Preliminary Report: The residual toxicity of field-weathered insecticide residues on citrus leaves to a parasite of red scale

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Opsomming

Die rooiskaal parasiet *Comperiella bifasciata* (Howard) is in Mungerselle blootgestel aan natuurlike verouderde gifstof residue op sitrusblare. Twee formulasies van endosulfan is vergelyk maar geen betekenisvolle verskille ten opsigte van residuele nawerking kon getoon word nie. 'n Hoë mate van mortaliteit is vir ongeveer twee weke waargeneem.

Blootstellings is ook gedoen met residue van temefos en triasofos op sitrusblare. Beide middels toon residuele nawerking vir ongeveer ses weke onder winter toestande.

Braakwynsteen residue is ook getoets en het bewys gelewer dat dié middel relatief min invloed op *C bifasciata* het.

Abstract

The red scale parasite *Comperiella bifasciata* (Howard) was exposed to field weathered insecticide residues on citrus leaves in Munger cells.

Two formulations of endosulfan were compared but no differences in terms of residual toxicity could be observed. High mortalities were registered for approximately two weeks.

Exposures were also done on temephos and triazophos residues. Both the foregoing chemicals exhibit residual toxicity for approximately six weeks under winter conditions.

Tartar emetic residues were also tested and results indicated that this chemical had very little or no effect on *C bifasciata*.

Introduction

The development of resistance to organophosphates by the red scale *Aonidiella aurantii* (Mask) (Georgala, 1979) has increased the desire of growers to promote the biological control of this pest. Resistance has not yet been recorded on *Zebediela Estates*, but has occurred to a limited extent on another farm in its immediate vicinity.

For many years the biological control of red scale has been promoted on the *Estates* and the prospects of resistance has created a need to expand the areas under biological control as fast as possible. During the 1980-81 season the whole *Estates*, comprising approximately 540 000 trees, will be under an integrated pest management programme with red scale under biological control.

It is well-known that red scale can be adequately controlled by its natural enemies. (Bedford 1975, 1978, 1979(a)). However, there are other pests which require chemical treatments to obtain commercial control. On *Zebediela Estates* the most important of these are the bollworm *Heliothis armigera* (Hübn), the citrus psylla *Trioza erytreae* (Del Guercio) and the citrus thrips *Scirtothrips aurantii* Faure. These pests can be regarded as annual threats requiring the application of insecticides over large areas of the *Estates*.

Where red scale is under biological control it is important to select treatments for the control of the foregoing pests that will have the least impact on the natural enemies of red scale. This applies particularly to thrips which remains a threat for up to three months after petal fall. In view of the large areas requiring treatment it is also desirable to use the most economical insecticides possible.

At Zebediela, endosulfan 47,5% m/m wettable powder is primarily used for psylla and occasionally for bollworm control. In recent years triazophos 42,8% m/v emulsifiable concentrate has increasingly been used for thrips control. Two formulations of endosulfan are available which to date have differed significantly in price and are also reputed to differ significantly in residual toxicity to parasitic hymenoptera. In the case of thrips control there is also a signiticant cost ditterence when the cheaper temephos treatment is used. However, the use of temephos has been reported to be incompatible with the biological control of red scale. (Bedford, 1971, 1978, 1979(a)).

The opinions and reports in regard to the ability of the foregoing treatment to have a detrimental effect on natural enemies were not based on critical comparative data for recommended concentrations or normal usage patterns. In view of this it was decided to conduct preliminary bioassay trials to study the toxicity of the treatments to a hymenopterous parasite of red scale.

Procedure

Two trials were commenced at different times during autumn and winter. The registered treatments involved were as follows:

0,048% ai endosulfan (Thiodan) 47,5% m/m
0,048% ai endosulfan (Thiojack) 47,5% m/m
0,026% ai triazophos (Hostathion) 42,8% m/v
0,01% ai temephos (Abate) 50% m/v

Only the endosulfan treatments were used in both trials. Each of the treatments was applied to two navel trees as a high pressure spray to thoroughly wet the foliage canopy. At the time of the first trial a tartar emetic bait treatment was applied to a small block of navel trees with a mistblower to simulate an aerial application. This treatment was applied at a rate equivalent to 5 kg tartar emetic plus 7,1 *l* molasses plus 3,5 kg white sugar per hectare.

At intervals after treatment five leaves were removed from each treatment and placed in modified Munger cells. (Bartlett, 1951). The leaves selected were taken from the outer foliage canopy on the eastern side of the trees, and were of approximately equal size. Each leaf was placed in the Munger cell with the adaxial (dorsal)

surface exposed in the arena area. Leaves from untreated trees were used as controls.

