Eco-Friendly Management of Phytonematode by Aqueous Extract of Some Agricultural Weeds for Sustainable Agricultural Production

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Abstract

Chemical control of plant-parasitic nematodes, essentially, involves the use of synthetic nematicides. However, apart from its very high cost, increased concern for the environment has necessitated a reduction in the amount of nematicide used for nematode control. Additionally, there has been an increase in the intensity of search for other efficient, ecologically sound and safe control methods. *Meloidogyne incognita*. (Kofoid and White) Chitwood, eggs were exposed to concentrations of leaf extracts of agricultural weeds such as *Parthenium hysterophorus, Nicotiana plumbaginifolia, Avena fatua, Chenopodium album, Amaranthus retroflexus, Chenopodium murale, Amaranathus spinosus, Oxalis corniculata*. One hundred percent concentration of root extracts of *P. hysterophorus, N. plumbaginifolia* exhibited 100% inhibition of egg hatch and larval mortality. While 100% concentration of root extracts of *A. fatua, C. album* exhibited 97.83 and 96.52% inhibition of egg hatch and 95 % larval mortality in both plants at 48 hour. Other plants also exhibited the nematicidal properties. Egg inhibition and larval mortality decreased with an increase in the dilution of all the extracts. Similarly with an increase in exposure time, juvenile mortality was also increased.

Keywords: weed, management, hatching, larval mortality, leaf extracts, *Meloidogyne incognita*

Introduction

Among various pests and diseases, which damage crops, phytonematode nematodes present a formidable pest problem for different crops. Most species attack and feed on plant roots and underground plant parts. Root-knot nematode (*Meloidogyne* spp.), is an important pest of vegetables. Among root-knot nematode, *M. incognita* is a serious threat to the cultivation of both agricultural and horticultural crops throughout the world. For control of this serious plant parasitic nematode, a large number of nematicidal chemicals are used. But, the application of nematicidal chemicals creates serious ecological hazards, like soil and ground water pollution, killing large number of non-target friendly organism and also they are phytotoxic in few cases and costly (Adegbite and Adesiyan, 2005). On the other hand, searches are going on for the use of various plant parts namely root, leaf, bark, stem bulb, flower, fruit, seed etc. as a potential and eco-friendly source of nematicides throughout the world. Aqueous extracts, alcoholic extracts, and decomposition products of some indigenous medicinal plants have shown moderate to strong antihelminthic properties against various plant parasitic nematodes, especially against the root-knot nematode, *M. incognita* (Joymati et al., 2003; Saravanapriya and Shivakumar, 2004; Sasanelli et al., 2007; Saxena and Gangopadhayay, 2005; Joymatidevi, 2007. Plant extracts for nematicidal activity have are briefly reviewed by Sasnelli (1995). In the present *in vitro* experiment, an attempt has been made to investigate the nematicidal properties of leaf extracts of *P. hysterophorus, N. plumbaginifolia, A. fatua, C. album, A. retroflexus, C. murale, A. spinosus, O. corniculata* on the juvenile mortality and egg hatching of *M. incognita.*

Materials and Methods

Preparation of Extracts

The root-knot nematode, *M. incognita* was collected from pure culture maintained at Agricultural Institute, Aligarh Muslim University, Aligarh. Second stage juveniles of *M. incognita* were collected from the egg-masses of mature female nematodes in distilled water after 48 hours of incubation and were used for mortality test. The leaves of *P. hysterophorus, N. plumbaginifolia, A. fatua, C. album, A. retroflexus, C. murale, A. spinosus, O. corniculata* were collected from the agriculture field adjoining area of Aligarh Muslim University, Aligarh. The crude extracts leaves were prepared by 25 g of leaves of each weed plant were macerated separately in 100 mL distilled water for five minutes. All the blended plant extracts were then passed through double layered muslin cloth, then filtrate were centrifuged at 3000rpm for five minutes and finely filtered through Whatman No. 1 filter paper. Filtered and extracts designated as standard (**S**). By the addition of the required quantity of distilled water to the standard extract, other dilution S/2, S/10, and S/100 were prepared. The extracts were stored in a refrigerator for vitro experiments. To assess larvicidal action of the S, S/2, S/10, S/100 solution of leaves of –*P. hysterophorus, N. plumbaginifolia, A. fatua, C. album, A. retroflexus, C. murale, A. spinosus, O. corniculata* , 500±10 freshly hatched second stage juveniles were transferred separately to Petri dishes (40mm diameter) containing 10ml of different solution. Petri dishes containing distilled water served as control. Five replicates for each treatment were kept. The number of dead and surviving second stage juveniles (J2) were counted after 24, 48 and 72 h and mean percent mortality was calculated. Nematode mortality was checked by transferring the immobile nematodes into distilled water for one hour, following the treatment to differentiate between those not moving and killed and those are coma stage. In second experiment five freshly picked and uniform egg masses of *M. incognita* were transferred to 10 mL solution of each dilution of leaf extracts of above weed plants kept in small Petri dishes (40 mm diameter). These Petri dishes were kept in BOD incubation at 27±1°C. Five replicates were maintained for each treatment including the sterile distilled water as control. The observations on the larval hatching were recorded on 5th day of initiation of experiment. The data thus obtained was statistically evaluated (Gomez and Gomez, 1984).

