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EFFECT OF SOME PLANT EXTRACTS AND ESSENTIAL OILS ON ROOT-KNOT NEMATODE *Meloidogyne incognita* AND YIELD COMPONENTS OF TOMATO CROP

Kamal A. M. Abo-Elyousr[1)], Magd El-Morsi Awad[2)] and Abdel Gaid, M. A. [3)]

1) Plant Pathology Department, Faculty of Agriculture, Assiut University, Assiut, Egypt

2) Plant Pathology Department, Plant Pathology Research Institute, Agricultural Research Center, Giza, Egypt

3) Horticulture Research Institute, Agricultural Research Center, Giza, Egypt.

Corresponding author e-mail: kaaboelyousr@yahoo.com

Abstract: The effect of plant extracts of eucalyptus (*Eucalyptus chamadulonsis)* , garlic (*Allium sativium),* marigold (*Tagetes erecta*) and neem (*Azadirachta indica*) and essential oils were tested against the root-knot nematode, *Meloidogyne incognita*. All tested treatments had nematicidal effect on nematode juveniles *in vitro* after 24 and 48 hours from exposures. The highest percentage of nematode mortality was achieved by application of neem (65.4%), essential oils (64.4%) and marigold (60.5%), followed by garlic and eucalyptus (38.7- 39.5 %). Under greenhouse and field conditions, neem extract and essential oils treatments were more effective in reducing population numbers of the *M. incognita* in soil and root gall index compared to other treatments. Also, in field experiments the highest reduction of root gall index was achieved by neem treatment and essential oils, 44.2 and 32.6% respectively.

Keywords: Garlic, Marigold, Neem, Eucalyptus, Essential oils, *Meloidogyne*, Tomato**.**

Introduction

Root-knot disease of tomato caused by *Meloidogyne incognita* is an important disease of tomato in Egypt (El-Sherif *et al.* 1999). Root-knot nematodes *Meloidogyne* spp. cause high levels of economic loss in many of agricultural crops worldwide. They are capable of severally damaging a wide range of crops, causing dramatic yield losses **(**Kiewnick and Sikora, 2006).

Many investigators had managed root-knot nematodes by using some plant extracts of certain ornamental plants **(**Natarajan *et al.* 2006 and Javed *et al.* 2007). Korayem *et al.* (1993) stated that exposure of *M. incognita* juveniles to standard water extract solution of *Artemesia obsinthium, Thymus vulgaris* shoot powder and *Punica granatum* fruit powder for 72 hr reduced the number of active

nematodes by 100%. Some plant extracts were evaluated for their nematicidal potentials in controlling *M. incognita* infesting tomato (Javed *et al*. 2007**).** The tested plant extracts have significantly inhibited the total number of nematode juveniles, numbers of galls and egg-masses, as well as the total number of root-knot nematodes in soil.

The aims of this study were to evaluate the efficacy of certain Egyptian plant extracts and essential oils for controlling root-knot nematode *M. incognita* and yield components of tomato crops in greenhouse and field conditions.

Materials and Methods

Nematode identification:

Galled roots were collected from naturally infected tomato plants. Species of *Meliodogyne* were identified on the basis of the perineal pattern of mature females according to the keys of Taylor *et al.* (1956) and Seinhorst (1966).

Preparation of plant extracts and essential oils:

Ten grams of whole fresh leaves of eucalyptus (*Eucalyptus chamadulonsis*), garlic (*Allium sativium*), marigold (*Tagetes erecta* L) and neem (*Azadirachta indica*) were separately mixed in 100 ml distilled water in an electric blender for 10 min, and then left for 72 hr before filtration through Whatman filter paper No.1. Each filtrate was considered as a standard solution of 100% concentration and then kept in a freezer until using.

