AN INDEX OF ACTIVITY OF PYRETHROID INSECTICIDES ON TWOSPOTTED SPIDER MITES

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SUMMARY

The activity of the pyrethroid insecticides, flucythrinate and fenvalerate, against adult female twospotted spider mite, (*Tetranychus urticae*) was compared using a measure of direct toxicity (slide dip tests) and repellency (run-off from broad bean leaf discs). Slide dip tests showed that the two chemicals had a similar level of toxicity but flucythrinate had a significantly greater repellent activity. A ratio of LC50/Run-off 50 is suggested as a suitable measure to reflect the relative roles of toxicity and repellency in the effects of pyrethroid insecticides on twospotted spider mite.

INTRODUCTION

Pyrethroid insecticides have long been recognised as giving excellent control of target pests such as Lepidoptera (Elliot *et al* 1978), yet they have been responsible for outbreaks of secondary pests such as spider mites. If pyrethroids are to achieve wide acceptance, particularly in top fruit crops, the pest outbreak problem must be countered.

The conventional approach to insecticide-induced pest outbreaks is to include additional chemicals in the spray programme. In the case of spider mite outbreaks, this practice increases the risk of resistance to miticides. Under the conventional organophosphorus insecticide programmes in apples, for example, integrated mite control using resistant predatory phytoseiids has evolved to provide a stability in spider mite control. Pyrethroid use would be highly disruptive to integrated mite control due to the high toxicity of the chemicals to the predatory phytoseiid mites (e.g. Wong and Chapman 1979). Efforts in selecting strains of phytoseiids resistant to pyrethroids offer promise for the continuation of integrated mite control (Hoy *et al* 1983).

Predatory mortality is not, however, the only cause of pyrethroid-induced mite outbreaks. There are differences in direct toxicity to spider mites between different pyrethroids and formulations (Chapman and Penman 1979; Iftner and Hall 1983a). Subtle behavioural influences are also becoming apparent, such as the repellency of spider mites from pyrethroid-treated surfaces (Iftner and Hall 1983b; Penman *et al* 1981; Penman and Chapman 1983), inducing mites to disperse from colonies which may otherwise have been subject to density-dependent population regulation.

The conventional measure of pesticidal effects on insects and mites has been through direct toxicity expressed as LD or LC50's. Spider mites are commonly tested using a slide dip technique which measures direct toxicity after 24 or 48 h. The immobilisation of the mites on the slide does not permit a measure of the behavioural influences of the chemicals. In this paper we present a comparison of methods for the measurement of pyrethroid activity against the twospotted spider mite, incorporating a measure for direct toxicity and for repellency.

METHODS

Twospotted spider mites were reared in the laboratory on French dwarf beans (*Phaseolus vulgaris* cv 'Super Long'). The strain was of mixed parentage originating from organophosphate resistant and susceptible strains.

Direct toxicity was measured by a slide dip method in which 20-30 adult female twospotted spider mites were placed dorsal side down onto double-sided sticky tape. Slides were dipped for 5 seconds in serially diluted insecticide solutions, dried and held

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for 24 h at 26 °C (70% RH). A water/acetone treated control was run for each chemical. Mortality was assessed by the failure of the mites to respond positively by leg movement following prodding with a fine brush.

Repellent effects were measured on isolated leaf discs of broad bean (*Vicia faba* c.v. 'Exhibition Long Pod'). The lower surface of 10 mm diameter discs were sprayed in a Potter Tower (2 ml, 10 seconds settling time) with serial dilutions of insecticide and a water/acetone treated control. Fifty discs were sprayed for each treatment. Discs were air-dried, placed upper surface down on wet cotton wool. One mature female twospotted spider mite was placed on each disc and the complete experiment run for 24 h at 26 °C (70% RH) in a 16:8 light-dark regime. Repellency was assessed by mite 'run-off', by recording the numbers trapped in the water barrier around the leaf discs.

Two pyrethroid insecticides, flucythrinate and fenvalerate, were tested as technical grade compounds dissolved in acetone. Serial dilutions were 1:1 acetone/water.

Data were analysed by probit analysis using POLO (Robertson *et al* 1980) determining LC50 (for toxicity) and Run-off 50 (for repellency). 95% confidence intervals and slopes (and standard error) of the dosage-mortality lines were also calculated.

RESULTS

Data from analysis by POLO are presented in Table 1. Both toxicity and run-off data can be adequately described by the log-probit model.

Comparison of LC50 values showed that flucythrinate was 2.8 times more toxic than fenvalerate. However, they are not significantly different as the 95% confidence intervals overlap. By contrast, Run-off 50 values were markedly different between the two compounds. Flucythrinate induced 50% run-off at a concentration 16.4 times lower than fenvalerate, although the change in repellency with concentration was similar as evidenced by similar slopes of concentration-run-off lines.

One possible method of expressing the relationship between toxicity and repellency is by an LC50/Run-off 50 ratio. A value of ≤ 1 could indicate repellency would be unlikely to contribute to the control of a pest; a value > 1 could indicate the opposite. Such ratios calculated for flucythrinate and fenvalerate were 7.4 and 1.3 respectively and suggest the repellency action of flucythrinate could have a considerable influence on its control of twospotted spider mite.

