COMPARISON OF THE NEMATICIDAL POTENTIALS OF DRIED LEAVES OF FIVE PLANT SPECIES AGAINST *MELOIDOGYNE INCOGNITA* INFECTING TOMATO

M.A. Radwan*, E.K. El-Maadawy and M.M. Abu-Elamayem

Department of Pesticide Chemistry, Faculty of Agriculture, University of Alexandria, Egypt

Summary. The nematicidal activity of dried ground leaves of *Datura stramonium, Melia azedarach, Lantana camara*, *Nerium oleander* and *Ricinus communis* against the root-knot nematode, *Meloidogyne incognita*, infecting tomato, was assessed in a glass-house. The powdered leaves of the tested plants were incorporated into the soil at rates of 5 and 10 g/kg and their activity was compared with that of the nematicide carbofuran at the rate of 0.01 g a.i./kg. The effects of the treatments on the growth of tomato were also examined. Populations of *M. incognita* in the soil and root galling of tomato were significantly suppressed by dried leaves of all five plant species tested, with greatest reduction occurring in soil amended with *D. stramonium*, followed by soil treated with leaves of *R. communis*, *M. azedarach*, *L. camara* and *N. oleander.* The control of the nematode was best with the highest rate of application. Eradication of the nematode was obtained by amending the soil with 10 g of dried leaves of *D. stramonium*/kg. All amendments, except leaves of *N. oleander*, significantly improved the growth of tomato.

Key words: Control, *Datura stramonium*, *Lantana camara*, *Lycopersicon esculentum*, *Melia azedarach*, *Nerium oleander*, organic amendments, *Ricinus communis*, root-knot nematodes.

Plant-parasitic nematodes cause diseases to nearly all crop plants of economic importance with estimated losses of US$ 125 billion per year worldwide (Chitwood, 2003). Root-knot nematodes, *Meloidogyne* spp., are the major nematode pests responsible for crop losses all over the world. Control of nematodes relies mostly on the use of synthetic nematicides (Whitehead, 1998), which has led to environmental concerns and problems of mammalian toxicity. This has encouraged scientists to search for alternative sources of effective and eco-friendly chemicals for nematode control (Noling and Becker, 1994).

Soil organic amendments have been explored as a method of suppressing plant parasitic nematodes (Muller and Gooch, 1982; Rodriguez-Kabana, 1986; D'Addabbo, 1995; Akhtar and Malik, 2000; Chitwood, 2002). However, they have mainly been investigated separately. The objective of this research was, instead, to compare the nematicidal efficacy of dried leaves of five plant species that are widely distributed and abundant in different parts of Egypt, and whose nematicidal activity as soil amendments was already known against the root-knot nematode *M. incognita* (Kofoid *et* White) Chitw.

* Corresponding author: e-mail: mohamedradwan5@hotmail.com

MATERIALS AND METHODS

The five plant species were china berry (*Melia azedarach* L.), oleander (*Nerium oleander* L.), lantana (*Lantana camara* L.), castor (*Ricinus communis* L.), and jimson (*Datura stramonium* L.). The leaves of each plant species were collected during the summer season of 2006, air dried under laboratory conditions at 25 °C and finely powdered in an electric grinder. They were then separately mixed with steam sterilized sandy clay loam soil (51% sand, 15% silt and 34% clay, pH 7.8, organic matter 0.73%) at the rate of 5 and 10 g/kg soil and the mixtures used to fill 15-cm-diameter clay pots. The nematicide carbofuran (10% G), provided by FMC Corporation Agric. Chem. Group, was used for comparison. Controls were pots without amendments and without nematodes and pots with the nematode only.

All pots were arranged in a completely randomized block design on a bench in a glass-house at 27-32 °C. Each treatment was replicated three times. The pots were watered daily to ensure proper decomposition of organic matter. After one week, two one-month old tomato cv. Super strain B seedlings were transplanted into each pot. The treatment with the nematicide carbofuran at 10 ppm (0.01 g a.i./kg) was made after transplanting the tomatoes. The plants were inoculated three days later with 5,000 eggs of the nematode per pot by pouring an aqueous suspension of the nematode eggs into four holes 2-4 cm deep around the base of the plants. The eggs of *M. incognita* had been extracted from infected roots of eggplant (*Solanum melongena* L.)

Table I. Effects of amending the soil with dried leaves of some plant species on galls and second stage juveniles (J_2) of *Meloidogyne incognita* and growth of tomato in a soil infested with the nematode.

Treatment	Rate	Galls		Juveniles (J_2) in 250 g soil		Shoots		Roots	
	(g/kg soil)	Per root	% decrease	Numbers	% decrease	Length	Weight	Length	Weight
Datura stramonium	5	13.0	93.4	54.0	93.9	29.0	2.9	16.0	1.5
	10	0.0	100.0	0.0	100.0	22.7	6.8	18.3	2.6
	Mean	7.5	97.1	27.0	97.0	25.8	4.8	17.2	2.1
Ricinus communis	5	69.0	69.1	93.3	89.5	29.5	4.0	18.8	1.7
	10	35.0	84.3	27.7	96.9	25.8	4.1	23.0	2.0
	Mean	52.0	76.7	60.5	93.2	27.7	4.1	20.9	1.8
Melia azedarach	5	68.7	69.2	140.0	84.3	27.3	4.6	17.2	1.7
	10	4.3	98.1	76.0	91.5	28.3	7.5	18.8	2.6
	Mean	36.5	83.6	108.0	87.9	27.8	6.0	18.0	2.1
Lantana camara	5	79.3	64.5	168.0	81.2	25.4	4.7	14.5	0.7
	10	57.7	74.2	140.0	84.3	27.9	5.4	15.9	0.9
	Mean	68.5	69.3	154.0	82.7	26.6	5.0	15.2	0.8
Nerium oleander	5	138.0	38.2	360.0	59.7	20.7	2.8	14.4	0.9
	10	90.0	59.7	216.0	75.8	22.5	3.0	15.0	0.9
	Mean	114.0	48.9	288.0	67.8	21.6	2.9	14.7	0.9
Carbofuran (a.i.)	0.01	45.7	79.5	193.3	78.3	23.6	3.2	10.9	0.7
Control (without nematode)						25.3	4.0	8.8	0.9
Control (with nematode)		223.3		893.3		22.7	2.1	7.9	0.8
$LSD_{0.05}$									
Treatments (T)		30.36		35.20		4.74	1.56	1.83	0.40
Rates (R)		22.40		23.05		4.52	0.73	1.52	0.36
Interaction (T · R)		N.S		N.S		N.S	2.31	N.S	N.S

