

Management of Root-Knot Nematode *Meloidogyne incognita* on Eggplant with some Plant Extracts

Susan A. Hasabo and E.M.A. Noweer

Plant Pathol. Dept., Nat. Res. Centre, Giza, Egypt.

Under laboratory conditions, five aqueous extracts, of basil leaves (*Ocimum basilicum*), marigold leaves (*Tagetes erecta*), pyrethrum leaves (*Chrysanthemum cinerariaefolium*), neem seeds (*Azadirachta indica*) and China berry leaves (*Melia azedarach*) were tested against the root-knot nematode *Meloidogyne incognita*. All the tested materials affected the survival of the nematode juveniles depending on material property and concentration. Under field conditions, most tested materials have significantly reduced second stage juveniles of *M. incognita* in soil and roots of eggplant (*Solanum melongena*) cv. Baladi compared to oxamyl 24% L and the untreated check. The degree of nematode reduction varied according to the concentration and type of the tested materials. Significant increase in weight of fruits / plant was also achieved by the most tested materials.

Key words: Eggplant, *Meloidogyne incognita* and plant extracts.

Eggplant (*Solanum melongena* L.) is severely damaged by the root-knot nematode *Meloidogyne incognita* (Dhawan and Sethi, 1976 and Netscher and Sikora, 1990). Although chemical nematicides have a great promise for the control of nematodes, but due to hazards involved, use of bioagents has become one of the most feasible alternatives to these chemicals. Many investigators had managed root-knot nematodes by using some extracts of certain ornamental plants (Abd-Elgawad and Omer, 1995). Korayem *et al.* (1993) stated that exposure of *M. incognita* juveniles to standard water extract solution of *Artemisia obsinthium*, *Thymus vulgaris* shoot powder and *Punica granatum* fruit powder for 72 hr reduced the number of active nematodes by 100%. Korayem and Hasabo (1994) also reported that the activities of *M. incognita* juveniles exposed to standard solutions of bulb extract of *Allium sativum* shoot extract of *Chenopodium album*, *C. ambrosioides* and *Senecio aegyptius* were reduced by 100% after 24 hr exposure. In a laboratory study carried out by Joymati *et al.* (1998) on the effect of some aqueous plant extracts on egg hatching and juvenile mortality of *M. incognita*, indicated that seed extract of *Melothria purpusilla* was the most inhibitory one followed by those of *Jatropha curcas* and *Lantana camara*. Extract of *Jasminum multiflorum* showed stronger nematicidal activity than that of *Mimosa pudica*. Flower extract was more effective than leaf or stem extracts of some commercial medicinal plants (El-Nagdi and Mansour, 2003). Also, plant oils (Akhtar and Mahmood, 1993), oil cakes and leaves of neem and seed extracts of castor (Akhtar and Mahmood, 1994 and Youssef and Amin, 1997) have been found to be very promising. Some plant extracts were evaluated for their nematicidal potentials in controlling the root-knot nematode,

M. incognita infesting peanut, *Arachis hypogaea* L (Alshalaby and Noweer, 2003). They showed that the tested plant extracts have significantly inhibited the total number of nematode juveniles, number of galls and number of egg-masses, as well as the total number of root-knot nematodes in soil and peanut roots.

The present study is outlined to test nematicidal potentials of some plant extracts against *M. incognita* juveniles under laboratory and field conditions.

Materials and Methods

Plant extracts:

Ten grams of whole fresh leaves or seeds from each of basil leaves (*Ocimum basilicum*), marigold leaves (*Tagetes erecta*), pyrethrum leaves (*Chrysanthemum cinerariaefolium*), neem seeds (*Azadirachta indica*) and China berry leaves (*Melia azedarach*) were separately mixed in 100ml distilled water in an electric blender for three minutes, then left for 72 hr before filtration through Whatman filter paper No. 1. Each filtrate was considered as a standard solution "S" of 100% concentration and then kept in a freezer until using.

Laboratory test:

Nematicidal effect of plant extracts were evaluated against *M. incognita* under laboratory conditions. Concentrations as 0.5, 2.5 and 5% were prepared by diluting "S" solution with distilled water. About 100 specimens of *M. incognita* juveniles were transferred to the different concentrations of plant extracts in sterilized Petri-dishes in five replicates while, distilled water served as a check (Alam, 1985). Mortality of nematodes was checked microscopically after 24 hr. Nematodes were considered dead when the specimens immobilized, shrunk, or internally vacuolated. Percentage of nematode mortality was calculated according to Abbot's formula (1925).

