TEFLUBENZURON AND PHOSALONE ALONE AND IN COMBINATION FOR PEST CONTROL ON KIWIFRUIT: I. ARMoured SCALE INSECTS

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SUMMARY

Field trials were conducted in Waikato and Tauranga kiwifruit orchards during 1986-87 to evaluate teflubenzuron and phosalone used alone or combination to control armoured scale insects. Applications of teflubenzuron alone had little effect on greedy scale (*Hemiberlesia rapax*) and no effect on oleander scale (*Aspidiotus nerii*). Phosalone had some activity against both scale insect species. Only a standard spray programme using phosmet gave a commercially acceptable level of reduction in scale infestation of fruit.

Keywords: teflubenzuron, phosalone, kiwifruit, greedy scale, *Hemiberlesia rapax*, oleander scale.

INTRODUCTION

Armoured scale insects (greedy scale (*Hemiberlesia rapax*); latania scale (*Hemiberlesia lataniae*) and oleander scale (*Aspidiotus nerii*)) are key pests of kiwifruit. They are currently controlled by regular application of broadspectrum insecticides, mainly organophosphates, during the growing season. Many of these insecticides have high toxicity to mammals and beneficial organisms such as biological control agents (Ferguson and Stratton 1978) and bees (Clinch and Palmer-Jones 1974). Virtual reliance on a single group of insecticide risks resistance development (Carnean 1988). It is therefore advisable to broaden the range of insecticides employed and, where possible, to use insecticides with lower toxicity to non-target organisms. Phosalone is an organophosphate insecticide with relatively low toxicity to mammals, bees (Colinese and Terry 1967) and ladybird (*Chilocorus* spp.) predators of scale insects (Peter and David 1988) and has demonstrated activity against armoured scale insects (Rafal'skii and Nishenko 1988). Teflubenzuron is an insect growth regulator which has demonstrated activity against Lepidoptera, some hemipterous insects and nil toxicity to predatory insects (Becker and Deletraz 1987).

This paper reports on field trials to evaluate phosalone and teflubenzuron used alone and in combination against armoured scale insects. The effects of these experimental treatments on leafrollers, secondary pests and contaminants recorded in the same trials have been reported by Tomkins (1992).

METHODS

The trials were conducted on blocks of mature kiwifruit vines located at Rukuhia (cv. 'Hayward') and Tauranga (cvs. 'Elmwood' and 'Hayward'). Vines at both orchards had received no applications of any pesticide for several previous seasons.

The rates (g ai/ 100 litres) and timing of the applications used are listed in Table 1. The timing of applications followed conventional recommendations from the current export spray programme. Phosmet was included as a standard for comparison. Spreader/sticker (Citowett at 50 ml/100 litres) was used with phosalone and phosmet. All treatments were applied at a water rate of 2250 litres/ha using a Hardi handgun at 1750 kPa. Plots consisted of single vines buffered by at least one unsprayed vine within and between rows. Treatments had three replicates at Tauranga and six at Rukuhia.

Scale infestation was monitored throughout the season by collecting 20 mature leaves from the central area of each treatment vine at fortnightly intervals from

Proc. 45th N.Z. Plant Protection Conf. 1992: 151-155

December until May. Number of scale per leaf, scale species, stage and whether live, dead or parasitised were determined. Data were subjected to ANOVA after log_e transformation of scale + 1 per 20 leaves. Data for all greedy scale found on leaves sampled over the entire season were pooled and the proportions found in each instar subjected to logit regression analysis.

One hundred fruit per vine were randomly harvested on 12 and 15 May 1987 at Rukuhia and Tauranga respectively. The fruit were stored at 4°C until microscopic examination to determine numbers of scale insects per 100 fruit which, after log_e transformation, were subjected to ANOVA and logit regression analysis for the Rukuhia and Tauranga trial data respectively.

RESULTS

Greedy scale were recorded on leaves from some vines belonging to all treatments at both sites from early December (Fig. 1). At the Rukuhia site, oleander scale were also found on leaves, but infestations did not reach significant levels until February (Fig. 2). Very few leaves infested with oleander scale were found on the Tauranga vines, throughout the season.