TABLE 1: Direct toxicity (LC50) and repellency (Run-off 50) of technical grade pyrethroid insecticides to twospotted spider mite.

	Flucythrinate	Fenvalerate
LC50	0.37 (0.24 – 0.55)	1.06 (0.42 – 1.46)
Slope	1.15 $\pm$ 0.12	2.76 $\pm$ 0.28
N	800	1400
Run-off 50	0.05 (0.02 – 0.08)	0.82 (0.48 – 1.95)
Slope	1.27 $\pm$ 0.27	1.25 $\pm$ 0.40
N	300	300
Ratio: LC50/Run-off 50	7.4	1.3

(–) = 95% confidence intervals.

N = total number of adult female mites tested.

DISCUSSION

That the application of pyrethroid insecticides to several crops induces spider mite outbreaks is beyond dispute. However, a detailed examination of the mechanisms of pyrethroid-induced mite outbreaks may suggest alternative ways of using these

compounds or suggest activity relationships which may permit the manufacture of pyrethroids with greater acaricidal activity.

The action of pyrethroid insecticides against spider mites is complex. Direct toxicity can be measured by slide dip tests and these have often been used to compare direct acaricidal activity (e.g. Chapman and Penman 1979; Iftner and Hall 1983a). In many cases, LC50's for spider mites determined by slide dip tests are well above the recommended field rates for control of the target pests such as Lepidoptera. While slide dip tests suggest limited acaricidal activity of pyrethroids at field rates, field trials have shown wide variation in relative control of spider mites (Chapman and Penman, unpublished data). The failure of conventional slide-dip tests to accurately reflect field activity of different pyrethroids against twospotted spider mite means that alternative methods must be used to determine the complex activity of the chemicals. As previously indicated, the repellent action of pyrethroids, inducing mites to disperse to areas of the plant low in residues, is an important component of chemical action. In the present work this response was measured by the leaf disc residue technique which allowed mites to leave the treated surfaces. Virtually all mites left the leaf discs at concentrations of pyrethroid insecticide below those causing direct toxicity which could not, therefore, be measured by this method. The immediate effect of contact with pyrethroids is to stimulate spider mites to leave the residue. Run-off 50 as measured by the leaf disc technique provides a relative measure of repellency but allowing mites to choose freely between treated and untreated leaf surfaces with minimal barriers to dispersal may reveal even lower thresholds for repellency (Penman and Chapman 1983).

A wide range of susceptibility to different pyrethroids has been revealed in other slide dip tests on twospotted spider mite (Chapman and Penman 1979; Iftner and Hall 1983a) and formulation induced differences are also apparent. The methods outlined in this paper, and further refinements of them, may reveal more subtle differences in the responses of spider mites to pyrethroids so assisting our understanding of mite outbreaks and of the relative acaricidal activity of these compounds.

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REFERENCES

- Chapman, R.B. and Penman, D.R., 1978. Toxicity of synthetic pyrethroid insecticides to phytophagous orchard mites. *Proc. N.Z. Weed and Pest Control Conf.* 32: 240-244.
- Elliot, M., Janes, N.F., Potter, C., 1978. The future of pyrethroids in insect control. *Ann. Rev. Ent.* 23: 443-469.
- Hoy, M.A., Westigard, P.H. and Hoyt, S.C., 1983. Release and evaluation of a laboratory-selected, pyrethroid resistant strain of predaceous mite, *Metaseiulus occidentalis* (Acari:Phytoseiidae) in southern Oregon pear orchards and a Washington apple orchard. *J. econ. Ent.* 76: 383-388.
- Iftner, D.C. and Hall, F. R., 1983a. Toxicities of selected synthetic pyrethroids to two species of phytophagous mites. *J. econ. Ent.* 76: 687-689.
- Iftner, D.C. and Hall, F.R., 1983b. Effects of fenvalerate and permethrin on *Tetranychus urticae* Koch (Acari:Tetranychidae) dispersal behaviour. *Environ. Ent.* 12: 1782-1786.
- Penman, D.R. and Chapman, R.B., 1983. Fenvalerate-induced distributional imbalances of two-spotted spider mite on bean plants. *Ent. exp. and appl.*, 33: 71-67.
- Penman, D.R., Chapman, R.B. and Jesson, K.E., 1981. Effects of fenvalerate and azinphosmethyl on two-spotted spider mite and phytoseiid mites. *Ent. exp. and appl.*, 30: 91-97.
- Robertson, J.L., Russell, R.M. and Savin, N.E., 1980. POLO: A users guide to probit or logit analysis. Pacific Southwest Forest and Range Experiment Station, Berkeley. 14p.
- Wong, S.W. and Chapman, R.B., 1979. Toxicity of synthetic pyrethroid insecticides to predaceous phytoseiid mites and their prey. *Aust. J. agric. Res.* 30: 497-501.