Results and Discussion

Larval Mortality

Table 1 shows the effects of larval mortality over time due to the concentration of extracts of leaves of the test plants. The leaf extracts of test plants were effective in causing larval mortality; S concentration of extracts being more efficacious and show high significant difference than other concentrations. S concentration extracts of *P. hysterophorus* showed 100% mortality after 48 h of exposure time. The juvenile mortality increased with increase in exposure time. The between different concentrations of extracts of the tested plants at all the three intervals tried (12, 24 and 48 h.). The present investigation are in adjustable conformity with the findings of Chandravadana et al (1996) who tested twenty one oil extracts obtained from 12 edible plants species against root knot nematode larvae in terms of their mortality rate and found effective. The work also supported the findings of Nidiry et al. (1994) who investigated seed extracts of *G. superba* against *M. incognita* juvenile for their larval mortality and found inhibitory effect. Recently (Saravanpriya and Sivakumar, 2005) tried out different methanol extracts of plant against *M. incognita* and found effective. Thus from the above findings it can be concluded that the incorporation of plant products such as oil of pre selected plants could provide a suitable and cheaper alternative for management of *M. incognita* and such method of nematode management can also applied in field studies also.

Egg Hatch

Table 2 shows the effect of concentration of extracts of weed plants on number of eggs and percentage hatch inhibition indicated that one hundred percent concentration of leaf extracts of *P. hysterophorus, N. plumbaginifolia* gave the maximum inhibition of egg hatching (100%) followed *A. fatua, C. album, A. retroflexus, C. murale, A. spinosus and O. corniculata* by other plants (Table 2). Other dilutions viz. S/2, S/10 and

Table 1 Effect of aqueous extracts of leaves of different agricultural weeds on the mortality of *Meloidogyne incognita* (J_2) *in vitro*.

Plant species	Exposure period (h)	Percent mortality in different concentration					Regression equation
		S	S/2	S/10	S/100	DW	
Parthenium hysterophorus	12	72(72.00)	54(54.40)	36(36.80)	22(19.20)	0(1.60)	Y=36.80+17.60(X-2.0)
	24	85(86.60)	65(65.80)	48(45.00)	27(24020)	0(3.40)	Y=45.00+20.80(X-2.0)
	48	100(106.80)	87(82.50)	60(58.20)	44(33.90)	0(9.60)	Y=58.20+24.30(X-2.0)
Nicotiana plumbaginifolia	12	68(63.80)	43(48.00)	29(32.20)	21(16.40)	0(0.60)	Y=32.20+15.80(X-2.0)
	24	70(70.00)	51(53.30)	38(36.60)	24(19.90)	0(3.20)	Y=36.60+16.70(X-2.0)
	48	98(100.00)	75(76.30)	56(52.60)	34(28.90)	0(5.20)	Y=52.60+23.70(X-2.0)
Avena fatua	12	66(60.80)	40(45.40)	26(30.00)	18(14.60)	0(-0.80)	Y=30.00+15.40(X-2.0)
	24	68(65.80)	45(49.90)	35(34.00)	22(18.10)	0(2.20)	Y=34.40+19.90(X-2.0)
	48	95(96.20)	71(73.70)	54(51.20)	36(28.70)	0(6.20)	Y=51.20+22.50(X-2.0)
Chenopodium album	12	60(56.60)	39(42.30)	25(28.00)	16(13.70)	0(-0.60)	Y=28.00+14.30(X-2.0)
	24	69(65.00)	42(49.80)	34(34.60)	28(19.40)	0(4.20)	Y=34.60+15.20(X-2.0)
	48	95(95.60)	70(73.10)	53(50.60)	35(28.10)	0(5.60)	Y=50.60+22.50(X-2.0)
Amaranthus retroflexus	12	57(54.40)	38(40.80)	25(27.20)	16(13.60)	0(0.00)	Y=27.20+13.60(X-2.0)
	24	68(64.20)	42(49.00)	33(33.80)	26(18.60)	0(3.40)	Y=33.80+15.20(X-2.0)
	48	93(94.00)	69(71.90)	53(49.80)	34(27.70)	0(5.60)	Y=49.80+22.10(X-2.0)
Chenopodium murale	12	54(51.60)	36(38.60)	24(25.60)	14(12.60)	0(-0.40)	Y=25.60+13.00(X-2.0)
	24	68(62.80)	40(47.60)	30(32.40)	24(17.20)	0(2.00)	Y=32.40+15.20(X-2.0)
	48	90(91.20)	67(69.90)	52(48.60)	34(27.30)	0(6.00)	Y=48.60+21.30(X-2.0)
Amaranathus spinosus	12	52(49.20)	34(36.70)	22(24.20)	13(11.70)	0(-0.80)	Y=24.20+12.50(X-2.0)
	24	68(62.00)	39(46.70)	28(31.40)	22(16.10)	0(0.80)	Y=31.40+15.30(X-2.0)
	48	90(90.60)	66(69.30)	51(48.00)	33(26.70)	0(5.40)	Y=48.00+21.30(X-2.0)
Oxalis corniculata	12	51(47.00)	31(34.70)	20(22.40)	10(10.10)	0(-2.20)	Y=22.40+12.30(X-2.0)
	24	65(59.40)	38(44.40)	26(29.40)	18(14.40)	0(-0.60)	Y=29.40+15.00(X-2.0)
	48	90(89.80)	65(68.40)	49(47.00)	31(25.60)	0(4.20)	Y=47.00+21.40(X-2.0)

