J.Pest Control & Environ.Sci. Vol:4 No:1 pp 85 - 96 (1992).

EFFECT OF ALDICARB AND CARBOFURAN, INSECT GROWTH INHIBITORS AND THEIR MIXTURE ON ROOT-KNOT NEMATODE ON TOMATO PLANTS

BY

M.Y. El-Shoura; M.A. Radwan; A.S. M. Marei and M.M. Abu-Elamayem

Plant Protection Department, Pesticide Chemistry Division, Faculty of Agriculture, Alexandria University, Alexandria, Egypt.

Received 28/4/1992 Accepted 20/6/1992.

ABSTRACT

Separate and joint effects of two nematicides ;aldicarb (Temik) and carbofuran (Furadan), and three insect growth inhibitors (IGI's) namely diflubenzuron (Dimilin) , chlorfluozuron (IKI) and teflubenzuron (CME-134) against root-knot nematode, Meloidogyne incognita infecting tomato were studied in pot trials. Concerning to the compound alone,the data generally indicated that aldicarb (10 and 20 Kg/feddan), carbofuran (60 Kg/feddan) and diflubenzuron (200 g/feddan) gave good results in reducing the number of galls and egg masses compared with the control and rest treatments. In regard to the nematicidal mixtures with IGI's , it was found that the mixture of teflubenzuron + aldicarb (20 Kg) had high significant effect for controlling the root-knot nematode, followed by diflubenzuron + aldicarb (20 Kg) which was equall to the mixture of chlorfluozuron + aldicarb (20Kg). Mixing of teflubenzuron with carbofuran at 40 or 60 Kg/feddan exhibited an antagonistic effect , while the mixture of diflubenzuron or teflubenzuron with carbofuran (20 Kg) resulted in synergistic action. On the other hand,all of the mixtures of chlorfluozuron in combination with any of the tested nematicides at different rates had an additive effect.

INTRODUCTION

Root-knot nematodes , Meloidogyne spp. , have been generally distributed in Egypt specially in the northern regions. They represent a major agricultural pests of various crop plants (Ibrahim et al.,1976).

Many studies have been conducted on the effect of insect growth inhibitors (IGI's) on root-knot nematodes.Diflubenzuron suppressed the number of egg masses formation by the root-knot nematode on cotton (Veech, 1978). Insect growth inhibitors; RO-0308, RO-8-9800 and dimilin 5% granules gave satisfactory control measure against Meloidogyne javanica in tomato roots (Salem and Radwan, 1978). Dimilin and polyxine-D significantly decreased egg production of M. javanica on tomato plants (Spiegel and Chet, 1985). Also,the insect growth inhibitor, BAY SIR 8514 surpassed both diflubenzuron and IKI 7899 in reducing the population of root-knot nematode ,M. javanica on tomato (Salem et al., 1985).

The joint toxic action between nematicides and other pesticides against nematodes has been reported by several investigators(Schmitt et al. ,1977 ; Abu-Elamayem et al., 1978 and 1985 and El-Shoura et al., 1983), while the possible antagonistic, additives and synergistic effects of nematicides with IGI's against nematodes should not be overlooked. Therefore , the goal of this study was carried out to investigate the effects of aldicarb,carbofuran and certain insect growth inhibitors alone and their combinations against root-knot nematode , M. incognita on tomato plants.

MATERIALS AND METHODS

Nematode culture:

Root-knot nematode, Meloidogyne incognita was isolated from infected Guamia, Myoporum pictum.

plants grown in the garden of Faculty of Agriculture (El-Chatby),University of Alexandria ,Egypt. Root galls were homogenized in a morter and passed through 200 and 400 mesh sieves to obtain single eggs before carrying out experiment directly. Second stage juveniles 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).

Chemicals:

Aldicarb 10% G " 2-methyl-2-(methylthio) propional-dehyde-O-methylcarbamoyl oxime" was used at two concentrations (10 and 20 Kg/feddan) and carbofuran 10% G "2,3-dihydro-2,2-dimethyl-7-benzofuranyl methyl carbamate" was used at three concentrations(20,40 and 60 Kg/feddan).The IGI's; diflubenzuron 25% WP "1-(4-chlorophenyl)-3-(2-6-difluorobenzoyl)urea;chlorfluozuron 5% EC "1-(3, 5-dichloro-4-(3-chloro-5-trifluoromethyl) -2-pyridyloxyl phenyl)-3-(2,6-difluorobenzoyl) urea ; teflubenzuron 48% SC "1-(3,5-dichloro-2,4-difluorophenyl)-3-(2,6-difluorobenzoyl)urea. These IGI's were used at the concentration of 200 g ,0.4 L and 0.1 L/feddan, respectively.

