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MANAGEMENT OF ROOT KNOT NEMATODE *MELOIDOGYNE INCOGNITA* BY USING OIL CAKE, BIOAGENT, TRAPCROP, CHEMICALS AND THEIR COMBINATION

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ABSTRACT
Tobacco (Nicotiana *tabacum L.*) is one of the most important commercial crops of tropical countries and it is being cultivated in most of the countries. Tobacco is susceptible to several diseases caused by fungi, viruses, Bacteria, root parasites and nematodes, which affect the yield and quality of tobacco both in nursery as well as field. This experiment was conducted to test the efficacy of organic amendment (neem), bio-control agent (*Trichiderma viride*), trap crop (*Tagetes patula*) and chemicals (carbofuran and phorate) as individual treatments and in combinations on the growth of tobacco plants and on the development and multiplication of root-knot nematode *M. incognita.* Among individual treatments, the maximum shoot height, shoot weight, number of leaves (75.66 cm,169.50 g, 12.66 respectively) were recorded in T4 carbofuran treatment where as minimum shoot height, shoot weight and number of leaves (70.50 cm, 156.00 g, 17.33 respectively) were recorded in T3 marigold treatment. Further, maximum root length and rtoot weight (22.33 cm, 45.66 g) were recorded in T4 carbofuran treatment where as minimum was recorded (17.33 cm, 40.66 g) in T3 marigold treatment respectively. The bio-control agent, *Trichoderma viridae* T2 significantly increased the plant growth with respect to plant height; (70.83 cm) shoot weight (158.22 g), number of leaves (10.66) root length and root weight (18.10 cm and 42.16 g) of tobacco plant infested with the *M. incognita*. From the present study, it may be concluded that the improved plant growth is obtained in combination treatments than in individual treatments, which might be due to the additive and interactive effect of the treatment on tobacco plants.

KEYWORDS: Tobacco, neem, root knot nematode, carbofuran, phorate.

INTRODUCTION

Tobacco (*Nicotiana tabacum L.*) is one of the most important commercial crops of tropical countries and it is being cultivated in most of the countries of the world like China, USA, Turkey, Sweden and New Zealand. It is said to have been introduced in to India during 17th century. Tobacco production in the world shows that soil and climate are very important factors which determine the suitability of a region for commercial cultivation of tobacco crop. In general tobacco grows best on sandy loam soils and slightly finer sub soils having ample of drainage, good aeration and high moisture holding capacity. As for climate, a frost free growing seasons of 100 to 120 days with a mean temperature of about 26.7^{o}C and well distributed rainfall from 8.8 to 12.5 cm per month are ideal requirements for tobacco crop. The relative humidity varies from 70-80 per cent in the morning to 50-60 per cent at midday.

Tobacco is rich source of several phytochemicals *viz*, nicotine, nicotinic acid, solanesol amide, organic acids (mallic, oxalic and citric) leaf protein concentrate (LPC), Pentosans and non edible oil. Nicotine sulphate is used as insecticide and also for pharmaceutical purposes.

Tobacco is susceptible to several diseases caused by fungi, viruses, bacteria, root parasites and nematodes, which affect the yield and quality of tobacco both in nursery as well as field. More than 15 species of plant parasitic nematodes from 11 genera found to be associated with tobacco. Among this major damage is caused by root knot nematode *Meloidogyne incognita* followed by stunt nematode *Tylenchorhynchus spp.* The root knot nematode is very common, destructive and widely distributed and it is causing threat for economic production on some of the crops. It has been reported to cause crop loss in tobacco ranging from 15 to 60 per cent.

The control of root knot nematode in tobacco crop is of utmost importance for economic production. Several methods like physical, chemical, biological, breeding for resistance use of organic amendments and integrated management have been made to combat the root knot nematodes. But the present method of control by the use of chemicals is also found to have limitations due to higher cost, non availability, environmental pollution and adverse effect on beneficial micro flora and fauna of the soil. This situation emphasizes on limited use of chemicals for checking the root knot nematode. Hence, there is a need to develop on eco friendly, economical and alternative method for effective management of root knot nematode disease in tobacco.

