INVESTIGATING TWO BEE-SAFE MATERIALS FOR CONTROLLING LATANIA SCALE ON AVOCADOS DURING POLLINATION

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SUMMARY

Latania scale (*Hemiberlesia lataniae*) was identified as an important pest on avocados near Awanui, Northland, with up to 34% of fruit infested. The high proportion of immature scale (94%) on fruit in late November indicated that scale invasion coincided with pollination. Two bee-safe materials, fluvalinate and buprofezin, gave poor contact activity against latania scale. Buprofezin in bioassay tests had no effect on white cap settlement whilst fluvalinate reduced settlement by 90-95% 5-6 days after application and 47% after 19 days. Uneven distribution of scale in the field trial prevented clear results but treatments gave 47-74% reductions of scale on avocados.

Keywords: latania scale, *Hemiberlesia lataniae*, avocado, pollination, fluvalinate, buprofezin.

INTRODUCTION

The main pest groups found on avocado in New Zealand are armoured scale (Diaspididae), leafroller (Tortricidae), thrips (Thripidae) and mites (Tetranychidae). Leafroller caterpillars and thrips damage the fruit, whilst the presence of these insects, scale, leafroller eggs and mites can cause rejection for export because of quarantine requirements.

Latania scale *Hemiberlesia lataniae* (Signoret) (Hemiptera :Diaspididae) is an important insect pest of avocados in Australia, Israel and U.S.A. (Waite 1988; Gerson and Zor 1973). In 1991 we identified latania scale as being responsible for up to 25% rejection from export of part of some avocado crops in Northland, in spite of a regular insecticide spray programme having been used. One of the factors that may have contributed to this high level of fruit contamination was the long pollination period in October and November when no insecticides were applied, in order to protect the bees. Studies of latania scale on other host plants, including kiwifruit, suggested that crawler release and settlement of the spring generation may well coincide with the avocado pollination period (Blank unpublished).

Avocados are different from many other fruit crops as mature fruit are present on the tree while the new season's crop is set. Hence, lack of protection over the pollination period could result in scale settlement on mature fruit prior to harvest. Mature avocados are commonly harvested over an extended period (October-March) according to size.

The object of this study was to investigate the potential of two bee-safe materials to prevent scale settlement on mature fruit. The pyrethroid fluvalinate is non-toxic to bees (Van Toor 1989), has activity against thrips (Teulon and Penman 1987; Tomkins *et al.* 1992), spider mites (Holland and Chapman 1991), lepidoptera and scale (Heath 1985). The efficacy of fluvalinate against latania scale was unknown, but the repellent properties of this pyrethroid (Holland and Chapman 1991) suggested that it might be useful for preventing settlement of crawlers on the fruit.

Buprofezin is an insect growth regulator with a high level of activity against armoured scales causing immature stages to die during moulting (Yarom *et al.* 1988). Buprofezin is highly selective and shows no efficacy against bees, hymenopteran

parasites and other beneficials and so would be useful in integrated pest management programmes. It also has a long residual efficacy (20-30 days) against some insects (Nihon Nohyahu Co Ltd Technical Information). It is not effective against thrips (Steven and Sale 1985).

METHODS

Laboratory toxicity tests

Potatoes cv. Desiré infested with 10-day old white cap latania scale were dipped for 5 seconds in a range of six concentrations of buprofezin (Applaud 25W) or of fluvalinate (Mavrik Aquaflow 24% suspension concentrate) in addition to a water control. Potatoes were held at 20±2°C and 80±5% relative humidity for 23 days before mortality assessment. Mortality was assessed from 50-100 scale per potato and there were two potatoes per concentration. The silken cover of scale was removed with a pin to reveal the scale body. Scale which had dark brown shrivelled bodies were assessed as dead compared to the yellow turgid bodies of live scale. Probit analysis was used to calculate LC_{50} and LC_{90} critical concentrations using Abbott's formula (Busvine 1971) to correct for control mortality which did not exceed 7%.

Bioassay of crawler settlement

The bioassay procedure was similar to that developed in an earlier study using greedy scale (*H. rapax*) on kiwifruit (Blank *et al.* 1992). Avocado fruit were picked from trees used in the field trial, using the two replicates which had been sprayed on the same day. Tests were carried out 6 and 19 days after sprays applied on 17 October 1992 and 5 days after sprays applied on 8 November 1992. Five mature fruit from separate trees were picked from each plot. Fruit were partially dipped in molten paraffin wax to create an unwaxed test arena on the side of the fruit. The test arena on each fruit was inoculated with 20-25 crawlers from a laboratory colony of latania scale. Fruit were held at 20±1°C and 70±5% relative humidity for 3-4 days before assessment of settlement. Crawlers were considered to have settled if the silken cover of the first settled white cap stage was completed. The number of white caps per test arena and the percentage fruit infested with settled scale were assessed.

Field trial

An avocado orchard near Awanui with a past history of armoured scale infestation was used for this study. Eight insecticide sprays (diazinon/carbaryl (3), chlorpyrifos (2), methidathion, diazinon/permethrin and pirimiphosmethyl/permethrin) had been applied since the end of the previous pollination period (21 November 1991). Three northerly facing blocks (1 ha) of 7 m high 10 year old avocados and three blocks (0.8 ha) of 3-6 metre high 6-8 year old avocados with a southerly or southwest aspect were used as replicates. Treatments were fluvalinate (8 g/100 litres), buprofezin (16.7 g/100 litres), fluvalinate/buprofezin (8/16.7 g/100 litres) and an unsprayed control. The four treatments were allocated within the six replicates using a randomised block design with each plot comprised of at least four rows of 4-8 trees.

Insecticides were applied using a Cropliner airblast sprayer with a one-sided volute and using 28 TX 4, 6 and 8 nozzles to deliver 1500 litres/ha. The configuration used produced a large number of small droplets. The first spray application was applied on 17 and 18 October 1992. The second spray application was on 8 November (Reps 1-3 fluvalinate, fluvalinate/buprofezin) or 16-18 November (Reps 1-3 buprofezin, Reps 4-6). The split second application was due to a combination of factors including the long spraying time (2 h/block), the requirement to spray after dusk (8 pm) with fluvalinate to avoid bees foraging on flowers, while restricting noise levels, and unsuitable weather. Conditions during the evening spray applications were fine and calm. Beehives (2/ha) were present for pollination from 1 October - 21 November.

Fully sized mature fruit (>72 mm diameter) were harvested from the middle two rows of each plot between 30 November - 2 December 1992. Fruit numbers per tree were often low and tended to be concentrated in the top of the canopy. A minimum of 100 fruit/plot were examined under a microscope for scale, leafroller eggs and other insects. The scale stage and mortality were determined and mature scale were collected

for identification (Lo and Blank 1989). Analysis of variance was used to detect significant differences between treatments in the number of scale/infested fruit and percentage of scale infested fruit (angular transformed). Levels of control were determined from the mean number of scale on the treated fruit divided by the untreated scale numbers.

RESULTS

Toxicity was evaluated 23 days after dipping when 94% of untreated scale had moulted into the second instar (yellow cap), 5% were dead and 1% were live first instars (white cap). The buprofezin LC_{50} value was 23 fold less than the recommended usage rate of 12.5 g/100 litres compared to the fluvalinate LC_{50} value which was 0.7 of the recommended rate 9.6 g/100 litres (Table 1).

TABLE 1: Critical concentration levels, 95% confidence intervals, slopes of the logarithm concentration probit regression curves, and total numbers of latania scale tested (n) using buprofezin and fluvalinate.

Chemical	n	LC_{50} (95% CI) (g ai/100 litres)	LC_{90} (95% CI) (g ai/100 litres)	Slope±SE	Ratio : label rate LC_{50}
buprofezin	660	0.54 (0.41-0.72)	2.53 (1.66-3.87)	1.89±0.05	23
fluvalinate	920	14.6 (6.6-32.5)	474 (95-2360)	0.78±0.04	0.7

The bioassay of crawler settlement showed buprofezin had no significant effect on latania scale settlement (Table 2). Fluvalinate ($P<0.05$) and the fluvalinate/buprofezin ($P<0.01$) treatments significantly reduced the numbers of scale per infested fruit compared to untreated fruit 5-6 days after both spray applications. The fluvalinate/buprofezin treatment also significantly ($P<0.05$) reduced numbers of scale per infested fruit 19 days after the October spray application.

TABLE 2: Settlement of latania scale on avocado fruit inoculated with crawlers at various times after insecticide application.

Treatment	% fruit infested	Scale/infested fruit	% fruit infested	Scale/infested fruit
Sprayed 17 Oct 1992		6 days		19 days
untreated	100	6.8	80	4.5
buprofezin	80	4.6	80	4.6
fluvalinate	80	1.8*	50	3.8
fluvalinate /buprofezin	20	1.5**	10	1.0*
SED	11	1.12	14	1.06
Sprayed 8 Nov 1992		5 days		
untreated	100	8.2	-	-
buprofezin	90	9.1	-	-
fluvalinate	40	1.0*	-	-
fluvalinate /buprofezin	60	1.8*	-	-
SED	11	1.47	-	-

* differs significantly ($P<0.05$) from untreated
** differs significantly ($P<0.01$) from untreated