Experiment:

Clay pots (12 cm in diameter) containing one kilogram of sterilized clay loam soil were used. Two tomato seedlings of one month old were transplanted in each pot and then inoculated with 5000 second juveniles stage.Each nematicide ,IGI and their mixtures were applied at the time of nematode inoculation, to the soil in pots at depth of 3-5 cm.The treated plants and untreated one as control were then watered daily. Treatments were arranged in a complete randomized block design in a greenhouse at 25 ± 5°C and were replicated three times. At the end of the experiment (7 weeks) plants were gently removed from pots. Roots were washed, stained with acid

fuchsin in Lactophenol for egg masses counting. The number of galls per root system was also counted.

Analysis of interaction data for mixtures:

Interaction data for mixtures were estimated by using Limpel's formula reported by Richer (1987) as follows:

$$E = X + Y - XY / 100$$

where:

E= The expected additive effect of the mixture.
X= The effect due to component A alone.
Y= The effect due to component B alone.

The expected effect was compared with the actual effect obtained experimentally for mixture to determine the additive or synergistic and antagonistic effect according to the equation given by Mansour et al. (1966) as follows:

$$\text{Co-toxicity factor} = \frac{\text{Observed effect} - \text{Expected effect}}{\text{Expected effect}} \times 100$$

This factor was used to classify results into three categories. A positive factor 20 or more is considered potentiation,a negative factor 20 or more means antagonism and intermediate values between -20 and +20 indicate only additive effect.

All the data were represented as mean ± S.D., subjected to analysis of variance and means were compared for significance by LSD method at the probability of 0.05 and 0.01 (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Nematicidal activity of the three chitin synthetase inhibitors namely : diflubenzuron , chlorfluozron and teflubenzuron compared with the two nematicides: aldicarb and carbofuran

Table (1): Nematicidal activity of certain chitin synthetase inhibitors against M. incognita compared with aldicarb and carbofuran on tomato plants.

Treatments	Rate / feddan	No.of Galls/root system		No.of egg masses/g root	
		Mean ± S.D.	Percent effectiveness	Mean ± S.D.	Percent effectiveness
Chlorfluazuron	0.4 L	87.66 ± 0.27	44.40	11.66 ± 0.45	36.39
Diflubenzuron	280 g	51.00 ± 0.14	67.65	6.66 ± 0.59	63.67
Teflubenzuron	0.1 L	56.33 ± 0.60	64.27	10.00 ± 0.32	45.44
Carbofuran	20 Kg	100.66 ± 0.50	36.15	15.66 ± 0.39	14.56
Carbofuran	40 Kg	82.33 ± 0.28	47.78	10.66 ± 0.64	41.84
Carbofuran	60 Kg	44.66 ± 0.23	71.67	6.00 ± 0.41	67.27
Aldicarb	10 Kg	33.00 ± 0.35	79.07	9.00 ± 0.00	50.90
Aldicarb	20 Kg	29.33 ± 0.28	81.40	4.00 ± 0.50	78.18
Untreated		157.66 ± 0.20	---	18.33 ± 0.59	---
L.S.D 0.05		5.11		2.73	
0.01		7.04		3.76	

Table (1): Nematicidal activity of certain chitin synthetase inhibitors against M. incognita compared with aldicarb and carbofuran on tomato plants.

Treatments	Rate / feddan	No.of Galls/root system		No.of egg masses/g root	
		Mean ± S.D.	Percent effectiveness	Mean ± S.D.	Percent effectiveness
Chlorfluazuron	0.4 L	87.66 ± 0.27	44.40	11.66 ± 0.45	36.39
Diflubenzuron	280 g	51.00 ± 0.14	67.65	6.66 ± 0.59	63.67
Teflubenzuron	0.1 L	56.33 ± 0.60	64.27	10.00 ± 0.32	45.44
Carbofuran	20 Kg	100.66 ± 0.50	36.15	15.66 ± 0.39	14.56
Carbofuran	40 Kg	82.33 ± 0.28	47.78	10.66 ± 0.64	41.84
Carbofuran	60 Kg	44.66 ± 0.23	71.67	6.00 ± 0.41	67.27
Aldicarb	10 Kg	33.00 ± 0.35	79.07	9.00 ± 0.00	50.90
Aldicarb	20 Kg	29.33 ± 0.28	81.40	4.00 ± 0.50	78.18
Untreated		157.66 ± 0.20	---	18.33 ± 0.59	---
L.S.D 0.05		5.11		2.73	
0.01		7.04		3.76	

against M. incognita on tomato plant are shown in Table (1).