MATERIAL AND METHODS

This experiment was conducted to test the efficacy of organic amendment (neem), bio-control agent (*Trichiderma viride*), trap crop (*Tagetes patula*) and chemicals (carbofuran and phorate) as individual treatments and in combinations on the growth of tobacco plants and on the development and multiplication of root-knot nematode *M. incognita.* The seeds of tobacco cultivar

KST 19 were sown in earthen pans filled with sterilized soil; simultaneously antagonistic trap crop marigold was raised separately in seed pan containing sterilized soil. Fifty days old tobacco seedlings were transplanted singly in earthen pots. Four marigold *Tagetes patula* seedlings were planted around the tobacco plant. The organic cake (neem), bio-control agent (*Trichiderma viride*), chemicals (carbofuran and phorate) were applied to the soil. A set of tobacco plants were also maintained using with out any treatment but with inoculation of nematodes which served as control. One week after treatments, about 1000 freshly hatched 2nd stage larvae of *M.incognita* were inoculated to each tobacco plant making four holes around the plant and then holes were closed with sterilized soil. The treatments were replicated three times.

The treatment details

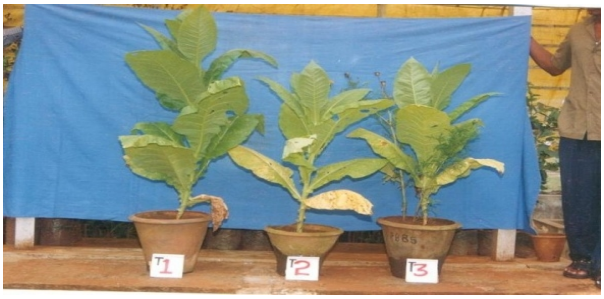
T_1 : Neem cake (NC) (30 g/plant)
T_2 : *Trichoderma viride* (TV) (10 g/plant)
T_3 :Marigold (MG) *Tagetes patula* 4 seedlings/plant
T_4 :Carbofuran (CF) (3 g/plant)
T_5 :Phorate (4 g/plant)
T_6 :NC+TV (15g+5 g/plant)
T_7 :NC+CF (15g+5 g/plant)
T_8 :NC+ Phorate (15+2 g/plant)
T_9 :NC +MG (15 g+2 seedlings)
T_{10} : Control

Forty five days after nematode inoculation the plants were carefully uprooted by lifting the roots, washed free of soil particles under slow running water and were cut into small pieces of 2 cm for counting the number of galls. Observations were recorded on the growth of tobacco plants with respect to shoot height (cm), shoot weight (g), root length (cm), root weight (g), number of leaves per plant and development and multiplication of galls per plant, egg masses per plant.

RESULTS AND DISCUSSION

Among individual treatments, the maximum shoot height, shoot weight, number of leaves (75.66 cm,169.50 g, 12.66 respectively) were recorded in T4 carbofuran treatment where as minimum shoot height, shoot weight and number of leaves (70.50 cm, 156.00 g, 17.33 respectively) were recorded in T3 marigold treatment. Further, maximum root length and toot weight (22.33 cm, 45.66 g) were recorded in T4 carbofuran treatment where as minimum was recorded (17.33 cm, 40.66 g) in T3 marigold treatment respectively (Table 1). Application of carbofuran either individually or in combination with neem cake significantly increased the plant growth parameters of tobacco plants. The results on the effectiveness of carbofuran in improving plant growth parameters are in accordance with the observations made by Gowda *et. al.,* (1988) who reported that tobacco roots when dipped in carbofuran 3G for 60 minutes increased the plant height, root weight and number of leaves of tobacco plants infested with *M incognita*.

