DORMANT SEASON CONTROL OF GREEDY SCALE ON KIWIFRUIT

A.R. Tomkins, P.T. Holland, K.C. Phillip, C.P. Malcolm

Ruakura Soil and Plant Research Station, MAF, Private Bag, Hamilton

SUMMARY

The insecticidal effectiveness and residual life of single dormant season applications of chlorpyrifos, diazinon or oil for greedy scale (*Hemiberlesia rapax*) control on kiwifruit (*Actinidia deliciosa*) was studied. Oil and chlorpyrifos increased scale mortality significantly more than diazinon. Twenty eight days after treatment, overall mortality was 88, 79, 64 and 41% on oil, chlorpyrifos, diazinon and unsprayed vines respectively. However, numbers of first instar scale on leaves were similar on insecticide-treated vines in spring. Chlorpyrifos and diazinon residues decreased rapidly in the first week after application, then declined more slowly with half lives for two decay phases of 1.5 and 2, and 17 and 23 days respectively.

INTRODUCTION

Greedy scale is a serious potential contaminant of kiwifruit. Control relies mainly on regular insecticide applications during the growing season but, to assist control, treatments are also recommended while kiwifruit vines are dormant. Two advantages of dormant season treatments are that no harvest residues are produced and it is relatively easy to get good spray coverage. Current recommendation for the dormant season treatment consists of a lime sulphur application in mid-August followed 10-14 days later with a diazinon treatment. A few growers use oil as an alternative insecticide (Sayers 1985). However, dormant applications of oil have been shown to delay bud break and damage shoots developing in the following spring (Sale 1972). More recent studies of oil phytotoxicity (D. Steven, pers. comm), have recorded occasional damage to vines although yield was not always affected. Laboratory (Ferguson and Wallace 1979) and field (Blank *et al.* 1985) studies have shown that chlorpyrifos and diazinon provide a similar level (i.e. corrected mortalities of 55-68% and 46-62% respectively) of greedy scale control. Sale (1974) has evaluated diazinon applied in autumn but its effectiveness has not been compared with chlorpyrifos or oil. This paper reports on a trial comparing the residual life of these insecticides on the bark of kiwifruit vines and their effectiveness in controlling overwintering populations of greedy scale.

METHODS

Four 100 m rows of 10-15 year old T-bar 'Elmwood' and 'Hayward' kiwifruit vines at a Tauranga orchard infested with greedy scale were used. Treatments were applied on 16 August 1985 to run-off with a Solo knapsack sprayer (on setting four delivering 2.5 litres/min), which required an average of 3.8 litres per vine. Trial layout was a randomised block design with five single vine replicates of five treatments, two of which were unsprayed controls. Treatment vines were buffered by single unsprayed vines both within and between rows. Treatments are listed in Table 1. Lime sulphur was not applied prior to the application of any of the insecticide treatments to allow the assessment of their effectiveness alone. The adjuvants in the 30 ATP chlorpyrifos formulation were designed to enhance bark penetration (R. Buchanan pers. comm.).

Additional residue data were obtained from applications at a Waikato site. Single vines were sprayed (28 November) to run-off. Treatments were: chlorpyrifos 40 EC, chlorpyrifos 40 EC plus 2% oil, chlorpyrifos 30 ATP and chlorpyrifos 50 WP all at 25 g ai/100 litres; and diazinon 80 EC at 50 g ai/100 litres.

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

TABLE 1: Number of settled first instar greedy scale (live + dead) on twigs and leaves 56 and 91 days respectively after a single insecticide application (16 August 1985).

Treatment	Mean proportion (%) of twig population as first instar	Mean number of first instar per 100 leaves
chlorpyrifos (Lorsban 30ATP)	8.5	4.8
diazinon (Basudin 50WP)	23.6	5.6
oil (Sunspray)	13.7	4.8
untreated control	36.8	15.2
SED	15.9	6.2

Following spray application, twig samples were removed from each treatment vine for assessment of greedy scale mortality and residue analysis. Samples were collected at fortnightly intervals over 2 months. A pre-spray sample was also taken to assess stage composition of the population and natural scale mortality on all treatment vines. Greedy scale samples consisted of several twigs per vine infested with at least 30-40 insects. Samples were individually examined and scales counted and identified to stage (first, second, third and mature third instars) (Berry 1983) before mortality assessment. In addition to the twig samples, a single sample of 10 mature leaves from the centre of each of the treated vines was collected on 15 November to determine the level of scale infestation on the new season's growth. Scale mortality expressed as proportion of insects sampled which were dead was analysed using logit analysis.