Essential oils were used at a concentration of 0.05 % (diluted with tap water) by added at transplanting and after two weeks from planting. They were provided by, Dept. of Research Self-pollination of Vegetable, Horticulture Research Institute, Dokki, Giza, Egypt. Essential oils are composed oils of nigella (*Nigella sativa*), spearmint (*Mentha spicata*), eucalyptus (*Eucalyptus chamadulonsis*), cumin (C*uminum cyminum*), thyme (*Thymbra spicata*), onion (*Allium cepa*) and lemon (*Citrus lemon*)

Effect of certain plant extracts and essential oils on mortality of nematode *in vitro:*

Nematicidal effects of plant extracts and essential oils were evaluated against *M. incognita* under laboratory conditions. About 300 juveniles of *M. incognita* juveniles were transferred to the concentration of plant extracts and essential oil in sterilized Petri dishes while distilled water served as a control (Alam, 1985). Five replicates were used. Separate sets of Petri dishes were maintained for each period of observation (24 and 48 h). Mortality of nematodes was confirmed by touching the juvenile with fine needle.

Effect of certain plant extracts and essential oils on root-knot nematode under greenhouse conditions:

Tomato seedlings cv. Super Strain B about 45 days old were planted in clay pots 20 cm filled with steam-sterilized sandy loam soil (two seedling/pot), five pots were used for each treatment. Each treatment was replicated two times and pots were arranged in a completely randomized design in greenhouse. A total of 500 juveniles were transferred to a glass beaker containing100 ml water and poured evenly around the stem of each tomato seedling 3-day after transplanting. One hundred ml of each treatment (plant extracts and essential oils) was applied to the soil around the plant stem after 10 and 30 days after nematode infestation. The nematicide, Vydate (Oxamyl) 10% G, (Methyl N'N'-dimethyl-N-[(methyl carbamoyl) oxy] -1-thiooxamimidate) obtained from Dwbon De-Nymwrz, USA, (0.5 g/pot) was sprinkled over the soil around the plants stems, raked and watered (100 ml) into the soil. Pots with nematode treatment alone were used as control. Each treatment had five replications and experiment was repeated twice. After 40 days from the last treatments, soil samples (250 g) were collected from rhizosphere pots and nematode populations were extracted and counted (Goodey, 1963)

Two months after nematode inoculation, plants were uprooted and washed by water. Root gall severity was assessed on a 0–5 rating scale according to the percentage of galled tissue, in which 0 = 0–10%; 1 = 11–20%; 2 = 21–50%; 3 = 51–80%; 4 = 81–90%; and 5 = 91–100% (Barker, 1985).

Field experiment:

Plant extracts and essential oils added as soil irrigation were evaluated under field conditions; each in four replicates (rows). Field experiments were divided to plots of 10.5 m^2 which included 2 rows of 1.2 m width. The tomato seedlings were transplanted during the first week of October 2006 and 2007 growing seasons. Traditional agricultural practices were carried out according to technical recommendations in tomato cultivation. The tested materials were added three times starting from October 15, 2006 and end of October. The experiments were carried out at New Valley Governorate in naturally heavily infested soil with root-knot nematodes *M. incognita*. The experiments were repeated twice in 2006/2007 growing seasons. Untreated plants served as control. All treatments were arranged in a split plots design in four replicates for each treatment. Soil and root samples were collected after 40 days from the last treatments for nematode analysis. Juveniles in roots were extracted by incubating roots in water for egg hatching and nematode severity were recorded as above.

Percentage of reduction in the second juveniles (J2) counts were estimated according to Anderson and Tilton formula (Puntener, 1981) as follows:

$$\text{Reduction (\%)} = \frac{A - B}{B} \times 100$$

Whereas: A= Population of the treated plots after application, B= Population of the check plots before application.

Total tomato yield (tons/ feddan), fruit weight (gm) and number of fruits per kg were recorded.

All obtained data were subjected to statistical analysis by using F. test and the means were compared according to L.S.D. Test (Gomez and Gomez. 1984).

Results and Discussion

1. Effect of certain plant extracts and essential oils on root-knot nematode *in vitro*:

In general, all plant extract treatments significantly reduced the number of viable live juveniles. Data in Table (1) showed that after 24 h the greatest percentages of nematode mortality (65.3 and 64.2%) were achieved by neem and essential oils, respectively, followed by marigold (60.5%). The lowest inhibition was caused by eucalyptus and garlic leaves (38.7 and 31.5%). After 48 h, all treatments significantly reduced the number of viable nematode juvenile compared to control treatment. The highest reduction was achieved by neem extract 60%, while the lowest reduction was caused by eucalyptus extract 19.4%. The nematicidal mechanism of plant extract against plant parasitic nematode was suggested as a direct effect of second stages juveniles in particular the egg stage (Kiewnick and Sikora, 2006).

