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Influence of certain nematicides on the population of the citrus nematode, *Tylenchulus semipenetrans*

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ABSTRACT

The effect of organophosphorus nematicides (cadusafos, ethoprophos), and carbamates, (aldicarb, carbofuran) on citrus nematode (*Tylenchulus semipenetrans*) population densities was determined in sandy clay loam soil. Results indicated that all evaluated nematicides reduced population densities vastly throughout seven months from the duration of the experiment after treatment, where efficiency reached 83.2 %, then nematicides efficiencies decreased sharply for next months for them except carbofuran. Data analysis indicated that there are significant reduction in population densities on citrus nematode between cadusafos and ethoprophos and other nematicides used in 1st to 4th months, while significant differences was obtained between control and tested nematicides.

Key Words: Nematicides, citrus nematode, *Tylenchulus semipenetrans* cadusafos, ethoprophos, aldicarb, carbofuran.

INTRODUCTION

The citrus nematode, *Tylenchulus semipenetrans* (Cobb), is a serious pest in citrus orchards (Heald, 1970), it distributed throughout the citrus growing regions of the world and often causes significant reductions in tree growth and yield (Van Gundy and Meagher, 1977). *T. semipenetrans* is a sedentary semi-endoparasitic nematode which does not induce necrosis, but does alter root physiology, while high citrus nematode populations reduce yield and fruit size (Schenider and Baines, 1964). The reason for using a nematode control agent is to prevent, arrest, or mitigate adverse plant reactions attributable to plant–parasitic nematode. Use of nematicides usually results in a beneficial plant response. Such responses may be due to control of the target nematode, control of one or more non-target pests, or a stimulative effect on the plant. Chemicals can induce adverse as well as beneficial plant responses (Orr and Heald, 1986).

Application of nematicides in flood irrigation systems provided long – term control of *T.semipenetrans* (Heald, 1970). Several soil-applied nonfumigant nematicides have proved effective response for citrus nematode control. Soil applied aldicarb controlled citrus nematode and increased yields of oranges (Baines *et al.*, 1977), but the rates used were much higher than would be economically feasible. In Egypt, field evaluation of granular and liquid nematicides against citrus nematode was studied by Abu El-amayem *et al.,* (1981 and 1982) and El-Shoura *et al.,* (1985).

The present study was undertaken to determine the efficacy of certain nematicides for citrus nematode control on soils of high clay content (sandy clay loam soil), and responses of citrus nematode after nematicides application for a one year.

MATERIALS AND METHODS

The orange grove selected was on a sandy clay loam soil (49.15 % fine sand, 6.1 % coarse sand, 17.5 % silt, 24.5 % clay and: p H 7.8), at Azizia, Sharqia Governorate. Navel orange (*Citrus sinensis* var. Navel) and Sweet orange, (*Citrus sinensis* L.) grown on sour orange (*C.aurantium* L.). Plots consisted of 15 trees of 10 years old uniform size, each with three rows. Plants were spaced 4 m apart within and between rows.Plots were 128 m^2. Nematicides used were in granular formulation (cadusafos "Rugby" 10 %, ethoprophos "Mocap" 10 %, aldicarb "Temik" 15 % and carbofuran "Furadan" 10 %), were used at 24, 40, 17 and 40 kg / feddan, respectively. Nematicides were uniformly distributed all over the plots surfaces and incorporated in the top (15 cm) of soil, on April 25, 2002. Treatments replicated three times and arranged in randomized complete blocks design. Soil samples were collected under the canopy from two sites per tree in April 10 before treatments, to determine the initial population of citrus nematode. After treatments, samples were collected monthly from three locations within each plot. Samples were collected from soil area surrounding the citrus trees in polyethylene bags and were transferred directly to the laboratory in ice box (containing ice bags 13 – 18 °C) for nematode extraction. Each sample was made of subsamples which were carefully mixed together to form a composit sample, and 150 cm^3 subsamples extracted for 72 hours on Baermann Trays (Townshend, 1962 and 1963) .A single determination made for each replication or each sample was counted individually and the three counts averaged, to determine the population densities (PD), Reproduction rates (Rr) and nematicides efficiencies (NE)

$$NE = \frac{\text{Control Rr} - \text{Treatment Rr}}{\text{Control Rr}} \times 100$$

