EVALUATION OF A MINERAL OIL FOR PEST CONTROL ON KIWIFRUIT

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ABSTRACT

A field trial in 1991-92 evaluated the efficacy of a mineral oil used at 0.5, 1.0 and 2.0% against insects and mites in a season long programme on kiwifruit. Other treatments included phosmet or were unsprayed. Infestation of leaves and fruit by armoured scale insects was reduced by all oil treatments, but only the 2.0% rate gave control equivalent to the phosmet programme. Oil treatments reduced fruit damage and infestation by caterpillars but not to a commercially acceptable level. All spray programmes gave a similar reduction in fruit infestation by thrips. Only fruit from vines treated with 2% oil were free of mites. No cocoons of the whirlygig mite (*Anystis baccarum*) were found on oil-treated fruit. Leaves and fruit of oil-treated vines had phytotoxic marking, probably due to the accidental inclusion of a spreader/sticker with applications in mid December and early January.

Keywords: mineral oil, kiwifruit, armoured scale insects, leafroller, mites

INTRODUCTION

The key pests of kiwifruit (*Actinidia deliciosa*) are armoured scale insects (greedy scale (*Hemiberlesia rapax*), latania scale (*Hemiberlesia lataniae*), oleander scale (*Aspidiotus nerii*)) and leafrollers (Steven *et al.* 1994). Until recently, these pests were managed using calendar spray programmes based on the regular application of insecticides, mainly organophosphates. A first-stage Integrated Pest Management (IPM) system, commonly referred to as 'Kiwigreen', is now gaining wide adoption and uses alternative insecticides (mineral oil and *Bacillus thuringiensis* products), and monitoring systems to determine when to spray for key pests (Steven *et al.* 1994).

The introduction of mineral oils on kiwifruit has been an important step towards developing an IPM system. Their introduction was hampered by phytotoxicity problems in early attempts to control armoured scale insects on kiwifruit (Sale 1972). These problems were overcome by the development of more highly refined oils and the identification of factors influencing phytotoxicity on kiwifruit (McKenna and Steven 1993).

This paper reports on a field trial conducted to determine the efficacy of the oil which was subsequently adopted for use in the kiwifruit IPM system.

MATERIALS AND METHODS

The trial was conducted in an orchard near Paeroa on mature vines cv. 'Hayward' which had been untreated with pesticides for several previous seasons. Several features of this trial were experimental and are not or cannot be recommended commercially. These include the use of higher than normal water rates and the timing of oil applications. In particular, oils do not have a label claim for use from 10 days after flowering until February 1 due to the risk of phytotoxicity as indicated in this trial, and confirmed by more detailed investigations (McKenna and Steven 1993). Treatments were replicated six times in a completely randomised block design using single vine plots buffered by unsprayed vines.

The insecticides and their rates (g a.i./100 litres) used were: phosmet as Imidan 75WP (112.5g) and mineral oil as Sunspray Ultra-Fine oil (0.5, 1.0 and 2.0%). Phosmet was used as a standard in this trial, but its use has since been restricted to pre-flowering applications on export kiwifruit. A spreader/sticker (Multifilm) at 25ml per 100 litres was used with phosmet, and also accidentally used with the first three applications of the oil treatments. Treatments were applied on: 5 November and 17 December 1991, 3 and 15 January, 11 February, 19 March and 15 April 1992, at a water rate of 3600 litres/ha using a Hardi handgun at 1750 kPa. A high water rate was used to ensure thorough wetting of vines which did not receive summer pruning, although lower water rates (2000 litres/ha) are generally used in kiwifruit orchards.

Scale insect infestation was monitored by randomly sampling twenty mature leaves from the centre of vines at 2-4 weekly intervals from December to May. Number of scale per leaf, scale species, instar and whether they were live, dead or parasitised were recorded. Data were analysed by ANOVA after $\log_e$ transformation of the number of scale insects per 20 leaves + 1. Leaves sampled for scale insects on 24 January were also assessed for phytotoxicity after suspected damage was noticed. The marking observed was spotting of the leaf surface and/or darkening or death of the leaf edge.

Fruit damage and contamination by insects and mites was determined for 25 and 100 fruit per vine randomly sampled on 15 January and 6 May 1992, respectively. The fruit were cool-stored at 4°C until microscopic examination for insects or mites, and fruit marking due to physical or chemical factors. The numbers of insects or mites per 100 fruit were subjected to $\log_e (X+1)$ transformation before analysis using ANOVA and percent damage/infestation data were analysed using logit regression analysis.

RESULTS

Scale insects

Greedy scale infested leaves were found in all treatments (Fig. 1), whereas very few oleander scale and no latania scale were found. The numbers of live greedy scale were largely static on unsprayed vine leaves until early February whereas they declined on phosmet-treated vines to a very low level from late January onwards. The level of greedy scale infestation of the leaves on oil-treated vines was related to the rate of oil with only 2% oil reducing infestation to a low level. No fruit from vines treated with phosmet or 2.0% oil were infested with scale insects (Table 1). These results show that mineral oils can provide good control of scale insects in spite of their relatively low toxicity compared with some of their broadspectrum insecticide predecessors (Blank *et al.* 1993).

