

MINERAL OIL AND DIAZINON TO CONTROL ARMoured SCALE ON KIWIFRUIT

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SUMMARY

Laboratory tests on immature and mature greedy scale *Hemiberlesia rapax* stages showed mineral oil had a lower toxicity compared to diazinon or mineral oil/diazinon mixtures. Mixing mineral oil and diazinon enhanced the relative synergism by 22-145 fold for the mineral oil alone and 3-15 fold for the diazinon alone. When applied as a dormant season spray to kiwifruit the mineral oil/diazinon mixtures gave 86-96% control of latania scale *H. latania* compared to diazinon 82% and mineral oil 73% control.

Keywords: armoured scale, kiwifruit, dormant season control, toxicity

INTRODUCTION

The kiwifruit industry has always had a considerable interest in using mineral oil sprays as possible alternatives to organophosphate insecticides. This is because of their low mammalian toxicity, nil residue requirements and effectiveness in controlling scale pests on other fruit crops (Riehl 1988). However, earlier trials using oil sprays as main season or as a dormant season spray encountered phytotoxicity problems (Sale 1972).

The narrow range of mineral oil products available today have a much lower phytotoxicity risk than products available in the seventies. There has consequently been a renewed interest in evaluating mineral oil products on kiwifruit.

In field trials on kiwifruit Blank *et al.* (1985) showed that mineral oil alone and in combination with diazinon consistently gave higher mortality of armoured scale than diazinon or chlorpyrifos. Tomkins *et al.* (1986) showed that dormant season applications of mineral oil gave similar levels of scale control to chlorpyrifos and was superior to diazinon but this depended on time of assessment.

The object of this study was to determine the toxicity to armoured scale of mineral oil and a mineral oil/diazinon mixture and then to compare the efficacy of these sprays with diazinon when applied to kiwifruit as a dormant season spray.

MATERIALS AND METHODS

Toxicity tests

The laboratory toxicity testing procedure used was similar to that described by Blank and Olson (1987). Potatoes infested with greedy scale (*Hemiberlesia rapax* (Comstock)) were dipped for 5 seconds in the test solution. There were at least 2-3 repeats (potatoes) per concentration with at least six chemical concentrations tested in addition to a control which was dipped in water. Potatoes were held at $20 \pm 2^\circ\text{C}$ for 14-21 days before mortality was assessed from 50 of each scale stage per potato. One series tested ten day old first instar (white cap) whilst another series tested mixed populations of second instar (yellow cap), immature third instar (black cap) and mature scale.

Mineral oil (Mobil Superior 663) was tested either alone or mixed with diazinon (technical 91.5%) at the full (2% oil/48 g diazinon/100 litres) or half rate (2% oil/24 g diazinon/100 litres).

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Log dose probit regression analysis was used to calculate LC_{50} and LC_{90} critical doses and 95% confidence intervals. This analysis took into account Abbott's formula (Busvine 1971) for correcting for control mortality which did not exceed 16%.

Field trial

Latania scale (*H. latania* (Signoret)) infested kiwifruit vines in Kerikeri were used for this trial. Plots comprised two female vines (11 x 5 m) and treatments were replicated three times in a randomised block design. Treatments were sprayed to runoff (2.5 litres/vine) on 2 August 1988 using a manually operated solo knapsack (No.5 disc/No.25 core) and ensuring complete coverage. The weather was fine with no rain for 5 days after application. Scale mortality was assessed by destructively harvesting 1 and 2 year old wood from the central region of each plot 49-64 days after spraying. Harvested wood was kept in a cool store (4°C) for up to 7 days. At least 35 scale for each stage were assessed giving a total of 420 scale per treatment.

The analysis of variance was carried out on angular transformed data. Actual percentage mortalities are presented and hence the standard error of the difference is only approximate. The corrected percent kill value gives an adjustment for untreated mortality.

RESULTS

Toxicity tests

Oil had a low toxicity to scale (Table 1). The LC_{90} for the white cap, yellow cap, black cap and mature stages were 2.6, 5.2, 5.2 and 11.2% respectively.

It was not possible to distinguish between the toxicity of the oil/diazinon mixtures using full and half rates of diazinon for yellow cap, black cap and mature stages and these data have been combined (Table 1). The addition of diazinon to the oil gave a 22-145 fold increase in toxicity of the mixture to scale. In contrast, the addition of oil to diazinon when expressed in terms of the diazinon component increased toxicity by 3-15 fold (Table 2).

TABLE 1: Total numbers of greedy scale stages tested (n), critical concentration levels (95% confidence intervals) and slopes of the logarithm concentration probit regression curves expressed in terms of the oil concentration (litres/100 litres water). The increase in toxicity due to the addition of diazinon to the oil is also shown.