Field experiment:

Plant extracts as soil drench were evaluated under field conditions, naturally heavily infested with root-knot nematodes *M. incognita*, at El-Mansouria village, Giza governorate. A field experiment comprised of rows 5 m long and 70 cm wide and 70 cm apart between hills. Eggplant seedlings (*S. melongena* L.), about 30 days old, were transplanted at the first of March, 2003. Fifteen days after transplanting, leaf extracts any of basil, marigold, pyrethrum, China berry and extract of neem seeds were used at the concentrations of 5 and 2.5 % at the rate of 50 ml/plant as soil drench. Vydate (oxamyl 24% L) was used at the rate of 0.5% as a comparable treatment. Untreated plants served as a check.

All treatments were arranged in a completely randomized block design in five replicates (replicate= 3 rows) for each treatment. Soil and root samples were collected after four and five months of soil drench (July and August) for nematode analysis by sieving and decanting methods. Juveniles in roots were extracted by incubating roots in water for egg hatching. Also, the weight of eggplant fruits per plant was recorded.

Obtained results were statistically analyzed using Duncan's multiple range test (Duncan, 1955) and percentage of reduction in the second juveniles (J2) counts was estimated according to Anderson and Tilton formula (Puntener, 1981) as follows:

$$\text{Reduction (\%)} = 1 - \frac{\text{J2 PTA} \times \text{J2 PCB}}{\text{J2 PTB} \times \text{J2 PCA}} \times 100$$

Whereas: J2 PTA= Population of the treated plots after application, J2 PCB= Population of the check plots before application, J2 PTB= Population of the treated plots before application and J2 PCA= Population of the check plots after application.

Results

As shown in Table (1) it was noticed that the inhibitory effect of an extract on nematode activity or mortality was concentration dependent, i.e. the activity of the nematode decreased by increasing of extract concentration.

Table 1. Effect of certain concentrations of some plant extracts on *M. incognita* survival under laboratory conditions

Treatment	Nematode mortality (%)		
	Tested concentration		
	0.5 %	2.5 %	5%
Basil	26 *	55	61
Marigold	67	72	100
Pyrethrum	39	48	67
China berry	20	54	56
Neem	16	100	100

* Values are average of 5 replicates.

At 0.5%, the highest percentage of nematode mortality (67%) was caused by extract of marigold followed by pyrethrum (39%) and basil (26%). At 2.5% concentration, the greatest percentage of nematode mortality (100%) was achieved by neem followed by marigold (72%), basil (55%) and China berry (54%). At 5% concentration, the highest percentage of nematode mortality (100%) was achieved by neem, and marigold, pyrethrum (67%), basil (61%) and China berry (56%).

Data in Table (2) indicate that the most tested plant extracts has significantly affected soil and root populations of *M. incognita* infecting eggplant, cv. Baladi, 4 and 5 months after application. In general, the highest concentration of each material achieved the highest reduction percentage of nematode either in soil or roots. After 4 months, the greatest nematode reduction in soil (78.95%) was achieved by 5% neem extract followed by China berry (78.33%) at the same concentration. The lowest nematode reduction (13.78%) occurred in basil or pyrethrum extract at the lowest concentration. After 5 months, the highest nematode reduction (87.43%) was achieved by oxamyl followed by China berry (81.71%) at the highest concentration. The lowest nematode reduction was occurred in basil extract at the highest concentration.

