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TRIALS ON THE CONTROL OF THE CITRUS RUST MITE (PHYLLOCOPTRUTA OLEIVORA ASHM.) WITH FOUR PESTICIDES, AND ON THEIR TOXICITY TO PREDACEOUS MITES (ACARINA: PHYTOSEIIDAE)

by

E. Swirski, N. Dorzia, S. Amitai and S. Greenberg *

ABSTRACT

Several acaricides were evaluated during 1967-1968 for control of the citrus rust mite Phyllocoptruta oleivora Ashm. Effective control was obtained with Neoron (isopropyl-4, 4'-dibromobenzilate) (50%) 0.06% and 0.03% and with E 102 (chlorinated hydrocarbon compound) (20%) 0.15%, and fair control with Polyram Combie (zinc-activated polyethylene thiuram disulphide) (80%) 0.12% . In the laboratory, Neoron and E 102 killed many larvae and some adults of Amblyseius swirskii Athias on the day of treatment, but eight days afterwards they were ineffective; on the other hand, the predaceous mite was not affected by Polyram Combie. In the citrus grove, all these compounds caused a moderate reduction in the phytoseiid mite population.

INTRODUCTION

Since 1963, zineb compounds have failed to control the citrus rust mite at many locations in Israel; hence, chlorobenzilate and to a much lesse extent ma- neb are now being used for this purpose (9, 10). The trials reported in the present paper were designed to compare additional acaricides with chlorobenzilate.

Since the importance of predaceous mites in the natural control of various pests has been reported by many workers, a study was made to determine any possible adverse effects of the materials tested in the present work. The work is part of a project aimed at the integration of chemical and biological control measures in the citrus grtoves of Israel.

Field trials and large-scale tests for the control of the citrus rust mite, as well as laboratory and field trials on the toxicity of the materials to phytoseiids, were conducted during the years 1967-1968 in the citrus groves and laboratories of The Volcani Institute of Agricultural Research at Bet Dagan.

MATERIALS AND METHODS

The effectiveness of the pesticides against the citrus rust mite was evaluated by counting the number of mites before treatment and at various intervals afterwards. In order to determine the rate of infestation, the fruits (in trial V- the leaves) were examined in the citrus grove with the aid of a magnifying glass, and rated in the following manner: 0, no mites; 1, 1-10 mites; 2, 11-20 mites; 3, 21 or more mites. On each tree 20-25 fruits, from each of four directions, were examined. The trees were inspected also for symptoms of phytotoxicity.

Laboratory screening tests on the effect of toxicants on phytoseiids were conducted with Amblyseius swirskii Athias (the dominant species in the Coastal Plain of Israel), reared on the pollen of Carpobrotus edulis (3, 7). Grapefruit tree branches were dipped for 20 seconds in an agitated suspension or emulsion. The tests were conducted in a rearing cage (7) at a temperature of 25-27°C and a relative humidity of at least 60%, with a treated leaf serving as the substrate.

In the field trials with the phytoseiids, 25 fruits from each tree were examined before treatment and at various intervals thereafter. Larvae, nymphs and adults, mostly of Amblyseius swirskii, were counted with the aid of a magnifying glass. The fruits were picked up in order to discover any mites present under the sepals.

The following materials were tested:

1) chlorobenzilate (25% W. P.), ethyl 4, 4'-dichlorobenzilate, J. R. Geigy S. A., Basel; distributed by Chemicals and Technical Supplies (Green) Ltd., Tel-Aviv.

2) E 102 (20% E. C.), chlorinated hydrocarbon compound, U. S. patent application No. 784911, developed by Prof. Y. Sprinzak at the Weizmann Institute of Science, Rehovot.

3) Neoron (GS 19851) (50% E. C.), isopropyl-4, 4'-dibromobenzilate, J. R. Geigy S. A. Basel; distributed by Chemicals and Technical Supplies (Green) Ltd., Tel-Aviv.

4) Polyram Combie (80% W. P.), zinc-activated polyethylene thiuram disulphide-Mefiram, B. A. S. F., W. Germany; formulated by Agan Ltd., Tel-Aviv.