The data in Table (1) showed significant differences for the effectiveness of the individual treatments in reducing the galls and egg masses compared with the untreated check. The higher rates of each nematicide were more effective than the lower ones. Also,aldicarb has higher effect on the toxicity against the nematode than carbofuran.Among the individual IGI's treatments .diflubenzuron has the highest effects followed by teflubenzuron and chlorfluozuron.

In general, aldicarb at both rates was apparently the highest effective control measure among all treatments followed by carbofuran (60 Kg/feddan) and diflubenzuron, whereas carbofuran (20 Kg/feddan) was the lowest one. These results are in harmony with that obtained by Abu-Elamayem et al. (1979), they found that aldicarb gave better control of M. javanica than carbofuran on tomato seedlings. On the other hand, concerning the effect of IGI's on root-knot nematode, the present results were also confirmed with those by several workers (Veech,1978 ; Salem and Radwan, 1978; Spiegel and Chet, 1985 and Salem et al., 1985).

In regard to the nematicidal mixtures with IGI's, the results are shown in Table (2), indicated that there were statistically significant differences among the treatments in reducing the number of galls or egg-masses compared with the untreated control. The mixture of teflubenzuron + aldicarb (20 Kg/feddan) had high significant effect for controlling the root-knot nematode, M. incognita, as indicated by the notable reduction in the number of egg-masses followed by the mixture of diflubenzuron + aldicarb and chlorfluozuron + aldicarb. The values of percent effectiveness of these combinations were 89.09, 87.29 and 87.29,respectively. On the other hand, the mixture of teflubenzuron+carbofuran (60 Kg/feddan) was the least effective in this respect

Table (2): Joint effects of certain nematicides / IGI's against M. incognita on tomato plants.

Treatments	Rate / Feddan	No. of Galls/root system		No. of egg masses/g root	
		Mean ± S.D.	Percent effectiveness	Mean ± S.D.	Percent effectiveness
Chlorfluazuron + Carbofuran	0.4 L + 20 Kg	89.33 ± 0.22	43.34	10.56 ± 0.64	41.84
Chlorfluazuron + Carbofuran	0.4 L + 40 Kg	70.00 ± 0.32	55.60	8.00 ± 0.00	56.35
Chlorfluazuron + Carbofuran	0.4 L + 60 Kg	54.33 ± 0.44	65.54	4.66 ± 0.27	74.58
Chlorfluazuron + Aldicarb	0.4 L + 10 Kg	25.66 ± 0.60	83.72	7.00 ± 0.00	61.81
Chlorfluazuron + Aldicarb	0.4 L + 20 Kg	11.66 ± 1.38	92.60	2.33 ± 0.38	87.29
Diflubenzuron + Carbofuran	200 g + 20 Kg	49.33 ± 0.22	68.71	3.00 ± 0.58	83.64
Diflubenzuron + Carbofuran	200 g + 40 Kg	53.66 ± 0.82	65.96	6.66 ± 0.48	63.57
Diflubenzuron + Carbofuran	200 g + 60 Kg	76.66 ± 0.48	51.38	5.00 ± 0.00	72.73
Diflubenzuron + Aldicarb	200 g + 10 Kg	25.00 ± 1.31	84.14	4.33 ± 0.73	76.38
Diflubenzuron + Aldicarb	200 g + 20 Kg	7.33 ± 0.93	95.35	2.33 ± 1.00	87.29
Teflubenzuron + Carbofuran	0.1 L + 20 Kg	48.66 ± 0.86	69.14	4.33 ± 0.73	76.38
Teflubenzuron + Carbofuran	0.1 L + 40 Kg	77.66 ± 0.51	50.74	9.00 ± 0.00	50.90
Teflubenzuron + Carbofuran	0.1 L + 60 Kg	96.33 ± 0.72	38.90	13.00 ± 0.56	29.08
Teflubenzuron + Aldicarb	0.1 L + 10 Kg	21.66 ± 0.69	86.26	7.00 ± 0.38	61.81
Teflubenzuron + Aldicarb	0.1 L + 20 Kg	12.00 ± 0.87	92.39	2.00 ± 0.00	89.09
Untreated		157.66 ± 0.20	—	18.33 ± 0.59	—
L.S.D. 0.05		6.91		2.15	
0.01		9.32		2.89	

Table (3): Interaction effect of aldicarb and carbofuran with IGI's against M. incognita on tomato plants.

