STRATEGIES FOR CONTROL OF GREENHOUSE WHITEFLY IN TAMARILLO ORCHARDS

R.H. BLANK, M.J. BLAGROVE, A.R.W. WHITE¹

Agricultural Research Division, MAF, P.O. Box 943, Whangarei

¹*White's Orchards, R.D. 2, Kerikeri*

SUMMARY

Pesticide treatments were evaluated in large scale tamarillo (*Cyphomandra betacea*) orchard trials for their ability to contain greenhouse whitefly (*Trialeurodes vaporariorum*) below levels which caused sooty mould contamination of fruit. An adult whitefly threshold count technique based on the selection of young leaves at the top of the canopy was used to determine when to spray. A soap/diazinon treatment was ineffective at controlling whitefly. A total of 11-12 oil/deltamethrin or deltamethrin sprays, applied when adult whitefly numbers exceeded the threshold level, were successful in preventing sooty mould contamination of fruit. The costs of these successful spray programmes are compared with losses suffered from whitefly damage the previous season.

INTRODUCTION

A whitefly outbreak on tamarillos in Kerikeri during the 1984/85 season caused serious crop losses to growers. The lack of an effective insecticide was part of the problem (Blank *et al* 1986) but also growers were unsure when to spray. Different strategies, such as spraying 3 times at weekly intervals or spraying at 2-4 weekly intervals were tried, but the whitefly persisted. Even at relatively low densities, leaves and fruit became contaminated with a honeydew secretion from the whitefly on which formed a black sooty mould. In severe infestations, larvae completely covered all available space on the underside of leaves at densities of 8000-65000/leaf and adult whitefly completely smothered the underside of the young leaves. These heavy infestations caused fruit and leaf drop of up to 70%.

The objective of this investigation was to develop and test at the orchard level, cost-effective control strategies. This entailed evaluating insecticides in conjunction with the development of an action threshold for deciding when to spray.

MATERIALS AND METHODS

A mixed subtropical fruit orchard in Kerikeri was used in these trials. Whitefly had been a persistent problem on tamarillo for 3 years with high populations in 1985 causing severe damage. Four blocks of 5 year old and eight blocks of 3 year old red tamarillo were used. Block size was approximately 0.5 ha.

Threshold counts

Adult whitefly have a distinct preference for settlement on the underside of young leaves on which they feed and lay eggs. Adult counts were made on young leaves about 70-125 mm in length and 60-120 mm wide. Leaves were gently turned towards the observer to prevent the whitefly flying away. The underside of a tamarillo leaf is separated into eight areas by the main leaf veins. Adults were individually counted in one area and the number multiplied by the number of areas containing whitefly. A range of whitefly densities were counted in this manner to calibrate the eye, after which visual estimates of whitefly populations were made.

The distribution of whitefly adults on tamarillo was assessed on 17 January 1986 from three lightly infested (52 adults/leaf) and three heavily infested plants (102 adults/leaf). Ten leaves were selected at random from each of 4 heights, spaced at 0.6 m intervals from the top of the canopy (3.0 m), for each plant.

Proc. 39th N.Z. Weed and Pest Control Conf.

Four methods of taking threshold counts were compared on 17 January 1986 (Table 1). Leaf counts were taken at 5 randomly selected locations spaced at regular intervals down the middle rows of each of the 12 tamarillo blocks giving a total of 60 leaf counts for each method. Randomly selected counts were taken first. Counts of heavily infested leaves were taken within 2 m of each random count. A maximum of 1 minute was allowed for the selection of heavily infested leaves. A ladder was used when taking counts at the top of the canopy.

TABLE 1: A comparison of four methods of estimating adult whitefly threshold counts on young tamarillo leaves.

Method	Adults/leaf
Canopy top, select heavily infested leaves	351
Mid-canopy, select heavily infested leaves	202
Canopy top, random	197
Mid-canopy, random	47
SED	29

Evaluation of insecticide spray programmes

Two insecticide treatments, selected from a laboratory screening trial (Blank *et al* 1986), were tested in October and November 1985. An oil (Sunspray mineral oil 96 EC 300 g ai/100 litres)/deltamethrin (Decis 2.5 EC 0.6 g ai/100 litres) treatment was compared with the same cost equivalent rate to a soap (Lux soap flakes 450 g/100 litres)/diazinon (Basudin 80 EC 45 g ai/100 litres) treatment. The two treatments were randomised amongst the four old and eight young tamarillo blocks giving six replicates per treatment. Insecticides were applied at 2000 litres/ha using an airblast sprayer at 150 kPa with the bottom nozzle (D5-35) switched off to ensure 80% of spray was directed to the top of the tamarillo canopy. To decide when to spray, adult counts were made from five leaves per block, selected at random at a height of 1.8-2.4 m. The action threshold for application of pesticides was arbitrarily set at 10 adults/leaf. Twenty leaves were picked at random on 30 October and 14 November 1985 and the levels of infestation and mortality of all whitefly stages determined (Blank *et al* 1986).