R E S U L T S

Citrus rust mite

Results of field trials against the citrus rust mite are reported in Table 1.

Table 1. The effect of various pesticides on the percentage of citrus fruits (In Trial V only leaves) infested at three degrees of infestation* by the citrus rust mite. (Application with a motor-gun sprayer, rate of about 20 litres per tree.)

Trial No.	Date of treatment	Tree variety	Counts, days after treatment	Materials	No. of trees sprayed	Examinations											
						Prior to treatment				After treatment							
										First count				Last count			
						1	2	3	Total	1	2	3	Total	1	2	3	Total
I	Nov. 7, 1967	Shamouti orange	8,81	Neoron 0.03%	24	4.5	2.3	40.2	47.0	0	0	0	0	0	0	0	0
				Neoron 0.06%	30	13.0	2.0	39.0	54.0	0	0	0	0	0	0	0	0
				chlorobenzilate 0.12%	150	2.5	0	57.5	60.0	0	0	0	0	0	0	0	0
II	Dec. 15, 1967	Shamouti orange	5.47	E 102 0.15%	2	4.5	0	77.3	81.8	0	0	0	0	0	0	0	0
				chlorobenzilate 0.12%	2	2,3	0	64.6	66,9	0	0	0	0	0	0	0	0
				control	4	10.0	0	36.3	46.3	0	0	50.0	50.0	16.7	0	13.3	30.0
III	Oct. 23, 1967	Shamouti orange	8,92	Neoron 0.06%	38	0.8	3.2	86.4	90.4	0	0	0	0	0	0	0	0
				chlorobenzilate 0.12%	30	5.0	8.0	79.0	92.0	0	0	0	0	0	0	0	0
IV	Oct. 9, 1968	Valencia orange	12, 146	chlorobenzilate 0.12%	96	8,0	5.3	58.7	72.0	0	0	0	0	0	0	0	0
				Neoron 0.06%	70	4.7	0	80.8	83.5	0	0	0	0	0	0	0	0
				Polyram Combie 0.12%	50	11.2	0.8	62.4	74.4	8.8	6.4	17.6	32.8	0	0	0	0
				E 102 0.15%	40	3.3	0	78.7	82.0	0	0	0	0	0	0	0	0
V	Nov. 11, 1968	Pummelo	18	E 102 0.15%	2	46.0	0	42.0	88.0	0	0	0	-	-	-	-	-
				Control	2	60.0	6.0	14.0	80.0	30.0	4.0	26.0	60.0	-	-	-	-
VI	Oct. 13, 1968	Shamouti orange	9,59	Polyram Combie 0.12%	20	13.6	0	67.2	80.8	10.4	1.6	30.4	42.4	5.6	0	0	5.6
				Neoron 0.03%	25	4.0	0	42.0	46.0	0	0	2.0	2.0	0	0	6.0	6.0
VII	Oct. 11, 1968	Shamouti orange	11.41	Neoron 0.03%	80	0	2.0	72.0	74.0	0	0	0	0	0	0	0	0
				Neoron 0.06%	60	1.0	2.0	36.0	39.0	0	0	0	0	0	0	0	0
				Polyram Combie 0.12%	70	1.6	0	1.2	47.2	4.8	1.6	4.8	11.2	0	0	0	0
				chlorobenzilate 0.12%	200	3.0	0	66.0	69.0	0	0	0	0	0	0	0	0
VIII	Oct. 15, 1968	Shamouti orange	10,57	Neoron 0.06%	4	2.3	0	38.7	41.0	0	0	0	0	0	0	0	0
				Neoron 0.03%	12	2.3	0	65.3	67.6	0	0	1.3	1.3	0	0	0	0
				Polyram Combie 0.12%	36	0.8	0	51.2	52.0	4.0	2.4	4.8	11.2	0	0	0	0
				chlorobenzilate 0.12%	80	0	0	56.0	56.0	0	0	0	0	0	0	0	0
IX	Oct. 13, 1968	Shamouti orange	14, 67	Neoron 0.06%	45	0	0	48.0	48.0	0	0	0	0	0	0	0	0
				E 102 0.15%	70	1.3	0	30.7	32.0	0	0	0	0	0	0	0	0

* 1, 1-10 mites; 2, 11-20 mites; 3, 21 or more mites.

