because of their ubiquitous nature and very wide host range (Adesiyan *et al.,* 1990).The use of synthetic pesticides has been found to increase the yield of agricultural products by over ten times when used to manage nematode problems.

However, the effects of pesticide overuse and misuse around the world has led to costly environmental pollution and disruption of the balance of nature (IITA, 2000). The concern over indiscriminate use of chemicals in the control of pests has

led to the sourcing of alternatives. that are effective, ecologically safe and economical (Rajapakse, 1990). Such alternatives include the use of botanicals derived from very cheap and renewable sources, especially tropical plants (Ewete and Alamu, 1999).

The present study was undertaken to evaluate the comparative performance of fym, *neem cake, mustard cake,* nemola in comparison to carbofuran in the management of *M. graminicola* and the consequent effect on the yield of wheat.

Materials and Methods:

An experiment was conducted in a glass house at the SHIATS, Allahabad during November 2013 to March 2014. Soil was collected from naturally *M. graminicola* infested field of SHIATS, Allahabad. Infested soil was filled @ 5 kg /pot of 25 cm diameter. Organic amendments *viz.,* neem cake, mustard cake, nemola were incorporated in to the soil @ of 400 kg/ha and FYM @ 10t/ha. Carbofuran 3G @ 2 kg a. i./ha (0.3 g/pot) 15 days prior to sowing of wheat seeds. Four pots were kept as control (*i.e.* without amendments).To get three larvae / gm of soil culture of *Meloidogyne graminicola* was prepared from the infested roots and tearsed in to small pieces by needle, to prepare nematodes suspension. The larvae suspension of *Meloidogyne graminicola* @ 2250 J_2 / pot was inoculated in each replicate of the treatments at two leaf of wheat seedling in the pots. The treatments were replicated four times in a complete randomized block design.

Ninety days after inoculation plants were uprooted and washed gently with running tap water to remove soil. Data were recorded on shoot length (cm) (30, 60 and 90 days), shoot weight (g), root-length (cm), root weight (g), number of root-knot gall, the number of larvae per root system and length of the ear head, seeds per ear head at 90 days after inoculation according to (Sharma-poudyal *et al.,* 2002).

Statistical analysis

The data recorded on various aspects during the experiment was statistically analyzed by the method suggested by Fisher and Yates (1968). The interpretation of the result was carried out on the basis of F-test and critical difference at 5% level of significance between means (Table: 1).

Results and Discussion

Result shows significantly increased root- weight (gm) of wheat plant at 90 DAI (days after inoculation) of the *Meloidogyne graminicola* in different treatments T_3 -*M. graminicola*+Neemcake (3.97); T_7 –Plant alone (3.72); T_4 -*M. graminicola*+Mustard cake (3.62); T_2 –*M. graminicola*+FYM (3.23); T_6 -*M. graminicola*+carbofuran (3.13); T_5 -*M. graminicola*+Nemola (2.48) as compared to T_1 (2.72). Significantly decreased the root-weight was recorded in T_5 -*M. graminicola*+Nemola (2.48) as compared T_1 -*M. graminicola* (2.72); T_6 –*M. graminicola*+Carbofuran (3.13), T_2 -*M. graminicola*+FYM (3.23) were non-significantly with each other but significant over the treatments T_4, T_7 and T_3. Similar results are agreement with those of Dongre and Simon (2013) who reported that the 100% plant leaf extracts of Neem and Bael showed highest significantly increased plant growth parameters of shoot length 30.23 and 29.50 (cm), root length 54.00 and 51.33 (cm), root weight 0.66 and 0.43 (gm) and highest significantly reduction of root gall 22.66 and 35.33 as compared to treatment (T_1 - Nematode alone). The use of organic amendment which will act as an asset to control environmental pollution.

Result revealed that significantly increased root length (cm) of wheat plant at 90 DAI of the *Meloidogyne graminicola* in the treatments T_6 –*M. graminicola*+Carbofuran (15.25), T_7 – Plant alone (15.15), T_3 -*M. graminicola*+neemcake (15.06), T_4 -

M. graminicola+Mustard cake (13.12), T_5 -*M. graminicola*+nemola (13.12), T_2 -*M. graminicola*+FYM (12.46) as compared to T_1 (11.06). Among the treatments (T_6, T_7, T_3, T_5, T_4) and (T_5, T_4, T_2, T_1) were not statistically from one another.
Result recorded significantly increased shoot weight (gm) in the treatment T_3 (17.33) as compared with T_7 (17.08); T_4 (14.91); T_5 (14.58); T_6 (14.13) and T_2 (13.86) including with control T_1 (11.56). Whereas, treatments T_4, T_5, T_6 and T_2 were found non significant among themselves.

