A Comparative Toxicological Characteristics of Some Wild Plants in North Sinai against Nematode *Meloidogyne incognita*

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Abstract: The sedentary endoparasitic root-knot nematode [RKN], *Meloidogyne incognita* (Kofoid and White) Chitwood, is worldwide an economically important agri-pest, reducing the yield and quality of crops. The traditional method of RKN control is based mainly on chemical nematicides, which will not be frequently available from last decade onwards; their use is highly objectionable due to their major contribution to ground water contamination and dangers to the environment and to human and animal health. In a glasshouse in pot trial, dried leaves of eight wild plants in comparison with oxamyl were evaluated against *M. incognita* infecting olive cv. Picual. Powdered leaves were used at 5, 10 and 20 gm/kg soil, while oxamyl was applied at 4, 8 and 16 ppm. Results revealed that incorporation of dried leaves of the tested plants and oxamyl reduced galling and reproduction of *M. incognita* compared to plants free from any amendments. This reduction was varied according to wild plant species and rate of application. The wild plant *H. elegans* at three applied concentrations proved to be more effective in controlling *M. incognita*. Number of galls, egg-masses and juveniles for *H. elegans* at the lowest conc. (5gm/kg soil) were 38.33, 9.33 and 220 respectively, while at the highest cons. (20 gm/kg soil) completely eliminated galls, egg-masses and juveniles. On the other hand, *C. colocynthis* gave good results in reducing galling and reproduction, since number of galls, egg-masses and juveniles at the three conc. did not differ significantly with those obtained with oxamyl. Other tested plants showed a relatively median effect in decreasing galling and reproduction of *M. incognita*. Also general mean of the three conc. for each treatment was calculated and the nematicidal efficiency based on percent reduction in galling and reproduction was separately estimated in relation to the parallel values of untreated plants. It was clear that *H. elegans* has the upper hand, followed descendingly by oxamyl at ppm range, *C. colocynthis* and *A. santalina*. From all what mentioned it could be concluded that there is a promising possibility of using an ecofriendly effective alternatives or non chemical pest management systems for achieving a sustainable agricultural practices.

Keywords: Olive, Nematode, *Meloidogyne incognita*; root-knot nematode.

INTRODUCTION

The prolonged and overuse of chemical pesticides has resulted in several ill effects such as health hazards, ecological imbalances, development of resistance in pests, resurgence of pests, emergence of newer pests and environmental pollution. All these factors led to a search for safer and more compatible alternatives among which natural products are of first importance. In Egypt, previous studies showed that the root-knot nematodes can be considered one of the most important pests limiting agricultural productivity especially in localities with light sandy soils (Ibrahim, 1985). Control of such nematodes by cultural methods is very difficult, because of the extensive host range and ability to survive adverse conditions. On the other hand, chemical control has several problems such as high cost, pollution of environment, toxicity to man and animals as well as disturbance of natural balance in environment. Therefore, in the past few years many non-pesticidal approaches including plant extracts were studied to search for a suitable control methods against root-knot nematodes. Accordingly, this study was designed to study the effect of certain wild plants in controlling the root-knot nematode *M. incognita* under greenhouse conditions.

MATERIALS AND METHODS

Effect of Certain Wild Plants in Controlling The Root-Knot Nematode *Meloidogyne incognita*:

Eight wild plant species widely grown in North Sinai were collected. Leaves of these plants were dried at air. The dried materials were ground to powder. Scientific name, common name, arabic name, family and source of collection for these plants were listed in Table (1).

Nematicidal potentials of dried leaves of certain wild plants against *M. incognita* infecting olive under greenhouse conditions:

This experiment was conducted under greenhouse conditions in Al-Matala locality (Rafah county). Clay pots of 20-cm diameter were filled with sandy soil. Mechanical analysis of the soil used in this experiment was as follows: sand (92.5%), silt (4.2%) and clay (3.3%), with pH 7.35 and $CaCO_3$ 0.77%. One olive seedling of 40 – cm height, variety Picual was transferred to each pot.

