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NEMATICIDAL POTENTIAL OF SOME ESSENTIAL PLANT OILS AND YEAST EXTRACT IN CONTROLLING *Meloidogyne Incognita* AND *Rotylenchulus Reniformis* ON TOMATO.

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ABSTRACT

The nematicidal potential of clove oil, black cumin oil, orange peels oil, tobacco (2% nicotine) and yeast extract were evaluated for controlling the root-knot nematode, *Meloidogyne incognita* and the reniform nematode, *Rotylenchulus reniformis* infecting tomato plants cv. Balady under greenhouse conditions. All the treated materials significantly reduced number of galls, immature stages, females, egg-laying females and total number of nematodes in tomato roots. The highest significant reduction was recorded in numbers of swollen and egg-laying females of *R. reniformis* on tomato roots. In most cases, the previous materials were more effective on *Rotylenchulus reniformis* than on *Meloidogyne incognita*. Yeast and tobacco extracts gave the greatest reduction on numbers of both species. There was a positive reaction, in most cases, between essential oils, tobacco and yeast extract treatments and tomato plant growth.

Keywords: Essential oils, *Meloidogyne incognita*, nematode, *Rotylenchulus reniformis*, yeast and nicotine extract.

INTRODUCTION

Tomato, *Lycopersicon esculentum* Miller is one of the most important vegetables growing in Egypt and worldwide. The root knot nematode, *Meloidogyne incognita* (Kofoid and White) Chitwood and the reniform nematode, *Rotylenchulus reniformis* (Linford and Oliviera) are the most important and common nematode pests in Egypt (Ibrahim, 1994). Plant parasitic nematodes are controlled by cultural practices, solarization, growing of resistant cultivars and chemical nematicides. However, nematicides are expensive and harmful on health, efforts are needed to develop alternative nematode management strategies, effective, safe and less cost methods of control. Many plants are known to have nematicidal effect against plant parasitic nematodes when they are used as soil amendments or plant extracts. There are many reports on utilization of plant parts as organic amendments for the control of nematodes (e.g. Anjum *et al.*, 1996; Ehteshamul *et al.*, 1996; Rao *et al.*, 1996; Amin and Youssef, 1997 and 1998,Youssef & Amin 1997; Ismail 1998 and Zarina *et al.*, 2003). Other investigators tested the plant as extracts or oils (e.g. Miller 1979; Vijayalakshmi & Goswami , 1987; Goswami & Vijayalakshmi, 1990; Gotke *et al.*, 1990; Sangwan *et al.*, 1990; Akhtar & Mahmood, 1995; Abd-Aziz *et al.*, 1996; Alica & Sivaprakasam, 1996; Haseeb & Butool, 1996; Khurma *et al.*, 1997; McPortland,1997; Nagesh *et al.*, 1997; Abbott *et al.*, 1998; Al-Shalaby and Ali, 2001 and Amin and Farag, 2004). The aim of the present study, is to evaluate the nematicidal potential of some essential plant oils and yeast extract in reducing the population and development of *Meloidogyne incognita*

and *Rotylenchulus reniformis* and improve the corresponding growth of tomato plants.

MATERIALS AND METHODS

In this experiment, four essential oils or plant extracts of four plants belonging to four families; clove tree, *Syzygium aromaticum* (Merill & Perry); black cumin, *Nigella sativa* L.; orange peels, *Citrus sinensis* L.(Osbeck.); and tobacco, *Nicotiana tobacum* L. (water extracts 2% nicotine) and yeast extract, *Saccharomyces cerevisiae* (Table 1) were investigated against *M. incognita* and *R. reniformis* infecting tomato. One ml of each essential plant oil dissolved in one ml of 95% ethanol per pot was added and incorporated by shaking to one Kg sandy-loam soil (1:1 v/v) in 15 cm-d. plastic pot. In a comparable set, eight pots were treated with ethanol only. Five grams of yeast were each incorporated in four replicates one week before nematode inoculation. Two weeks later, one-month old seedlings of tomato cv Balady were singly transplanted in treated pots. After two weeks, each pot was inoculated with 1 000 infective stage of either *R. reniformis* or *M. incognita*. Un-inoculated four replicate pots were served as plant control. There were four replicates for each treatment. Plastic pots were arranged in a completely randomized design in a greenhouse at 35±5C° and watered daily. Fifteen days after nematode inoculation, tomato plants were carefully uprooted and nematodes in roots were counted by staining roots in boiling lactic-acid fuchsin solution for 2-3 min., cleaned in 45% lactic acid for 24 hours and examined under stereomicroscope. Percentages of reduction of female as compared to untreated plants were calculated. Length and weight of shoots and roots were also recorded. Data were statistically analyzed using least significant difference (LSD).

