RELATIVE EFFICACY OF CHEMICALS FOR DORMANT SEASON CONTROL OF ARMOURED SCALE ON KIWIFRUIT

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SUMMARY

Thirteen chemical treatments were evaluated for control of over-wintering latania scale *Hemiberlesia latania* by spraying kiwifruit vines in August 1988 and August and October 1989. Methidathion, chlorpyrifos, etrimfos and diazinon gave 79-96% control and are recommended for dormant season scale control. Lime sulphur, azinphos-methyl and phosmet gave 0-50% control of scale. Pirimiphos-methyl/permethrin, half rates of diazinon and cyanamide gave intermediate levels of control (65-71%). The effect of low volume cyanamide sprays on scale on the main leader and trunk needs to be evaluated.
Keywords: armoured scale, kiwifruit, pesticides, dormant season control, latania scale

INTRODUCTION

Dormant season applications of pesticides to kiwifruit are used to control armoured scale (Hemiptera: Diaspididae) over-wintering on the woody parts of the vine (Sale 1980). This prevents these scale releasing crawlers during the growth season which may subsequently infest fruit.

A number of studies have investigated dormant season pesticide application (Tomkins *et al* 1986; Blank and Olson 1988, 1989a, 1990a; Hill and Allan 1990). However, there has been no comparative study of the wide range of chemical options available. There are 10 chemicals currently registered for use on kiwifruit during the dormant season which may have an influence on armoured scale.

The objective of this study was to compare the relative effectiveness against armoured scale of dormant season chemical applications.

MATERIALS AND METHODS

Two trial sites at Kerikeri were used for this study which was carried out over two seasons. Kiwifruit vines were no longer in commercial production and had not received any insecticide sprays for at least one season enabling high populations of armoured scale to build up. Latania scale *Hemiberlesia latania* was the dominant armoured scale species present comprising approximately 90% of the population with greedy scale *H. rapax* making up the remainder of the population.

The seven treatments shown in Table 1 were applied on 2 August 1988 to 5 year old vines at one site. Plots comprised two female vines (11 x 5 m) and treatments were replicated three times in a randomised block design. Vines were sprayed to run-off (2.5 litres/vine) using a manually operated solo knapsack (5 disc/25 core) and ensuring complete coverage. The weather was fine at application and there was no rain for 5 days after application.

The 11 treatments shown in Table 2 were applied on 17 August 1989 to 7 year old vines at the second site. Plots comprised unpruned single female vines (5.5 x 5 m) and there were four replicates per treatment arranged in a randomised block design. An additional four treatments (Table 3) were applied on 20 October to plots randomised amongst the August treated plots. Vines were sprayed using a Braglia Varigun at 800-1000 kPa using a 2 mm nozzle. A high water rate (8 litres/vine) was used to ensure complete coverage of all parts of the vine. The hydrogen cyanamide was sprayed using a solo knapsack and ensuring even coverage, but avoiding droplet formation on the wood, and applying 2.5 litres/vine. The weather was fine at spraying and there was no rain for 2 days after application.

Scale mortality was assessed by destructively harvesting 1 and 2 year old wood from the central region of each plot 49-74 days after spraying. Harvested wood was kept in plastic bags in a coolstore at 4 °C for up to 2 weeks. The mortality and stage of scale were assessed under a microscope. At least 35 of each of the four scale stages were assessed giving a total of 420 (1988) and 560 (1989) scale per treatment. The analysis of variance were carried out on angular transformed data. However, the actual percentage mortality is presented, and the standard error of the difference (SED) quoted is only approximate. Actual mortalities were adjusted for natural mortality using Abbott's formula to obtain corrected percentage kill.

RESULTS

The lime sulphur treatments in the 1988 trial had no significant effect on scale mortality compared to untreated plots (Table 1). The azinphos-methyl treatment ($P<0.05$) and all other treatments ($P<0.001$) gave significantly higher scale mortality than the untreated. There was no significant difference in scale mortality amongst the best three treatments.