RESULTS AND DISCUSSION

Pretreatment counts indicated that the population was high in the orchard selected for the experiment (Tab.1&2 and Fig.1). Data showed that all used nematicides significantly reduced citrus nematode for complete seven months. Whereas high increases in population densities were observed through next months, compared to sever decline in (control) untreated check population. Efficiency percent average of three treatment replicates of cadusafos 10 % at 24 kg / fed in controlling citrus nematode throughout seven months was 79.9 % with Rr 0.5 dropped to 24.6 % with Rr 1.4 at the last months, with greatest loss in efficiency (55.3 %), while efficiency average of ethoprophos through mentioned period was 73.0 % with Rr 0.72 dropped to 48.7 % with Rr 1.01 (loss was 24.3 %). Efficiency of aldicarb was 60.3 % with Rr 1.42, dropped to 36.5 % with Rr 1.4 (% loss was 23.8 %). In respect to carbofuran, efficiency was 68.5 % with Rr 0.80 to 45.4 % and Rr 1.07.with the least loss 23.1 %.Those compared to control Rr2.98declined in the last to 1.9. Nematicides efficiencies were at the highest at the 7th month (reached 80%-90 %). During the first seven months reproduction rates at the 2nd month was the highest whereas the lowest were at the 6th and 7th months, then increases in population density in all treatments with sharp decline in the control.

Data analysis indicated that there are significant reduction between cadusafos and ethoprophos and other nematicides used in 1st to 4th months, while it was significant differences between control and nematicides in nearly all months between increasing and decreasing effect on the population densities.

One of five undesirable consequences of the chemotechnology revolution is pest population density resurgence (Bird, 1987). Increases in population densities after seven months are believed to be due to:-

Table (1): Initial and monthly population densities of the citrus nematode *Tylenchulus semepenetrans* after nematicides applications.

Nematicides	Pretreatment	1	2	3	4	5	6	7	8	9	10	11	Mean
Rugby (Cadusafos) GR 10 %-24kg/ fed.	4962	559	5070	1989	1822	2434	1989	2539	4778	9155	6022	6500	3985
Mocap (Ethoprophos) GR10%-40kg/fed.	5335	2246	2078	3233	2749	2877	5922	3067	3544	8322	5223	5967	4214
Temik (Aldicarb) GR15%-17kg / fed.	4071	5377	408	4858	6766	3977	2567	1056	2366	4477	5133	5622	4476
Furadan (Carbofuran) GR10% - 40kg/fed.	7383	4647	7026	5411	2694	3655	2267	1666	2533	6733	7155	5900	4756
Control	2004	5436	3796	7466	5833	3166	8667	7466	899	1433	1767	11167	4925
L.S.D.													
1%	6673	3216	4560	4700	5830	5043	7015	4387	29253	8788	5183	5666	
5%	4586	2550	3601	3230	4007	3466	4812	3015	20104	6039	3565	3894	

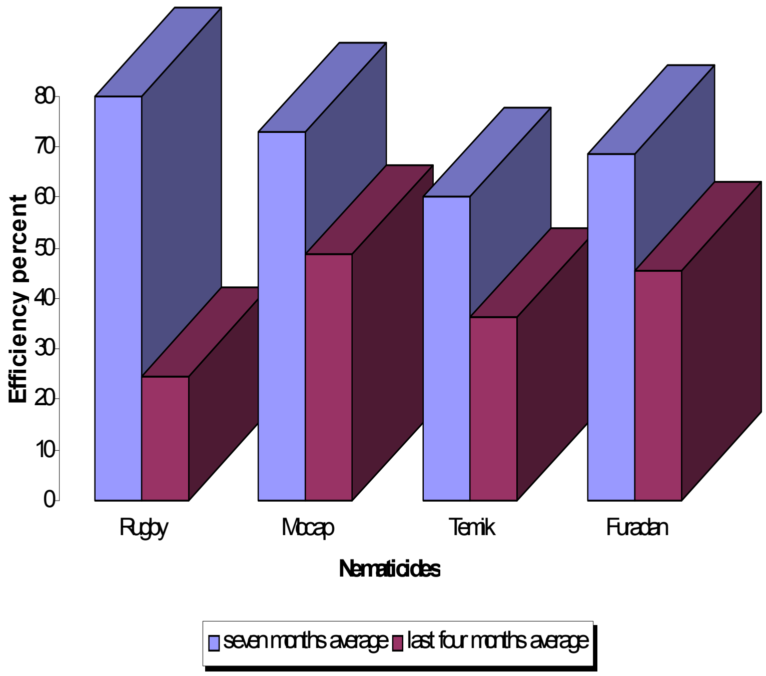
Table (2): Population densities of recovered nematodes , their reproduction rates and the nematicides efficiencies against those nematodes.