At Rukuhia, greedy scale numbers declined on the leaves of phosmet-treated vines during December-early January and remained at a low level from January onwards (Fig. 1). Greedy scale numbers were reduced on phosalone-treated vines, except for a period during late February-March. At Tauranga, leaf infestation of vines treated with phosmet or phosalone were significantly lower ($P < 0.05$) than on unsprayed vines only in the latter part of the season, in April and May. Few oleander scale were found on the leaves of vines treated with phosalone and even fewer on phosmet-treated vines.

Although there were usually fewer greedy scale on the leaves of the Rukuhia vines treated solely with teflubenzuron than on unsprayed vines the differences were not significant. In contrast, the numbers of oleander scale were similar on the leaves of unsprayed vines and those treated with teflubenzuron alone (Fig. 2). When teflubenzuron was used in combination with phosalone the numbers of greedy scale infesting leaves were analogous with those on phosalone only treated vines.

Fig. 1: Total (live + dead) number of greedy scale per 20 kiwifruit leaves at Rukuhia in 1986-87 (bars represent SED).

A smaller proportion of the greedy scale settling on Rukuhia vines developed past the first instar on vines treated with phosmet (23%) than phosalone (45%) (Fig. 3). On the teflubenzuron-treated vines 61-66% of the greedy scale developed past the first instar compared with 80% on the unsprayed vines. The proportions of the greedy scale found in each of the three instars differed significantly ($P < 0.001$) between treatments.

Parasitism of the third instar scale insects found on unsprayed vine leaves sampled throughout the season, was 11% for oleander scale and 25% for greedy scale. The level of parasitism of third instar greedy scale was lower on all sprayed treatments (0-19%) than on unsprayed vines, with no parasitism recorded for greedy scale infesting leaves from vines treated with either phosmet or phosalone at Rukuhia (Fig. 3).

Fig. 2: Total (live + dead) number of oleander scale per 20 kiwifruit leaves at Rukuhia in 1986-87 (bars represent SED).

Fig. 3: Percent stage (instar) composition of greedy scale infesting kiwifruit leaves at Rukuhia, 1986-87. (bars represent SED per instar).

TABLE 1: Number of greedy scale and oleander scale per 100 fruit harvested at Rukuhia and Tauranga on 12 and 15 May 1987 respectively.

Treatment ^a	Rate g ai/ 100 litres	Greedy scale		Oleander scale	
		Rukuhia	Tauranga	Rukuhia	Tauranga
unsprayed	-	4.0 ^b (57) ^c	3.2(31)	2.2(10)	1.8(8)
phosmet (Imidan 75WP)	112.5	0.5(2)	1.3(2)	0.2(1)	0.2(1))
teflubenzuron (Nomolt 15SC)	7.5	2.8(17)	-	3.6(42)	-
phosalone (Zolone 30WP)	10.0	1.9(7)	-	3.7(43)	-
teflubenzuron + phosalone	75.0	2.2(9)	2.0(7)	0.2(1)	0.0(0)
teflubenzuron + phosalone	3.8	2.8(16)	2.9(16)	1.2(4)	1.2(3)
teflubenzuron + phosalone	45.0	3.0(20)	-	0.4(2)	-
SED	75.0	0.36		0.66	

^a applications for Rukuhia and Tauranga respectively were; pre-flowering (14 and 17 November); post-blossom (12 and 8 December); 14-21 days later (27 and 23 December 1986); at 3-4 weekly intervals until withholding period (10 and 12 January, 9 and 9 February, 12 and 17 March and 6 and 8 April 1987).

^b log_e transformed.

^c back-transformed.

At harvest, the relative levels of scale insect infestation of fruit (Table 1) generally reflected the differences in the levels of leaf infestation found between treatments. The numbers of both species of scale insects were reduced on phosmet and phosalone-treated vine fruit, but to commercially acceptable levels only on the former.