The red scale parasite *Comperiella bifaciata* Howard was used as the test insect. On each exposure date, day old specimens were obtained from the mass-rearing unit on the *Estates*. Twenty to thirty parasites (mixed sexes) were exposedd in each cell arena. During each exposure period the cells were maintained at a constant 27°C and 65% RH. An aquarium air pump was used to maintain 5 to 6 air changes per minute in the cells, using air from the room in which the trial was conducted. A small drop of honey was applied to the roof of each cell to act as food for the parasites during the exposure period.

All exposures of parasites to residues on leaves were conducted during daylight when the test insects were most active. The preparation of the cages and insertion of the parasites was completed early in the morning. The first mortality counts were conducted one hour after the insertion of the parasites. Thereafter counts were conducted over a total exposure period of 7,9 hours at log-spaced time intervals. At each count parasites exhibiting no antenna or leg movement were regarded as dead. In assessing the data from each count a correction was made for natural mortality in the control. (Abbot, 1925).

The data for each exposure and treatment were plotted on log probit paper. The regression lines were fitted by eye and the LT_{50} values were subsequently derived from the graphs. Between each exposure the Munger cells were thoroughly washed to remove possible toxic residues.

Discussion

The comparatively long residual toxicity exhibited by all treatments in these trials can be attributed to the cool, dry weather which prevailed. These conditions differed considerably from the warmer spring conditions with occasional rain which prevail when the treatments are used in practice for pest control. The effect of climate at this time can be expected to reduce residual toxicity to a varying degree. It will be important to repeat the trials at the normal application times to obtain the most realistic indication of residual toxicity to *C bifasciata*. However, these preliminary trials do give an indication of the relative toxicity of the registered treatments to this parasite. From this it is clear that triazophos and temephos are considerably more toxic than endosulfan at registered concentrations.

The similar toxicities exhibited in the trials by the two endosulfan formulations could have considerable financial implications for the *Estates*. The results obtained with temephos relative to triazophos were surprising. The toxicity of temephos to natural enemies has frequently been emhasised while triazophos has come to be regarded as suitable for use in programmes designed for the integrated control of red scale. (Bedford, 1979(a)). It now seems possible that at the registered concentrations tested the two treatments are fairly similar in their residual toxicity to *C bifasciata*. The progressive increase in residual toxicity of temephos during the first 10 days of the trial suggests that breakdown products were mainly responsible for this trend.

Table 1 Mortality of *C bifasciata* following exposure to progressively aged residues of two endosulfan formulations applied on 21 May 1980 (Trial 1)

	Thiojack		Thiodan	
Days after treatment	% Mortality at 7,9 hours	LT_{50} hours	% Mortality at 7,9 hours	LT_{50} hours
1	100	<1	100	<1
2	100	<1	100	<1
3	100	<1	100	<1
5	100	<1	100	1,1
6	98,5	1,7	95,9	2,2
7	97,9	2	90,9	3,2
8	88,6	3,6	77,6	3,1
9	68,5	4,2	69,7	4,6
12	67,6	4,3	64,9	4,5
14	70,8	4,2	67,0	4,6
15	77,3	5,2	66,8	5,8
19	38,1	>7,9	37,8	>7,9
21	35,0	>7,9	37,5	>7,9
23	7,9	>7,9	4,5	>7,9

Table 2 Mortality of *C bifasciata* following exposure to progressively aged residues of two endosulfan formulations applied on 23 June 1980 (Trial 2)

	Thiojack 0,048% ai		Thiodan 0,048% ai	
Days after treatment	% Mortality at 7,9 hours	LT_{50} hours	% Mortality at 7,9 hours	LT_{50} hours
2	100	<1	100	<1
4	100	<1	100	<1
7	100	<1	100	<1
9	97,3	2	93,4	3,1
11	71,6	3,5	90,5	4,2
14	74,1	3,2	67,3	4,1
18	67,6	4,2	64,9	4,5
21	42,1	>7,9	56,7	6,8
23	38,5	>7,9	44,4	>7,9
28	27,7	>7,9	14,0	>7,9
32	18,7	>7,9	13,8	>7,9
35	8,1	>7,9	9,4	>7,9

Table 3 Mortality of *C bifasciata* following exposure to progressively aged residues of Temephos and Triazophos applied on 23 June 1980.