In combination treatments, the maximum shoot height, shoot weight and number of leaves per plant (82.33 cm, 204.33 g and 14.33 respectively) were recorded in neem cake+ carbofuran (T7), where as minimum (75.16 cm, 181.00 g and 11.66 respectively) was recorded in neem cake + marigold (T9). Zaki and Maqbool, (1995) reported that carbofuran at 0.02 g/kg of soil increased the fresh shoot weight of tomato plants infested with *M. incognita*. Likewise, Bhagyarathy, (1997) showed that application of neem cake or carbofuran was effective in increasing the leaf yield of mulberry from 2898 kg to 5352 kg /ha. Neem cake (T1) significantly increased shoot height (73.83 cm) shoot weight (163.33g) and root length, root weight and number of leaves (20.00 cm, 42.33g and 11.33 respectively). The present findings on the efficacy of neem cake in the management of *M. incognita* in tobacco is in conformity with the reports of Reddy, *et.al.,* (1993) who opined that application of chopped leaves of neem at 100 g/2 kg of infested soil was effective in reducing the root knot nematode population and improved the plant growth in papaya. Similarly, Chen and Tue (1991) showed that neem cake 20 g per pot was found effective in the management of root knot nematode and increasing the plant growth. Likewise, Gowda, (1999) who showed that application of neem cake at 8



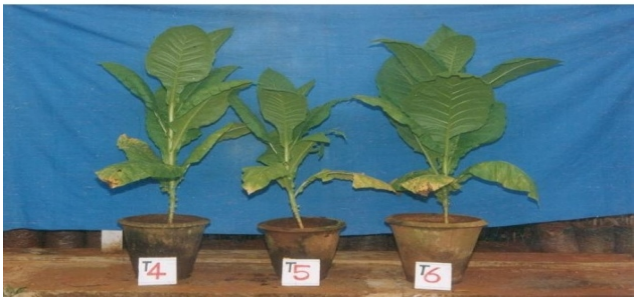


PLATE 1. Effect of various treatments on growth of tobacco plants and galls on roots infested with root-knot nematode *Meloidogyne incognita*

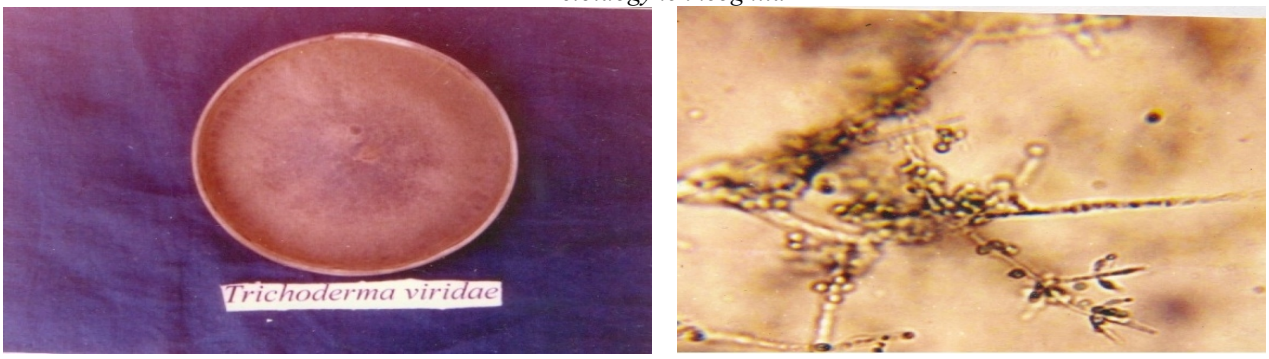


PLATE 2. Growth of *Trichoderma viridae* of potato dextrose agar and mycelium and spore of *T. viridae*

q/ha was effective in reducing root knot nematode population and improved plant growth. Similarly, Deka, U. and Pukhan, (1997) showed the neem cake at 15 g per pot was found effective in management of *M. incognita* on tomato and in increasing the plant growth. The results are also in conformity with the work of Bhattacharya and Goswami, (1989) who observed that significant increase in plant growth and reduction in root galling by *M. incognita* with neem cake at 4% concentration. Further, neem cake significantly increased plant growth of tomato and reduced nematode infestation.The bio-control agent, *Trichoderma viridae* T2 significantly increased the plant growth with respect to plant height; (70.83 cm) shoot weight (158.22 g), number of leaves (10.66) root length and root weight (18.10 cm and 42.16 g) of tobacco plant infested with the *M. incognita*. The present results on the efficacy of *Trichoderma viridae* on plant growth parameters are in conformity with the observations made by Abd-el-Moiety *et.al.,* (1993) who reported that *Paecilomyces lilacinus, Trichoderma harzianum* and *Epicoccum sp* reduced the percentage of egg hatching and larval activity of *M. incognita* and found that reduction was more significant when any two fungal species used in combination or in higher dosage of individual fungus.

The trap crop, Marigold T3 significantly increased plant height (70.50 cm), shoot weight (156.66 g), number of leaves (10.33), root length and root weight (17.33 cm and 40.66 g) when compared to control. The present results on the effectiveness of marigold as trap crop in improving the growth of tobacco plants is in conformity with the work carried out by Kum Kum Walia and Guptha (1997)who showed that the extracts of marigold plants found effective in improving plant growth and reducing nematode population. Further Rangaswamy and Parvathareddy (1993) reported that maximum shoot height, shoot weight was observed in tomato grown with *Tagetes patula*. Similarly, Abid and Maqbool (1990) revealed that the increased root length, shoot weight, number and weight of fruits of tomato grown with *Tagetes* species and there was significant reduction in number of galls due to *M. javanica.* Richard and Dupree (1998) opined that growing of marigold cultivars results in improved growth by reducing root galling in tomato. The combination of treatments significantly improved the plant growth parameters of tobacco. The treatment T7 (neem cake + carbofuran) significantly increased shoot height (82.53 cm), shoot weight (204.33 g) number of leaves (14.33) and root length and root weight (24.33 cm, 48.36 g) when compared to control. The results are in accordance with the observations made by Goswamiand Meshram, (1991). Jain and Guptha (1990) opined that neem cake with carbofuran found effective in improving the plant growth parameters and by reducing the activity of *M. incognita.*

The treatment T8 (neem cake + phorate) significantly increased shoot height (78.33 cm) shoot weight (198.66 g) number of leaves (13.00) root length and root weight (22.66 cm, 46.66 g) which is superior over control. The results of the present study are in line with the observations made by Darekar, (1986)who stated the efficacy of neem cake and phorate in improving the plant growth parameters by reducing the activity of *M. incognita.*The treatment T9 (neem cake + marigold) significantly increased shoot height (75.16 cm), shoot weight (181.00 g), number of leaves (11.66), root length and root weight (20.33 cm, 44.46 g) when compared to control. The results of present study are in line with the observation made by Facknath and Jadunundan, (1990) who stated the efficacy of neem cake and marigold as inter crop in improving the plant growth parameters against *M. incognita* on tomato.

TABLE 1. Management of root – knot nematode (*Meloidogyne incognita*) on tobacco by using oilcake, bio-agent, trap crop and chemicals both individually and in combinations on the growth of tobacco

Treatments	Shoot length (cm)	Shoot weight (g)	Root length (cm)	Root weight (g)	No. of leaves per plant
T_1: Neem cake (NC)	78.83	163.33	20.00	42.33	11.33
T_2:*Trichoderma viride* (TV)	70.83	158.52	18.10	42.16	10.66
T_3:Marigold (MG) *Tagetes patula*	70.50	156.66	17.33	40.66	10.33
T_4:Carbofuran (CF)	75.66	169.50	22.33	45.66	12.66
T_5:Phorate	74.66	165.50	19.66	43.33	12.33
T_6: NC+TV	76.50	182.33	21.16	44.66	11.00
T_7:NC+CF	82.33	204.33	24.33	48.36	14.33
T_8:NC+ Phorate	78.33	198.66	22.66	46.66	13.00
T_9:NC +MG	75.16	181.00	20.33	44.46	11.66
T_{10}:Control	59.83	117.33	15.00	40.33	9.00
SEm±	0.79	0.78	0.74	0.59	0.53
CD at 5 %	2.36	2.33	2.20	1.75	1.58

However, from the results of present study, it may be concluded that the improved plant growth is obtained in combination treatments than in individual treatments, which might be due to the additive and interactive effect of the treatment on tobacco plants.