Table 1: Main components of plant and yeast extracts.

Botanical name	Common name	Family	Plant part	Main components*
SSyzygium aromaticum	Clove	Myrtaceae	Fruits	60-90% eugenol, eugenyl acetate, caryophyllene.
NNigella sativa	Black Cumin	*Ranunculaceae*	Fruits	50-60%apethol, limonene, 18-20%fenchone, phellandrene, pinene, anisic acid, aledhydre, camphene
CCitrus sinensis	Orange	*Rutaceae*	Peel	Over 90% Limonene , bergapten, auraptenol, and acid
NNicotiana tabacum	Tobacco	Solanaceae	Foliage	Nicotine
fSSaccharomyces cerevisiae	Backer's Yeast			C_{47} H $_{6.3}$ O_{33} N_6 $P_{1.2}$ $Salts_{4.5}$ according to Barry, 1988) + microelements like (Potassium and Magnesium)

*According to Lawless (1992)

RESULTS

The present data showed that plant and yeast extracts significantly and variably reduced female numbers of *M. incognita* and ranged from 29.9% (black cumin) and 88.9% (yeast extract). Yeast and tobacco extracts were the

most effective in reducing the percentage of *M. incognita* females (88.9% and 85.2%) respectively followed by orange peel oil (33.3%), black cumin (29.6%) and clove tree oil (20.4%) (Table 2 and Fig. 1).

Table 2. Efficacy of some essential plant oils as well as tobacco and yeast extract on the final population of *Meloidogyne incognita* on tomato.

Treatment	Family name	Nematode final population in root/ plant					Female Reduc. %
		No. of galls	Developmental stages	No. of females	No. egg-laying females	Total no. of nemas	
Syzygium aromaticum	*Myrtaceae*	44.0	5.0	43.0	36.0	48.0	20.4
Nigella sativa	*Ranunculaceae*	34.0	20.0	38.0	33.0	58.0	29.6
Citrus sinensis	*Rutaceae*	31.0	11.0	36.0	32.0	47.0	33.3
Nicotiana tabacum	*Solanaceae*	9.0	6.0	8.0	6.0	14.0	85.2
Yeast		4.0	4.0	6.0	5.0	10.0	88.9
Inoculated plants (Check)		53.0	20.0	54.0	53.0	74.0	0.0
LSD (P>0.05)		7.5	3.7	9.4	8.6	10.4	-
LSD (P>0.01)		10.4	5.1	12.9	11.9	14.3	-

Each value presented the mean of four replicates.

Data presented in table 3 indicated that, the percentage of *R. reniformis* females reduction was between 80.5% (black cumin) and 92.6% (tobacco) and was between 79.8% (black cumin) and 96.1% (tobacco extract) for egg-laying females reduction. Tobacco extract was the most effective in reducing the population of females and egg-laying females (92.6% and 96.1% respectively), followed by clove oil (90.5% and 89.2% respectively) and yeast (90.0% and 91.6%).

Table 3. Efficacy of some essential plant oils as well as tobacco and yeast extract on the final population of *Rotylenchulus reniformis* on tomato.