Spraying with either Neoron (50%) 0.06% or E 102 (20%) 0.15% caused a big drop in the mite population until fruit-picking time. Neoron at a concentration of 0.03% gave fair results in one trial (VI), with 6% of the fruit infested 59 days after treatment; but in other tests it effectively controlled the pest (Trials I, VII, VIII).

In all its trials (IV, VI, VII, VIII) Polyram Combie produced a low initial kill: 9-12 days after treatment, a considerable number of fruits were infested. Later on there was a reduction in mite population until the end of the season.

The details of the large-scale tests are given in Table 2.

Table 2 - Test conditions of large-scale trials on the effect of Neoron (50%), chlorobenzilate (25%), E 102 (20%) and Polyram Combie (80%) on the citrus rust mite (Bet Dagan, 1968)

Trial No.	Date of treatment	Tree variety	Sprayer	Materials	Application rate		No. of acres sprayed
					Fluid, l/acre	Acaricide, g/acre	
X	Oct. 5	Shamouti ora.	Mist	chlorobenzilate	280	2800	1.5
				Neoron	280	2000	1.5
				Polyram Combie	280	4000	2.0
XI	Oct. 9	Valencia ora.	Mist	chlorobenzilate	300	2800	1.25
				Polyram Combie	300	4000	1.0
XII	Oct. 11	Shamouti ora.	Mist	chlorobenzilate	300	2800	1.25
				Neoron	300	2000	0.5
				Polyram Combie	300	4000	2.5
XIII	Oct. 11	Shamouti ora.	Mist	Neoron	300	2000	2.5
				chlorobenzilate	300	2800	2.5
XIV	Oct. 22	Shamouti ora.	Mist	chlorobenzilate	320	2000	0.5
				Polyram Combie	320	2000	2.0
XV	Oct. 26	Shamouti ora.	Motorgun	chlorobenzilate 0.1%	4000	4000	1.0
				Neoron 0.06%	4000	2400	1.0
XVI	Nov. 6	Shamouti ora.	Mist	Neoron	300	3200	2.0
XVII	Nov. 6	Shamouti ora.	Mist	E 102	360	3200	0.7
XVIII	Nov. 15	Grapefruit	Motorgun	E 102 0.12%	3200	4800	0.5
XIX	Nov. 15	Grapefruit	Mist	Neoron	320	2000	0.75

Neoron, E 102 and Polyram Combie, applied with a mist-sprayer or a motor-gun sprayer, gave commercially acceptable control of the pest.

Parallel to the citrus rust mite counts, observations on the flat mites

(Brevipalpus spp.) were carried out, showing that good control of the mite on the fruits was obtained with Neoron and E 102, whereas Polyram Combie was ineffective.

No phytotoxic effects were observed from E 102 or Polyram Combie. In trial VII slight burns, not causing any commercial damage, were discovered on fruits sprayed with Neoron (50%) 0.03%; in all the other trials and in the large-scale tests no injured fruits were observed in plots treated with this miticide, regardless of concentration.

Predaceous mites

Larvae. On the day of treatment, the acaricides were toxic to the phytoseiid larvae in the following descending order (Table 3): Neoron (50%) 0.06%, E 102 (20%) 0.15%, chlorobenzilate (25%) 0.12%. However, on the eighth day, no more adverse effect could be detected from any of these compounds. The initial kill of Polyram Combie was negligible.

Table 3 - The effect of forced contact (72 hours) with grapefruit leaves dipped in chlorobenzilate (25%) 0.12%, Neoron (50%) 0.06%, E 102 (20%) 0.15%, or Polyram Combie (80%) 0.12%, on the larvae of Amblyseius swirskii Athias. (percent mortality of 45 larvae per treatment in three replications (15x3).

