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EFFICACY OF CERTAIN CONTROLLED RELEASE PESTICIDES FORMULATIONS AGAINST ROOT-KNOT NEMATODES ON TOMATO PLANTS

BY

M.A. Radwan*; Sh.M.I. Kassem*; M.M. Abu Elamayem* and Hala S. Ibrahim**

* Department of Pesticide Chemistry , Faculty of Agriculture (El-Shatby) , University of Alexandria

** El-Sabahia Research Station, Central Agricultural Pesticide Lab., Agric. Res. Center , Alexandria , Egypt.

ABSTRACT

Contact toxicity of aldicarb, carbofuran, carbosulfan, oxamyl, pirimiphos-methyl and triazophos was tested against root-knot nematode, *Meloidogyne incog nita* juveniles. Triazophos was the most toxic compound, while carbofuran was the least one. Conventional and controlled release formulations (CRF's) of the six tested insecticides/nematicides were evaluated in controlling nematode infecting tomato plants in pot trials. In addition, their effects on tomato growth was also investigated. Concerning the nematicidal efficacy of traditional formulations, the results generally revealed that only the granulated type of aldicarb and carbofuran gave high nematicidal effect as indicated by the percent reduction of nematode juveniles in soil, whereas the percent reduction in nematode juveniles for other tested types of pesticide formulations e.g. E. C, W. P, and L were between low and moderate control measures. Among the CRF's formulations, the data showed that aldicarb PSBD and PS- matrices had the highest effectiveness in controlling the nematode followed by triazophos PS - matrix and oxamyl PS - matrix. On the other hand, PS-CRF of carbofuran as well as PSBD-CRF of triazophos and pirimiphos-methyl have the lowest effectiveness. The tested pesticides formulations when used at 2 or 10 ppm (a.i) had no phytotoxic effect on the growth of tomato plants, as indicted by fresh weight and height of root and shoot systems.

INTRODUCTION

The control of nematode pests which infest vegetable crops is essential to improve their productivity. The use of chemical insecticide/ nematicide is generally recommended as a nematode control measure. To minimize cost, dose of chemical, the frequency of application, hazards, phytotoxicity and to extend residual activity for a long time, the application of controlled release insecticide/nematicide formulations is recommended.

Various controlled release pesticide formulations have been tested against plant parasitic nematodes.Feldmesser and Shasha (1977) mentioned that the formulations of DBCP and diazinon which show slow release patterns were found to control *Meloidogyne incognita* on tomato at a rate that was inffective when used as emulsifiable concentrates. Batterby *et al.* (1980) and Birtle and Wright (1983) have examined the usefulness of controlled release formulations of aldicarb and oxamyl against the sugerbeet cyst nematode, *Heterodera schachtii.* They have found that such formulations might be most useful on soil of low organic content. El-Shoura *et al.* (1985) studied the efficacy of different CRF of carbofuran for controlling citrus nematode, *Tylenchulus semipentrans.* They found that carbofuran in the formulation of RN-302-2 at 10 ppm was apparently the most effective in reducing nematode juveniles and females and was followed by RN-302-1 which also exceeded that of its conventional one. In addition, El-Shoura *et al.* (1992b) found that the CRF, RN -302-2 was also the most effective against root-knot nematode, *Meloidogyne javanica,* which also improved the growth of tomato plants more than the use of traditional formulations of carbofuran.

The present study was designed to evaluate the comparative efficacy of certain CRF formulations and their conventional formulations against root-knot nematode, *Meloidogyne incognita* on tomato plants, and to observe effects on the growth of tomato plants.

MATERIALS AND METHODS

Nematode inocula :

Root-knot nematode, *Meloidogyne incognita* was isolated from infected roots of eggplants (*Solanum melongena*). Root galls were homogenized in a blender and passed through 200, 400 mesh sieves to

obtain free eggs directly before carrying out the experiment. Second stage juveniles (J_2) of *M. incognita* were obtained by incubating infested wet roots for 24 hours, washing and passing through the sieves as before. The active juveniles present were extracted by Baermann plate technique (Goodey, 1963).