Treatment	Family name	Nematode final population in root/ plant		Female Reduction %	Egg-laying Reduction %
		No. of swollen females	No. of egg-laying Females		
Syzygium aromaticum	Myrtaceae	5.5	5.5	90.5	89.2
Nigella sativa	Ranunculaceae	11.3	10.3	80.5	79.8
Citrus sinensis	Rutaceae	6.3	4.5	89.1	91.2
Nicotiana tabacum	Solanaceae	4.3	2.0	92.6	96.1
Yeast		5.8	4.3	90.0	91.6
Inoculated plants (Check)		57.8	51.0	0.0	0.0
LSD (P>0.05)		8.4	6.4	-	-
LSD (P>0.01)		11.5	8.8	-	-

Each value presented the mean of four replicates.

The maximum reduction of *R. reniformis* infection and reproduction was significantly achieved by using either yeast or tobacco extracts. Essential oils of black cumin, clove and orange peels were less effective in reducing *M.*

incognita numbers than did in reducing *R. reniformis* (tables 2 & 3 and Fig. 1 &2).

Tomato plants showed luxuriant vegetative growth, in which weight and length of shoots were greatly increased in plants grown in soil treated with yeast or tobacco extracts (tables 4 and 5).

Table 4. Effect of some essential plant oils of certain aromatic plants as well as tobacco and yeast extract on growth of tomato infected by *Meloidogyne incognita*.

Treatment	Family name	Shoot		Root	
		Length (cm)	Weight (g)	Length (cm)	Weight (g)
Syzygium aromaticum	Myrtaceae	29.0	9.5	19.6	12.0
Nigella sativa	Ranunculaceae	31.0	11.1	20.3	15.0
Citrus sinenses	Rutaceae	31.0	10.0	20.9	12.3
Nicotiana tabacum	Solanaceae	31.0	1.8	21.3	9.4
Yeast		34.0	12.3	23.0	15.0
Inoculated plants (Check)		25.5	9.0	15.3	8.3
Plant free of nematode inoculation		32.0	12.8	21.5	15.5
LSD (P>0.05)		2.4	1.2	1.7	2.2
LSD (P>0.01)		3.2	1.7	2.2	2.9

Each value presented the mean of four replicates.

Table 5. Effect of some essential plant oils of certain aromatic plants as well as tobacco and yeast extract on the growth of tomato infected by *Rotylenchulus reniformis*.

Essential plant oils	Family name	Shoot		Root	
		Length (cm)	Weight (g)	Length (cm)	Weight (g)
Syzygium aromaticum	Myrtaceae	28.3	8.8	18.8	11.0
Nigella sativa	Ranunculaceae	29.8	10.5	19.6	11.5
Citrus sinensis	Rutaceae	31.0	9.1	20.0	11.5
Nicotiana tabacum	Solanaceae	29.5	11.3	20.5	9.8
Yeast		32.3	12.5	22.3	12.5
Inoculated plants (Check)		23.8	9.8	14.5	8.5
Plant free of nematode inoculation		32.0	12.8	21.5	15.5
LSD (P>0.05)		1.9	1.4	1.6	1.4
LSD (P>0.01)		2.6	1.9	2.1	1.9

Each value presented the mean of four replicates.

DISCUSSION

It is evident from the present results that yeast or tobacco extracts gave the greatest reduction in numbers of *M. incognita* and *R. reniformis*. Whereas, the essential oils black cumin, clove tree and orange peels were less effective in reducing *M. incognita* than on *R. reniformis* on tomato cv. Balady. This effect may be due to the differential toxicity of essential oil compounds released during decomposition as suggested by Mahmood & Saxsena (1992). Presumably, it has been due to their quick decomposition or