Chemical	n	LC_{50} (95%CI) (%)	Slope \pm SE	Increase in toxicity
White cap				
oil	1900	0.13(0.11-0.15)	0.98 \pm 0.05	-
oil/diazinon (half rate)	1200	0.006(0.005-0.007)	1.67 \pm 0.09	22
oil/diazinon (full rate)	1200	0.003(0.002-0.003)	1.68 \pm 0.11	43
Yellow cap				
oil	1400	0.29(0.25-0.34)	1.03 \pm 0.05	-
oil/diazinon (both rates)	2400	0.002(0.001-0.003)	0.98 \pm 0.07	145
Black cap				
oil	1400	0.27(0.22-0.32)	0.99 \pm 0.05	-
oil/diazinon (both rates)	2800	0.003(0.002-0.004)	1.01 \pm 0.07	90
Mature				
oil	1400	1.40(1.22-1.63)	1.42 \pm 0.07	-
oil/diazinon (both rates)	3100	0.021(0.019-0.023)	1.47 \pm 0.06	67

TABLE 2: Critical concentration values for diazinon toxicity to greedy scale (Blank and Olson 1987) and estimates for the oil/diazinon mixtures expressed in terms of the diazinon component.

Chemical	LC ₅₀ g ai/100 litres	Increase in toxicity
White cap diazinon	0.3	-
oil/diazinon (both rates)	0.07	4
Yellow cap diazinon	0.6	-
oil/diazinon (both rates)	0.04	15
Black cap diazinon	0.7	-
oil/diazinon (both rates)	0.05	14
Mature diazinon	1.1	-
oil/diazinon (both rates)	0.4	3

Field trial

All treatments gave significantly ($P < 0.01$) higher mortality of scale than the untreated (Table 3). There was no significant interaction between the oil and diazinon, so each treatment can be considered as independent. A comparison of individual treatments showed no significant difference between the best oil/diazinon treatment and the next four best treatments.

TABLE 3: The effect on latania scale mortality of oil and diazinon treatments either alone or in mixtures applied to kiwifruit as a dormant season spray.

Treatment	Rate (% or g ai/ 100 litres)	% Mortality				Corrected	
		White cap	Yellow cap	Black cap	Mature	All stages	% kill All stages
oil/diazinon ¹	2/24	97	100	99	96	98	96
oil diazinon	2/48	100	100	99	91	97	95
oil/diazinon	1/48	90	99	96	83	92	86
oil/diazinon	1/24	95	97	92	85	92	86
diazinon ²	48	89	96	90	84	90	82
oil ³	2	94	95	84	66	85	73
oil	1	96	91	88	55	82	68
diazinon	24	77	91	81	76	82	68
untreated	-	35	68	56	26	44	-
SED(approx)	-	7.9	6.2	7.5	6.9	4.8	-

¹Superior 663/tech. 91.5%

²Basudin 80 EC

³Superior 663

An analysis of main rate effects showed that the full rate of diazinon in the oil/diazinon mixtures did not give significantly higher levels of control compared to the

half rate. However, the full rate of oil gave significantly ($P < 0.05$) 5% higher control of all stages, 9% higher control of mature and 2% higher control of yellow caps compared to the half rate.

DISCUSSION

Berry (1983) investigated the toxicity of an 'oil' to white cap stages of greedy scale. Although her studies suffered from large confidence limits due to testing insufficient scale numbers and few oil concentrations, her LC_{50} estimates of 0.4-1.4% oil and LC_{90} of 1.6-4.9% oil are similar to those obtained in this study.

These laboratory tests show oil has a low toxicity to greedy scale compared to diazinon. However, mineral oil is commonly used at much higher concentrations (2000 g/100 litres) than diazinon (48 g/100 litres). Even when compared at these concentrations diazinon is still approximately 12-fold more active against scale than oil.

More importantly this study has demonstrated the synergistic effect of the oil and diazinon when mixed. In addition to smothering the scale, the oil component may help penetration of the scale cap and in this manner assist the dispersal of the diazinon toxicant into the body of the scale.

The field trial showed that oil/diazinon mixtures are extremely effective at controlling scale. This confirms an earlier study in which a mineral oil/diazinon mixture also gave control of scale as good as, or better, than the control achieved with a range of organophosphate insecticides (Blank *et al.* 1985). The levels of control achieved with the oil/diazinon mixtures were comparable to the best dormant season treatments evaluated in a similar study (Blank *et al.* 1991). Low rates of diazinon can be mixed with oil to give enhanced control of all scale stages including the hard to kill mature stages.

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