Treatments	Rate / feddan	Percent effectiveness for egg masses		Co-toxicity factor	Type of combination
		Observed	Expected		
Chlorfluazuron + Carbofuran	0.4 L + 20 Kg	41.84	45.45	- 8.35	+
Chlorfluazuron + Carbofuran	0.4 L + 40 Kg	56.35	63.00	-10.56	+
Chlorfluazuron + Carbofuran	0.4 L + 60 Kg	74.58	79.19	- 5.81	+
Chlorfluazuron + Aldicarb	0.4 L + 10 Kg	61.81	68.77	-11.26	+
Chlorfluazuron + Aldicarb	0.4 L + 20 Kg	78.29	86.12	- 9.09	+
Diflubenzuron + Carbofuran	200 g + 20 Kg	83.64	69.04	+21.15	++
Diflubenzuron + Carbofuran	200 g + 40 Kg	63.67	78.89	-19.27	+
Diflubenzuron + Carbofuran	200 g + 60 Kg	72.72	88.11	-17.47	+
Diflubenzuron + Aldicarb	200 g + 10 Kg	76.38	82.16	- 7.03	+
Diflubenzuron + Aldicarb	200 g + 20 Kg	87.29	92.07	- 5.19	+
Teflubenzuron + Carbofuran	0.1 L + 20 Kg	76.38	53.38	+43.09	++
Teflubenzuron + Carbofuran	0.1 L + 40 Kg	50.90	68.27	-25.44	*
Teflubenzuron + Carbofuran	0.1 L + 60 Kg	29.08	82.14	-64.59	*
Teflubenzuron + Aldicarb	0.1 L + 10 Kg	61.81	73.21	-15.57	+
Teflubenzuron + Aldicarb	0.1 L + 20 Kg	89.09	88.09	- 1.13	+

* Antagonism ++ Synergism + Additive

which had an 29.08% effectiveness.

Table (3) shows the effect of combinations of two nematicides with three insect growth inhibitors against M. incognita on tomato plants: Expected and observed percent effectiveness , co-toxicity factor (C.F.) and types of combination resulted from nematicide/IGI mixtures are also recorded. The values of C.F. indicated that teflubenzuron in combination with carbofuran at 40 or 60 Kg/feddan, decreased the observed toxicity when compared with the expected one and exhibited antagonistic effects. On the contrary, mixture of diflubenzuron or teflubenzuron with carbofuran at 20 Kg/feddan resulted a synergism where the synergism was more pronounced with teflubenzuron (C.F.= +43.09) than with diflubenzuron (C.F. = +21.15). In addition, all the mixtures of chlorfluozuron in combination with any of the tested nematicide at different rates had an additive effect.

From the previous results, it could be concluded that diflubenzuron proved to be effective against root-knot nematode, M. incognita. Also, it is concluded that the proper candidate nematicide to be mixed with IGI's: diflubenzuron or teflubenzuron is carbofuran at 20 Kg/feddan. These mixtures gave a synergistic effect for controlling the root-knot nematode, M. incognita on tomato plants.

Further study is needed to determine the effect of these mixtures under field conditions, since most of chemicals in the field are exposed to a wide array of factors that may lead to increase or decrease in effectiveness.

REFERENCES

Abu-Elamayem, M.M. ; Shehata, M.R.A. ; Tantawy, G.A. ; Ibrahim, I.K.A. and Schuman, M.A. (1978). Effect of CGA 12223 and benomyl on Meloidogyne javanica and Rhizoctonia solani. Phytopathol. Zeit. , 92 (4): 289-93.

Abu-Elamayem, M.M. ; Tantawy, G.A. ; Ibrahim, I.K.A. and Schuman, M.A. (1979). Evaluation of dosage rate and application time of granular nematicides and the effect of soil type on the control of Meloidogyne javanica. Alex. J. Agric. Res. , 27 (2): 451-58.

Abu-Elamayem, M.M.;El-Shoura, M.Y.;Radwan, M.A.; Ahmed, A.H. and Abdel-All, A. (1985). Joint action effects of some nematicides and benomyl against Meloidogyne incognita and Rhizoctonia solani on soybean. Med. Fac. Landbouww. Rijksuniv. Gent. 50/3a. 839-50.