Twig samples for residue assessment consisted of ten 100-150 mm twigs per treatment. Samples were frozen (at -18°C) until residue extraction with 50-200 mls of petroleum ether. Extract was analysed by gas liquid chromatography with electron capture detection (Holland and McGhie 1983). The length and diameter of the twigs were measured and the residue data expressed as $\mu\text{g}/\text{cm}^2$ assuming the twigs to be smooth cylinders. Residue data were logarithmically transformed and analysed by linear regression.

RESULTS

At the time of insecticide application 63% of the greedy scale were third instars some of which had begun to produce crawlers. Crawler production increased in September and continued throughout the trial. Between 11 and 22% of the live mature third instars found on the untreated vines on different sample dates had crawlers beneath them. As a result, the proportion on the live scale population on untreated vines composed of first instars increased from 28% at the time of spray application to 34, 36, 46 and 66% respectively 13, 28, 43 and 56 days later. Overall natural mortality was high (41%), but was lower for first instars, e.g. 28, 58 and 38% for first, second and mature third instar scales respectively.

Figure 1 shows that scale mortality in all insecticide treatments had begun to increase by the 13th day after application. After 28 days, differences between treatments became significant. Mature third instar mortality was higher on the oil (78%) than on the chlorpyrifos (50%) or the diazinon (45%) treated vines ($p < 0.01$). First instar scale mortality was also higher on the oil (100%) and chlorpyrifos (93%) than on the diazinon (24%) treated vines ($p < 0.05$). Mortality of the mature third and first instars on untreated vines was 21 and 18% respectively on the same date. Higher first instar mortality due to all three insecticides had reduced the proportions of the scale population which were settled first instars on day 56 (Table 1). The insecticide treatments also reduced the number of scales settling on leaves by 63.2 - 68.4% (Table 1). All treatments were equally effective.

Fig. 1: Percent mortality of first and mature third instar greedy scale after a single dormant season application of insecticide. Average SED's are shown by vertical bars.

Both organophosphate insecticides showed very rapid decay so that after 7 days less than 10% of the initial deposit remained (Table 2). The residues then declined more slowly reaching about $0.005 \mu\text{g}/\text{cm}^2$ after 75-88 days. Bimodal decay patterns could be

TABLE 2: Decay of residues ($\mu\text{g}/\text{cm}^2$) on kiwifruit twigs following application of diazinon (50gai/100 litres) or chlorpyrifos (25gai/100 litres).

Insecticide Site ^a	diazinon		chlorpyrifos				
	T	R	T	R	R	R	R
Formulation	50WP	80EC	30ATP	50WP	40EC	40EC + oil	30ATP
Day							
0	1.60	1.40	0.73	1.21	0.75	1.02	1.43
1		1.50		0.65	0.47	1.08	0.95
3		0.27		0.13	0.31	0.53	0.19
7		0.10		0.08	0.14	0.16	0.07
14	0.06	0.08	0.05	0.03	0.05	0.12	0.09
21		0.03		0.05	0.06	0.08	0.03
28	0.031	0.03	0.02	0.02	0.04	0.08	0.05
42	0.013	0.014	0.009	0.02	0.03	0.04	0.04
56	0.010		0.006				
62		0.010		0.02	0.02	0.01	0.03
75	0.005		0.004				
88		0.004		0.006	0.005	0.004	0.006

^a T = Tauranga, R = Rukuhia

described by two first order rate equations. Mean half lives for the two decay phases were 1.5 and 17 days for diazinon and 2 and 23 days for chlorpyrifos. Within the error of determination (10%) there was no significant effect of site or formulation on these decay rates.

DISCUSSION

No treatment gave 100% control of mature third instar greedy scale (Figure 1). Mortality on the untreated and insecticide-treated vines was not significantly different for the first 2 weeks after treatment. Differences emerged over later samplings, although mortality on untreated vines rose as an increasing proportion of the mature third instars produced crawlers and died. Oil caused greater scale mortality than either chlorpyrifos or diazinon, as found by Blank *et al.* (1985) for treatments applied during the growing season. Throughout the trial, surviving mature third instars on untreated and insecticide-treated vines provided a continual source of crawlers.