Another two insecticide treatments were tested from January-April 1986. Oil/deltamethrin (300/0.6 g ai/100 litres) was compared with the same cost equivalent rate of deltamethrin (1.2 g ai/100 litres). Treatments were randomised evenly amongst the old and young tamarillo blocks and between blocks exposed to the earlier treatments. Three blocks thus received oil/deltamethrin in both trials. The method of assessing adult threshold counts was changed from random to selectively choosing heavily infested leaves from the top of the canopy. The threshold for spraying was arbitrarily set at 50 adults/leaf. On 12 February, 12 leaves/plot were picked at random and assessed for spray misses by searching for pockets of live whitefly surrounded by dead ones. The effectiveness of treatments was assessed from leaves picked on 9 April 1986 as described previously. Sooty mould contamination of leaves and fruit was noted at each threshold count. An estimate of sooty mould contamination was made from five locations within each block on 9 April 1986.

Part of a block of 8 year old tamarillos, 250 m from the tamarillo blocks used in these trials, was left unsprayed to serve as a control. Copper and fungicides were applied to all blocks as necessary to control diseases.

RESULTS AND DISCUSSION

Adult whitefly counts taken at random from young leaves at different heights showed that 60-95% of adults were concentrated in the top of the canopy. The slope of the regression of log variance on log mean of adult counts was 1.8 which was significantly ($P < 0.001$) greater than unity confirming the aggregated distribution of the adults (Taylor 1961). Selection of young leaves at the top of the canopy with heavy infestations gave significantly ($P < 0.001$) higher counts than the other methods (Table 1). The threshold counts taken in the January-April trial used this method, rather than

the random selection of leaves, as it was assumed sooty mould contamination was caused by these heavy infestations rather than an average population density.

Threshold counts were found to be simple, quick to carry out and avoided problems of assessing the minute eggs, larvae and pupae. Counts should not be made in wet, cold conditions when adults sometimes shelter within the canopy.

The adult threshold counts and insecticide applications made during the 1985/86 season are given in Table 2. Generally counts were well above threshold levels before sprays were applied. Weather, kiwifruit pollination, other orchard management requirements, and the rapid whitefly population build up all contributed to the less than ideal spray intervals.

TABLE 2: Adult whitefly threshold counts and dates of insecticide applications.

Date	Adults/leaf (random 1.8-2.4 m)		Date	Adults/leaf (selected 2.4-3.0 m)	
	soap/ diazinon	oil/ deltamethrin		deltamethrin	oil/ deltamethrin
1985			1986		
16.10	17	16	18-19.1	spray	spray
22.10	spray	spray	24.1	126	296
30.10	11	0.8	30-31.1	—	spray
			5.2	spray	—
4.11	12	1.1	6.2	—	240
7.11	spray	—	6.2	—	spray
14.11	5.5	0.8	11.2	121	178
			13-15.2	spray	spray
	oil/ deltamethrin	oil/ deltamethrin	21.2	109	189
15.11	spray	spray	21.2	—	spray
2.12	1.5	0.4	26.2	spray	—
17.12	12	13	2.3	64	242
20.12	—	spray	5-6.3	—	spray
27.12	spray	—	6-7.3	spray	—
15.1	23	3.3	12.3	156	246
			16-17.3	spray	—
			17-18.3	—	spray
			24.3	76	99
			29-30.3	spray	—
			31.3	—	spray
			9.4	83	97

Two soap/diazinon sprays were needed in October/November whereas a single oil/deltamethrin application maintained adult counts below the threshold level (Table 2). The soap/diazinon treatments gave poor to moderate control of larvae and pupae and failed to kill eggs which hatched to give high densities of first instars (Table 3). The oil/deltamethrin treatment gave moderate to good control of all stages, reduced oviposition and maintained whitefly at low densities. The few high infestations found in the oil/deltamethrin treatment were attributed to spray missing insects in depressions on the underside of leaves.

Difficulties were experienced in dissolving soap flakes in the 2000 litre spray tank, with globules of soap often floating on the surface. The amount of soap actually in solution may thus have been lower than necessary to achieve good kills of whitefly (Blank *et al* 1986). The use of a liquid soap, such as Safers Insecticidal Soap, would overcome mixing problems but would still not control egg stages. The superior control of whitefly shown by pyrethroid treatments in screening trials (Blank *et al* 1986) was thus confirmed and the difficulty of finding alternative materials highlighted.

