Evaluation of some plant extracts for their nematicidal properties against root-knot nematode, *Meloidogyne incognita*

M. Pavaraj*, Ga. Bakavathiappan and S. Baskaran

ABSTRACT

Nematicidal activities of extracts from plants were assayed against *Meloidogyne incognita*. Ten different plants were collected from in and around Sivakasi area. The plants were shade dried and powdered. The plant extracts were prepared by soxhlet apparatus using methanol as a solvent. Methanol extracts of ten plants were screened for egg hatchability and nematicidal activity against second stage juveniles of *M. incognita* in the laboratory. The nematode egg and juveniles exposed 24, 48 and 72 hrs in different concentrations (10 ppm to 100 ppm) of plant extracts. The plant extracts of *Couroupita quianensis* and *Nepeta cataria* exhibited highly promising mortality 73-86% after 72 hrs exposure. There was a gradual decrease in egg hatching with increase in extract concentration. *Nepeta cataria, Couroupita quianensis* and *Pentanema indicum* were found to be most effective in reducing egg hatching. Larval hatching and nematode mortality were strongly influenced by concentration of extract, plant species and duration of exposure.

Key words: *Couroupita quianensis*, larval hatching, nematicidal activity, nematode mortality, *Nepeta cataria*, *Pentanema indicum*

INTRODUCTION

Root–knot nematode, *Meloidogyne incognita* (Kofoid and White Chitwood) (Tylenchida : Heteroderidae) is a major plant – parasitic nematodes affecting quantity and quality of the crop production in many annual and perennial crops. Infected plants shows typical symptoms including root galling stunting and nutrient deficiency, particularly nitrogen deficiency (Siddiqui *et al.,* 2001). Davis and May (2005) reported that the yield loss of cotton production caused by *M. incognita* in 2002 was estimated to be between 18.0–47.3%. Root-knot nematodes (*Meloidogyne*) are among the most destructive nematodes in agriculture, causing an estimated yearly crop loss of $100 billion worldwide (Oka *et al.*, 2000). Nematodes are difficult to control because of their wide host range and high rate of reproduction, with females capable of producing upto thousand eggs/female (Natarajan *et al.,* 2006). Plant–parasitic nematodes are recognized as the causes of serious yield losses on a wide range of crops (Javad *et al.,* 2006). The most destructive species is *M. incognita* which cause serious problem in various agricultural crops.

Chemical control is expensive and is economically viable only for high value crops and create a potential hazard to the environment and human health (Tsay *et al.,* 2004). Because of these inconveniences scientists identified natural products with nematicidal activity such as, root exudates, plant volatile compounds (Linford *et al*., 1938), endophytic bacteria (Vetrivelkalai *et al.,* 2010) and plant extracts (Muniasamy *et al*., 2010; Pavaraj *et al*., 2010). A wide variety of plant species, representing 57 families have been shown to nematicidal compounds (Sukul, 1992), which includes isothiocynates, thiophenics glycosides, alkaloids, phonolics and fatty acids (Gommers, 1973**).** Nematicidal phytochemicals are generally safe for the environment and humans (Chitwood, 2002). These compounds are similar to the synthetic origin compounds, behaving as deterrents, repellents and respiratory poisons or purely as constant nematicides (Baneriji *et al.,* 1985). Hence, the present study has been carried out to evaluate some plant extracts for their nematicidal properties against root-knot nematode *M. incognita*.

MATERIALS AND METHODS

Gomphrena serrata, Pentanema indicum, Crotaloria retusa, Couroupita quianensis, Allamanda cathartical, Guazuma ulmifolis, Nepeta cataria, Leucus aspera, Cymbopogon citratus and *Aristida stricta* leaves were used. The plants were collected in and around Sivakasi. The collected leaves were shade dried and powder with the help of grinder. The powder was extracted by Soxhlet apparatus with 200 mL of methanol as a solvent. The extracted material was then dissolved in methanol (1:10) w/v to prepare stock solution. Different concentrations of plant extracts (10 to 100 ppm)