Pesticide		Genera														
		Tylenchulus					*Tylenchorhynchus*					*Meloidogyne*				
		16/11	17/12	20/1	20/2	Mean	16/11	17/12	20/1	20/2	Mean	16/11	17/12	20/1	20/2	Mean
Control	PD	700	200	240	370	378	130	90	60	170	113	200	60	140	90	123
	Rr		0.28	0.34	0.53	0.38		0.69	0.46	1.31	0.82		0.3	0.7	0.45	0.48
Ethoprophos 10 % GR 30 kg / f.	PD	600	280	160	300	355	340	140	60	140	170	240	200	140	230	202
	Rr		0.47	0.27	0.5	0.25		0.41 40.6	0.18	0.41	0.33		0.59	0.41	0.68	0.56
Monceren 25 % WP 4g /1 m2	PD	200	460	60	230	237	140	170	200	180	173	460	200	200	210	268
	Rr		2.3	0.3	1.15	1.25		1.2	1.4	1.29	0.87		0.44	0.43	0.47	0.45
Cadusafos 10 GR 30 kg /f.	PD	400	140	140	270	238	130	170	60	170	133	140	60	60	130	98
	Rr		0.35	0.35	0.67	0.46		1.31	0.46	1.31	1.03		0.43	0.42	0.93	059
Oxamyl 20 kg/f.	PD	2200	540	460	630	958	300	400	60	200	240	100	70	60	90	80
	Rr		0.25	0.21	0.29	0.25		1.33	0.2	0.67	0.73		0.7	0.6	0.9	0.73
Fenamiphos	PD	100	340	60	160	165	500	460	140	230	332	80	80	60	170	97
	Rr		3.4	0.6	1.6	1.87		0.92	0.28	0.46	0.55		0.8	0.6	1.7	1.03

PD= Population density Rr = Reproduction rate

1) The interference of nematicides with larval hatch from eggs (Soliman, 2002) demonstrated that the results of the population densities of citrus nematode increased on some months of growing season in loamy sand nematicides treated soil more than the initial population (pretreatment) , this may be explain by the ineffectiveness of nematicides against females and eggs.

fig.1 Mean efficiency percent of tested nematicides used against citrus nematode at different times.



2) The nematicidal and nematistatic action of nematicides, may affect nematode orientation, therefore *T. semipenetans* don't attack root systems of citrus trees and, it would appear that nematodes can not penetrate the roots, therefore, it could be recovered from the soil (Di Sanzo, 1973). Also, Thomas (1959) observed that carbofuran may affect sensory receptors so that feeding cannot start when nematodes reach the root. Since carbofuran is a systemic nematicide, the possibility also exists that plant itself may be affected so that attractants are not produced. Knowledge of the mode of

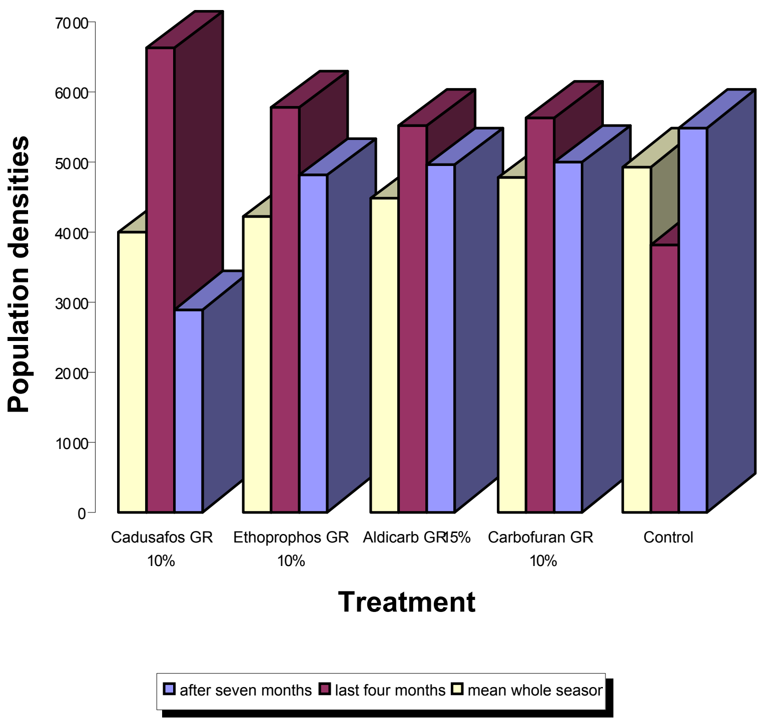
action of a pesticide is of primary importance in a determination of the best method for evaluating efficacy. The problem is not great when nematodes are killed because the performance of such a nematicide can be determined easily. An active compound, however, may not necessarily kill nematodes but may act in other ways. Sensory organs of nematodes may be affected and, when a compound is systemic, the plant itself may not produce the stimuli required by nematodes to initiate the feeding process. If the chemical expresses its activity in one of these ways, nematode counts, at least in the soil, are useless (Di Sanzo, 1973).