Result shows that significantly increased number of root-knot of wheat plant at 90 days inoculation of the *Meloidogyne graminicola* in treatment T_1 (104) as compared with T_4 (46),T_5 (45), T_2 (41) T_3 (36), T_6 (12) and T_7 (0). However, maximum reduction of the root knot gall in the chemical treatment while, all the organic amendments were reduced in root knot gall as compared with control (*M. graminicola*). Similar results are in agreement with those of Pramanik et al. (2004) who reported that the Carbofuran 3G @ 1 kg a.i./ha once in nursery and another at 45 DAT in main field achieved 61–75% reduction of *M. graminicola* population along with simultaneous increase in grain yield of rice.

Result revealed that significantly increased number of root-knot larvae in the control T_1 (370) followed by T_5 (255); T_2 (191); T_3 (188.75); T_4 (188.75); T_6 (70) and T_7 (0). Among all the organic amendments were least number of larvae as comparison to control. Similar result is reported by Javed *et al.* (2007) who find curative application of neem formulations significantly reduced the number of egg masses and eggs per egg mass as compared with the control.

Results revealed that the shoot length (cm) varied from 20.81 cm to 28.41cm at 30 days after inoculation of *M. graminicola*. Significantly reduction of plant height recorded in Nemola treatment (28.41) as compared with FYM (28.41), Neem cake (28.31), Mustard cake (27.77) and un-inoculated

plants (24.75). Among the treatment (T_1, T_5), (T_2, T_3, T_4, T_7), which was not significantly different from one another.

It was observed from the result of 60 days after inoculation of *M. graminicola.* The shoot length was significantly increased in Neem and FYM cake treated pots followed by Mustard cake. The shoot length of (T_2, T_3) and (T_4, T_7) formed non-significantly from each other. Inoculated the treatments of neem cake show maximum height followed by FYM, Mustard cake and plant alone. Which are significantly increased from the treatment of Carbofuran, nematode inoculated plants and Nemola.

At 90 days after inoculation the plant height of wheat shows the variation of shoot length from (54.75 cm) (66.49 cm), among the treatments maximum shoot length was obtained in Neem cake (66.49) as compared with FYM (62.71) and Mustard cake (61.93). Which are non significant to each other but significantly increased shoot length from Nemola (54.75) Carbofuran (58.66). Among the treatments (T_7, T_1) and (T_5, T_6) are non significant to each other. Similar results are in agreement with those of Kumar and Khanna (2006) who reported that the NSKE drench produced the best plant growth, closely followed by Econeem. Meena *et al.* (2009) also reported biopesticidal of some organic cakes, *viz.* neem cake, sesamum cake, mustard cake, cotton cake and castor cake at the dose of 3g and 5g/pot were found significantly effective in plant growth promotion and reduction in nematode population (*Heterodera cajani*) in the following order: neem cake>sesamum cake>mustard cake>cotton cake>castor cake.

Results shows number of seed per ear head, all the treatments of organic amendments including control significantly increased number of seed from nematode alone including plants. Among the treatments carbofuran (34.7) and nemola (31.5) are not significantly from each other, whereas FYM, Mustard cake (38) and Plant alone (36.5) also found significant from one another.

In conclusion, the results show that the significantly increased of root weight, shoot weight, number of larvae and number of seeds per ear head in the treatment neem cake. While, maximum significantly increased the root length in the carbofuran (3G). Thus, the use of control agent must be given considerable attention on a priority basis for the welfare of the farmers as well as the human community.

Table: 4.1 Effect of oil cakes and FYM on growth parameter and root-knot nematode in Wheat plant.