FIGURE 1: Total (live + dead) numbers of greedy scale per 20 kiwifruit leaves at Paeroa in 1990-91 (bars represent SED).

TABLE 1: Numbers (after $\log_e(X+1)$ transformation) of scale insects per 100 fruit harvested on 6 May 1992. Back-transformed means in brackets.

Treatment	Rate (g ai or L/100 litres)	Greedy scale	Oleander scale
Unsprayed		2.8(16.7)	1.9(6.9)
Phosmet	112.5	0.0	0.0
Mineral oil	0.5	1.1(3.2)	0.1(1.2)
	1.0	0.4(1.5)	0.0
	2.0	0.0	0.0
SED		0.52	0.51

Leafrollers

Most fruit damage and infestation (65% for unsprayed fruit) occurred before the 15 January assessment (Table 2). The phosmet programme maintained a high level of caterpillar control throughout the season. All of the oil treatments reduced fruit damage, with a rate effect evident. Subsequent studies have shown that mineral oils can have both ovicidal and larvicidal activity against leafrollers (Thomson and Tomkins 1993).

TABLE 2: Percent fruit damage and infestation by lepidopterous larvae.

Treatment	Rate (g ai or L/100 litres)	15 Jan. 1992	6 May 1992
Unsprayed		15.0	23.1
Phosmet	112.5	0.0	1.0
Mineral oil	0.5	10.3	10.9
	1.0	5.1	11.9
	2.0	0.0	6.1
SED		5.64	2.86

Thrips and mites

All spray programmes reduced fruit infestation by thrips, probably the greenhouse thrips (*Heliothrips haemorrhoidalis*), to a similar degree, with no programme achieving complete control (Table 3). The ability of mineral oils to provide some thrip control supports the results of more recent laboratory bioassays conducted by Blank and Gill (1995) which demonstrated moderate toxicity to some stages of greenhouse thrips.

TABLE 3: Percent of fruit infested by mites or thrips, harvested on 6 May 1992.

Treatment	Rate (/100 litres)	Mites	Thrips
Unsprayed		9.6	11.0
Phosmet	112.5	1.0	2.3
Mineral oil	0.5	3.1	1.9
	1.0	4.5	1.7
	2.0	0.0	1.0
SED		2.91	2.44

A small proportion of fruit were infested by various non-phytophagous mites, mostly oribatids (Table 3). All spray programmes reduced fruit infestation by mites although only the 2.0% oil programme achieved fruit free of mite infestation. Steven and Lofroth (1987) had previously shown that mineral oils can have a high level of

contact toxicity to oribatid mites. Moulting cocoons of the predatory whirlygig mite (*Anystis baccarum*) were found on unsprayed fruit only (4 per 100 fruit).

Phytotoxicity

Significant differences were found between treatments in the levels of both darkened leaf edges and spotting damage ($P < 0.001$ and $P < 0.05$ respectively), with the incidence of both types of leaf damage higher on oil than phosmet-treated vines (Table 4). This damage was probably caused by the oil application made in early January which coincides with the period when kiwifruit are sensitive to chemical applications (McKenna and Steven 1993).

TABLE 4: Percent of leaves harvested on 24 January 1992 with damage to leaf edges or spotting.

Treatment	Rate (g ai or L/100 litres)	Edge	Spotting
Phosmet	112.5	7.4	6.1
Mineral oil	0.5	22.7	15.9
	1.0	18.3	21.0
	2.0	42.8	27.5
SED		6.04	6.31

Speckling of the skin of fruit harvested on 15 January 1989 was only found for vines treated with 2% oil (8% of fruit). However by 6 May, speckling and increased skin reddening was found on fruit from all oil treatments (Table 5). The level of both types of marking differed significantly among oil treatments ie. $P < 0.01$ and $P < 0.001$ for reddening and speckling respectively. The higher level of fruit speckling recorded on the vines treated with 1 and 2% oil than that recorded with the same treatments by (McKenna and Steven 1993) is probably due to the accidental inclusion of the sticker.

TABLE 5: Percent of fruit harvested on 6 May 1992 with reddening or speckling.

Treatment	Rate (L/100 litres)	Reddening	Speckling
Mineral oil	0.5	7.0	16.9
	1.0	19.2	50.4
	2.0	39.2	60.8
SED		8.0	5.0

CONCLUSIONS

This trial demonstrated that mineral oils can provide economically acceptable control of armoured scale insects, and this has been confirmed by their use within Kiwigreen. However, the trial also showed that mineral oils can contribute to the management of mites and some other pests, in particular caterpillars. These results are of particular interest with regard to leafrollers as this means that their control within Kiwigreen does not have to depend solely upon applications of *Bacillus thuringiensis*.

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