Date of treatment:	May 27, 1968		June 24, 1968		
Age of pesticide deposit in days:	0	8	0	8	16
Neoron	100.0	0	82.2	0.5	0
chlorobenzilate	15.5	0	78.9	0	2.2
E 102	51.1	0	77.7	0	0
Polyram Combie	0	0	-	-	-
Control	0	4.4	0	4.4	2.2

In order to evaluate the effect of Neoron in various concentrations on the larval mortality, "trial mites" (45 larvae per treatment in three replicates) were placed on grapefruit leaves on Aug. 2, 1968 for 72 hours of forced contact. The resulting mortality rates were: Neoron 0.06%- 44% of the larvae; Neoron 0.03%- 17.8%; control- 2.2% of the larvae.

Since in a previous experiment Polyram Combie did not kill larvae on the day of treatment, its effect was tested again on Aug. 4, 1968. In this trial 45 larvae (in three replications) were placed for 72 hours of forced contact on grapefruit leaves covered with a four-day-old deposit of the compound; all the young mites, including the control, survived. Thus, Polyram Combie under laboratory conditions is not toxic to larvae of A. swirskii.

Adults and eggs. The results of the adulticide screening are presented in Table 4. Among the acaricides tested, Neoron (50%) 0.06% was the most active one on the day of treatment, and resulted in a high mortality; chlorobenzilate (25%) 0.12% and E 102 (20%) 0.15% were slightly toxic and Polyram Combie was practically inactive. Eight and 16 days after treatment these materials were ineffective.

Table 4 - The effect of forced contact (72 hours) with grapefruit leaves dipped in chlorobenzilate (25%) 0.12%, Neoron (50%) 0.06%, E 102 (20%) 0.15%, or Polyram Combie (80%) 0.12%, on the percent mortality of adults of Amblyseius swirskii Athias (45 young adults per treatment in three replications (15x3)).

Date of treatment:	May 27, 1968		June 24, 1968		
Age of pesticide deposit (in days):	0	8	0	8	16
Neoron	82.2	0	57.8	0.5	0
chlorobenzilate	0	0.4	7.4	0.	0
E 102	5.7	0	8.9	2.3	0
Polyram Combie	0	0	-	-	-
Control	0	0	3.3	0	0

To determine the rate of oviposition and survival of A. swirskii treated with Polyram Combie (80%) 0.12%, grapefruit tree branches were dipped for 20 seconds on Aug. 12, 1968, in a suspension of the material. Three females and one male were placed for 10 days in each of the five cages, in which the treated leaves served as the substrate. Five other cages with the same number of adults served as a control. Pollen of Carpobrotus edulis was given as food. In the Polyram Combie series the daily oviposition rate reached 0.87 eggs per female, whereas in the control it was 0.82. Similarly, no significant differences were found between the treatment and control in the survival of adults: on the treated leaves, four males and two females died at the end of test, whereas in the control three males and two females perished. Eggs of A. swirskii were placed on leaves which had been dipped in Polyram Combie 0.12%, in order to test its effect on hatching. Out of 60 eggs (20 x three replications) in the treatment, three eggs failed to hatch; in the control, one egg succumbed. Thus, it may be concluded that in the laboratory Polyram Combie has almost no effect on the egg stage.

Field trials. The effect of different pesticides on the phytoseiid mites in the citrus orchard are illustrated in Figs. 1-3. It should be noted that, in the control, a decline occurred in the mite population due to factors not connected with the compounds used in the trial. This summer decline was observed also in 1965 and 1966 (9).