Pesticides used :

Three different formulations of aldicarb, carbofuran, triazophos, pirimiphos-methyl, carbosulfan and oxamyl were used. Two of which are CRF namely polystyrene (PS) and polystyrene butadiene(PSBD);eachat 5% and were prepared according to El-Sebae *et al.*(1979), and Kassem *et al.* (1997). The other conventional formulations were aldicarb 15% G "2-methy-2-(methylthio)propionaldehyde-O-methyl carbamoyl oxime", carbofuran 10% G "2,3-dihydro-2,2-dimethyl-7-benzofuranyl methyl carbamate", triazophos 40% EC "1-phenyl 1, 2, 4-triazolyl-3-(0,0-diethyl-thiono-phosphate", pirimiphos-methyl 40% EC "O-(2-diethylamino-6-methyl pyrimidin-4-yl) 0,0-dimethylphosphorothioate, carbosulfan 25% W.P "2,3- dihydro -2,2-dimethyl-7 -benzofuranyl{(dibutylamino)thio} methyl carbamate, and oxamyl 24% L "Methyl N,N-dimethyl -N- {(methyl carbamoyl) oxy} -1-thiooxamimidate".

Bioassay studies :

Conventional formulations of aldicarb, carbofuran, triazophos, pirimiphos - methyl, carbosulfan, and oxamyl were tested for their nematicidal activity against juveniles of *M. incognita* in aqueous solutions as described by McBeth and Bergeson (1953). About 200 second stage juveniles were transfered into separate glass cups. Each compound was tested using five to seven concentrations of three replicates each. Mortality counts were recorded, 24 hours after treatment. The data were corrected using Abbott formula (Abbott, 1925). The LC_{50} values as well as their confidence limits were calculated according to the method of Litchfield and Wilcoxon (1949).

Pot experiment :

According to the bioassay data, the insecticides/ nematicides, namely; aldicarb (PS-CRF 5%, PSBD-CRF 5%, and G 15%), triazophos (PS-CRF 5%, PSBD-CRF 5%, and E.C 40%) and oxamyl (PS-CRF 5%, PSBD 5%, and L 24%) were applied to the soil in the center of the pots at the rate of 2 ppm (a.i) , whereas carbofuran (PS-CRF 5% PSBD-CRF 5%

and G 10%), pirimiphos-methyl (PS-CRF 5% PSBD-CRF5%, and E.C 50%), and carbosulfan (PS-CRF 5%, PSBD-CRF 5% and W.P 25%) were applied at the rate of 10 ppm (a.i). The pots were then arranged in a complete randomized block design, with three replications for each treatment in addition to the control. Clay pots (12 cm in diameter) containing 1 Kg of sandy clay loam soil were inoculated with 5000 eggs of *M. incognita* per pot. Three tomato seedlings (*Lycopersicum esulentum* var. Castlerock) of one month old were transplanted in each pot and watered every two days. Nematode inoculation, pesticidal treatment and transplanting of tomato seedling were carried out at the same time. The efficiency of the six tested insecticides / nematicides was judged, eight weeks after treatment, by determining the number of second juveniles per 250 gm soil, and recording the growth indices length as well as fresh weight of root and shoot systems. The obtained data of juveniles were transformed according to $\sqrt{X^{-} + 1}$. All data were statistically analyzed according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Bioassay of six insecticides / nematicides on *M. incognita* juveniles under laboratory conditions :

LC_{50} values expressed as ppm for the tested compounds were recorded in Table (1). The data in Table (1) showed that triazophos was the most toxic compound, while carbofuran was the least one as contact nematicide. Aldicarb, pirimiphos-methyl, oxamyl and carbosulfan had LC_{50} values between those of triazophos and carbofuran. Thus, the tested pesticides could be arranged ascendingly according to LC_{50} as follows: triazophos(0.65), aldicarb (2.0), pirimiphos-methyl (2.6), oxamyl (3.1), carbosulfan (5.1), and carbofuran (13.0).