Table 2. Effect of different plant extracts on *M. incognita* infecting eggplant cv. Balady

Treatment	Initially 31/5/ 2003	No. of juveniles / 200g soil				No. of juveniles / 1g roots				Total No. of juveniles in soil and roots			
		4/7/ 2003	Red (%)	1/8/ 2003	Red. (%)	4/7/ 2003	Red. (%)	1/8/ 2003	Red. (%)	4/7/ 2003	Red. (%)	1/8/ 2003	Red. (%)
Untreated check	105	646	-	175	-	1123	-	202	-	1769	-	377	-
Basil extract													
at: 5%	180	348	46.13d	139	20.57e	536	52.27c	105	48.02cd	884	50.03c	283	46.15d
2.5%	120	557	13.78f	203	16.00e	775	30.99de	144	28.71e	1332	24.70e	308	18.30f
Marigold extract													
at: 5%	43	291	54.95cd	50	71.43bc	111	90.12a	69	65.84bc	416	67.22ab	119	68.44bc
2.5%	80	305	52.79cd	71	59.43cd	581	48.26c	188	6.93f	872	50.71cd	259	31.30ef
Pyrethrum extract													
at: 5%	132	273	57.74cd	65	62.86c	517	53.96c	78	61.39c	823	53.48bc	143	62.07c
2.5%	96	557	13.78f	91	48.00d	550	51.02c	132	34.65d	1074	39.29d	223	45.70d
China berry extract													
at: 5%	40	140	78.33a	32	81.71ab	634	43.54cd	82	55.41c	774	56.25bc	114	69.76bc
2.5%	20	470	27.25e	86	50.86d	836	25.56e	105	48.02cd	1306	26.17e	191	42.34de
Neem extract													
at: 5%	25	136	78.95a	38	78.29ab	284	74.71b	49	75.74b	420	76.26a	87	76.92b
2.5%	72	221	65.79bc	153	12.52ef	777	30.81de	85	57.92c	998	43.58cd	23	36.87de
Oxamyl 24% L													
at: 0.5%	28	233	63.93bc	22	87.43a	734	34.64de	6	97.03a	967	45.34cd	28	92.26a

- Values are averages of 5 replicates.

- Data with the same letter(s) within a column are not significantly different according to Duncan's new multiple range test.

- Red. (%) = Percentage of reduction in the second juveniles (J2) counts was estimated according to Anderson and Tilton formula (Puntener, 1981).

In roots, 4 months after application, the highest percentage of nematode reduction (90.12%) was achieved by marigold extract followed by that of neem (74.71%) at the highest concentration. The lowest nematode reduction (25.56%) occurred in China berry extract at 2.5% concentration. After 5 months, the highest nematode reduction (97.03%) was achieved by oxamyl followed by neem extract (75.74%) at 5%, whereas the lowest nematode reduction in roots (6.93%) was occurred by marigold at 2.5% concentration.

As for the total juveniles in soil and roots, it was found that the number of juveniles has significantly differed according to the sampling period. The pronounced reduction in nematode numbers was noticed after 5 months from application as the greatest percentages of reduction were achieved by the highest concentrations of the tested materials. The highest percentage of nematode reduction (92.26%) was achieved by oxamyl followed by neem extract (76.92%), China berry (69.76%) and marigold (68.44%). The lowest nematode reduction (18.30%) was occurred by basil extract at the lowest concentration.

As for eggplant yield, data in Table (3) reveal that all the tested plant extracts have significantly increased weight of eggplant fruits per plant. The greatest increase in fruit weight (120%) was achieved by oxamyl 24% L, followed by extracts of China berry (110%), neem (100%), pyrethrum (80%) at 5% concentration and neem extract (80%) at 2.5% concentration. The lowest one was occurred by basil (20%) when used as 2.5% concentration.

Table 3. Effect of soil drenching with different plant extracts on weight of eggplant fruits formed on plants grown in infested soil with *M. incognita*

Treatment	Average eggplant * fruits/plant (kg)	Increase (%) **
Untreated check	5 e	-
Basil extract at: 5 %	7.0 cde	40
2.5 %	6.0 de	20
Marigold extract at: 5%	8.0 bcd	60
2.5%	6.0 de	20
Pyrethrum extract at: 5%	9.0 abc	80
2.5%	7.0 cde	40
China berry extract at: 5%	10.5 ab	110
2.5%	8.0 bcd	60
Neem extract at: 5%	10.0 ab	100
2.5%	9.0 abc	80
Oxamyl 24% L at: 0.5%	11 a	120

* Data with the same letter(s) within a column are not significantly different according to Duncan's a new multiple range test.

$$** \text{ Increase (\%)} = \frac{\text{Weight of a treatment} - \text{Weight of check}}{\text{Weight of check}} \times 100$$