Table 5 - Details and test conditions of three field trials on the effect of pesticides on the density of the phytoseiid mite population in Shamouti groves at Bet Dagan (application with a motor-gun sprayer at a rate of 20-22 liters per tree)

Trial No.	Date of treatment (1968)	Materials	No. of trees sprayed	No. of trees inspected	No. of trees control	Design
Ph I	June 12	Neorón 0.06% chlorobenzilate 0.12% Polyram Combie 0.12% E 102 0.15%	45	5	45	5 random replicate plots of 9 trees, of which the central one was inspected
Ph II	June 18	Neoron 0.06% Neoron 0.03% chlorobenzilate 0.12% Polyram Combie 0.12% E 102 0.15%	36	4	36	4 random replicate plots of 9 trees, of which the central one was inspected
Ph III	July 21	Neoron 0.06% Neoron 0.03% chlorobenzilate 0.12% E 102 0.15%	36	4	36	as in Ph II

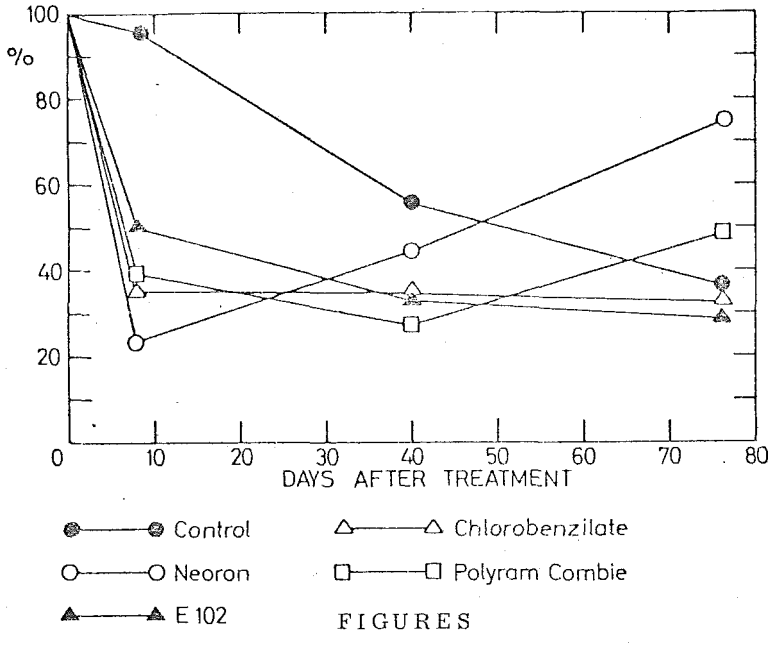

Fig. 1: The effect of Neoron (50%) 0.06%, E 102 (20%) 0.15%, chlorobenzilate (25%) 0.12%, and Polyram Combie (80%) 0.12% on the density of the mite population on Shamouti fruits (before treatment-100%)(trial Ph I).

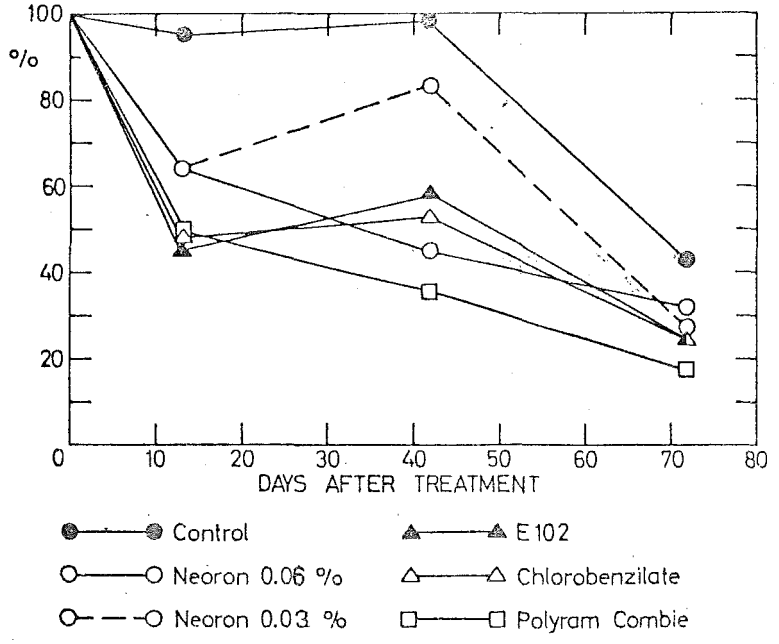

Fig. 2: The effect of Neoron (50%) 0.03% and 0.06%, chlorobenzilate (25%) 0.12%, and Polyram Combie (80%) 0.12% on the density of the mite population on fruits (before treatment-100%)(trial Ph II).