Nematicidal activity of the tested insecticides/nematicides formulations against *M. incognita* on tomato seedlings :

According to the obtained results in Table (1), aldicarb, triazophos, and oxwere eat 2 ppm, while carbofuran, pirimiphos-methyl and carbosulfan were evaluated at 10 ppm concentration. Each insecticide/ nematicide was tested as conventional formulation, PS and PSBD matrices against *M. incognita* on tomato seedlings. Effects of the conventional

Table (1): Toxic effect of centain insecticides / nematicides on *Meloidogyne incognita* juveniles

Pesticides	Functions of Ld-p Line		Confidence Limits of LC_{50}	
	LC_{50} (ppm)	Slope Function	Upper	Lower
Aldicarb	2.00	10.51	2.24	1.78
Carbofuran	13.00	52.15	15.73	10.74
Triazophos	0.65	5.63	0.71	0.59
Pirimiphos – methyl	2.60	6.15	2.83	2.38
Carbosulfan	5.10	9.51	5.81	4.47
Oxamyl	3.10	6.45	3.44	2.79

insecticides/nematicides and the controlled release formulations of the tested compounds on the *M. incognita* juveniles were recorded in Table (2). The obtained data were classified to five groups according to the nematicidal efficacy ; very high effective treatments which gave 90- 100% efficacy, high effective treatments which gave 80-<90 % efficacy, moderate treatments which gave 60-<80% efficacy, Low effective treatments which gave 40-<60 % efficacy, and finally slight effective treatments which gave less than 40% efficacy. The very high effective treatments were aldicarbG (2ppm), aldicarb-PSBD matrix (2ppm) and carbofuran G (10ppm). The nematicidal effcacy of these treatments were 94.9%, 92.26 % and 91.99%, respectively. The high effective treatments were aldicarb-PS matrix (2ppm), triazophos-PS matrix (2ppm) and oxamyl-PS matrix (2ppm), with percent effectiveness of 89.85%, 88.13% and 83.03%, respectively. The moderate effective treatements were carbofuran-PSBD matrix (10ppm), oxamyl-L (2ppm),carbosulfan-WP (10ppm),carbosulfan-PSBD matrix (10ppm), triaszophos- EC (2ppm), carbosulfan-PS matrix (10ppm), giving 75.05, 73.14, 69.95, 68.79, 68.57 and 67.82% efficacy, respectively. The low effective treatments were pirimiphos-methyl-PS metrix (10ppm), carbofuran-PS matrix (10ppm), pirimiphos-methyl-EC (10ppm), and triazophos-PSBD matrix (2ppm), with values of 57.76,52.99,47.25 and 43.98% efficacy, respectively. The slight effective treatment (11.14%) was pirimiphos-methyl - PSBD matrix (10ppm).

Table (2): Effect of certain controlled-release pesticides formulations on *Meloidogyne incognita* control on tomato seedlings.

Treatments	Formulations (% a.i)	Dose	Number of 2nd juveniles/ 250 g soil	Nematicidal efficiency (%)
Aldicarb	PS 5%	2 ppm	40.66* ab	88.85
	PSBD 5%		30.99a	92.26
	G 15%		20.44a	94.90
Carbofuran	PS 5%	10 ppm	188.44bcde	52.99
	PSBD 5%		99.99abc	75.05
	G 10%		32.11a	91.99
Triazophos	PS 5%	2 ppm	47.55abc	88.13
	PSBD 5%		244.55cde	43.98
	EC 40%		125.99abcd	68.57
Pirimiphos-methyl	PS 5%	10 ppm	169.32bcd	57.76
	PSBD 5%		356.21de	11.14
	EC 50%		211.44bcde	47.25
Carbosulfan	PS 5%	10 ppm	128.99abcd	67.82
	PSBD 5%		125.11abcd	68.79
	WP 25%		120.44abcd	69.95
Oxamyl	PS 5%	2 ppm	68.00abc	83.03
	PSBD 5%		157.88bcd	60.61
	L 24%		107.66abc	73.14
Control	---	---	400.88e	---

* Means followed by the same letter did not significantly differ according to L.S.D. at 0.05 level of probability .

