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CITRUS AND KIWIFRUIT INSECT PEST CONTROL WITH PIRIMIPHOS METHYL AND PERMETHRIN

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Summary

Pirimiphos methyl and permethrin, both insecticides of low mammalian toxicity, were evaluated for the control of the main insect pests of citrus and kiwifruit (*Actinidia chinensis* var *chinensis*) in replicated trials carried out in the Bay of Plenty. Inadequacies in the spectrum of activity of each chemical alone were evident in three trials on citrus and two on kiwifruit. However, mixtures of both chemicals demonstrated a high level of activity against the pests encountered and provided control at least comparable to that of the current standard treatments.

INTRODUCTION

The main insect pests of kiwifruit are greedy scale (*Hemiberlesia rapax*), leaf roller (principally *Ctenopseustis obliquana*), passion vine hopper (*Scolypopa australis*) and a native moth *Strathmopoda skelloni* (Ferguson and Stratton 1978). Control of these pests and their associated damage on kiwifruit is essential for the retention of valuable export markets obtained for this crop.

On citrus the principal insect damage symptoms contributing to the down grading of fruit quality are skin blemish and discolouration, sooty mould and the presence of insects on the fruit. Leaf roller larvae damage fruit by surface chewing and this in turn may predispose fruit to the entry of fungal or bacterial infection. Sooty mould develops on honey dew excreted by mealy bugs (*Pseudococcus* spp), black scale (*Saissetia oleae*), Chinese wax scale (*Ceroplastes sinensis*), and soft wax scale (*Gascartia destructor*). Heavy infestations of these insects will also cause general weakening of the plant (Penman 1976). California red scales (*Aonidiella aurantii*) are important even at low levels of infestation as their presence on fruit is very obvious. Citrus red mite (*Panonychus citri*) remove chlorophyll from leaves and fruit resulting in a pale mottled appearance.

Control programmes in kiwifruit and citrus generally rely on the use of two or more insecticides to prevent damage by the aforementioned pest complexes. Trial work was initiated in Bay of Plenty in 1976 to evaluate pirimiphos methyl and permethrin alone and in mixture for insect pest control in both crops.

Pirimiphos methyl is a fast acting, broad spectrum organophosphorus insecticide, of notably low mammalian toxicity. It was discovered at the ICI Jealott's Hill Laboratories in U.K. and first introduced in 1970 under the code number PP 511. Insects are killed by contact, ingestion and fumigant action and pirimiphos methyl is readily absorbed into leaves resulting in translaminar activity. Residues remain for up to 12 weeks on inert surfaces, but rapidly degrade on living plant tissue. The acute oral LD 50 for female rats is 2050 mg/kg and the acute dermal LD 50 is greater than 2000 mg/kg.

Permethrin is a synthetic pyrethroid, described as a broad spectrum insecticide with a high level of activity on Lepidoptera (Jackson and Graham 1979).

METHODS

The trials reported in this paper (Table 1) were conducted on commercial orchards in the Bay of Plenty district. Plots comprised single vines for kiwifruit and

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single trees for citrus, with treatments replicated four times in a randomized block design. Application was made by a handgun fitted with a D. 7 tip and using 2070 kPa pressure and treatments were sprayed to run off. Spray schedules and standard treatments were based on the current (1977) Ministry of Agriculture and Fisheries recommendations.

TABLE 1: Location, variety and application dates

Trial	A	B	C	D	E
Crop	Orange	Orange	Tangelo	Kiwifruit (Pergola)	Kiwifruit (T-Bar)
Variety	Carters Navel	Caters Navel	Tangelo	Hayward	Hayward
Location	Pe Puke	Te Puke	Omokoroa	Te Puke	Te Puna
Treatment	30.12.76	28.12.77	18.12.77	8.11.77	8.11.77
Dates	24.1.77	17.1.78	17.1.78	19.12.77	19.12.77
	1.3.77	10.2.78	15.2.78	17.1.78	17.1.78
	10.5.77	29.5.78	29.5.78	16.2.78	16.2.78
				21.3.78	21.3.78
				11.4.78	11.4.78
Harvest					
Date	28.8.77	16.9.78	27.9.78	2.5.78	11.5.78

Assessments were made by visual determination of leaf roller and sooty mould damage to the fruit; mealy bug by presence at touching fruit sites; and scale populations measured under microscopic examination. Results were analysed using Duncan's new multiple range test.

RESULTS AND DISCUSSION

Citrus

The results presented in Tables 2 and 3 show all treatments to have reduced the level of leaf roller damage significantly with the lowest incidence recorded on the treatments containing tank mixtures of permethrin plus pirimiphos methyl. Except for untreated, much of the leaf roller damage present at harvest on Trials B and C was recent, as three months had elapsed between the final spray treatment and harvest, during which time leaf roller flights were recorded by the Ministry of Agriculture and Fisheries (P.R. Sale pers comm). Therefore, the results do not fully reflect the effectiveness of the insecticides, as they could not be expected to afford protection for such periods. The intensity of shelter planting in Bay of Plenty has probably resulted in micro climates suited to an extension of leaf roller cycles further into the winter and, therefore, some adjustment in spraying programmes will be required to facilitate adequate leaf roller control where such conditions exist.

All insecticide treatments in trial A reduced the percentage of fruit damaged by sooty mould to below 6% compared to 53.7% on untreated. Except for permethrin, a positive correlation between mealy bug and sooty mould infested fruit was evident. The proportionally high mealy bug numbers relative to sooty mould incidence on permethrin (4.4 g) suggests the treatment was exercising some influence on mealy bug behaviour. On trial C there was a marked reduction in sooty mould on all insecticide treatments, with diazinon plus carbaryl and permethrin plus pirimiphos methyl being significantly superior to either components of the latter mixture applied alone. The two mixture treatments reduced the number of damaged fruit to fewer than 2% compared to 93.8% on untreated. Mealy bug were the main casual factor of sooty mould on trial A whereas on trial C black scale also contributed to the damage recorded on untreated and the pirimiphos methyl treatment.

