LABORATORY BASED RELATIVE PESTICIDE EFFICACY AGAINST CYCLAMEN MITE, *PHYTONEMUS PALLIDUS* (BANKS) (ACARI: TARSONEMIDAE)

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Summary

This is the first instance of laboratory pesticide testing of *Phytonemus pallidus.* Six pesticides and two horticultural spray oils were evaluated under laboratory conditions against *P. pallidus*, using a Potter spray tower. Pesticide toxicity fell into three distinct groups, the antibiotic abamectin, conventional miticides and oils. Both oils proved ineffective, and a heterogeneous response was demonstrated against these latter products.

Keywords: Bioassay method, discriminating concentration, cyclamen mite, *Phytonemus pallidus.*

INTRODUCTION

Cyclamen mite *Phytonemus pallidus* (Banks) is an important cosmopolitan phytophagous pest. It was first described in New York, USA (Banks 1901) and has been recorded damaging ornamentals in several countries (Smith 1933; Gellatley 1983) as well as strawberry (Huffaker and Kennett 1956; Welch *et al.* 1989; Bayan 1998). Damage mainly occurs on terminal growth, including buds and flowers, causing malformation and arrested growth. Like other Tarsonemidae, cyclamen mite is favoured by high humidity and low light intensity (Gerson 1992). Tarsonemids are commonly pests of field and semi protected areas in late summer and autumn, as well as heated production houses. Their small size ($\leq$ 0.25mm) and cryptic behaviour makes their chemical control and bioassy difficult.

Current Australian chemical control is based on the organochlorine pesticide, dicofol (National Registration Authority 2003). This product, however, is disruptive to integrated mite control (IMC) of the key horticultural mite pest, two-spotted mite *Tetranychus urticae* Koch, based on use of the predatory mite *Phytoseiulus persimilis* Athias-Henriot (Croft and Brown 1975), as well as to predators of *P. pallidus* (Easterbrook *et al.* 2001; Tuovinen, 2002).

Studies have shown acaricidal activity in petroleum and vegetable spray oils (Herron and Rophail 1994; Herron *et al.* 1995; Beattie *et al.* 2002), synthetic pesticides such as tebufenpyrad (Bower 1991) and the antibiotic abamectin (Lasoto and Dybas 1991), but these have not been evaluated for their efficacy against cyclamen mite in Australia. In addition, a reliable bioassay method has not been developed for this species so consequently base-line data for future efficacy testing and resistance monitoring are not established. Recommendations for control have to date been based on field trials (Welch *et al.* 1989; Goodwin 1990; Labanowska 1992).

In this study, we describe a bioassay method to test pesticide toxicity of established acaricides and oils against *P. pallidus* using a Potter spray tower. The data are contrasted to similar investigations against another tarsonemid mite pest, broad mite, *Polyphagotarsonemus latus* (Banks).

MATERIALS AND METHODS

Chemicals tested

Mites were tested against the following formulated pesticides: the antibiotic abamectin (Avid® 18g ai L^{-1} Emulsifiable Concentrate (EC)), the organochlorines dicofol (Kelthane® 240g ai L^{-1} EC) and endosulfan (Thiodan®, 350g ai L^{-1} EC) the Mitochondrial Electron Transport Inhibitors (METI) fenpyroximate (Acaban®, 50g ai L^{-1} Suspension Concentrate), pyridaben (Sanmite®, 250g ai L^{-1} EC) and tebufenpyrad (Pyranica®, 200g ai L^{-1} Wettable Powder), plus a petroleum spray oil (Ampol DCTron Plus®) and canola oil (Synertrol®).

Mite collection and culturing

P. pallidus were found infesting flowers of azalea (*Rhododendron* sp.) at Bilpin, New South Wales (33º 37'S 150º 41'E) in a commercial nursery. As initial attempts to culture *P. pallidus* in the laboratory for bioassay were unsuccessful azalea flowers and buds infested with cyclamen mite were field collected and placed in a small insulated container inside sealable plastic bags with strips of paper towel to absorb excess moisture. The plastic bags were placed in a

refrigerator at approximately 10ºC for the test period, and only taken out to transfer mites for testing. Flower buds were kept for a maximum of two weeks before being replenished from the field.

Bioassay

Adult female mites were transferred onto impatiens, *Impatiens sultanii* Hook, leaf discs (18mm diameter). Mites were transferred with the aid of a stereomicroscope under low light intensity, using a fine camel-hair brush. Approximately eight mites were transferred to the under-side of each disc, which was then suspended over moist cotton wool on elastic bands in dishes to maintain high humidity, and covered with a steel tray. Mites were bioassayed with the aid of a Potter spray tower using methods described in Herron *et al*. (1996). After spraying, leaf discs were returned to the dish on the elastic bands, allowed to dry in a dark location, then the dish was covered with plastic film and maintained at 21ºC. Mortality was assessed after 24 h. Log dose probability regressions that included control mortality (<10%) correction (Abbott 1925) were then calculated with the aid of Probit 5 for Windows (Gillespie 1995).

RESULTS

The relative efficacies of the pesticides tested against *P. pallidus* are given in Table 1. Pesticide efficacy fell into three distinct groups: abamectin, the conventional pesticides and oils. Abamectin was the most efficacious (LC_{50} $2.4x10^{-5}$ g ai L^{-1}), followed by pyridaben (LC_{50} $1.5x10^{-4}$ g ai L^{-1}), dicofol (LC_{50} $4.8x10^{-4}$ g ai L^{-1}), tebufenpyrad (LC_{50} $7.6x10^{-4}$ g ai L^{-1}), fenpyroximate (LC_{50} $8.2x10^{-4}$ g ai L^{-1}) and endosulfan (LC_{50} $2.1x10^{-3}$ g ai L^{-1}). By far the least efficacious chemicals were petroleum spray oil (LC_{50} 10.7 g ai L^{-1}) and canola oil (LC_{50} 12.7 g ai L^{-1}).

The flat probit regression slopes (0.8 and 0.7 for petroleum spray oil and canola oil respectively) demonstrate a highly heterogeneous response by cyclamen mite to these chemicals.

DISCUSSION

This appears to be the first bioassay result reported for *P. pallidus.* Abamectin was the most efficacious chemical tested, although it was less efficacious against *P. pallidus* than against the closely related species broad mite, *P. latus* (Herron *et al.* 1996). However, the slope of the probit regression for abamectin was 2.6, much steeper than the 1.0 reported for *P latus*. These data indicate a high level of homogeneity in the response of *P. pallidus* to abamectin, which suggests the likelihood of good field control at the appropriate application rate. This conclusion supports investigations reported by Welch *et al*. (1989) in strawberry fields in California.

The efficacy of the METI pesticides pyridaben,

Table 1. Relative efficacy of six pesticides and two oil sprays oils against *P. pallidus.*

Chemical	N	χ^2	df	Slope (se)	LC_{50} g ai L^{-1} (95% FL)	$LC_{99.9}$ g ai L^{-1} (95% FL)
Abamectin	227	7.2	3	2.6 (0.51)	2.4×10^{-5} ($1.7x10^{-5} – 3.2x10^{-5}$)	3.8×10^{-4} ($1.1x10^{-4} – 1.3 x10^{-3}$)
Dicofol	216	5.5	2	5.3 (1.12)	4.8×10^{-4} ($3.6x10^{-4} – 6.3x10^{-4}$)	1.8×10^{-3} ($7.7x10^{-4} – 4.3x10^{-3}$)
Fenpyroximate	235	4.2	3	2.4 (0.37)	8.2×10^{-4} ($6.1x10^{-4} – 1.1x10^{-3}$)	1.5×10^{-2} ($4.6x10^{-3} – 4.9x10^{-2}$)
Tebufenpyrad	363	4.7	5	2.1 (0.19)	7.6×10^{-4} ($6.0x10^{-4} – 9.7x\ 10^{-4}$)	2.4×10^{-2} ($1.0x10^{-2} – 5.7x10^{-2}$)
Endosulfan	230	6.3	3	3.0 (0.47)	2.1×10^{-3} ($1.6x10^{-3} – 2.8x10^{-3}$)	2.2×10^{-2} ($9.5x10^{-3} – 5.3x10^{-2}$)
Pyridaben	168	2.3	3	2.6 (0.28)	1.5×10^{-4} ($1.1x10^{-4} – 2.0x10^{-4}$)	2.4×10^{-3} ($8.3x10^{-4} – 6.8x10^{-3}$)
Petroleum Spray Oil	173	5.7	2	0.8 (0.57)	10.7 ($6.6x10^{-2} – 1.7x10^{3}$)	1.3×10^{4} ($1.2x10^{-5} – 1.4x10^{15}$)
Canola Oil	180	4.5	3	0.7 (0.33)	12.7 ($3.0x10^{-1} – 4.6x10^{2}$)	2×10^{5} ($8.3x10^{-2} – 4.6x10^{11}$)