PS = Polystyrene
PSBD = Polystyrene butadiene
G = Granules
E.C = Emlsifiable concentrate
W.P = Wettable powder
L = Liquid

Also, the data presented in Table (2) indicated that formulations of the tested pesticides reduced the number of nematode juveniles significantly, except carbofuran-PS matrix (5%), triazophos-PSBD matrix (5%) and pirimiphos-methyl - PSBD matrix (5%) and EC (50%) as compared with the untreated check. The granulated formulations of aldicarb and carbofuran gave high nematicidal efficiency against *M.incognita* juveniles on tomato plants.These results are in good agreement with those reported by Darekar (1986). Sheela and Nair (1988), Nayak *et al.* (1990) and El-Shoura *et al.* (1992b) on different vegetable crops.

The nematicidal efficacies of the controlled release formulations of carbofuran (PS and PSBD) at 10 ppm were 52.99% and 75.05%, respectively. This result is supported by the observations of El- Shoura *et al.* (1985 and 1992a). PS-CRF of oxamyl significantly gave similar nematicidal efficacy to PS-CRF of aldicarb or triazophos. Also, PSBD-CRF of oxamyl, carbofuran or carbosulfan significantly gave the same effect against *M. incogntia* juveniles on tomato plants. These results are in harmony with those obtained by Tocker (1979) who found that the controlled release formulation which containe 1% oxamyl and 16% polymer was effective against *M. incognita* in laboratory test.

The nematicidal activity of triazophos PS -CRF was ranked in the second group (high effective treatments) and was effective as aldicarb PS-CRF or oxamyl PS-CRF. But PSBD-CRF of triazophos gave the same nematicidal activity of carbofuran PS-CRF or pirimiphos-methyl PSBD-CRF without significant differences compared to the control. Also, the traditional formulation of triazophos (E.C 40%) gave good results in nematicidal efficacy and did not show any significant differences with the granular formulations of aldicarb and carbofuran. These results coincide with those reported by Radwan (1988) who found that the insecticide, triazophos tended to be the highest toxic compound against *M. incognita* under laboratory and greenhouse conditions.

All tested formulations of carbosulfan had reasonable nematode control potency. The percent reductions in nematode juveniles were 67.82, 68.79, and 69.95 for PS - CRF (5%),PSBD - CRF (5%) and W.P (25%), respectively (Table2). These results coincide with the results of Deleon (1984) who found that carbosulfan gave good conotrol against both *Meloidogyne sp* and *Pratylenchus coffeae.*

Effect of the tested insecticide/nematicide formulations on the growth of tomato plants :

Concerning the effect of the tested pesticides formulations on tomato growth indices, including root, shoot length and fresh root, shoot weight were recorded and preseted in Table (3). The results revealed that oxamyl PS - matrix and L-formulation significantly increased the fresh weight of shoots more than that obtained from control treatment. On the contrary,carbosulfan-formulation treatments and triazophos PS - matrix decreased fresh weight of shoots without significant differences. As for the effect of the tested pesticides fromulations on the length of shoots, no significant differences were noticed among the control and all treatments.

However, the highest effect was obtained in the treatment of carbosulfan PSBD - matrix, while the lowest effect was observed with oxamyl PS-matrix. Regarding to the effect of the tested treatments on roots length and weight,no significant differences among all treatments and control was noticed. Thobtained results agreed with those of Prasad *et al* (1977);who found that oxamyl and carbofuran had no adverse effect on the growth of tomato. Also, Perlaza *et al.*(1979) found that aldicarb did not increase the weight of carrot.

Table (3): Effect of certain controlled-release pesicides formulations on the length and weight of tomato plant shoots and roots.