were prepared from the stock solution using distilled water. For obtaining of egg masses and larvae pure culture of *M. incognita* maintained on tomato plants in sterilized soil. Effect on hatching was evaluated on five mature uniform size egg masses of *M. incognita* were suspended in the extracts and water (control), replicated three times in cavity blocks. The blocks were kept at room temperature. Observations were recorded on number of hatched larvae, dead and alive after 24,48 and 72 hrs. For effect of nemic mortality 30 freshly hatched J_2 of *M. incognita* were placed in each dilutions and control, replicated three times in cavity blocks. The blocks were kept at room temperature. Mortality of larvae was calculated as a percent of total larvae suspended and LC_{50} and LC_{90} values were determined by using probit analysis (Finney, 1971).

RESULTS AND DISCUSSION

Hatchability

There was a gradual decrease in egg hatching with increase in extract concentration (Table 1). Abdalla *et al*. (2008) reported that methanol and hexane extracts of the 27 samples were screened for nematicidal activity against second stage juveniles of *M. incognita* in the laboratory. The juveniles were exposed to 500 ppm of each plant extract for 24, 48 and 72 hrs. Five plant extracts exhibited highly promising mortality rates of 95-99% after 72 hrs of exposure ($P<0.05$). The present study reveled that plant extracts of *N. cataria, C. quianensis* and *P. indicum* were found to be most effective in reducing egg hatching. Plant extracts of basil, marigold, pyrethrum, neem and china berry proved to be effective against *M.incognita* (Susan and Noweer, 2005).

Mortality

Couroupita quianensis and *N.cataria* exhibited more mortality (73-86%) after 72 hrs exposure (Table 2). Okeniyi (2010) observed that the leaf extracts egg hatching of nematode and mortality of the second juveniles of *M. incognita in vitro* after 12 hrs of exposure. Undiluted crude leaf extracts of *H. umbellata* and *M. oppositifolius* exhibited 100% inhibition of egg hatchability and larval mortality, while undiluted leaf extracts of *B. micrantha* and *C. medica* exhibited 92 and 93.2% inhibition of egg hatchability and 62.1 and 73% larval mortality, respectively. Egg inhibition and larval mortality decreased with increase in dilution of all the extracts. Juvenile mortality increased corresponding to an increased time of exposure. The potential of using plant extracts in controlling plant parasitic nematodes has been shown by several

Table 1. Effect of in different concentrations of plant extracts on egg hatchability in the root-knot nematode, *Meloidogyne incognita*

