Toxicity of pesticides to the red-legged earth mite *Halotydeus destructor*

David G. James
Yanco Agricultural Institute, New South Wales Department of Agriculture, Yanco, New South Wales, 2703

Summary

The toxicities of 15 pesticides to *Halotydeus destructor* were determined in the laboratory. The order of contact toxicity was methidathion > azinphos-ethyl > phosmet > omethoate > dimethoate > malathion > diazinon > monocrotophos > carbaryl > cyhexatin > chlorpyrifos > propargite > oxythioquinox > dicofol > azinphos-methyl.

Introduction

The red-legged earth mite, *Halotydeus destructor* (Tucker), is an important cool-season pest of establishing crops and pastures in southern Australia (Swan 1934; Wallace 1940; Wright 1961; Hely *et al.* 1982). Mite activity commences following autumn rains and in some years (e.g. 1978, 1986) populations reach plague proportions and can cause severe economic loss to crops such as rapeseed, cereals, peas and lettuce. Heavily infested seedlings may be severely damaged or killed. A number of generations are produced during late autumn, winter and spring resulting in peak mite populations in September or October. With the increased desiccation of natural host plants (broad-leaved weeds, particularly *Arctotheca calendula* L. (capeweed) during spring, the mites die retaining over-summering diapause eggs within their bodies (Wallace 1970*a*,*b*). The eggs are able to tolerate extremely high temperatures and do not hatch until the return of cool, wet conditions in autumn.

For many years satisfactory control of *H. destructor* was achieved by a single treatment of DDT which generally provided protection for the whole winter (Wright 1961). Following the withdrawal of DDT as a registered pesticide for use in field crops, a number of alternative chemicals have been registered for use against *H. destructor*. Most of these are organophosphate compounds which provide higher contact toxicity to *H. destructor* but are substantially less effective in their residual action than DDT. Following reports during 1986 of control problems with some of these chemicals against *H. destructor* in southern New South Wales, laboratory bioassays were undertaken to evaluate the relative toxicity of recommended and alternative pesticides. Another aim was to establish base-line data which could be used as a reference for detecting any developing pesticide resistance.

Materials and methods

Mites for bioassay were obtained from large unsprayed populations occurring on weeds, primarily *A. calendula*, at the Yanco Agricultural Institute and Leeton Field Station in the Murrumbidgee Irrigation Area of southern New South Wales, during September–November 1986. It is unlikely that these populations had ever been exposed to pesticides. Mites were either used immediately or stored for a maximum of 7 days at 5°C before testing.

The following commercial formulations of insecticides and acaricides were tested against *H. destructor*:

Gusathion A [50% w/v azinphos-ethyl emulsifiable concentrate (ec)];
Gusathion [50% w/w azinphos-methyl wettable powder (wp)];
Carbaryl [80% w/w carbaryl (wp)];
Diazinon [80% w/v diazinon (ec)];
Rogor [30% dimethoate (ec)];
Folimat [80% w/v omethoate (ec)];
Lorsban [25% w/w chlorpyrifos (wp)];
Kelthane [40% w/v dicofol (ec)];
Maldison [50% w/v malathion (ec)];
Supracide [40% w/v methidathion (ec)];
Azodrin [40% w/v monocrotophos];
Imidan [15% w/v phosmet (ec)];
Plictran [50% w/w cyhexatin (wp)];
Omite [30% w/w propargite (wp)]; and
Morestan [25% w/w oxythioquinox (wp)].

Adult mites were separated from immature stages by filtering through 0.5 mm diam. muslin, and bioassayed using a Potter Spray Tower. Pesticides were evaluated for contact and residual toxicity by spraying 4 or 5 serial dilutions on to glass Petri dishes containing 25–150 mites. Two ml of each concentration were sprayed at a tower pressure of 50 kPa which gave a deposit of 1.6 mg of liquid cm^{-2} at 23°C. Each test was replicated three times and a water only treatment was included in each replicate as a control. After spraying, a small leaf of *A. calendula* was added to each dish as food and the lid replaced. Dishes were held at 25 ± 0.5°C, 80–90% R.H. under a 14.5-h photophase. Mortality was assessed after 48 h and mites were considered dead if unable to show coordinated movement. The dose–mortality data were corrected for control mortality (Abbott 1925) and analysed by probit analysis (Finney 1971). Tests were discarded if control mortality exceeded 15%.