Effect of various treatments individually and in combination on nematode development and reproduction of *M. incognita* on tobacco.

Among the individual treatments, carbofuran (T4) recorded significant reduction in root galling, number of egg masses (59.66 and 25.33) respectively, followed by neem cake T1 (64.00 and 27.00), *Trichoderma viridae* T2 (66.33 and 29.33) and T3 and (67.66 and 30.00) with respect to nematode development and reproduction. However, the combination treatments were better than individual treatments in suppressing the nematode development and reproduction. The treatment T7 (neem cake + carbofuran) recorded lowest number of galls (36.00) egg masses (19.66) compared to control which had highest number of galls (139.33) and egg masses (59.00) per plant (Table 2).

The treatment T4 carbofuran significantly reduced the number of galls and egg masses (59.66 and 25.33) respectively. The present findings are in conformity with earlier reports of Gowda and Setty (1973) who opined that the number of galls, number of egg masses in tobacco plants infested with root knot nematode was significantly reduced with the application the application of carbofuran. Similar results were also obtained by Reddy *et.al.,* (1993) who also reported the number of galls and egg masses were significantly reduced with the application of carbofuran to tomato plants infested with root knot nematode.

Application of phorate T5 significantly reduced the number of galls and egg masses (62.00 and 26.00) in tomato infested with root knot nematode. The present results with respect to the efficacy of phorate in suppressing nematode development and reproduction are in accordance with the reports of Darekar, (1986) who also indicated that the application of phorate found effective in reducing the root knot nematode population and root knot index on tomato.

TABLE 2. Management of root – knot nematode (*Meloidogyne incognita*) on tobacco by using oilcake, bio-agent, trap crop and chemicals both individually and in combinations on the development and reproduction of the root knot nematode

Treatments	Number of galls/plant	Number of egg masses/plant
T_1: Neem cake (NC)	64.00	27.00
T_2:*Trichoderma viride* (TV)	66.33	29.33
T_3:Marigold (MG) *Tagetes patula*	67.66	30.00
T_4:Carbofuran (CF)	59.66	25.33
T_5:Phorate	62.00	26.00
T_6: NC+TV	56.66	25.33
T_7:NC+CF	36.00	19.66
T_8:NC+ Phorate	43.33	20.33
T_9:NC +MG	59.00	25.00
T_{10}:Control	139.33	59.00
SEm±	1.27	1.58
CD at 5 %	3.79	4.70

The treatment T1 (neem cake) significantly reduced number of galls and egg masses (64.00 and 27.00) respectively. The present findings are in conformity with earlier reports of Gowda and Setty (1973) and Bhattacharya and Goswami (1989) on tomato, who have reported that application of neem cake significantly reduced the nematode population in terms of galling and egg masses per plant on tomato. Application of bio agent *T. viridae* on tobacco infested with root knot has reduced the number of galls (66.33) and egg masses (29.33) and is significantly superior over control. The present findings with regard to the efficacy of *T. viridae* in suppressing the nematode development and reproduction are in conformity with earlier reports of Abd-el-Moiety *et.al,* (1993), they observed that application of *Trichoderma harzianum* reduced the percentage of egg hatching and larval activity of *M. incognita.* The trap crop marigold as inter crop (T3) significantly reduced the number of galls (67.66) and egg masses (30.00) in tobacco infested with root knot nematode. The results are in accordance with the observations made by Kum Kum Walia and Guptha (1997) who opined that inter cropping of marigold with tomato, significantly reduced juvenile hatching in root knot infested tomato plants. Similar results were also obtained by Kum Kum Walia and Guptha, (1997) and Abid, M. and Maqbool (1990) who reported the significant reduction of galling when tomato intercropped with marigold.

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