Treatments	Formulations (% a.i)	Dose	Shoot		Root	
			Length (cm)	Fresh Weigth (g)	Length (cm)	Fresh Weight (g)
Aldicarb	PS 5%	2 ppm	18.63*a	2.87*ab	12.97*ab1	1.12*a
	PSBD 5%		17.04a	3.40ab	6.62ab	1.37a
	G 15%		19.04a	2.91ab	18.91ab	1.04a
Carbofuran	PS 5%	10 ppm	19.24a	2.97ab	19.66ab	1.24a
	PSBD 5%		18.04a	2.78ab	13.29ab	0.93a
	G 10%		17.29a	2.73ab	22.81b	0.82a
Triazophos	PS 5%	2 ppm	15.50a	1.98a	14.62ab	0.87a
	PSBD 5%		20.10a	3.18ab	12.38ab	0.83a
	EC 40%		20.38a	2.72ab	15.80ab	1.03a
Pirimiphos-methyl	PS 5%	10 ppm	19.29a	3.50ab	17.25ab	1.52a
	PSBD 5%		20.09a	3.41ab	16.14ab	1.14a
	EC 50%		20.16a	3.50ab	16.27ab	0.95a
Carbosulfan	PS 5%	10 ppm	12.20a	1.50a	11.54ab	0.80a
	PSBD 5%		10.44a	1.12a	6.94ab	0.57a
	WP 25%		12.79a	1.40a	9.08ab	0.46a
Oxamyl	PS 5%	2 ppm	20.77a	5.32b	12.30ab	0.95a
	PSBD 5%		19.81a	3.95ab	11.65ab	0.84a
	L 24%		19.37a	5.29b	14.58ab	1.37a
Control	---	---	15.29a	2.27a	21.28ab	1.56a

* Means followed by the same letter did not significantly differ according to L.S.D. at 0.05 level of probability.

• Abbreviations see Table (2).

Finally, it could be concluded that all the tested pesticide formulations were significantly superior over the control in reducing the nematode population in the soil,except carbofuran PS - CRF, triazophos PSBD-CRF and pirimiphos-methyl PSBD & E.C formulations which were equal to control. Growth rate, as indicated by fresh weight and height of root and shoot systems revealed that all treatments at selected concentrations had no phytotoxic effect on tomato plants. Further studies are needed to evaluate the efficacy of the tested CRF against root -knot nematodes in relation to thier effect on plant growth under field conditions.

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الملخص العربى

كفاءة بعض تجهيزات المبيدات المتحكم فى درجة أنسيابها ضد نيماتودا تعقد الجذور فىالطماطم

محمد على رضوان* ، شحاته محمود إبراهيم قاسم* ،
محمود محمد ابو العمايم* ، هالة سعد إبراهيم **

* قسم كيمياء المبيدات -كلية الزراعة (الشاطبى) - جامعة الاسكندرية
** محطة البحوث الصبحية،المعمل المركزى للمبيدات، مركز البحوث الزراعية - الإسكندرية

تم دراسة الفعل السام لكل من الالديكارب والكاربوسلفان والاوكساميل والبريمفوس - ميثايل والترياز فوس ضد يرقات العمر الثانى لنيماتودا تعقد الجذور تحت الظروف المعملية ووجد ان الترياز فوس أشد المركبات المختبرة و الكاربوفيوران أقلها فى الفعل السام ضد نيماتودا تعقد الجذور - بالاضافة الى انه قد تم تقييم المركبات السته المختبرة بالتجهيزات التقليدية وبالتجهيزات المتحكم فى تحرر المادة السامة منها ضد نيماتودا تعقد الجذور فى الطماطم و كذلك دراسة تجهيزات هذه المبيدات على نمو نبات الطماطم .

وقد أوضحت النتائج أن التجهيزات المحببة التقليدية لكل من الالديكارب و الكاريوفيوران قد اعطت فاعلية عالية فى خفض تعداد يرقات النيماتودا بالتربة بينما بقية التجهيزات المختبرة قد اظهرت فاعلية منخفضه الى متوسطه فى خفض التعداد اليرقى ، اما بالنسبه للتجهيزات المتحكم فى درجة انسيابها فقد اظهرت بوليمرات البولى ستيرين والبولى ستيرين بيوتاداين كهياكل للالديكارب فاعلية عالية فى مكافحة النيماتودا يليه البولى ستيرين للترياز فوس ثم للاوكساميل - وان تجهيز البولى ستيرين للكاربوفيوران ، والبولى ستيرين بيوتاداين للترايازفوس والبريمفوس - ميثايل قد أظهروا فاعلية منخفضة ضد النيماتودا.

وقد أوضحت النتائج أيضا أن كل تجهيزات المبيدات المختبرة عند استخدامها بتركيز ٢ أو ١٠ جزء فى المليون مادة فعالة لا تظهر أية سمية نباتية على نمو نباتات الطماطم المعاملة.