DISCUSSION

Neither phosalone or teflubenzuron, alone or in combination, gave economically acceptable scale insect control at the rates tested. Phosalone may give better control of scale insects if used at a higher rate. San Jose' scale (*Quadraspidiotus perniciosus*) is effectively controlled by 3 kg ai/ha (Rafal'skii and Nishenko 1988) whereas only 1.7 kg ai/ha was used in this trial. A smaller proportion of the greedy scale population survived moulting between instars to reach the third instar on vines treated with teflubenzuron only. However, too many greedy scale were able to mature and produce crawlers which infested an unacceptable proportion of fruit. Similar problems have been found with other insect growth regulators (Tomkins 1991).

Teflubenzuron had less effect on oleander scale than it did on greedy scale. However, oleander scale may be more susceptible than greedy scale to organophosphates, as shown by the complete absence of live oleander scale on phosmet-treated vines which still had some live greedy scale. This trial shows the need to check for differences in susceptibility of scale insect species to insecticides when developing new products or spray programmes.

Strategies are needed for using an insect growth regulator which kills scale insects during moulting between instars, without resulting in an economically unacceptable level of fruit infestation. The insect growth regulator could be used in combination with a second insecticide with faster or greater activity against first instar scale insects. Alternatively, the insect growth regulator could be applied early in the season to reduce the scale population, with applications of the faster acting insecticide timed to coincide with the peak period of fruit infestation by second generation crawlers (Tomkins *et al* 1992). This trial evaluated the first approach, using phosalone to increase the speed of kill of scale insects resulting in the death of more insects during the first instar with teflubenzuron improving the kill of later instars. This combination failed, mainly due to the poor activity of teflubenzuron, particularly against oleander scale, but also due to the failure of phosalone to provide sufficient control.

Laboratory studies are presently underway to determine the effectiveness of a range of insect growth regulators including teflubenzuron, on different scale insect stages in order to more effectively time applications. The efficacy of mixtures of insect growth regulators with other types of insecticides is also being studied.

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REFERENCES

- Becker, P. and Deletraz, H., 1987. Teflubenzuron an insect growth regulator for the control of important insects in orchards. *Meded. Facult. Landbouw. Rijksuniv. Gent* 52(2b): 455-462.
- Carmean, L., 1988. Managing pesticide resistant red and yellow scale. *Citrograph* 73(7): 142.
- Clinch, P.G. and Palmer-Jones, T., 1974. Effect on honey bees of azinphos-methyl applied as a pre-blossom spray to Chinese gooseberries. *N.Z. J Exp. Ag.* 2: 205-207.
- Colinese, D.L. and Terry, H.J., 1967. Phosalone - a wide spectrum organophosphorous insecticide. *Proc. 10th British Crop Prot. Conf.*: 380-391.

- Ferguson, A.M. and Stratton, A.E., 1978. Insect control on kiwifruit. Part II. *Proc. 31st N.Z. Weed and Pest Control Conf.*: 140-146.
- Peter, C. and David, B.V., 1988. Comparative toxicities of some insecticides to *Chilocorus nigritus* (F.) (Coccinellidae: Coleoptera). *Pesticides* 22(1): 23-25.
- Rafal'skii, A.K. and Nishenko, A.A., 1988. The California scale in the southern steppe of the Ukraine. *Zashchita-Rastenii-Moskva* 9: 40-42. In: *Rev. App. Ent. Series A 1990 Ref*: 078-08580.
- Tomkins, A.R., Thomson, C., Wilson, D.J. and Greaves, A.J., 1992. Armoured scale insects on unsprayed kiwifruit vines in the Waikato. *N.Z. Ent.* 15: (In press).
- Tomkins, A.R., 1991. Evaluation of an insect growth regulator, fenoxycarb, for greedy scale control on kiwifruit. *Acta Horticulturae* 297: 517-522.
- Tomkins, A.R., 1992. Teflubenzuron and phosalone alone or in combination for pest control on kiwifruit. II. Caterpillars, secondary pests and contaminants. *Proc. 45th N.Z. Plant Protection Conf.*: