MONITORING GREEDY SCALE CRAWLER ACTIVITY ON KIWIFRUIT VINES

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SUMMARY

A simple technique was devised to monitor greedy scale (*Hemiberlesia rapax*) crawler activity on kiwifruit (*Actinidia deliciosa* cv. Hayward) vines using traps made of adhesive bands. Preliminary results from three sites investigated showed that crawlers were produced continuously throughout the growing season and crawler densities were greatest on the upper trunk and leaders. Comparison of crawler numbers from adhesive bands and aerial sticky traps at the same sites suggested that dispersal occurred primarily by walking on the plant. Number of crawlers trapped in a single band placed at the top of the trunk were correlated with crawler numbers on other woody parts of the vine, and with percentage infested fruit at harvest.

INTRODUCTION

Greedy scale infestations on kiwifruit vines are difficult to control. Repeated applications of insecticide throughout the growing season are recommended to avoid infestations on fruit (Blank *et al* 1985; Sale and Steven 1984). This paper describes a simple system for monitoring the densities of scale crawlers (mobile first instar) on kiwifruit vines and discusses the use of this technique in understanding greedy scale biology and possibly improving future control.

METHODS

In Spring 1985 a technique was developed for monitoring greedy scale crawlers. A 25 mm wide band of clear plastic tape (Sellotape "all weather tape") was wrapped twice around the circumference of the area of bark to be monitored, and left for 1 or 2 weeks. The band was then cut from the vine and placed on a piece of clear acrylic sheet. In the laboratory, the band was examined under a binocular microscope at 10 x magnification, using an incident light source, with a mirror placed below the acrylic to give a combination of incident and reflected light. This made the translucent scale crawlers easier to see. In preliminary trials with this tape, a polybutene material had been applied to the outer surface to act as a sticky trap. Observations showed that most crawlers were trapped at the edge of the band, on the adhesive inner surface, and the sticky polybutene on the outer surface was not necessary. It was then discontinued, making the sticky bands easier and cleaner to use.

Since October 1985, bands of this type have been placed at six different points on female vines to gain information on the distribution of scale within vines. The six positions were 1) lower 1/3 of the trunk, 2) upper 1/3 of the trunk, 3) base of one leader near the trunk, 4) on wood 2 years old between leader and cane, 5) at the start of a fruiting cane, and 6) at the end of a fruiting cane. Sampling was carried out at three sites free from sprays harmful to greedy scale:

- i. DSIR Kumeu Research Orchard (T-bar, 6 yr old vines); bands changed weekly on six vines chosen randomly each week from a block of 48. Vines have never been treated with insecticide.
- ii. DSIR Te Puke Research Orchard (T-bar, 10 yr old vines); bands changed on nine vines weekly from a block of 18, banding the same nine vines on alternate weeks. The vines had been used for an insecticide timing trial in the preceding year. Both samples of nine vines had received similar treatments.

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- iii. Matahui Orchard near Katikati (pergola, 5 yr old vines); bands changed at 2-week intervals on 12 vines randomly chosen on each occasion from a block of 72 vines. The vines had all received winter oil applications in the previous 2 years, and a monthly application of *Bacillus thuringiensis* (Thuricide) during this growing season.

Aerial cylindrical sticky traps, six each at Kumeu and Matahui and four at Te Puke, were placed below the canopy within each orchard, and were replaced and examined at the same time as the vine bands.

In addition to this regular monitoring, bands were applied to the top of the trunks of 53 vines in one block (Block A) and 102 in a second block (Block B) at Matahui. Bands were applied on 21.1.86 in block A and 18.2.86 in block B and removed after 2 weeks. Crawler numbers on the bands were counted and the process was repeated 1 month later.

Twenty-five fruit were harvested from each of 21 vines on 29.4.86 in block B and examined for the presence of scale infestation in the laboratory. Sample size was restricted by time and financial constraints.

RESULTS AND DISCUSSION

The technique of trapping scale crawlers with adhesive bands was found to be useful for trapping mites and adult scale parasitoids as well.

There was no change in the relative distribution of crawlers between the different parts of the vine from October to May (the time of writing). Unpublished data from leaf samples showed a steady increase in infestation levels as the season progressed, and fruit samples showed an increasing infestation from mid-February onwards. Mean crawler numbers over all sampling occasions varied appreciably between band sites and between sampling localities (Table 1). Numbers were greater on the leader, at the top of the trunk, or on the intermediate aged wood between leader and cane, than on other parts of the plant.

TABLE 1: Mean number of crawlers/10 cm of band at each of the six sticky band sites within the vines (SE in brackets) Data collected between Oct 85 and April 86.