TABLE 1: The effect of pesticide treatments applied to kiwifruit in August 1988 on the mortality of white cap (WC), yellow cap (YC), black cap (BC), mature (M) and all scale stages.

Treatment	Rate (litre product or g ai/ 100 litres)	% Mortality					Corrected % kill
		WC	YC	BC	M	All stages	All stages
chlorpyrifos (Lorsban 40 EC)	24	98	99	89	96	96	93
etrimfos (Ekamet 50 EC)	50	91	98	91	86	92	85
diazinon (Basudin 800 EC)	48	89	96	90	84	90	82
diazinon	24	77	91	81	76	82	67
azinphos-methyl (Azinphosmethyl 50 WP) /Agral LN (0.00015%)	50	58	85	71	55	66	38
lime sulphur (McDonalds)	7*l*	48	76	52	40	54	16
lime sulphur	3.5*l*	27	72	50	23	42	0
untreated	—	35	68	56	26	45	—
SED (approx)	—	7.9	6.2	7.5	7.0	4.8	—

A direct comparison of the mortality of different scale stages was made difficult by the variable untreated mortality. The average corrected scale mortality on vines treated with the best three treatments, showed the small sized white and yellow caps to have a 23% higher mortality than the larger black cap and mature stages.

All treatments applied in August 1989, except for azinphos-methyl, significantly increased mortality ($P<0.001$) of all scale stages, compared to untreated scale (Table 2). There was no significant difference in scale mortality on the four best treatments. Methidathion gave significantly higher mortality than etrimfos ($P<0.05$) and diazinon ($P<0.01$).

The average corrected scale mortality of the best six treatments gave a 4% higher mortality for the small stages compared to the larger black cap and mature stages.

The October application of four treatments gave a similar ranking in effectiveness to that achieved from the August applications (Tables 2 and 3). Chlorpyrifos ($P<0.001$) and diazinon full rate ($P<0.05$) effected significantly higher mortality of all scale stages compared to that occurring on untreated vines. Other treatments were not significantly different from the untreated.

TABLE 2: The effect of insecticide treatments applied to kiwifruit in August 1989 on armoured scale mortality.

Treatment	Rate (g ai/100 litres)	% Mortality WC	YC	BC	M	All stages	Corrected % kill All stages
methidathion (Ultracide 40 WP)	50	97	99	97	97	98	96
diazinon (Basudin 800 EC) /Pulse 0.0025%	24	99	100	99	93	98	96
diazinon/Pulse 0.0025%	48	97	100	96	97	98	96
chlorpyrifos (Lorsban 40 EC)	24	98	99	98	89	96	92
etrimfos (Ekamet 50EC)	50	95	98	88	89	92	85
diazinon	48	85	91	95	85	89	79
hydrogen cyanamide (Hi-cane)	3000	76	90	92	82	85	71
pirimiphos-methyl/ permethrin (Attack)	47.5+2.5	89	96	88	70	85	71
diazinon	24	80	91	84	73	82	65
phosmet (Imidan 75WP) /Agral LN (0.0005%)	112.5	65	87	79	66	74	50
azinphos-methyl (Azinphosmethyl 50 WP) /Agral LN (0.00015%)	50	46	80	63	61	64	31
untreated	—	51	54	58	30	48	—
SED (approx)	—	8.5	6.4	5.8	7.7	4.3	—

TABLE 3: The effect of insecticide treatments applied to kiwifruit in October 1989 on armoured scale mortality.

Treatment	Rate (g ai/100 litres)	% Mortality WC	YC	BC	M	All stages	Corrected % kill All stages
chlorpyrifos (Lorsban 40 EC)	24	96	99	99	93	97	92
diazinon (Basudin 800 EC)	48	78	88	85	91	86	62
diazinon	24	43	72	90	86	73	27
azinphos-methyl (Azinphosmethyl 50 WP) /Agral LN (0.00015%)	50	42	54	79	70	62	0
untreated	—	41	61	74	70	63	—
SED (approx)	—	16.6	13.6	8.2	9.5	9.2	—

There was no significant effect of time of application on uncorrected mortalities. However, the comparison is confused by the increase in the natural mortality in October of the yellow cap, black cap and mature scale due to senescence combined with the recruitment of white caps from the new spring generation. After correcting for untreated mortality there is a trend for a higher kill at the August application time.