	Triazophos 0,026% ai (Hostathion)		Temephos 0,01% ai (Abate)	
Days after treatment	% Mortality at 7,9 hours	LT_{50} hours	% Mortality at 7,9 hours	LT_{50} hours
2	100	<1	28,9	>7,9
4	100	<1	62,9	6,8
7	100	<1	62,3	5,69
9	100	<1	81,4	2,72
11	100	<1	93,0	2,09
14	100	<1	90,1	3,31
21	100	<1	96,4	2,06
23	100	1,6	96,1	2,63
28	100	1,9	93,3	3,06
32	94,9	1,66	88,2	4,24
35	98,5	1,81	86,2	3,05
39	95,5	1,84	63,1	5,22
43	90,7	3,0	60,7	6,17
46	74,8	4,57	58,8	6,60
52	26,3	>7,9	30,6	>7,9
55	25,4	>7,9	13,2	>7,9
58	29,5	>7,9	11,3	>7,9
60	18,8	>7,9	13,1	>7,9
63	10,2	>7,9	11,1	>7,9

The results obtained with tartar emetic confirmed the well accepted view that this long standing treatment of thrips has comparatively little effect on parasitic hymenoptera. (Bartlett, 1953, Bedford, 1979(a)).Unfortunately it is a weak treatment and on occasion has performed poorly at *Zebediela Estates*.

Results

In all trials the natural mortality in the untreated control used for each exposure varied from 7 to 9% during the total exposure period of 7,9 hours. In each of the treatments evaluated, exposures were continued at intervals until the mortality in the treatments approximately equalled that of the control.

No major differences in residual toxicity were noticed between the two endosulfan formulations (Thiodan and Thiojack) in both trials. The residual toxicity of both endosulfan formulations appeared to decline more rapidly in the first trial than in the second. However, the general trend in both trials was similar. There was no rain during the course of either trial. Mean maximum daily temperature during the first trial was 22,4°C and during the second trial 20,3°C. The somewhat higher temperature level during the first trial may have accelerated the breakdown of residues.

At the registered concentration of 0,026% ai triazophos was markedly more toxic than endosulfan at 0,048% ai. For almost a month after application all test insects died on each exposure date within the total exposure time. This confirmed the results of an initial pilot trial with the same treatment in which a similar result was obtained during exposures up to a total of 25 days after application.

In contrast to triazophos, temephos at the registered concentration of 0,01% ai initially registered much lower mortalities than the first named treatment. Peak mortalities with temephos commenced eleven days after application and persisted for a further 24 days without reaching the mortality levels registered with triazophos during this time. The subsequent decline in residual toxicity of temephos coincided with that of triazophos and, throughout this latter period lowest mortalities were recorded with temephos. Analysis of a sample of the temephos used indicated that the active ingredient content was according to specification.

In the case of the tartar emetic treatment applied as part of the first trial, three exposures were made in the seven day period after application. In all cases mortality of *C bifasciata* was similar to, or less than, that in the control.

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Central California's 1980/81 navel orange crop

The 1980/81 California navel orange harvest appears to be a large one. Preliminary estimates forecast 69000 cars in the Central California orange belt. That is the largest volume on record. (1 car = 1000 cartons).

Because of the extremely large crop growers are planning an extended harvesting period. Growers are advised to use a growth regulator treatment such as gibberellic acid to slow down the aging process and to maybe utilize 2,4-D to help reduce preharvest drop.

Gibberellic acid applied in low volume as well as outside coverage. Both methods require good coverage achieved by proper ground speeds, nozzle adjustment and operating pressures. The material must however contact the fruit.

The recommended quantities applied are the equivalent of dilute applications on a per acre basis. Trees that require 19 grams of the active ingredient per acre in 500 gallons of spray respond in a similar manner with respect to delays in rind softening and aging with trees that receive 19 grams of active ingredient per acre applied in low volume at the rate of 100 gallons per acre on mature fruit.

The gibberellic acid result varies with the time of spray application. Green fruit treated in October or early November, before colour break, will have higher resistance to puncture injuries than fruit treated at time of colouring or later. If application of spray is too early, experiments showed a slight loss in puncture resistance. This implies that treatments during mid-October produce maximum effect, under Californian conditions.

Regarding preharvest fruit drop, the problem is to avoid droppage in orchards late in the season. The 2,4-D activity lasts for only about four months. Thus, October treatments will have little benefit after January.

Editors Note:– The Central Valley navel season starts in November and continues until March.

California's 1980/81 Avocado Crop

California' avocado crop is higher by an estimated 264 per cent from last year's 140 million production. It is expected that this may cut retail prices from one dollar each to perhaps, three for a dollar.
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