Treatments	Root weight (g)	Root length (cm)	Shoot weight (g)	No. of root-knot gall	No. of root knot larvae	Seeds/ear head
T_1- Control (*M. graminicola*)	2.72	11.06	11.56	104	370	24.25
T_2 -*M. graminicola*+FYM	3.23	12.46	13.86	41	191	38.5
T_3 -*M. graminicola*+neem cake	3.97	15.06	17.33	36	188.75	42
T_4 -*M. graminicola*+mustard cake	3.62	13.12	14.91ab	46	188.75	38
T_5 -*M. graminicola*+nemola	2.48	13.12	14.58	45	255	31.5
T_6 -*M. graminicola*+carbofuran	3.13	15.25	14.13	12	70	34.75
T_7 -Plant alone	3.72	15.15	17.08	0	0	36.5
F-test	S	S	S	S	S	S
C. V.	19.93	11.95	16.32	28.58	19.94	13.84
C.D (P=0.05)	0.96	2.41	3.58	17.22	53.49	7.21

Table: 4.2 Effect of oil cakes and FYM on Shoot length after inoculation with root-knot nematode in Wheat plant.

Treatments	Shoot length (cm)		
	30 DAI	60 DAI	90 DAI
T_1- Control (*M. graminicola*)	24.29	44.37	54.38
T_2 -*M. graminicola*+FYM	28.31	52.59	62.71
T_3 -*M. graminicola*+neem cake	28.41	52.87	66.49
T_4 -*M. graminicola*+mustard cake	27.77	49.21	61.93

T_5 -*M. graminicola*+nemola	20.81	42.93	54.75
T_6 -*M. graminicola*+carbofuran	22.53	45.81	58.66
T_7 -Plant alone	24.75	48.57	63.98
F-test	S	S	S
C. V.	13.18	6.53	6.94
C.D (P=0.05)	4.94	4.66	6.23

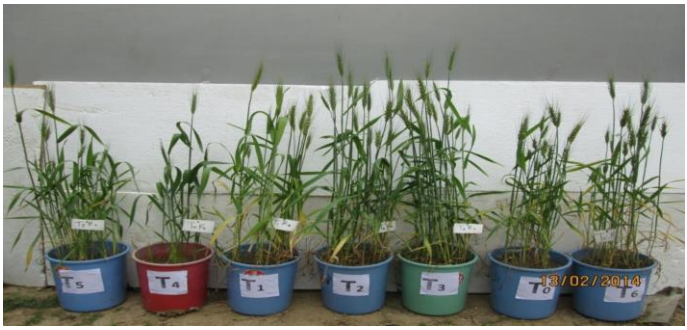

Plate:1. Effect of organic amendments on shoot-length (cm) at 90 day after inoculation in the *Meloidogyne graminicola*. T_0: Control (*M. graminicola*), T_1: *M. graminicola*+FYM, T_2: *M. graminicola*+neemcake,T_3:*M.graminicola*+Mustard cake, T_4: *M. graminicola+Nemola*,T_5: *M.graminicola*+Carbofuran 3G , T_6: plant alone).

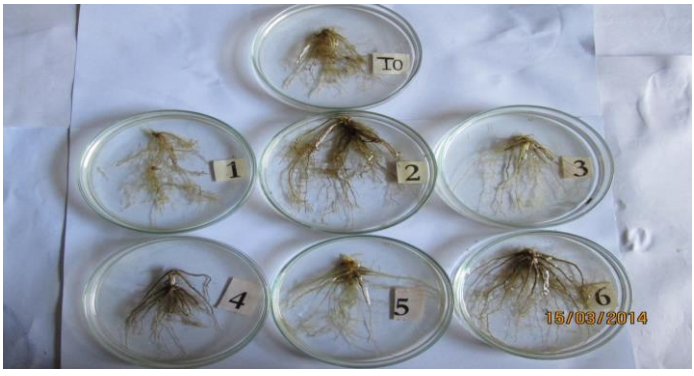

Plate:2. Effect of organic amendments on Root-length (cm), number Root-knot gall at 90 day after inoculation in the *Meloidogyne graminicola* of wheat plant T_0 : Control (*M. graminicola*), T_1: *M. graminicola*+FYM, T_2: *M. graminicola*+neem cake, T_3: *M. graminicola*+Mustard cake, T_4: *M. graminicola*+Nemola, T_5: *M. graminicola*+Carbofuran 3G, T_6: plant alone.

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