evaporation before nematode inoculation. In most cases, highly significant and greater reduction in nematode populations occurred in soil where plant extracts were added to the soil infested with *R. reniformis* than those used the soil infested with *M. incognita*. This may be due to possible difference in the nature of reproduction and parasitism on tomato plants and the effect of released compounds. It has been suggested that during decomposition or evaporation of the essential oils in soil, a certain compound toxic to nematodes be released (Vats *et al.*, 1996; Hussaini *et al.*, 1997), which are dispersed within the soil pore spaces where most of the noxious population of nematodes occurred e.g. Abd-Elgawad and Omer (1995) found that the main compound of the volatile oil of *Marjorana hortensis, Mentha longifolia, Mentha spicata* and *Thymus vulgaris* were terpinen-4-ol (41.6%), carvone (70.4%), carvone (58.1%) and P- cymene (40.5%), respectivelly). Suggesting the inhibitory effect of such essential oils on the nematode final population, Alam (1991) reported that each time when plants were watered, the soluble fractions of essential oils products released into pore and penetrated the root tissues to kill the nematodes, thus reducing the final population below the threshold level. Other investigator suggested that soluble plant extract are very effective in inhibiting egg-hatch and larval motility of nematodes (Onifade & Fawole 1996, Tabil & Walia 1996).

It may be some plant extracts have a repellent or nematicidal properties (McPortland, 1997). Moreover, the soil fertility improves and increases plant tolerance to nematode infection. Similar results on the effect of vegetable oils and essential oils of aromatic and medical plants on the population of nematodes have been reported (Sangwan *et al.*, 1985, Sangwan *et al.*, 1990, Ali & El-Hamawi, 1995). Growth improvement of tomato plants may be due to additive effect of nutrients produced (Alam *et al.*, 1980). Besides the roots of plants grown in unfavorable circumstances for nematode penetration and feeding, inducing certain degrees of resistance against nematode attack. As a result of a reduction of nematodes, plant growth and yields were improved with essential oils treatments (Akhtar & Mahmood 1996; Firoza & Maqbool 1996 and Vats *et al.*, 1996). This may be due to the nematode reduction and partly due to the fact that this additive have also serve as organic manure's (Siddiqui & Alam, 1988). Among the effect of yeast extracts, a high and significant reduction was recorded on population of *M. incognita* and *R. reniformis* and significant improvements was noticed on tomato plants. Contrary results were reported by Youssef and Soliman (1997). They were found that, yeast extract gave the least reduction in nematode galls and egg-masses of *M.incognita*. It can concluded that some plant extracts or oils could be considered as a bio-agent that may be limit the nematodes population densities below the threshold level. However, it seemed to be a safe and cheap method of control.

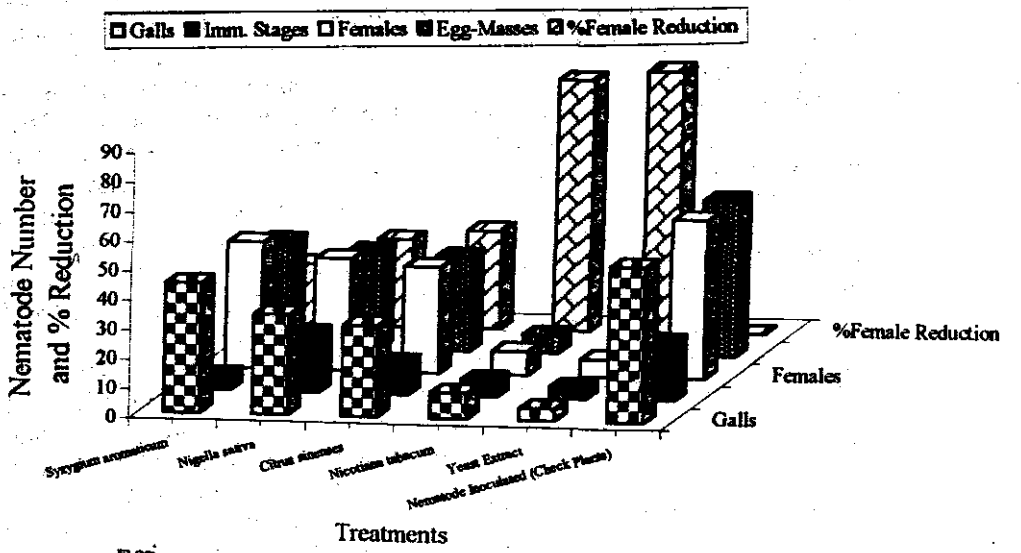

Fig.1: Efficacy of some essential oils and yeast extract on number of galls, immature stages, females , egg-masses and the percentage of females reduction of *Meloidogyne incognita* on tomato.