Each figure is the average of three replicates. For each treatment the mean is the average of the two application rates.

by means of the sodium hypochlorite extraction technique (Hussey and Barker, 1973).

Fifty days after transplanting, the tomato plants were uprooted, washed free of adhering soil and the number of galls per root system, second stage juveniles per 250 g soil, and length and weight of shoots and roots were determined. Second stage juveniles (J_2) were extracted from the soil by the decanting and sieving technique (Goodey, 1963) and counted.

The data were transformed to $\sqrt{x+1}$ and subjected to factorial analysis of variance. Means were compared by LSD at the probability level of 0.05 (Cohort Software Inc., 1985).

RESULTS

Powdered leaves of all tested plant species reduced the number of root galls caused by the nematode infection (Table I), the higher rate being more effective than the lower. Comparisons of treatment means showed that dried leaves of *D. stramonium* reduced root galling the most (97.1%), followed by *M. azedarach* (83.6%), *R. communis* (76.7%), *L. camara* (69.3%) and *N. oleander* (48.9%). However, the efficacy of *M. azedarach*, *R. communis* and *L. camara* was similar to that of carbofuran, and higher than that of *N. oleander*. Also, the higher rate of *D. stramonium* resulted in tomato roots free of galls, while the higher rates of *M. azedarach* and *R. communis* reduced galls by 98.1 and 84.3%, respectively.

Dried leaves of all plants also significantly reduced (59.7-100%) the number of second stage juveniles of the nematode in the soil (Table I) when compared to the inoculated but untreated check, with the higher rates of application being significantly more effective than the lower rates. Again, dried leaves of *D. stramonium* were the most effective as, in the soil amended with their higher rate, the nematode was eradicated. Also effective, but less so than those of *D. stramonium*, were the leaves of *R. communis*, *M. azedarach*, *L. camara* and *N. oleander*. All the treatments, except leaves of *N. oleander*, were significantly more effective than application of the nematicide carbofuran.

The nematode population reduced plant growth (Table I) but the observed differences from the nematode-free control were significant only for the effect on shoot weight. Except for *D. stramonium* and *N. oleander*, the other treatments significantly increased shoot length compared to the untreated inoculated plants. Significant increases in root length occurred in all treatments. The fresh weights of shoots of tomato plants were increased significantly by all treatments bar *N. oleander*, and of roots of all treatments bar *N. oleander* and *L. camara*, compared to those of untreated plants. None of the tested dried leaves was phytotoxic to tomato plants at either application rate.

DISCUSSION

In our study, the two rates of the tested plant leaves significantly decreased the nematode in the soil and tomato root galling compared to the untreated control. The difference in nematicidal activity exerted by the different plant species against *M. incognita* could be explained on the basis of the nematicidal principle(s) that they contain, which may vary qualitatively and/or quantitatively. The low numbers of J_2 in the soil and galling of tomato roots due to amendment of soil with leaves indicates that these plant leaves were effective against the root-knot nematodes, thus confirming previous findings. Chattopadhyay (1991) found that soil amended with leaves of *D. stramonium* reduced root galls caused by *M. incognita* on tomato. The leaves of this plant also reduced the severity of disease caused by *M. javanica* on eggplant (Nandal and Bhatti, 1990) and on sunflower (Amin and Youssef, 1997). Soil admixed with chopped leaves of *R. communis* effectively controlled *M. incognita* attacking tomato (Akhtar and Mahmood, 1993), *M. javanica* (Treub) Chitw. attacking eggplant (Nandal and Bhatti, 1990) and tomato (Zaki and Bhatti, 1989) as well as *M. arenaria* (Neal) Chitw. attacking eggplant (Ibrahim *et al.*, 1998). Leaves of *M. azedarach* or *Azadirachta indica* A. Juss. significantly suppressed the development of *M. incognita* infecting tomato (Akhtar and Mahmood, 1993) and chopped leaves of *L. camara* reduced root galling caused by *M. incognita* on papaya (Reddy *et al.*, 1993).

Application of organic matter to the soil is known to have beneficial effects on soil nutrients, soil physical conditions, soil biological activity and crop performance. Therefore, the growth improvement of tomatoes following amendment with the plant leaves can be attributed partly to nematode control and partly to an increase in soil nutrients. In turn, this may have helped the plant to better tolerate more nematode attack (Alam *et al.,* 1980; Rodriguez-Kabana, 1986; Akhtar and Alam 1993).

Therefore, the use of dried leaves of these plant species, and particularly of those of the unwanted weed *D. stramonium*, shows promise to suppress nematode populations and may provide an alternative to chemicals that is both environmentally safe and economical. However, further evaluation under field conditions is necessary to assess the feasibility of using these dried leaves as a component of an integrated nematode management strategy.

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