Plants	Exposure time (Hours	% of larval mortality at different dilution (ppm) of plant extracts										
		Con	10	20	30	40	50	60	70	80	90	100
Gomphrena serrata	24	-	-	-	-	-	-	3.33	6.67	6.67	10.00	13.33
	48	-	-	-	6.67	6.67	13.33	16.67	20.00	20.00	23.33	23.33
	72	10.00	3.33	6.67	16.67	23.33	30.00	30.00	33.33	43.33	46.67	53.33
Pentanema indicum	24	-	-	-	-	-	3.33	6.67	10.0	13.33	20.00	26.67
	48	-	-	3.33	16.67	16.67	23.33	26.67	33.33	40.00	46.67	53.33
	72	10.00	6.67	10.00	23.33	26.67	30.00	43.33	43.33	56.67	63.33	66.67
Crotaloria retusa	24	-	-	-	-	-	-	-	6.67	13.33	13.33	16.67
	48	-	-	3.33	3.33	6.67	13.33	16.67	20.00	23.33	23.33	26.67
	72	10.00	-	6.67	10.0	10.00	23.33	26.67	33.33	36.67	36.67	40.00
Couroupita quianensis	24	-	-	13.33	16.67	16.67	23.33	30.0	36.67	40.0	43.33	46.67
	48	-	13.33	13.33	16.67	23.67	30.0	33.33	40.0	46.67	53.33	53.33
	72	10.00	16.67	16.67	20.0	26.67	33.33	36.67	46.67	53.33	66.67	73.33
Allamanda cathartical	24	-	-	-	-	-	-	-	3.33	6.67	6.67	10.00
	48	-	-	-	-	10.00	13.33	20.00	23.33	26.67	36.67	43.33
	72	10.00	-	-	-	10.00	20.0	23.33	26.67	40.00	46.67	56.67
Guazuma ulmifolis	24	-	-	-	-	-	-	3.3	16.67	20.00	23.33	23.33
	48	-	-	6.67	6.67	13.33	16.67	20.00	23.03	33.33	33.33	36.67
	72	10.00	-	13.33	13.33	20.00	26.67	30.00	33.33	40.00	43.33	46.67
Nepeta cataria	24	-	-	-	-	20.0	20.0	23.33	26.67	33.33	36.67	40.00
	48	-	10.00	10.00	20.00	36.67	46.67	46.67	50.00	56.67	63.33	66.67
	72	10.00	20.00	23.33	33.33	36.67	53.33	60.00	66.67	73.33	86.67	86.67
Leucus aspera	24	-	-	-	-	-	-	-	-	3.33	6.67	6.67
	48	-	-	-	-	13.33	13.33	20.00	20.00	23.33	26.67	26.67
	72	10.00	3.33	3.33	6.67	10.0	16.67	16.67	23.33	26.67	33.33	36.67
Cymbopogon citratus	24	-	-	-	-	3.33	3.33	6.67	10.00	10.00	13.33	13.33
	48	-	3.33	3.33	6.67	10.0	16.67	20.00	20.00	23.33	26.67	26.67
	72	10.00	6.67	13.33	16.67	23.33	26.67	30.00	30.00	36.67	43.33	43.33
Aristida stricta	24	-	-	-	-	-	6.67	6.67	6.67	10.00	16.67	23.33
	48	-	-	-	10.00	10.00	13.33	16.67	20.00	23.33	26.67	26.27
	72	10.00	13.33	16.67	16.67	23.33	23.33	26.67	36.67	40.00	43.33	50.00

- indicates no mortality

Table 2. Effect of different concentrations of plant extracts on larval mortality in the root-knot nematode, *Meloidogyne incognita*

Plants	Exposure time (Hours	Egg hatchability at different concentrations (ppm)											Total
		Con	10	20	30	40	50	60	70	80	90	100	
Gomphrena serrata	24	27	39	39	37	36	33	25	20	17	13	07	266
	48	34	33	36	34	32	27	22	17	13	09	04	227
	72	42	24	24	22	18	18	15	15	12	11	07	166
Pentanema indicum	24	27	30	30	25	23	21	17	14	13	10	08	191
	48	34	26	25	22	21	18	15	12	10	07	06	162
	72	42	18	18	15	13	13	09	07	06	04	04	107
Crotaloria retusa	24	27	30	28	27	25	25	22	23	17	12	07	216
	48	34	22	25	23	20	21	18	13	10	08	06	166
	72	42	18	16	16	14	10	12	12	11	11	09	129
Couroupita quianensis	24	27	16	16	13	09	07	07	06	05	05	03	87
	48	34	12	09	07	06	04	03	02	02	01	01	47
	72	42	07	06	04	01	00	00	00	00	00	00	18
Allamanda cathartical	24	27	33	32	28	24	24	21	20	17	11	11	221
	48	34	22	22	22	17	15	12	09	09	05	03	136
	72	42	19	18	16	12	12	10	09	07	05	05	113
Guazuma ulmifolis	24	27	30	28	25	21	17	15	11	09	07	02	165
	48	34	25	25	22	20	16	13	08	07	05	03	144
	72	42	21	20	17	17	15	11	09	09	07	03	129
Nepeta cataria	24	27	13	13	13	10	08	05	04	02	02	01	71
	48	34	09	08	06	03	01	01	00	00	00	00	28
	72	42	02	02	00	00	00	00	00	00	00	00	04
Leucus aspera	24	27	39	33	33	28	25	25	21	18	13	10	245
	48	34	28	27	24	22	19	18	18	13	09	07	182
	72	42	18	17	16	16	13	11	11	09	06	03	120
Cymbopogon citratus	24	27	30	28	22	20	17	14	11	11	08	04	165
	48	34	27	25	22	19	16	13	12	08	05	05	152
	72	42	23	20	19	16	14	11	10	09	07	03	132
Aristida stricta	24	27	32	29	28	24	22	17	15	11	09	09	196
	48	34	24	24	20	22	19	14	13	10	08	05	159
	72	42	19	19	17	16	12	11	11	08	06	03	122