One week after transplanting, each seedling was inoculated with 1000 newly hatched juveniles of *M. incognita*. Second stage juveniles needed for this experiment were obtained from available pure culture formerly prepared and propagated by incubating egg-masses in distilled water. The nematode suspension was pipetted into holes around base of each seedling.

Table (1): Scientific name, common name, arabic name, family and source of collection for eight wild plant species used in controlling *M. incognita*

No	Scientifc name	Common name	Family	Source	Arabic name
1	*Achillea santolina* L.	Santonica	Compositae	Al-Hasana	الشيح
2	*Artemisia monosperma* Del.	-	Compositae	El-Sheikh Zewied	العادر
3	*Calotropis procera* Ait.	Calotropis	Asclipiadaceae	Wadi Al-Arish	العشار
4	*Citrullus colocynthis* (L.) Schrad.	Colocynth	Cucurbitaceae	Al-Hasana	الحنظل
5	*Cleome africana* Botsch.	-	Cleomaceae	Rafah	شلقة الكلب
6	*Hammada elegans* (Bunge) Botsch.	-	Chenopodiaceae	Wadi Al-Arish	العضو
7	*Hyoscyamus muticus* L.	Egyptian henbane	Solanaceae	Wadi Al-Arish	السكران المصرى
8	*Ricinus communis* L.	Caster bean	Euphorbiaceae	El-Sheikh Zewied	الخروع

Powdered leaves of each wild plants (Table 1) were added to pots at the rate of 5, 10 and 20 gm/kg soil. Materials were incorporated in the upper two inches of the soil. All treatments were compared with the nematicide oxamyl (Vydate) 24% Ec which was applied at concentrations of 4, 8 and 16 ppm. Control pots were inoculated and left free without any treatments. All treatments including control were replicated three times and the pots were placed in the greenhouse at temperature 28°C. ± 5°C. Pots were arranged in a complete randomized block design. The experiment was terminated four months. After this time, plants were uprooted and roots were gently rinsed in tap water to remove the adhering soil particles. Number of galls and egg-masses per root system, and number of second stage juveniles per 250 gm soil were counted. The nematicidal efficiency of each treatment was calculated.

Statistical analysis:

All obtained data were statistically analysed using F test and means were compared by Duncan's multible range test at 5% level of probability.

RESULTS AND DISCUSSION

Nematicidal activity of dried leaves of certain wild plants against *Meloidogyne incognita* infecting olive under greenhouse conditions.

Effect on galling and reproduction of *M. incognita* :

Data in Table (2) show that incorporation of dried leaves of the tested plants applied at 5, 10 and 20 gm/kg soil and the nematicide oxamyl at 4, 8 and 16 ppm significantly reduced galling and reproduction of *M. incognita* as compared to plants free from any amendments. This reduction was varied according to wild plant species and rate of application. Among the tested materials *H. elegans* at the three concentrations was the first one in reducing galls and egg-masses on roots and juveniles in soil. Since, when this plants was applied at 5 gm / kg soil, numbers of galls, egg-masses and juveniles were 38.33, 9.33 and 220, respectively, while at 10 gm/kg soil these values were reduced to reach 18.67, 7 and 206.7, respectively. However, application of *H. elegans* at 20 gm / kg soil completely eliminated galls, egg-masses and juveniles. On the other hand, the nematicide oxamyl came to the second in decreasing nematode numbers in roots or soils. Number of galls, egg-masses and juveniles at 4 ppm were 37.67, 22.33 and 226.7, respectively. These values were reduced to 11.0, 6.0 and 80.0 at 16 ppm, respectively. Dried leaves of the wild plant *C. colocynthis* gave good results in reducing galling and reproduction of *M. incognita*. Since, numbers of galls and egg-masses at the three doses did not differ significantly with those obtained with oxamyl at the three concentrations. Values of galls and egg-masses on roots treated with *C. colocynthis* at 5, 10 and 20 gm/kg soil were 34.33 (22.67), 21.67 (14) and 14.33 (7.33), respectively, while the parallel values on roots treated with oxamyl at 4, 8 and 16 ppm were 37.67 (22.33), 21.33 (13.33) and 11.0 (6.0), respectively.