Table(1): Effect of some plant extracts and essential oils on mortality of nematodes in laboratory test

Treatment	(%) Nematode mortality			
	Viable juveniles after 24 h	% Reduction	Viable Juveniles after 48 h	% Reduction
Eucalyptus , *Eucalyptus chamadulonsis*	155	38.7	141	19.4
Marigold, *Tagetes erecta*	100	60.5	99	43.4
Garlic, *Allium sativium*	153	39.5	136	22.3
Neem, *Azadirachta indica*	88	65.4	70	60.0
Essential oils	90	64.4	89	49.1
Control	253	-	175	-
L.S.D. at 0.05	8.1	-	10.4	-

2. Effect of some plant extracts and essential oils on number of nematodes in tomato plants under greenhouse condition:

Results in Table (2) showed that the highest percentage of nematode reduction was achieved by Vydate followed by neem extract. The lowest nematode reduction occurred in case of eucalyptus extract. Root gall index was reduced by all treatments especially when treated with Vydate, neem and essential oils.

Table (2): Effect of some plant extracts and essential oils on number of nematodes in tomato plants under greenhouse condition

Treatment	Root galls index	% Reduction	Nematode Population (250 c soil)	% Reduction
Eucalyptus , *Eucalyptus chamadulonsis*	3.1	36.7	1252	35.9
Marigold, *Tagetes erecta*	2.4	51.1	825	57.8
Garlic, *Allium sativium*	2.1	57.1	805	58.8
Neem, *Azadirachta indica*	1.5	69.4	620	68.2
Essential oils	1.9	61.2	680	65.2
Nematocide, Vydate	1.3	73.5	529	72.9
Control infected	4.9	-	1952	-
L.S.D. 0.05	0.6	-	77	-

These results are in agreement with those obtained by Lashein (2002), El-Nagdi and Mansour (2003). The inhibition of *M. incognita* population in this investigation may be due to the accumulation of toxic by-products of decomposition and/or to increase phenolic contents resulting in host resistance. Sivapalan (1972) mentioned that, the nematicidal compounds in marigold have been identified as α – terthiemyl and its analogues, which kill nematodes that enter the root. Also, Konstantopoulou

et al., (1994) mentioned that the mechanisms of plant extracts action may include denaturing and degrading of proteins, inhibition of enzymes and interfering with the electron flow n respiratory chain or with ADP phosphorylation.

3. Effect of certain plant extracts and essential oils on root-knot nematode and tomato yield under field conditions:

Under field conditions, the highest reduction percentage of nematode was achieved by the nematicide, Vydate followed by neem and essential oils while the lowest percentage was resulted by eucalyptus comparing to the control plants (Table 3). In case of disease index Vydate and essential oils were caused the highest reduction in root gall index and nematode population followed by others treatments. The results of present investigation agree with those reported by El-Zawahry (1994) who reported that plant extracts can reduce the number of nematode and disease severity in host plants.

Table (3): Effect of some plant extracts and essential oils on disease index (DI) of tomato seedlings under field conditions

Treatment	Root galls index	% Reduction	Nematode population (250 c soil)	% Reduction
Eucalyptus , *Eucalyptus chamadulonsis*	3.5	18.9	1720	35.2
Marigold, *Tagetes erecta*	3.1	27.9	1502	43.4
Garlic, *Allium sativium*	3.1	27.9	1420	46.5
Neem, Azadirachta indica	2.4	44.2	1210	54.4
Essential oils	2.9	32.6	1301	50.9
Nematocide, Vydate	1.5	65.1	1056	60.2
Control infected	4.3	-	2653	-
L.S.D. at 0.05	0.51	-	85	-

4. Effect of some plant extracts and essential oils on yield and yield components of tomato crops:

As shown in Table (4) the highest yield (ton/ feddan) was obtained from the treatment by essential oils (24.3), followed by eucalyptus (21.3). Meanwhile, the lowest yield (6.6) was found when the tomato plants planted without any treatments (control). Tomato plants cultivated without treatment recorded the highest number of fruits/ kg (12.7) followed by the nematicide, Vydate. The treatment by using essential oils recorded the lowest rate (8.2).