authors (Adegbite and Adesiyan, 2005; Opareke *et al.*, 2005; Orisajo *et al.*, 2007; Abbasi *et al.*, 2008). Extracts from *N. cataria* and *C. quianensis* were the most toxic compared to other plant extracts (Table 3). The nematicidal effect of the tested extracts may possibly be attributed to higher contents of certain oxygenated compounds which are characterized by their lipophilic properties that enable them to dissolve the cytoplasmic membranes of nematode cells and their functional groups interfering with enzyme protein structure (Knoblock *et al.*, 1989).

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Table 3. Toxic effect of different plant extracts against *Meloidogyne incognita*

Plants	Hours	LC_{50}	LC_{90}	Slope ± S.E	Chi Square (χ^2)	Spontaneous response rate
Gomphrena serrata	24	177.12	354.26	4.26 ± 1.52	1.01	0.00
	48	194.72	801.79	2.09 ± 0.51	1.76	0.00
	72	103.38	335.04	2.51 ± 0.71	1.72	0.06 ± 0.33
Pentanema indicum	24	137.56	265.90	4.48 ± 1.14	0.55	0.00
	48	98.56	330.65	2.44 ± 0.41	1.96	0.00
	72	77.96	209.12	2.99 ± 0.69	1.55	0.08 ± 0.04
Crotaloria retusa	24	139.19	233.41	5.71 ± 1.76	2.33	0.00
	48	187.82	775.55	2.08 ± 0.50	0.88	0.00
	72	122.62	377.77	2.62 ± 0.81	2.95	0.05 ± 0.03
Couroupita quianensis	24	110.78	532.38	1.88 ± 0.35	2.37	0.00
	48	101.29	773.18	1.45 ± 0.30	3.62	0.00
	72	80.42	166.44	4.06 ± 1.05	0.99	0.15 ± 0.04
Allamanda cathartical	24	168.71	294.96	5.28 ± 2.23	1.03	0.00
	48	112.51	267.19	3.41 ± 0.63	2.11	0.00
	72	94.21	188.23	4.26 ± 0.93	4.39	0.03 ± 0.02
Guazuma ulmifolis	24	124.98	220.73	5.19 ± 1.24	3.86	0.00
	48	146.03	621.95	2.04 ± 0.42	1.29	0.00
	72	116.19	429.50	2.26 ± 0.69	2.68	0.06 ± 0.03
Nepeta cataria	24	113.80	328.64	2.78 ± 0.51	5.97	0.00
	48	64.21	286.53	1.97 ± 031	3.05	0.00
	72	55.58	124.65	3.65 ± 0.72	1.91	0.16 ± 0.05
Leucus aspera	24	155.37	236.27	7.04 ± 3.63	0.97	0.00
	48	155.35	515.49	2.46 ± 0.54	4.30	0.00
	72	136.34	350.62	3.12 ± 1.17	0.96	0.55 ± 0.02
Cymbopogon citratus	24	161.36	376.56	3.48 ± 0.93	0.71	0.00
	48	245.28	1732.46	1.51 ± 0.39	0.01	0.00
	72	139.27	618.36	1.98 ± 0.75	0.65	0.08 ± 0.04
Aristida stricta	24	164.80	370.78	3.64 ± 1.02	2.43	0.00
	48	184.47	802.47	2.01 ± 0.47	2.20	0.00
	72	122.14	366.14	2.69 ± 1.07	0.63	0.13 ± 0.04

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