The wild plant *C. procera* showed median effect in decreasing galls, egg-masses and juveniles with values of 37.67, 29.67 and 246.7 at the highest dose, respectively. Other tested plants i.e., *A. monosperma*, *H. muticus* and *R. communis* were less effective in controlling *M. incognita*. Whereas, application of these plants at 5 and 10 gm/kg soil did not significantly reduce galling as compared to check control. Numbers of galls at 5 and 10 doses were 77.33 (60.67), 74.67 (54.0) and 74 (65.33) as compared to 75.22 for check control, respectively. However, when leaves of these plants were used at 20gm/kg soil, numbers of galls were significantly decreased to 48, 36.33 and 48.33, respectively.

Data in Table (3) show the nematicidal efficiency of the tested wild plants and oxamyl in controlling *M. incognita* infecting olive cv. Picual. General mean of the three doses for each treatment was calculated and compared with untreated plants. According to number of galls per root system general mean for treatment *H. elegans*, oxamyl and *C. colocynthis* were 19, 23.33 and 23.44 galls per root system, respectively with insignificant differences at P = 0.05. On the other hand the same criterion for *A. santolina*, *C. africana* and *C. procera* were 31.78, 35.67 and 46.00, respectively with insignificant variation also. In general the treatments could be arranged according to percent reduction (efficiency) in galls as compared to untreated plants in the following descending order : *H. elegans* (74.74%) oxamyl (68.98%), *C. colocynthis* (68.84%), *A. santolina* (57.75%), *C. africana* (52.58%), *C. procera* (38.85%), *H. muticus* (26.88%), *A. monosperma* (17.58%) and *R.communis* (16.83%).

According to number of egg-masses, the lowest general mean was detected with *H. elegans* (5.45 egg-masses per root system) with significant variations as compared to all other treatments. On the other hand, treatments of oxamyl, *C. colocynthis*, *A. santolina* and *C. Africana* were found with values 13.89, 14.67, 17 and 20 egg-masses per root system, respectively with

insignificant variations between these treatments. In general, the tested plants and oxamyl could be arranged descendingly according to percent reduction in egg-masses number as follows : *H. elegans* (91.53%) oxamyl (78.41%), *C. colocynthis* (77.20%), *A. santolina* (73.57%), *C. africana* (68.91%), *H. muticus* (41.80%), *C. procera* (41.80%), *R.communis* (35.75%) and *A. monosperma* (21.41%).

Table (2): Nematicidal effect of dried leaves of eight wild plants applied at three rates against *M. incognita* infecting olive cv. Picual under greenhouse conditions:

Treatments	Application rate gm/kg soil	Number of galls/root system	Number of egg-masses/ root system	Number of juveniles/250gm soil
Achillea santolina	5	52.00 $^{d-g}$	28.00 ^{hij}	333.3 $^{c-g}$
	10	25.67 ^{hij}	14.00 $^{k-n}$	246.7 $^{d-h}$
	20	17.67 $^{h-k}$	9.00 ^{mno}	246.7 $^{d-h}$
Artemisia monosperma	5	77.33 ^{ab}	66.67 ^{ab}	420.0 ^{cd}
	10	60.67 $^{b-f}$	54.67 ^{bcd}	340.0 $^{c-g}$
	20	48.00 ^{fg}	30.33 $^{g-j}$	313.3 $^{c-g}$
Calotropis procera	5	53.00 $^{d-g}$	46.67 ^{def}	380.0 ^{cde}
	10	47.33 ^{fg}	36.00 $^{f-i}$	246.7 $^{d-h}$
	20	37.67 ^{gh}	29.67 $^{g-j}$	246.7 $^{d-h}$
Citrullus colocynthis	5	34.33 ^{ghi}	22.67 ^{jk}	333.3 $^{c-g}$
	10	21.67 ^{hij}	14.00 $^{k-n}$	273.3 $^{c-h}$
	20	14.33 ^{ijk}	7.33 ^{no}	160.0 ^{ghi}
Cleome africana	5	49.33 ^{efg}	29.33 $^{g-j}$	466.7^{c}
	10	34.67 ^{ghi}	21.00 $^{j-m}$	366.7 $^{c-f}$
	20	23.00 ^{hij}	9.67 $^{l-o}$	260.0 $^{d-h}$
Hammada elegans	5	38.33 ^{gh}	9.33 ^{mno}	220.0 $^{d-h}$
	10	18.67 $^{h-k}$	7.00 ^{no}	206.7 $^{e-h}$
	20	00.00 ^{k}	00.00 ^{o}	00.0 ^{i}
Hyoscyamus muticus	5	74.67 ^{abc}	49.33 ^{cde}	380.0 ^{cd}
	10	54.00 $^{c-g}$	39.67 $^{e-h}$	400.0 ^{cde}
	20	36.33 ^{gh}	23.33 ^{ijk}	346.7 $^{c-g}$
Ricinus communis	5	74.00 ^{abc}	49.00 ^{cde}	426.7 ^{cd}
	10	65.33 $^{a-f}$	42.00 ^{efg}	393.3 ^{cde}
	20	48.33 ^{fg}	33.00 $^{g-j}$	313.3 $^{c-g}$
Oxamyl	4 ppm	37.67 ^{gh}	22.33 ^{jkl}	226.7 $^{d-h}$
	8 ppm	21.33 ^{hij}	13.33 $^{k-n}$	166.7 $^{f-i}$
	16 ppm	11.00 ^{jk}	6.00 ^{no}	80.00 ^{hi}
Control	-	75.22 ^{abc}	64.33 ^{bc}	824.4 ^{ab}
L.S.D 0.05	-	18.20	11.34	169.1

Same letter(s) indicate insignificant differences at the 5 % level with Duncan's multiple range test.

Table (3): Nematicidal efficiency of dried leaves of eight wild plants in controlling *M. incognita* infecting olive cv. Picual under greenhouse conditions

Treatments	Number of galls/root system	Nematicidal efficiency %	Number of egg-masses/ root system	Nematicidal efficiency %	Number of juveniles/ 250gm soi	Nematicidal efficiency %
Achillea santolina	31.78 ^{cd}	57.75	17.00 ^{d}	73.57	275.6 ^{bc}	66.57
Artemisia monosper	62.00 ^{b}	17.58	50.56 ^{b}	21.41	357.8 ^{bc}	56.60
Calotropis procera	46.00 ^{cd}	38.85	37.44 ^{c}	41.80	291.1 ^{bc}	64.69
Citrullus colocynth	23.44 ^{fg}	68.84	14.67 ^{d}	77.20	255.6 ^{c}	69.00
Cleome africana	35.67 ^{de}	52.58	20.00 ^{d}	68.91	364.4 ^{b}	55.80
Hammada elegans	19.00 ^{g}	74.74	5.45 ^{e}	91.53	142.2 ^{d}	82.75
Hyoscyamus muticus	55.00 ^{bc}	26.88	37.44 ^{c}	41.80	375.6 ^{b}	54.44
Ricinus communis	62.56 ^{b}	16.83	41.33 ^{c}	35.75	377.8 ^{b}	54.17
Oxamyl	23.33 ^{fg}	68.98	13.89 ^{d}	78.41	157.8 ^{d}	80.86
Control	75.22 ^{a}	-	64.33 ^{a}	-	824.4 ^{a}	-
L.S.D 0.05	10.51		6.55		97.61	

General means not followed by the same letter(s) are significantly different at P=0.05 by Duncan's multiple range test.

Regarding number of juveniles per 250 gm soil, it was noticed that the lowest general means were found with *H. elegans* (142.2) and oxamyl (157.8) with insignificant differences (P = 0.05). On the other hand, *C. colocynthis*, *A. santolina*, *C. procera* and *A. monosperma* were found with values 255.6, 275.6, 291.1 and 357.8 juveniles per 250 gm soil, respectively. In general the tested treatments could be arranged in descending order based on percent reduction in number of juveniles in soil as follows: *H. elegans* (82.75%) oxamyl (80.86%), *C. colocynthis* (69.0%), *A. santolina* (66.57%), C. procera (64.69%), *A. monosperma* (56.6%), *C. africana* (55.80%), *H. muticus* (54.44%) and *R.communis* (54.17%).