3) After seven moths from application, there are new nematode generations that free nematicidal effect, and the nematicides traces were existed in soil, which activate the nervous system, or may be the soil is free of nematicides streeses, which may allow to new generation reproduce greatly. Barker, *et al.*, (1986) reported that most nematicides exert their maximum effect on nematodes shortly after application, but long–term changes in soil biology often occur. For example, the proportions of species in nematode communities often shift after chemical treatment of soil.

4) High infected citrus tree take obligated direction to form new -strong - fibrous roots as a result to the weakness of roots after citrus nematode attacking to citrus root system, which consequently encourage to new invasion of citrus nematode that increases population density. Timmer, (1974) reported that four foliar applications of 1.5 and 3.0 lb of oxamyl / acre and a single soil application at 4.0 lb / acre, appeared to be effective but those made 71 and 86 weeks after the initial treatment failed to reduce larval populations. Nematicidal efficacy is influenced by factors such as length exposure, stage of nematode development, and location of nematode to the chemical toxicant, temperature, moisture, and soil composition which explain such variation results in the replicates of each nematicide and also sampling may partially account for these differences of population densities among the whole season months. Where soil samples were collected only from two sites per tree and may not be representative of root nematode invasion, therefore they were collected from a large area of the plot, and each was a composite of numerous patches. In contrast, soil sampling also varied, which made comparison difficult, in addition to soil management (Greco *et al.*, 1993). Lastly and really, efficacy of nematicides can be related to initial nematode population density.

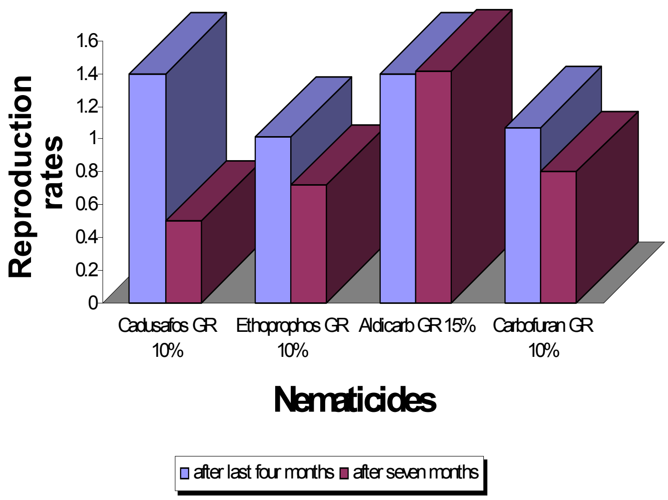
Finally, the efficiency of nematicides used on controlling the citrus nematode appeared clearly at first period by reducing its numbers, but soil can have profound effects on the efficacy of a chemical in two major ways: it can affect the susceptibility of a microorganisms to the chemical and it can directly affect the toxicologic properties of the chemical. Because soil properties can have a significant effect on the performance of a pesticide.

fig. 2 Population densities of citrus nematode with different nematicides and control



Also, two noticeable points were observed from data, firstly, the high increasing in population density of citrus nematode in cadusafos- treated plots in last months, is higher than other three nematicides in that period (Fig. 2), as Timmer (1974), when counted pretreatment population of *T.semipenetrans* larvae which was (6020 larvae), but became after soil application of oxamyl (11940 larvae), at rate of 4 lb/acre than other treatment. Generally, mean whole season population of control was the greatest. Second is the reproduction rates of citrus nematode in aldicarb-treated plots, at two mentioned periods were the same (Fig. 3), and the efficiency percentages as well, but because the populations were high at the two periods after the initial therefore the efficiency decreased, specially is referring to the reproduction rate of control.

Fig.3 Rates of reproduction of citrus nematode after seven months of treatment and at last four months



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