SCREENING PESTICIDES FOR CONTROL OF GREEDY SCALE ON KIWIFRUIT LEAVES

R.H. BLANK, M.H. OLSON, *J.E. WALLER

Agricultural Research Division, MAF, P.O. Box 943, Whangarei
**Ruakura Soil and Plant Research Station, MAF, Private Bag, Hamilton*

SUMMARY

Greedy scale (*Hemiberlesia rapax*) mortality was assessed following single pesticide applications to kiwifruit (*Actinidia chinensis*) leaves either in January or April. Mineral oil alone or combined with diazinon gave the highest mortality (56-88%). Other insecticides currently registered for greedy scale control on kiwifruit (azinphos-methyl, diazinon, chlorpyrifos, phosmet) gave 32-68% mortality. The relatively poor control from registered materials may, in part, explain the difficulties experienced by growers in achieving good greedy scale control on kiwifruit.

INTRODUCTION

Greedy scale is a common quarantine pest on kiwifruit. Many kiwifruit growers in the Whangarei area have a few scale infested fruit at harvest, in spite of closely following the MAF recommended spray programme. A small number of growers, particularly those cropping for the first time, may have part of, or all of, their crop rejected because of scale (G. Peake, MAF Field Officer, Whangarei pers comm). Current procedures recommended for control of greedy scale and the leaf-roller complex involve 7-9 insecticide applications at regular intervals throughout the growing season. Diazinon, azinphos-methyl, phosmet and chlorpyrifos are currently registered for control of greedy scale on kiwifruit. Lime sulphur is also recommended as a dormant winter spray to assist in scale control. The lack of information on the comparative effectiveness of these pesticides for scale control on kiwifruit prompted this study.

Early screening trials showed that oils combined with organophosphate insecticides gave good control of scale but that oil damaged kiwifruit (Sale 1972, 1980). More recent investigations suggest that oils, when applied as a dormant winter application, do not depress yield (D. Steven pers comm). Diazinon, parathion-methyl and omethoate were shown to be highly effective against scale in these early screening trials (Sale 1972). Laboratory studies found that diazinon as well as oil gave 90-100% kill and were superior to azinphos-methyl and phosmet (Ferguson and Wallace 1979). Multiple spray applications of azinphos-methyl, phosmet and diazinon in various combinations have been shown to give high levels of control (Love and Ferguson 1977; Sale and Steven 1984) but these studies are not relevant in comparing the efficacy of single pesticide applications. Available information thus suggested diazinon might be the most effective of the organophosphorus insecticides.

The objective of this study was to compare the efficacy of single applications of pesticides on greedy scale.

MATERIALS AND METHODS

Twelve scale-infested 'Bruno' and 'Hayward' kiwifruit vines at Maunu were used for these trials. The two rows of 8 year old vines had grown together in a manner similar to that found on pergola structures and had received little pruning or pest management. Bunches of approximately 25 leaves attached to 4-8 canes were separated from the rest of the vine foliage and covered with a plastic bag (1125 x 575 mm) during pesticide application. Pesticides (Table 1) were applied to the bunches using a solo knapsack sprayer and good coverage of leaves was obtained by spraying well in excess of run off.

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TABLE 1: Total number of greedy scale assessed for mortality to pesticide treatments using a visual, as well as a starch-agar plate technique. Mortalities are presented both before and after correction for control mortality. Wetting agent was added to all organophosphorus insecticides but not to the oil or oil plus diazinon treatments.

	g ai/ 100 litres	No. Tot.	% mortality				Corrected % mort.	
			Visual			Plate	Visual	Plate
			White	Yellow	Black	Tot.	Tot.	Tot.
January application								
mineral oil + diazinon	2000 + 48	90	69	87	76	82	76	74
mineral oil (Sunspray)	2000	75	87	71	58	71	68	58
chlorpyrifos (Lorsban 40 EC)	36	99	92	58	68	69	50	55
azinphos-methyl (Gusathion M50)	50	90	67	62	86	69	48	55
diazinon (Basudin 80 EC)	48	107	76	59	61	63	54	46
parathion-methyl (Folidol M50)	50	64	67	55	67	62	42	45
phosmet (Imidan 75 WP)	113	110	66	66	41	58	50	39
untreated	—	64	28	48	21	31	26	—
wetting agent (Agral LN)	75	103	23	27	17	22	27	—
average SE	—	—	10	9	11	5	5	—
April application								
mineral oil + diazinon	2000 + 48	88	84	90	96	92	82	88
mineral oil	2000	85	71	87	91	87	90	80
chlorpyrifos	36	86	80	69	88	79	76	68
diazinon	48	87	61	77	86	75	77	62
untreated	—	195	28	35	47	34	39	—
average SE	—	—	11	6	6	4	4	—

Leaf bunches were marked with eartags. Treatments were allocated at random among each of the four replicates. Two replicates were arranged along the southerly aspect and two replicates along the northerly aspect of the vines.

Pesticide efficacy was investigated from a January and an April application. Treatments applied on 7 January 1985 were assessed after 8-18 days. Conditions were fine and hot (23-30°C) during application. Light rain (6 mm) fell 5-7 days and heavy rain (48 mm) fell 13-15 days after application. Treatments applied on 12 April 1985 were assessed after 10-25 days. Conditions were overcast and warm (17-20°C) during application. There were considerable periods of rain — 3 days (5 mm), 6 days (55 mm), 10 days (60 mm) and 17 days (65 mm) after application.