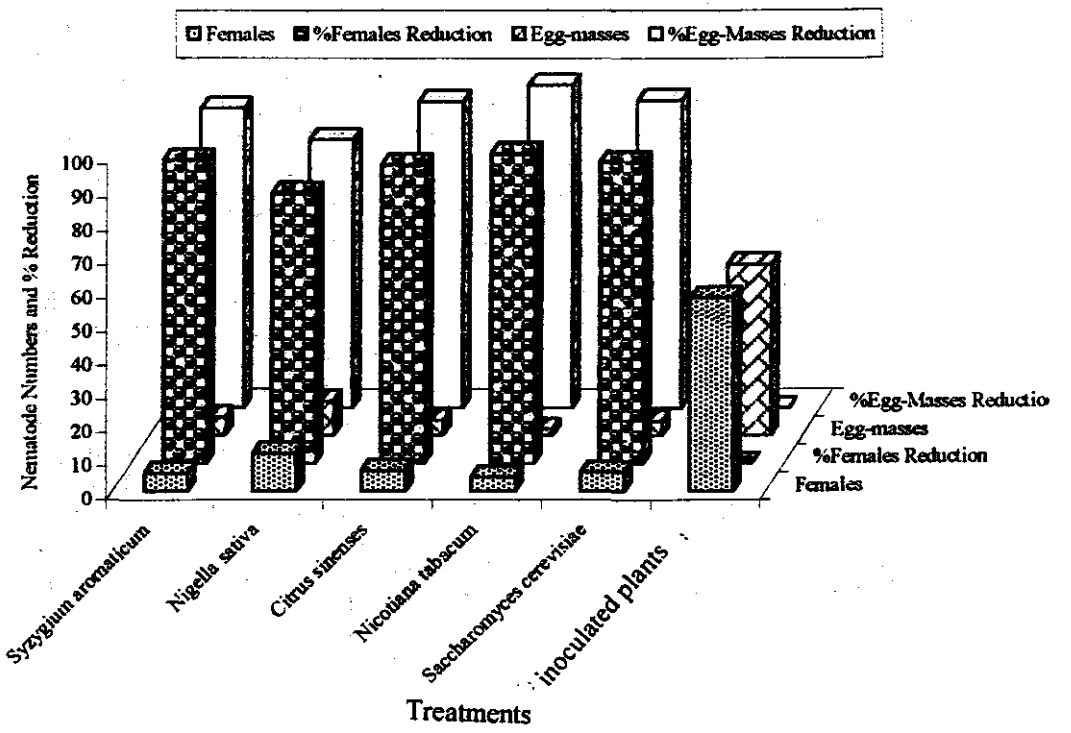

Fig.2: Efficacyof some essential oils and yeast extract on females and egg -masses of *Rotylenchulus reniformis* on tomato.

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تقييم تأثير استخدام المستخلصات الزيتية النباتية لبعض النباتات و الخميرة في مكافحة نيماتودا تعقد الجذور (ميلودوجين انكوجنيتا) و النيماتودا الكلوية (روتيلنكيولس رينيفورمس) على الطماطم.

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تم تقييم أربعة من مستخلصات الزيوت النباتية و هى مستخلص زيت القرنفل و حبة البركة و مستخلص زيت قشر البرتقال و مستخلص نبات الدخان (نيكوتين ٢%) و التي تتبع العائلات: الاسية (Myrtaceae) و الشقيقية (Ranunculaceae) و السذبية (Rutaceae) و العائلة البازنجانية (Solanaceae) على التوالي مقارنة بمستخلص الخميرة (أضافه فطريه عضوية). و ذلك لدراسة قدرتها فى مكافحة كل من نيماتودا تعقد الجذور "ميلودوجين انكوجنيتا" و النيماتودا الكلوية "روتيلنكيولس رينيفورمس" فى الأصص البلاستيك مقاس ١٥ سم المملؤه بواحد كيلو جرام من التربه الرملية الطميية بنسبه متساوية تحت ظروف البيوت الزراعية على نباتات الطماطم صنف بلدي.