DISCUSSION

The relative efficacy of pesticide treatments for the two season's trials are summarised in Table 4. The most effective chemicals for controlling scale were methidathion, chlorpyrifos, etrimfos and diazinon, which are all currently registered for use on kiwifruit and can thus be recommended. The choice of product may be largely dependent on cost, availability and convenience in addition to efficacy.

TABLE 4: Relative efficacy against all scale stages of pesticides applied to kiwifruit as dormant season sprays.

Rank	Treatment	Corrected % kill 1988	1989
1	methidathion	—	96
2	diazinon/Pulse (full and half rate)	—	96
3	chlorpyrifos	93	92
4	etrimfos	85	85
5	diazinon (full rate)	82	79
6	hydrogen cyanamide	—	71
7	pirimiphos-methyl/permethrin	—	71
8	diazinon (half rate)	67	65
9	phosmet/Agral	—	50
10	azinphos-methyl/Agral	38	31
11	lime sulphur (full and half rate)	16 & 0	—

Lime sulphur, azinphos-methyl, phosmet and half rates of diazinon all gave low levels of scale control and are not recommended as dormant season sprays to control established scale populations. The lime sulphur treatments have longer term residual effects against crawler settlement which may be of benefit if residues are present at times when crawler release occurs (Blank and Olson 1989a).

The relatively poor to mediocre performance of azinphos-methyl and phosmet against over-wintering scale is cause for concern if these products give similar levels of control against established scale when used as main season sprays. Whilst these products have traditionally been used for control of leafroller caterpillars they have been considered to give useful control of established scale when used as pre-blossom and main season sprays (Steven 1990). Further trials investigating single application of sprays are required to determine the relative efficacy of main season sprays against established armoured scale and scale crawlers (Blank *et al* 1985).

The moderate level of scale control achieved using hydrogen cyanamide is of considerable interest. Hill *et al* (1990) demonstrated that hydrogen cyanamide was insecticidal in a laboratory study. Whilst the August application of hydrogen cyanamide is primarily for enhancement of budbreak, flowering and fruit production, the additional benefits of lichen and scale control make the use of this material even more cost effective. It remains to be proven as to whether the hydrogen cyanamide spray can completely replace a dormant season spray. These trials evaluated scale mortality on 1 and 2 year old canes which had received full coverage of spray. It is therefore unknown if the low volume hydrogen cyanamide sprays (500-700 litres/ha) will impact on scale populations hidden in cracks, crevices and bark of the main leader and trunk.

Incorporation of the organo-silicone penetrant Pulse with diazinon gave enhanced efficacy against scale. Adams *et al* (1988) similarly demonstrated even greater improvements in pesticide efficacy against greenhouse whitefly *Trialeurodes vaporariorum*. The diazinón/Pulse mixture is experimental and may cause phytotoxic damage to the plants.

Laboratory studies have clearly shown a decreased sensitivity of the large mature scale stages to pesticides (Blank and Olson 1987, 1989b, 1990b). Under the field conditions of this study mortality differences between the small immature white cap and yellow cap stages and the larger mature stages of 4-23% were obtained. Therefore there may be some advantage, albeit small, in targeting sprays against immature stages.

Attempts to compare the efficacy of August with October pesticide applications were made difficult by the variable untreated scale mortalities. It can be concluded that final levels of mortality were not greatly influenced by time of application. This is further supported by a laboratory study which found that temperature does not influence final levels of mortality (Blank and Olson 1990b). Selection of an effective scalicide thus appears to be a more important consideration than time of application.

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