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TABLE 2: Mealy bug infestation, sooty mould and leaf roller damage on oranges (Trial A)

Treatment	Rate g/100 litres	Mealy bug % sites infested (100 touching fruit) 17 Aug	Sooty mould % damaged fruit (400 fruit) 29 Aug	Leaf roller % damaged fruit (400 fruit) 29 Aug
untreated	0 g	26.6 a	53.7 a	26.8 a
diazinon*	50 g	2.3 b	2.0 b	5.6 b
permethrin	4.4 g	19.0 ab	6.0 b	5.8 b
pirimiphos methyl	75 g	2.0 b	0.8 b	3.7 b
permethrin plus pirimiphos methyl	2.0 g 75.0 g	6.0 b	1.5 b	1.5 b
CV%		110.2	36.9	52.0

* plus maldison 62.5 g and mineral oil 1.5 litres at 2nd and 3rd spray dates

In trial C all insecticide treatments markedly reduced black scale numbers and except for 55 recorded on pirimiphos methyl all had less than two per 20 samples compared to 597 on untreated.

Mealy bug was well controlled by all insecticide treatments except permethrin alone, which at rates tested performed poorly in all trials. Both mixture treatments obtained comparable levels of control and were superior (although not significantly) to pirimiphos methyl (50 g) in trials B and C but similar to pirimiphos methyl (75 g) in trial A.

Commercial usage of a permethrin (2.5 g) plus pirimiphos methyl (47.5 g) formulation has verified the results obtained in the reported trials and also demonstrated a high level of activity against soft wax scale and citrus red mite on a comparative block evaluation in Kerikeri.

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All treatments except permethrin significantly reduced greedy scale on kiwifruit in trials D and E as shown on Table 4. Permethrin plus pirimiphos methyl was the only treatment to record zero greedy scale on either trial.

Passion vine hopper damage as expressed by the presence of sooty mould was controlled by all treatments except pirimiphos methyl. Permethrin and permethrin plus pirimiphos methyl were consistently superior and were closely followed by the standard treatment, although the differences were not statistically significant.

All treatments except pirimiphos methyl provided near complete control of leaf roller, with 1% or less of fruit recording damage. The spray programme followed in kiwifruit provided a more accurate gauge of treatment effectiveness against leaf roller than was obtained in the citrus trials.

CONCLUSION

The results demonstrate that a mixture of permethrin (2.5 g) plus pirimiphos methyl (50 g) offers a viable alternative to standard insecticide treatments used on citrus and kiwifruit. The results afforded by the mixture were comparable to those of standards on the spectrum of pests which affect quality of kiwifruit and citrus. The low mammalian toxicity of the mixture also offers operator safety advantages where spraying practices present risks of chemical exposure.

Citrus spray programmes should be extended to ensure optimal insecticidal protection is afforded for the duration of the insect pest infestation period. This will necessitate insecticide applications to be made further into the winter if quality fruit, free of insect damage are sought.

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TABLE 3: Mealy bug infestation, sooty mould and leaf roller fruit damage and black scale counts on oranges and tangelos (Trials B and C)

Treatment	Rate g/100 litres	Mealy bug % sites infested (80 touching fruit) Trial B Trial C 16 Aug 29 Sept	Sooty mould % damaged fruit (320 fruit) Trial C 27 Sept	Leaf roller % damaged fruit (320 fruit) Trial B Trial C 16 Sept 26 Sept	Black scale* mean population per 20 samples Trial C 24 June
untreated	0	72.5 a 90.0 a	93.8 a	20.5 a 37.3 a	597 a
diazinon + carbaryl	50 80	10.0 b 7.5 b	1.9 c	9.8 b 14.7 b	0 b
permethrin	7.5	35.0 b 46.3 a	24.6 b	6.3 b 10.9 b	1 b
pirimiphos methyl	50	20.0 b 12.5 b	27.5 b	7.8 b 13.4 b	55 b
permethrin + pirimiphos methyl	2.5 50	12.5 b 1.3 b	1.3 c	4.8 b 8.4 b	1 b
CV%		54.6 45.7	35.1	31.8 46.1	145.9
* assessment made on 80 samples 30 cm long including twig, leaf and fruit					

TABLE 4: An assessment of leaf roller and passion vine hopper damage and greedy scale counts on kiwifruit at harvest (Trials D and E)

Treatment	Rate g/100 litres	Greedy scale population per 200 fruit Trial D Trial E	Passion vine hopper damage (800 fruit) Trial D Trial E	Leaf roller damage (800 fruit) Trial D Trial E
untreated	0	94 a 42.3 a	31.3 a 8.6 a	30.6 a 21.9 a
*phosmet +plus surfactant	112.5	0.5 b 0.3 b	9.5 b 4.6 a	1.0 b 0 b
permethrin	7.5	12.3 b 21.5 ab	2.0 b 0.4 a	0 b 0 b
pirimiphos methyl	50	2.5 b 0.5 b	24.4 a 15.1 a	6.5 b 7.5 ab
permethrin + pirimiphos methyl	2.5 50	0 b 0 b	3.3 b 1.3 a	0.4 b 0 b
CV%		196.8 135.6	67.8 174.0	52.9 130.4
* on trial E azinphos-methyl 50 g was applied on treatment dates 1-4 and phosmet on 5 and 6				
+ the non ionic wetter used was Agral LN at 125 ml/100 litres				

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