تمت عدوى النباتات بألف من الأطوار المعدية بأي من نوعى النيماتودا المختبرة بعد أسبوعين من الإنبات فى تربة مخلوطة بواحد مل من المستخلص النباتي المذاب في كميه مساوية من الكحول الايثايل ٩٥% / أصبص و أضيفت الخميرة كمعاملة مستقلة بأذابه ٥ جرام من الخميرة الجافة فى ٥٠ مل من الماء و أضيفت للتربة قبل العدوى بأسبوع و تركت النباتات تنمو لمده ٦ أسابيع.

بعد حصاد التجربة (٦ أسابيع من العدوى) تم تسجيل أعداد العقد الجذرية و الأطوار الغير بالغة و أعداد الإناث و كتل البيض لنيماتودا تعقد الجذور و تسجيل أعداد الإناث و كتل البيض لنيماتودا الكلوية. و سجلت نسبة الانخفاض فى أعداد الإناث لكل من نوعى النيماتودا مقارنة بالكنترول (النباتات الغير معاملة و معداه بالنيماتودا). بالإضافة الى تسجيل أوزان و أطوال المجموع الخضري و الجذري.

و قد دلت النتائج على أن كل مستخلصات الزيوت المختبرة لها تأثير معنوي جدا فى خفض عدد العقد الجذرية و الأطوار المختلفة لنيماتودا تعقد الجذور (أطوار غير بالغة – أعداد الإناث و أعداد أكياس البيض) و أطوار النيماتودا الكلوية (أعداد الإناث و أعداد أكياس البيض) و بالتالي أدى الى مكافحة تلك الآفتين و أنعكس ذلك على زيادة فى النمو الخضري و الجذري فى معظم المعاملات. حيث انخفضت أعداد العقد الجذرية و الأطوار الغير بالغة و الإناث البالغة و أكياس البيض لنيماتودا تعقد الجذور بينما أنخفض كل من أعداد الإناث و أكياس البيض المسجلة على الجذور للنيماتودا الكلوية و بالتالي انخفضت الأعداد الكلية للنيماتودا لكلا النوعين.

و قد لوحظ أن نيماتودا تعقد الجذور أقل تأثرا بمستخلصات تلك النباتات العطرية و كذلك مستخلص الخميرة حيث كانت نسبة التناقص فى أعداد إناث نيماتودا تعقد الجذور فى حالة المعاملة بمستخلص الخميرة (٨٨,٩%) و مستخلص نباتات الدخان (٨٥,٢%) و تلى ذلك زيت قشر البرتقال (٣٣,٣%) و زيت حبة البركة (٢٩,٦%) ثم زيت القرنفل (٢٠,٤). بينما كانت نسبه الانخفاض فى أعداد الإناث للنيماتودا الكلوية لمستخلص نباتات الدخان (٩٦,٢%) و لمستخلص الخميرة (٩١,٦%) يلى ذلك زيت قشر البرتقال (٩١,٢%) ثم زيت القرنفل (٨٩,٢%) و يليهم زيت حبة لبركة (٧٩,٨%) و كذلك الأعداد الكلية للنيماتودا بالإضافة إلى العقد الجذرية و الأطوار الغير بالغة. و كان واضح أن كل من مستخلص الخميرة الجافة و مستخلص نباتات الدخان الاكثر تأثيرا على كل من نوعى النيماتودا.و قد لوحظ زيادة فى النمو الخضري والجذري نتيجة لانخفاض أعداد النيماتودا و زيادة فى معدل التسميد العضوي نتيجة تلك الإضافات. و هذه لنتائج مشجعة للتطبيق بدون الدخول فى مشاكل التلوث بالكيماويات الزراعية.