The possibility that results were influenced by fumigant action of pesticides within the Petri dishes was tested by caging mites in tubes, but separated from the highest rate of each pesticide by a muslin partition. Mortality in all cases was insignificant (<5%) when mites were unable to contact the deposits.

Results

Most of the chemicals tested showed a high degree of activity against *H. destructor* (Table 1). Methidathion was the most toxic followed closely by azinphos-ethyl and phosmet. Other chemicals giving 100% mortality at a rate of 2 ppm or less were dimethoate, omethoate, malathion, diazinon and monocrotophos. Carbaryl, cyhexatin and chlorpyrifos required a concentration of 10 ppm for total kills, whilst oxythioquinox, propargite, dicofol and azinphos-methyl were not effective at rates below 100 ppm.

Table 1 Efficacy of pesticides against adults of *H. destructor* in laboratory bioassays

Pesticide[A]	*n*	LC50[B] (95% C.I.)	Slope (±s.e.)
methidathion	710	0.005(0.006–0.004)	1.9 ± 0.20
azinphos-ethyl	622	0.020(0.022–0.019)	3.2 ± 0.19
phosmet	733	0.033(0.036–0.031)	3.4 ± 0.23
omethoate	717	0.16(0.19–0.13)	1.5 ± 0.39
dimethoate	569	0.20(0.23–0.17)	2.1 ± 0.37
malathion	666	0.35(0.38–0.32)	3.1 ± 0.13
diazinon	573	0.42(0.46–0.38)	3.3 ± 0.29
monocrotophos	713	0.54(0.59–0.50)	3.1 ± 0.53
carbaryl	750	2.6(2.8–2.4	3.0 ± 0.53
cyhexatin	663	2.7(3.0–2.5)	2.9 ± 0.31
chlorpyrifos	708	3.7(4.0–3.4)	3.7 ± 0.81
propargite	907	34(37–32)	2.8 ± 0.39
oxythioquinox	879	37(40–34)	2.7 ± 0.66
dicofol	687	191(207–177)	3.7 ± 0.27
azinphos-methyl	577	204(222–187)	3.2 ± 0.19

[A] Ranked in descending order of toxicity.
[B] Concentration expressed in ppm.

Discussion

This study provides the first data on effectiveness of pesticides against *H. destructor* under laboratory conditions. Bioassay of 15 pesticides showed that of the chemicals currently recommended for control of *H. destructor* in New South Wales, azinphos-ethyl, phosmet, methidathion, omethoate and dimethoate, possess greatest contact toxicity to this species. Methidathion, phosmet and azinphos-ethyl were highly toxic to *H. destructor* with 0.05–0.10 ppm sufficient for total kill of adults. The only recommended chemical which performed poorly in these tests was chlorpyrifos which ranked 11th in toxicity. The recommended field rate of methidathion, azinphos-ethyl, phosmet and dimethoate for use against *H. destructor* in winter crops in New South Wales is 36–37 g a.i. ha^{-1} (Mallise and May 1987). This concurs with the similar toxicity rating of these chemicals in the current laboratory study. Of the acaricides tested, cyhexatin, propargite, dicofol and oxythioquinox all performed poorly compared to the broad-spectrum compounds. However, the toxicity of these chemicals to *H. destructor* was similar to that obtained against two-spotted mite, *Tetranychus urticae* Koch (James and Edge, unpublished data). In the case of cyhexatin, *H. destructor* was at least 5× more susceptible than *T. urticae* (Edge and James 1986). The higher toxicity and lower cost of organophosphate compounds would appear to preclude the economic use of acaricides against *H. destructor* in pastures or broadacre field crops.

These results constitute a useful starting point for future studies on the efficacy of pesticides against *H. destructor* under field conditions. They also provide necessary base-line toxicological data on the susceptibility of *H. destructor* to the chemicals currently recommended for its control. Poor control of *H. destructor* has sometimes been attributed to pesticide resistance. The information presented here should allow confirmation or rejection of such suspicions in the future.

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