N - number of mites tested se - standard error
df - degrees of freedom FL - fiducial limits

fenpyroximate and tebufenpyrad fell between abamectin and the organochlorines, endosulfan and dicofol. The data suggest that these pesticides may be suitable alternatives to currently recommended organochlorine pesticides, provided field data also support efficacy. Labanowska (1992) reported pyridaben was as effective as endosulfan in controlling *P. pallidus* in strawberry crops.

The petroleum and canola oils were both ineffective in killing *P. pallidus*, and therefore appear to have a limited role in future field control. The slopes of the probit regressions were 0.8 and 0.7 respectively, indicating a heterogeneous response. This contrasts with results reported from similar investigations with *P. latus*, although a slightly different formulation of petroleum oil spray (Ampol DCTron ®) was used against the latter mite (Herron *et* a*l.* 1996). While this may partly explain the different mortality responses in the two mite species, the formulation of canola oil (Synertrol®) was identical for both investigations. It therefore appears that there is an inherent difference in response to oil sprays between *P. pallidus* and *P. latus.* This may be a result of morphological differences between the two species. *P. pallidus* has a different structure of stigmata on its dorsal shield (Linquist 1986) which may restrict the easy penetration of oils into the spiracles and tracheae.

The calculation of probit regressions for each pesticide tested allowed $LC_{99.9}$ values to be estimated. A concentration equivalent to the LC_{99} or the $LC_{99.9}$ is commonly used to detect resistant arthropods, with lower doses risking false positives and higher doses risking missing low level resistance (Busvine 1980). However, as Herron and Gullick (2001) reported, it may be more appropriate to use 2x $LC_{99.9}$ to account for natural variations in susceptibility of insect-naïve populations. We therefore suggest that the discriminating concentrations for the purposes of resistance monitoring in *P. pallidus* should be: abamectin $8x10^{-4}$ g L^{-1}, pyridaben $5x10^{-5}$ g L^{-1}, dicofol $4x10^{-3}$ g L^{-1}, tebufenpyrad and endosulfan $5x10^{-2}$ g $L^{-1}$and fenpyroximate $3x10^{-2}$ g L^{-1} (Table 1).

While these investigations aimed to generate reliable base-line data of the susceptibility of cyclamen mite for future efficacy testing and resistance monitoring, it should be noted that samples were obtained directly from a commercial nursery. Although there had been no recent use of any of the pesticides evaluated, it was not possible to determine whether the mites tested were from a susceptible population. Other factors may be the history of the two mite populations to pesticide exposure, or the extent of laboratory rearing prior to testing. Under optimum conditions, tarsonemid mites can complete their life cycle in four to five days (Gerson 1992). Over the period of bioassay testing, therefore, up to 15-20 generations of broad mite may have occurred. However, as cyclamen mite was not able to be laboratory reared, field collected samples were sequentially tested. Some or all of the above factors may also explain the differences in susceptibility to other pesticides exhibited by *P. pallidus.*

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