Most crawlers (83-96%) were beneath mother scales on all treatment vines. Although protected beneath mother scales, 90-100% of the crawlers on the chlorpyrifos- and oil-treated vines were dead in samples taken 28 or more days after spraying. Chlorpyrifos may be able to kill crawlers beneath mother scales by fumigant activity (Kenaga *et al.* 1965). The same explanation cannot apply to the oil treatment. Prior to crawler release the mother scale lifts the cap slightly to allow crawler escape and this might allow the penetration of oil which Berry (1983) has shown to be very effective against first instar greedy scale.

Settled first instars may have been affected by direct exposure to insecticides at the time of application or by contact with treated surfaces while dispersing before settling. Diazinon increased first instar (crawlers and settled) mortality initially, but a decline in mortality was found in samples taken after 13 days. In contrast, first instar mortality remained high on the chlorpyrifos treated vines until day 42 (Figure 1). This longer period of high mortality, even though mother scales surviving the insecticide treatment may have produced crawlers, indicates that the residual activity of this insecticide may be relatively longer. Similarly, residues on peach trees treated with chlorpyrifos at 0.6 g a.i./litre killed San Jose scale crawlers (*Quadraspidiotus perniciosus*) for 60-80 days (Howell and George 1984).

Leaf sampling showed that although the treatments reduced first instar scale numbers on early season leaves the difference from unsprayed vines was not significant. Diazinon reduced the numbers of scale on leaves by a similar level (63.2%) to that achieved by Sale (1974) using the same formulation and rate of diazinon applied in autumn. However, reinfestation from surrounding untreated buffer vines may have increased the numbers of scales found on the treated vines.

The initial rapid decline of insecticide residues (Table 2) is mainly due to volatilisation. The slower second phase of decay results from photochemical and hydrolytic degradation of pesticide more firmly attached to the twig cuticle. While chlorpyrifos was more persistent than diazinon, neither pesticide left high residues on twigs beyond 7-14 days after application. The oil combination or special formulation (ATP) of chlorpyrifos did not significantly extend persistence on the twigs.

This trial has shown that single insecticide applications in late winter/early spring increase the mortality of established scales and of crawlers produced by any surviving mother scales. Although, scale mortality was higher on the oil- and chlorpyrifos-treated vines, none of the treatments totally prevented reinfestation of new season's growth. Further avenues for dormant season control of scale could include combined autumn and winter oil applications, provided phytotoxic effects can be minimised. Use of more persistent insecticides could also give extended periods of control.

ACKNOWLEDGEMENTS

We would like to thank Mr A. Moorehouse for permission to use the kiwifruit vines, IWD for supplying an insecticide and Ms A. Arms, Mrs R.A. McGhie and Mr M. Koller for technical assistance and Ms B. Dow for statistical analysis.

REFERENCES

- Berry, J.A., 1983. Aspects of the ecology and control of greedy scale (*Hemiberlesia rapax* (Comstock). M.Sc. Thesis. Univ. Auckland. 112p.
- Blank, R.H., Olson, M.H., Waller, J.E., 1985. Screening pesticides for control of greedy scale on kiwifruit leaves. *Proc. 38th N.Z. Weed and Pest Control Conf.*: 219-222.
- Ferguson, A.M. and Wallace, A.R., 1979. A laboratory technique to evaluate pesticides for control of greedy scale on kiwifruit. *Proc. 32nd N.Z. Weed and Pest Control Conf.*: 220-224.
- Holland, P.T. and McGhie, T.K., 1983. Multi-residue method for determination of pesticides in kiwifruit, apples and berry fruits. *J. Assoc. Official Analytical Chemists* 44: 1003-1008.
- Howell, J.F. and George, D.A., 1984. Efficacy and persistence of chlorpyrifos residues on peaches for control of San Jose scale (Homoptera : Diaspididae). *J. econ. Ent.* 77: 534-536.
- Kenaga, E.E., Whitney, W.K., Hardy, J.L. Doty, A.E. 1965. Laboratory tests with Dursban insecticide. *J. econ. Ent.* 58 (6): 1043-1050.
- Sale, P.R., 1972. Oil and Chinese gooseberries do not agree. *Orchardist of N.Z.* 45(1): 30-31.
- Sale, P.R., 1974. Spray trials and the kiwifruit spray programme. *Proc. Kiwifruit Seminar*. Tauranga. pp: 27-32.
- Sayers, D., 1985. Matahui - an organic kiwifruit orchard. *Soil and Health* 44(1): 6-9.