Discussion

The tested plant extracts of basil, marigold, pyrethrum, neem and China berry proved to be effective against *M. incognita*. These results are in agreement with those obtained by Akhtar and Mahmood (1993 and 1994), Abd-Elgawad and Omer (1995), Lashein (2002) and El-Nagdi and Mansour (2003). The nematicidal effect of the tested extracts may possibly be attributed to their high contents of certain oxygenated compounds which are characterized by their lipophilic properties that enable them to dissolve the cytoplasmic membrane of nematode cells and their functional groups interfering with the enzyme protein structure (Knoblock *et al.*, 1989). The mechanisms of plant extracts action may include denaturing and degrading of proteins, inhibition of enzymes and interfering with the electron flow in respiratory chain or with ADP phosphorylation (Konstantopoulou *et al.*, 1994).

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مكافحة نيماتودا تعقد الجذور على الباذنجان باستخدام بعض المستخلصات النباتية

سوزان عبد العظيم حسبو – عزت محمد عبد الباقي نووير
قسم أمراض النبات – المركز القومي للبحوث – جيزة – مصر.

تم تحت ظروف المعمل دراسة تأثير المستخلصات النباتية لكل من الريحان، القطيفة، البيرثرم، الزنزلخت والنيم على نيماتودا تعقد الجذور *ميلويوجين اتكوجينيتا* بتركيزات ٠,٥% ، ٢,٥% ، ٥% وقد أسفرت النتائج عن زيادة نسبة موت الطور اليرقي الثاني بتركيز زيادة تركيز المستخلصات النباتية وكانت أعلى نسبة مئوية للموت لمستخلص النيم (١٠٠%) عند تركيز ٢,٥% ، أما بالنسبة لتركيز ٥% فكانت أعلى نسبة مئوية للموت (١٠٠%) لكل من النيم والقطيفة تحت ظروف المعمل.

أما تحت ظروف الحقل فقد أنقصت بمعنوية المستخلصات المستخدمة بتركيزات ٢,٥% ، ٥% أعداد الطور اليرقي الثاني لنيماتودا تعقد الجذور *ميلويوجين اتكوجينيتا* على صنف الباذنجان البلدى بالمقارنة بمبيد الأوكساميل ٢٤% وكانت النتائج كالتالى:

بعد ٤ شهور من المعاملة كانت أعلى نسبة خفض للطور اليرقي الثاني (٧٥,٩٥%) عند استخدام مستخلص بذور النيم بتركيز ٥% يليه مستخلص أوراق الزنزلخت بنسبة ٧٨,٣٣% عند نفس التركيز. بينما كانت أقل نسب خفض للطور اليرقي الثاني (١٣,٧٥% ، ١٣,٧٨%) عند استخدام مستخلصي أوراق الريحان والبيرثرم عند تركيز ٢,٥% على التوالى أما بعد ٥ شهور من المعاملة فكانت أعلى نسبة خفض في تعداد هذا الطور (٨٧,٤٣%) مسجلة لمبيد الأوكساميل يليه مستخلص الزنزلخت (٨١,٧١%) عند تركيز ٥% بينما مستخلص الريحان كانت عنده أقل نسبة خفض للتعداد النيماتودى عند التركيز العالى ٥%. وقد أوضحت نتائج الدراسة قدرة جميع المستخلصات النباتية على خفض الكثافة العددية لنيماتودا تعقد الجذور في التربة والجذر باستخدام التركيز العالى ٥%. كما أدت المعاملات إلى زيادة معنوية في محصول الباذنجان وذلك بزيادة عدد الثمار للنبات وكانت أعلى نسبة مئوية للزيادة فى الوزن باستعمال الأوكساميل (١٢٠%) يليه مستخلصات الزنزلخت (١١٠%) ، النيم (١٠٠%) ، وبيرثرم (٨٠%) وذلك عند التركيز العالى من هذه المستخلصات ٥%.

تشير هذه الدراسة إلى إمكانية استخدام المستخلصات النباتية كطريقة فعالة لمكافحة نيماتودا تعقد الجذور *ميلويوجين اتكوجينيتا* على نبات الباذنجان حيث تتميز هذه الزيوت بأنها غير ملوثة للبيئة وأمنة على الصحة العامة.