Band site	Crawler density			
	Te Puke sample 1	Te Puke sample 2	Katikati	Kumeu
lower trunk	14.2 (2.3)	4.7 (0.7)	0.6 (0.2)	5.8 (2.4)
upper trunk	24.9 (2.8)	5.6 (1.1)	4.5 (1.8)	7.2 (1.6)
leader	7.2 (1.5)	13.5 (2.2)	6.9 (1.8)	7.6 (2.1)
2 yr old wood	9.1 (2.8)	9.3 (1.5)	5.8 (1.7)	4.2 (2.1)
canes, near leader	2.9 (1.1)	4.1 (1.3)	3.1 (1.3)	0.9 (0.2)
canes, near end	0.5 (0.4)	0.6 (0.2)	1.3 (0.7)	0.3 (0.1)
n	11	11	11	22
(sampling occasions)				

Crawlers were produced continuously from October to the start of May in all three localities. Infestation varied greatly between vines, so that the data from the orchards in which vines were sampled at random was unsuitable for assessing seasonal variation in crawler abundance. Variations between the two samples of vines from the DSIR Te Puke research orchard which were banded on alternate weeks (Fig. 1) were also considerable throughout the season. However, there appears to be a peak in crawler numbers in both samples in late summer, agreeing with the findings of Berry (1983) and Ferguson (1974, 1979) for first instars settled on leaves, and possibly an earlier peak in December. This would agree with Ferguson's (1979) observation of two annual generations of greedy scale on kiwifruit. The continuous production of crawlers throughout the growing season demonstrates the need to maintain chemical control once fruit have set and points to the need for a study of within-season variability in fruit susceptibility to scale settlement, and crawler dispersal behaviour.

Fig. 1: Seasonal variation in crawler abundance on the woody parts of vines at Te Puke, expressed as the sum of the average crawler densities from each of the six within-vine sampling sites. Data from two sets of nine vines, 1985/86.

There was a correlation in all localities between crawler numbers trapped at the top of the trunk and numbers trapped on the four sites above the trunk (Te Puke sample I $r=0.84$, $n=45$, sample II $r=0.26$, $n=54$; Matahui $r=0.53$, $n=69$; Kumeu $r=0.76$, $n=79$; all $P<0.001$, except Te Puke II where $P=0.05$). Thus, numbers caught on the upper trunk or leader could possibly be used to compare overall crawler densities between vines, although correlation coefficients of 0.5 and below at two of the localities indicate some variability in this relationship.

The numbers of crawlers caught on bands placed on trunks in the blocks of kiwifruit vines showed considerable variation in infestation between vines within the block (Table 2). There was a correlation between crawler numbers trapped between the two sampling periods ($\log_e$ transformed data: block A, $r=0.76$, $n=74$, $P<0.001$; block B, $r=0.80$, $n=53$, $P<0.001$). These results suggest that chemical trials for greedy scale control could be more sensitive if they were carried out on vines of comparable infestation determined previously by band sampling for crawlers. Number of crawlers trapped on the first sampling occasion (the second was not tested) in block B was positively related to percentage infested fruit at harvest (Fig. 2) although there was considerable variation in percentage of fruit infested on vines with low numbers of crawlers on the upper trunk. This could be due to a poor correlation between crawler numbers trapped there and numbers on other parts of the vine, or it may suggest that other factors (e.g. fruit maturity or fruit positioning within the vine) are affecting fruit infestation levels. Whatever the cause, Fig. 2 suggests that unacceptably high levels of infestation on fruit for export may result from very low greedy scale bark populations where spraying is neglected. These results support the earlier finding of variability in crawler numbers on different parts of the vine, and suggest the need to look more carefully at distribution within individual vines. A similar (though non-linear) relationship between season-long crawler activity on bark and percent fruit infested has

TABLE 2: Map of 102 kiwifruit vines from block B, Katikati, showing numbers of crawlers trapped on bands placed at the top of vine trunks for 2 weeks from 18.2.86.

654	698	1	11	306	359
416	0	2	2	0	20
5	3360	1	8	3	1
1	8	0	31	2	129
0	0	0	0	1	13
17	0	851	0	0	3
1	877	9	0	11	6
16	0	0	3	0	58
52	10	0	0	1	2
5	30	611	43	0	5
0	0	0	1	0	0
3	0	10	2	2	57
0	1	1	167	1	1
0	1	4	0	3	25
0	1	5	1	1	206
0	0	2	2	0	33
1	8	11	0	7	0

Fig. 2: Relationship between percentage infested fruit in May and numbers trapped over a two week period on a sticky band on the upper trunk in February 1986 at Matahui. The Y-axis is an arcsine transformation. $Y = 0.62 + 0.00018 X$, $r^2 = 0.45$, $P < .001$.

been shown for San Jose scale (*Quadraspidiotis perniciosus*) on apples (Mague and Reissig 1983).

Crawlers were rarely caught on the aerial sticky traps, with a total catch of 11 at Kumeu, four at Matahui and 41 at Te Puke between October and May (compared with respective total catches on vines of 2800, 2737 and 13828). This suggests that crawlers

disperse to leaves and fruit principally by walking, rather than by being blown which agrees with suggestions by Ferguson (1974) and Berry (1983). This finding suggests that scale may be controlled by using a barrier of persistent insecticide applied to the woody parts of the plant rather than by repeated sprays aimed at protecting fruit.

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