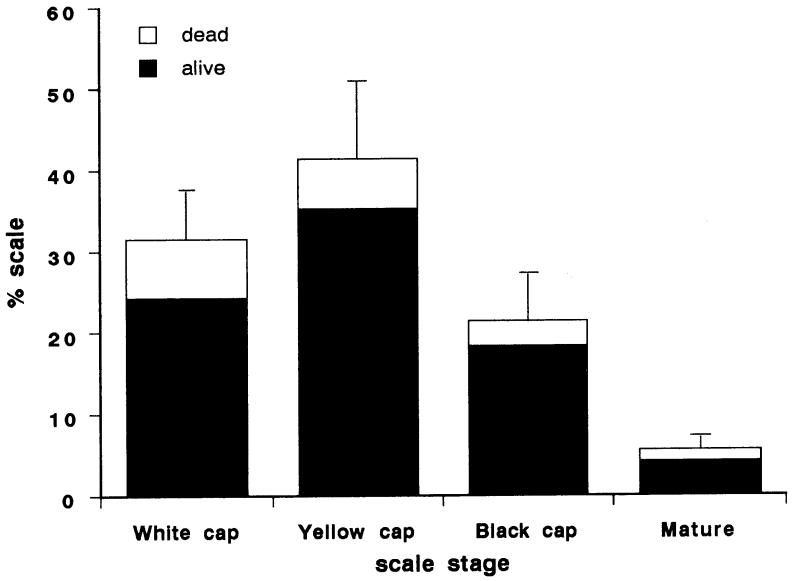

Figure 1: Stages of latania scale recovered from avocado fruit harvested at the end of pollination.

Three replicates from the field trial were abandoned after low numbers of scale (0.9% infested fruit with an average of 1 scale/infested fruit) were recovered on avocados from untreated plots. The remaining three replicates were all on a north facing slope and comprised the oldest trees on the orchard.

The severity of the scale problem in these blocks was illustrated by 34% of untreated fruit being infested with 8.6 scale/infested fruit (Table 3). Most scale were immature (94%) with only 6% mature scale (Fig. 1).

The spray treatments gave overall reductions compared to the untreated of 47-74% in total scale numbers and of 29-59% in live white caps and yellow caps. However, no significant differences in scale incidence were found between treatments.

All 103 mature scale recovered from avocado fruit in the field trial were identified as latania scale.

TABLE 3: The effect of two applications of bee-safe insecticides applied over the avocado pollination period on latania scale.

Treatment	Live I and II instars		Live and dead all scale stages	
	% fruit infested	Scale/infested fruit	% fruit infested	Scale/infested fruit
untreated	27	6.6	34	8.6
buprofezin	24	3.1	32	3.7
fluvalinate	16	4.3	23	5.5
fluvalinate /buprofezin	16	4.8	18	6.5
SED	11	2.4	12	3.2

DISCUSSION

Laboratory toxicity tests are useful for measuring the relative toxicity of chemicals and hence predicting field efficacy. Studies using greedy scale white caps have shown that where the ratio of recommended use rate to the LC_{50} is high, a chemical is likely to have a high field efficacy through direct contact activity (eg methidathion 625, diazinon 160), whilst a low ratio (eg lime sulphur 13) indicates poor field efficacy (Blank and Olson 1989,1990). In this study using the closely related latania scale, the low ratios for buprofezin (23) and fluvalinate (0.7), suggests that both chemicals are likely to give poor contact efficacy in the field. Both buprofezin, which interferes with moulting, and fluvalinate, because of low toxicity, are unlikely to be effective against mature stages. Buprofezin had a similar toxicity to latania scale as to another diaspidid scale, the California red scale *Aonidiella aurantii* (LC_{50} 1.27 g /100 litres) (Yarom *et al.* 1988).

The crawler settlement bioassay trial demonstrated that the buprofezin residue did not affect settlement. However, no attempt was made to determine if white caps would survive the first moult to yellow caps after settling on buprofezin-treated fruit. Fluvalinate gave a 90-95% reduction in overall scale settlement on avocados 5-6 days after application but this protection had diminished to 47% after 19 days. Buprofezin appeared to act as a synergist when combined with fluvalinate in the October application, increasing protection to 97% after 19 days.

The high proportion of immature compared to mature scale found on untreated avocados at the end of the pollination period confirmed that latania scale invasion is occurring at this time (Blank unpublished). Whilst these immature scale would not be on harvested fruit long enough to reproduce and so should not be considered a quarantine problem they do nevertheless currently constitute a substantial barrier to export (0.5% Maximum Pest Level).

Scale populations were low in blocks with smaller sized avocado trees suggesting that previous sprays had been more successful at controlling scale on these young trees than on the taller older trees. This effect may have been compounded by the need to harvest some fruit in the tops of trees where the risk of a 'spray shadow' is greatest.

Scale were unevenly distributed within this orchard, so that the field trial did not produce clear results. Even so, two ground spray applications of the treatments evaluated were not able to reduce scale settlement to below the low levels required commercially. This may have been due to a combination of factors including the high invasion pressure from reproducing mature scale already present on the avocado trees, mainly on the branches and trunk, or on adjacent host plants. That these mature scale had survived a reasonably intensive spray programme further illustrates the difficulty of targeting and achieving control of scale in these large trees.

Further work is required to derive an acceptable control recommendation to protect avocado fruit from latania scale infestation during flowering. Both reduced spray intervals and alternative materials should be considered.

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