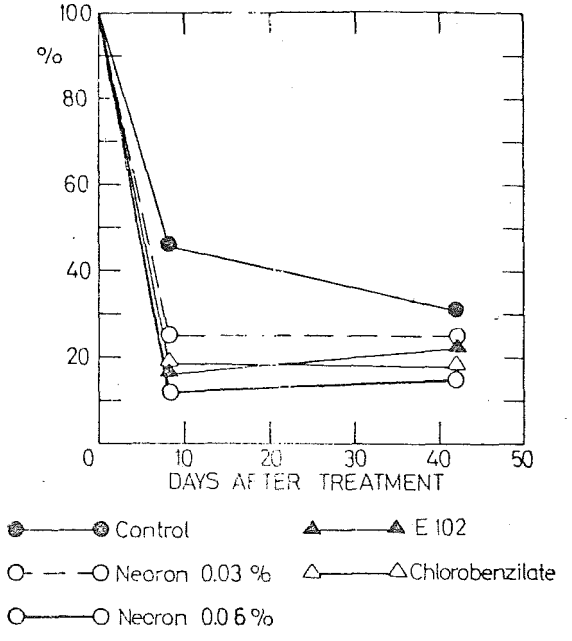

Fig. 3: The effect of Neoron (50%) 0.03%, 0.06%, E 102 (20%) 0.15% and chlorobenzilate (25%) 0.12% on the density of the mite population on Shamouti fruits (before treatment-100%)(trial Ph III).

The numbers of phytoseiid mites were probably affected by the prey-population levels as well as the various chemicals. All the acaricides resulted in a medium or slight initial suppression of the mite population, followed by a resurgence. Neoron (50%) 0.03% was less toxic than chlorobenzilate (25%) 0.12% (Figs. 2, 3); at 0.06% it gave a higher (Fig. 1, 3) or lower (Fig. 2) initial kill than chlorobenzilate. For unclarified reasons, Polyram Combie reduced the mite population in the citrus grove, although it did not kill larvae and adults or suppress the oviposition rate in the laboratory.

There was no significant difference in the density of phytoseiids between trees treated with chlorobenzilate or with E 102.

DISCUSSION AND CONCLUSIONS

The low citrus rust mite population in early summer does not permit extensive tests: hence, they were conducted during autumn. However, in autumn the phytoseiid mite population drops, due, inter alia, to bait-sprays with malathion against the Mediterranean fruit fly; therefore the adverse effect of the acaricides on them was evaluated during summer.

The low or moderate initial kill of the citrus rust mite by Polyram

Combie, followed by an improvement, was produced in the autumn also by some other carbamates, e. g. zineb, mancozeb, Antracol and, to a lesser degree, maneb (9).

Since the literature indicates that Neoron is an effective compound against red spider mites (1, 2, 4), it is worthwhile to evaluate its effect on Eutetranychus orientalis Klein, which is abundant on citrus in the drier areas Israel. Neoron gave very good results against some eriophyids, such as the citrus bud mite Aceria sheldoni Ewing (5) and un unidentified bud mite on Prunu domestica (2). The compound E 102 was also effective against the citrus bud mite (Dr. M. Sternlicht, personal communication). On the other hand, Neoron did not affect beetles or moths of stored products (6).

Thus, it was shown in the present and other works that Neoron and E 102 control the citrus rust mite effectively, reduce the infestation by flat mites and the citrus bud mite, and decrease the population of phytoseiids only moderately, without causing commercial-level phytotoxicity. Therefore, these two compounds are recommended against the citrus rust mite. Since E 102 was not tested on a large scale, it would be desirable to do so with commercial trials.

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