Also, the highest fruit weight (gm) was recorded with the treatment by using essential oils (122), followed by the treatment with eucalyptus (115), while, the lowest fruit weight (80) was observed when tomato plants without any treatment (control).

Table (4): Effect of some plant extracts and essential oils on yield and yield components of tomato crops.

Treatment	Yield ton/ Fed.	Number of fruits/ kg	Fruit weight (gm)
Eucalyptus , *Eucalyptus chamadulonsis*	21.3	8.7	115
Marigold, *Tagetes erecta*	16.4	10.2	98
Garlic, *Allium sativium*	13.7	11.0	91
Neem, *Azadirachta indica*	18.3	9.5	105
Essential oils	24.3	8.2	122
Nematocide, Vydate	13.1	11.6	86
Control	6.6	12.7	80
L.S.D. at 0.5	1.03	4.91	0.45

5. Effect of some plant extracts and essential oils on quality character of tomato crops:

Data in Table (5) indicated that using essential oils recorded the highest level of Firmness, T.S.S and Thickness (1.8, 8.6 and 0.40), respectively of tomato fruits. The lowest level of Firmness, T.S.S and Thickness was recorded without treatment (0.8, 6.5 and 0.30), respectively of tomato fruits.

Table (5): Effect of some plant extracts and essential oils on quality character of tomato crops.

Treatment	Firmness	T.S.S	Thickness
Eucalyptus , *Eucalyptus chamadulonsis*	1.7	8.3	0.40
Marigold, *Tagetes erecta*	1.5	8.0	0.34
Garlic, *Allium sativium*	1.3	7.6	0.32
Neem, *Azadirachta indica*	1.7	8.3	0.37
Essential oils	1.8	8.6	0.40
Nematocide, Vydate	0.9	6.7	0.32
Control	0.8	6.5	0.30
L.S.D. at 0.05	0.13	0.05	0.27

The greatest increase in fruit weight was achieved by essential oils, eyclptus and vydate and neem followed by marigold extracts. They may due to decrease the diseases severity in tomato plants. These findings agree with Natarajan *et al.* (2006) who mentioned that fruit yield from tomato plants treated with *T. erecta* extracts was significantly better than untreated checks and comparable with the nematicide carbofuran-treated plants

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تأثير بعض المستخلصات النباتية وبعض الزيوت الاساسية على نيماتودا تعقد الجذور وعلى المحصول وجودته فى الطماطم

كمال أحمد أبواليسر[1] ، مجد المرسى عوض المرسى[2] و محسن عبدالجيد[3]

[1] جامعة أسيوط – كليه الزراعة – قسم أمراض النبات

[2] وزارة الزراعة ، معهد بحوث أمراض النبات ، مركز البحوث الزراعية ، الجيزة ، مصر ،

[3] معهد بحوث البساتين ، مركز البحوث الزراعية ، الجيزة. مصر.

اجريت هذه الدراسة في مزرعة تجريبية فى مركز البحوث الزراعية في محافظة الوادي الجديد لدراسة تأثير بعض المستخلصات النباتية والزيوت الأساسية على الحد من تعقد الجذور النيماتودى وعلى جودة المحصول فى نباتات الطماطم.

وقد بينت المعاملة بكل من مستخلص نباتات الكافور والثوم والقطيفة وكذلك النيم وبعض الزيوت الاساسية ان لها تاثير مثبط على النيماتودا فى المعمل. بعد 24 ساعة من المعاملة كانت اكثر المواد فعاليه فى تثبيطها للنيماتودا هى الزيوت الاساسية 64.4% ومستخلص القطيفة 60.5% يليها الثوم والكافور 39.5 و 38.7% على التوالى.

كذلك درس تاثير هذه المواد تحت ظروف الصوبة وقد بينت التجارب ان مستخلص النيم والزيوت الاساسية اكثر المواد فعالية فى تثبيطها لاعداد النيماتودا وكذلك فى خفض شدة الاصابة.

وتحت ظروف الحقل فى الودى الجديد كانت اكثر المواد فعالية هى النيم والزيوت الاساسية فى خفض شدة المرض وفى خفض اعداد النيماتودا فى التربة.