Over the January-March period seven deltamethrin and eight oil/deltamethrin sprays were applied (Table 2). Treatments were often applied on different dates because

TABLE 3: Levels of whitefly infestations on tamarillo leaves after two soap/diazinon and one oil/deltamethrin applications. Leaves picked 14 November 1985.

Live stages/leaf	% leaves infested at each density	
	soap/diazinon	oil/deltamethrin
0	16	47
1-20	39	42
21-100	25	9
>100	20	2

of the large areas involved and the development of less than ideal spraying conditions after an early morning start. It was therefore not possible to directly compare threshold counts. In February, 45% of leaves from both treatments showed evidence of incomplete spray coverage with pockets of live larvae surrounded by dead ones. As oil acts as a wetting agent it was unlikely that the addition of commercial spreaders or wetting agents would have improved coverage.

Tamarillos from both treatments had light infestations of whitefly in April with 62-66% of leaves having less than 20 larvae and pupae per leaf (Table 4). Most (>70%) of the leaves with higher infestations were caused by pockets of whitefly which had obviously been missed by spray.

TABLE 4: Levels of whitefly infestations on tamarillo leaves after seven applications of deltamethrin and eight of oil/deltamethrin. Leaves picked 9 April 1986.

Live stages/leaf	% leaves infested at each density	
	deltamethrin	oil/deltamethrin
0	35	31
1-20	27	35
21-100	13	18
>100	25	16

Sooty mould first appeared in leaves in January as a light deposit in scattered patches throughout all tamarillo blocks. Heavier deposits occurred in February and March, irrespective of treatment. In April, from 1-10% of the top central leaf canopy was contaminated in half of the tamarillo blocks, but sooty mould contamination of fruit was minor with less than 1% of fruit affected across all treatments. Some deposits on fruit probably originated from whitefly infestations which developed during the 42 day interval in November and December when spraying could not be carried out because of the presence of beehives for kiwifruit pollination. Other sources of contamination probably originated from pockets of whitefly which were missed during spraying. Experimentation with different nozzles, fan and tractor speeds did not appear to improve penetration and coverage of the dense tamarillo foliage present late in the season. Growers should aim to reduce densities as low as possible before mid-December when the canopy starts to affect penetration.

Unsprayed tamarillos developed larval infestations of > 10000/leaf, with all leaves (except for the top young leaves) and fruit covered in a black sooty mould by March. Substantial leaf and fruit drop commenced on these unsprayed tamarillo in April. The oil/deltamethrin and deltamethrin spray programmes used were therefore largely successful in containing whitefly below the damaging levels seen in the unsprayed tamarillos. Application of sprays closer to the threshold of 50 adults/leaf may have improved control and prevented sooty mould contamination. Further experimental work is in progress to more rigorously define threshold counts necessary to prevent sooty mould contamination of fruit.

A major advantage of the threshold technique was that it shifted the emphasis from calendar spraying to applying sprays when necessary. Spray intervals were long in

cooler months but were shortened in hotter months when an exponential increase in whitefly populations occurred.

In the 1984/85 season, 10 applications of a range of insecticides were made to control whitefly on the tamarillos in this orchard, until 12 March 1985. Insecticides were applied at standard rates at an average cost of approximately \$80/ha (1986 prices) using 2000 litres of mixture per ha, but whitefly populations were not contained. Yields were reduced 30%, increased costs of 6c/kg for washing contaminated fruit were incurred, returns were reduced 25% due to down-grading of fruit, and overall losses amounted to \$5,200/ha (1985) prices.

In comparison a total of 11-12 sprays of oil/deltamethrin or deltamethrin were used in these trials from pruning until the commencement of harvest in April 1986. A total of 13 sprays at an average interval of 14 days were required until cool conditions in June restricted whitefly development. A major cost saving of 40% was achieved by using lower than normal rates of insecticide, at an average cost of \$50/ha (1986 prices). No additional costs, due to contaminated fruit or yield losses, should occur. Although these whitefly control strategies tested were successful on an orchard scale, they were expensive both in terms of chemicals and time spent spraying.

ACKNOWLEDGEMENTS

To Messrs D.S. Bell, M.H. Olson and Mrs J. Kelly for technical assistance.

REFERENCES

- Blank, R.H.; Blagrove, M.J. and Waller, J.E., 1986. Screening chemicals to control greenhouse whitefly on tamarillo. *Proc. 39th N.Z. Weed and Pest Control Conf.*
- Taylor, L.R., 1961. Aggregation, variance and the mean. *Nature* (London) 189: 732-735.