In addition to the main trial in January, four bunches of leaves on one vine were sprayed with systemic insecticide omethoate (58 g ai/100 litres Folimat 58 EC). Four unsprayed bunches of leaves on the same systemic insecticide treated vine were marked to serve as the omethoate controls. No other treatments were located on this vine.

All treatments from a single replicate were picked at one time and leaves were stored at 4°C for up to 5 days before being assessed. Leaves were examined under a binocular microscope with most attention given to the petiole and midrib region where

most scale were located. Scale numbers varied widely between leaf bunches with 64-195 scale assessed per treatment (Table 1). Scale were categorised into white (early and late settled), yellow and black cap stages corresponding to first, second and non-reproductive third instars (Ferguson 1974, Berry 1983). The mature reproductive third instars present in the April trial (4%) were grouped with the black cap stages. Mortality assessments were made using both a visual and plate method. The covering of the scale was removed to reveal the body of the scale which was punctured with a pin to expel fluids. Scale were visually considered dead when the body appeared dry and shrivelled with no obvious body fluids. The punctured body was then placed on a iodine-treated starch-agar plate (Ishaaya and Swirski 1970). Scale were considered dead when, after an hour the blue colour around the scale remained. With live scale, a clear circle developed around the scale after about 10 minutes.

All analyses of mortality were weighed for the number of scale per plot. The comparison of visual versus plate assessments used angular transformed data while the comparison between treatments used logit analysis. Standard errors were averaged over all treatments. Mortality was corrected for untreated mortality using Abbott's formulae.

RESULTS

Few (1%) early settled white cap stages were found in the January trial. In April 13% of the population were early settled stages on unsprayed leaves and 3% on sprayed leaves.

The three greedy scale stages gave similar mortality responses to pesticide treatments after allowing for variable natural (untreated) mortality (Table 1).

The plate assessment technique gave significantly ($P < 0.01$) lower mortality results than the visual technique for the January trial (Table 1). Some scale which appeared dry and lifeless gave a positive reaction on the plate. In some cases, particularly, with the smallest white cap stage the distinction between a positive and negative reaction was subjective. In the April trial there was no difference between assessment techniques. Treatments were ranked similarly by both techniques but with minor discrepancies.

All pesticides gave significantly ($P < 0.01$) higher mortality than untreated scale or scale treated with wetting agent which had no effect on mortality (Table 1). Pesticides generally gave similar mortality of each stage. Comparison of pesticide efficacy can be made from the combined mortality of all stages after correcting for natural (untreated) mortality. The mineral oil alone or combined with diazinon consistently gave higher mortalities than other treatments. The mineral oil/diazinon treatment gave significantly ($P < 0.05$) higher mortality than diazinon, parathion-methyl, phosmet (visual), all organophosphorus insecticides (plate) for the January application and chlorpyrifos, diazinon (visual) for the April application.

The omethoate treatment gave 52% mortality of all scale stages which was significantly ($P < 0.05$) higher than the 24% mortality of the unsprayed controls.

There was no detectable phytotoxicity effect from the oil or other treatments.

DISCUSSION

The interval between spray application and assessment was kept short to minimise possible further recruitment and losses of dead scale. There was no evidence of either after the January application but early settled white cap stages were present after the April application, although numbers were low and probably of little significance.

The plate assessment technique was found to be useful in confirming some visual determinations of mortality, but more experience is required with this technique before a recommendation on its use can be made.

It has been suggested that the crawler stage may be the most vulnerable to insecticides (Ferguson 1974). Crawlers, however, quickly settle and spin a protective covering to become a white cap stage within 1-5 days, depending on temperature (Berry 1983). It then becomes of interest whether some stages are more susceptible than others to pesticides. Berry (1983) in her laboratory studies found the LC_{50} of oil increased from 0.8 to 1.4% with increasing scale age from 3 to 32 days and suggested young stages were most susceptible to pesticides. The results presented here suggest that, under field

conditions and using high pesticide concentrations, differences in the susceptibility of stages is relatively unimportant compared to the selection of the most effective pesticides. However, the rationale of applying insecticides at peak crawler emergence may have merit, depending on the residual efficacy of the insecticide used and the need to kill scale as soon as they become established.

The systemic omethoate which did not appear to be translocated around the vine, and parathion-methyl gave no better control than the currently recommended organophosphate insecticides.

High natural mortality of scale populations have been demonstrated by other workers (Sale 1972 (21%); Love and Ferguson 1977 (36-82%); Ferguson and Wallace 1979 (20-68%); Berry 1983 (7-30%)). Death occurs due to dessication, moulting mortality, disease, parasitism and other factors (Ferguson 1974) and clearly must be accounted for in comparing chemicals for control. Some studies suggest mortalities of 90-100% from the best insecticide applications when no corrections for natural mortality have been made. After adjustment for natural mortality, the four currently recommended organophosphate insecticides gave 32-68% kill. These results imply less than satisfactory control is currently achieved from a single spray whether applied in January or April and may help to explain why multiple applications appear to be necessary to clean up scale populations on kiwifruit.

These trials demonstrated the superior kill (56-88%) achieved using the mineral oil alone or combined with diazinon. Should the application of oil mixtures to dormant kiwifruit be proven to be safe, then control of greedy scale may be improved and/or simplified compared to the current recommendations of applying 7-9 organophosphate insecticides.

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