Each value is an average of five replicates. Values given in parentheses are nematode mortality (%) calculated from regression equations. S = Standard Extract; S/2, S/10 and S/100 are dilutions of S; DW = Distilled Water.

S/100, though significant, were less effective as compared to S concentration. It is evident that as extract was diluted; toxicity was decreased resulting in correspondent decrease in inhibition and minimum inhibition was observed in distilled water (0% concentration). The inhibitory effect of the extracts might be due to the chemicals present in the extracts that possess ovicidal and larvicidal properties. These chemicals either affected the embryonic development or killed the eggs or even dissolved the egg masses. It has been reported (Adegbite, 2003) and Goswami et al. (1986) that extracts contained alkaloids, flavonoids, saponins, amides including benzamide and ketones that singly and in combination inhibited hatching. It has been concluded from present research that certain plant extracts are a source of cheap and effective nematicides of root knot nematodes. The leaf extracts of *P. hysterophorus, N. plumbaginifolia, A. fatua, C. album, A. retroflexus, C. murale, A. spinosus, O. corniculata* were found to have nematicidal properties. This finding is important from the point of view of controlling root-knot nematodes affecting vegetables without the use of nematicides in view of the environmental pollution likely to cause. The future looks bright for identifying new classes of pesticides from natural plants to replace the synthetic dangerous and expensive chemicals used at present.

Table 2 Effect of aqueous extracts of leaves of different agricultural weed plants species on the hatching of *Meloidogyne incognita* larvae *in vitro*.

Plant species	Number of larvae emerged in different concentrations (within 5 days)					LSD at 5%
	S	S/2	S/10	S/100	DW	
Parthenium hysterophorus	0(100)	15(96.74)	48(89.56)	92(80.00)	460	19.37
Nicotiana plumbaginifolia	0(100)	18(96.08)	52(88.69)	107(76.74)	460	19.48
Avena fatua	10(97.83)	22(95.22)	65(85.87)	137(70.22)	460	19.69
Chenopodium album	16(96.52)	26(94.35)	68(85.22)	149(67.61)	460	19.82
Amaranthus retroflexus	18(96.08)	32(93.04)	78(83.04)	162(64.78)	460	20.06
Chenopodium murale	21(95.43)	43(90.65)	81(82.39)	178(61.30)	460	20.41
Amaranthus spinosus	24(94.78)	52(88.69)	83(81.95)	181(60.65)	460	20.59
Oxalis corniculata	28(93.91)	53(88.49)	89(80.65)	189(58.91)	460	20.71

Each value is an average of five replicates. Values given in parentheses are nematode mortality (%) calculated from regression equations. S = Standard extract; S/2, S/10 and S/100 are dilutions of S; DW = Distilled water.

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