El-Shoura, M.Y.; Abu-Elamayem, M.M.; Salem, M.A. and Saad, A.S.A. (1983). Effect of oxamyl and benomyl on Rhizoctonia Meloidogyne complex. Proc. 5th Arab Pesticide Conf. Tanta Univ. Sept., 3: 66-78.

Goodey, J.B. (1963). Laboratory methods for work with plant and soil nematodes. Minist. of Agric. Fisheries and Foods : Tech. Bull. 2, London:44 pp.

Ibrahim. I.K.A.; Resk, M.A. and El-Saedy, M.A. (1976).Occurrence and distribution of plant parasitic nematodes in Northern Egypt.Alex. J. Agric. Res., 24: 93-100.

Mansour, N.A. ; El-Dafrawi, M.E. ; Tappozada, A. and Zeid, M.I. (1966).Toxicological studies on the Egyptian Cotton Leafworm , Proedenia litura. VI. Potentiation and antagonism of organophosphorus and carbamate insecticides. J. Econ. Entomol. 59: 307-11.

Richer, D.L. (1987). Synergism - a patent view. Pestic. Sci., 19: 309-15.

Salem, F.M. and Radwan, H.S. (1978). Response of Meloidogyne javanica in tomato roots to certain insect growth regulators. Proc. 4th Conf. Pest Control. NRC, Cairo, Vol.II: 909-12.

Salem, F.M.; Eisa, A.A.; Osman, G.Y. and Ammar, I.A. (1985). Nematicidal potentiality of certain IGR's doses in comparison with a nematicide, Nemacur on Meloidogyne javanica nematode on tomato.Proc. 6th Arab Pesticide Conf. Tanta Univ., Vol.II: 349-57.

Schmitt, D.P.;Bradley, J.R.;Corbin, F.T. and Van Duyn, J.W.(1977). Interaction of nematicide-insecticides and herbicides on control of Heterodera glycines. , Proc. Amer, Phytopathol. Soci. , 4: 229 (C.F.Helminth. Abst., 1979, 48 (2): 839).

Spiegel, T. and Chet, I. (1985). Chitin synthetase inhibitors and their potential to control the root-knot nematode, Meloidogyne javanica. Nematologica 31 (4): 480-82.

Steel, R.G.D. and Torrie, J.H. (1980). Principles and producers of statistics. A biometrical approach. 2nd. McGraw-Hill Kogakusha, Ltd. pp. 633.

Veech, J.A. (1978). The effect of diflubenzuron on egg formation by the root-knot nematode. J. of Nematol., 10: 208-9.

الملخص العربي

"حاشير الاديكارب و الفاربوفيوران كمبيدات نيماتودية ومثبطات النمو في الحقرات مفردة وفي خلائط ضد نيماتودا تعقد الجذور M. incognita على نبات الطماطم".

لقد تمت دراسة اثنين من المبيدات النيماتودية (الديكارب ، الفاربوفيوران) ، وثلاثة من مثبطات النمو في الحقرات (الديفلوبنزيورون ، الكلورفلوزيورون ، التيفلوبنزيورون) مفردة وفي خلائط ضد نيماتودا تعقد الجذور على نبات الطماطم.

ولقد اوضحت النتائج ان كل من مبيد الاديكارب (١٠ ، ٢٠ كجم/فدان) ، الفاربوفيوران (٦٠ كجم/فدان) و الديفلوبنزيورون (٢٠٠جم/فدان) قد اعطى نتائج جيدة في خفض عدد العقد الجذرية وكذلك عدد فقل البيض مقارنة بالكونترول.

ولقد تبين من النتائج ايضا ان كفاءة مخلوط التيفلوبنزيورون مع الاديكارب (٣٠كجم/فدان) هي اعلى المعاليط في مكافحة النيماتودا يليه مخلوط الديفلوبنزيورون مع الاديكارب (٣٠كجم/فدان) و الذي يتساوى مع مخلوط الكلورفلوزيورون مع الاديكارب بنفس المعدل.

وقد اظهر مخلوط التيفلوبنزيورون مع الفاربوفيوران (٤٠ او ٦٠ كجم/فدان) تاثير تثبيطي، بينما اظهر مخلوط الديفلوبنزيورون او التيفلوبنزيورون مع الفاربوفيوران (٣٠ كجم/فدان) تاثير تنشيطي ، اما كل معاليط الكلورفلوزيورون مع اي من المبيدات النيماتودية المختبرة وباي معدل قد اظهرت تاثير اضافة.