The present finding are in the same line with those reported by (Watt and Breyer-Brandwijk, 1962; Duke, 1978; Al-Obaedi *et al.*, 1987; Mahrous, 1988; Nandal and Bhatti, 1990 and Charu & Trivedi, 1997).

It is quite clear in the light of the results presented in this study very much greater emphasis should be given that some indigineous plants having phytotherapeutic effect have to be developed using natural products against nematodes as an attempt to promote IPM systems.

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دراسات مقارنة للخصائص التوكسيكولوجية لبعض النباتات البرية في مكافحة نيماتودا تعقد الجذور *Meloidogyne incognita* في شمال سيناء

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تم تقييم كفاءة الأوراق المجففة لثمانية نباتات برية بالمقارنة بالمبيد النيماتودي أوكساميل في مكافحة نيماتودا تعقد الجذور النوع *M. incognita* على نباتات الزيتون صنف بيكوال في الصوبة واستخدم مسحوق الأوراق بمعدل ٥ ، ١٠ ، ٢٠ جرام لكل كيلوجرام تربة ، بينما تم إضافة مبيد الأوكساميل بتركيز ٤ ، ٨ ، ١٦ جزء في المليون. وقد أوضحت النتائج أن المعاملة بكل من مسحوق الأوراق المجففة للنباتات المختبرة ومبيد الأوكساميل قد قللت تكوين العقد وأيضاً التكاثر بالمقارنة بالنباتات الخالية من أي إضافات. وقد تغير هذا الانخفاض طبقاً لنوع النبات البري ، ومعدل الإضافة. فعلى سبيل المثال أظهرت معاملة التربة باستخدام ثلاثة معدلات من نبات العضو أكبر الأثر في مكافحة نيماتودا تعقد الجذور *M. incognita* بالمقارنة بالمبيد أوكساميل عند استخدامه بثلاث تركيزات أيضاً. وكانت أعداد كل من العقد وكتل البيض ، واليرقات عندما أضيف نبات العضو بمعدل منخفض (٥ جرام لكل كيلوجرام تربة) هي ٣٨,٣٣ ، ٩,٣٣ ، ٢٢٠على التوالي ولكن عندما أضيف نبات العضو بأعلى معدل (٢٠ جم لكل كيلوجرام تربة) فإنه أدى إلى عدم تكوين العقد وكتل البيض واليرقات. ومن ناحية أخرى سجل نبات الحنظل نتائج جيدة في تقليل التعقد والتكاثر حيث أن عدد كل من العقد وأكياس البيض واليرقات لم يختلف معنوياً عن تلك المتحصل عليها من مبيد الأوكساميل. وقد أظهرت نباتات أخرى تأثيراً متوسطاً نسبياً في تقليل التعقد وتكاثر نيماتودا التعقد.

وعند حساب المتوسط العام للثلاثة معدلات لكل معاملة وأيضاً عند تقدير الكفاءة الإبادية على أساس النسبة المئوية للإنخفاض في أعداد كل من العقد ، واكياس البيض واليرقات بالمقارنة بالنباتات الغير معاملة ، اتضح من النتائج أن نبات العضو احتل المرتبة الأولى وتلاه تنازلياً مبيد الأوكساميل ثم نبات الحنظل ثم نبات الشيح ، حيث كانت الكفاءة الإبادية للمعاملات السابقة الذكر على أساس النسبة المئوية للانخفاض في عدد العقد وأكياس البيض هي ٧٤,٧٤٪ (٩١,٥٣٪) ، ٦٨,٩٨٪ (٧٨,٤١٪) ، ٦٨,٨٤٪ (٧٧,٢٠٪) ، ٥٧,٧٥٪ (٧٣,٥٧٪) على التوالي ، بينما كانت القيم المماثلة لأعداد اليرقات هي ٨٢,٧٥٪ ، ٨٠,٨٦٪ ، ٦٩٪ ، ٦٦,٥٧٪ على التوالي.