Horticultural Crops

INSECT CONTROL ON KIWIFRUIT, PART 1

A. M. FERGUSON and A. E. STRATTON

*Entomology Division, DSIR, Christchurch and
Shell Chemicals (N.Z.) Ltd, Hamilton*

Summary

Multiple applications of azinphos-methyl, phosmet, chlorfenvinphos, a single application of the pyrethroid, cypermethrin and an unsprayed control were compared for their efficacy against a number of insects found inhabiting kiwifruit vines (*Actinidia chinensis* var. *chinensis*) in the 1975-76 summer. Overall, azinphos-methyl proved the superior chemical for control of lepidopterous larvae and was adequate for greedy scale (*Hemiberlesia rapax*) control. Limited field samplings of developing fruit indicated that better timing of applications for lepidopteran control was required which could have reduced the number of sprays.

INTRODUCTION

The Bay of Plenty kiwifruit industry has expanded production rapidly over the past decade (Rutherford 1978) with a high percentage of the crop going to overseas markets. Export fruit must be virtually free of insects, mites and/or their associated damage.

A complex of arthropods is found on the vines. The major fruit-damaging insects are leaf rollers (principally *Ctenopseustis obliquana*), greedy scale (*Hemiberlesia rapax*), the native moth *Stathmopoda skelloni* and the passion vine hopper (*Scolypopa australis*). Other undesirable insects and mites on the fruit and/or vines include the privet mite (*Brevipalpus obovatus*), *Tydeus* spp., tetranychid mites (*Eotetranychus sexmaculatus* and *Tetranychus urticae*), thrips, four additional scales, two weevil species and a mealy bug (*Pseudococcus longispinosus*). A diverse predator and parasite fauna is also present.

Current measures for the control involve multiple applications of azinphos-methyl from October until February for leaf rollers, followed by two phosmet sprays one month apart for greedy scale.

It was hypothesised that the application of azinphos-methyl alone throughout the season would result in acceptable greedy scale control. Therefore multiple applications of azinphos-methyl, phosmet and chlorfenvinphos at two rates were evaluated for their effect on the insect and mite fauna present. A similar assessment was undertaken following a single application of the pyrethroid cypermethrin.

METHOD

Because the 1975-76 and 1976-77 (see Part II) trial methods were similar, experimental details of both trials are combined.

Trial design for 1975-76 comprised a row of 10 vines divided equally with each treatment appearing once in both blocks on single vines. In a separate orchard two adjacent trials in 1976-77 were laid down using a six by six latin square design. The orchards lay N.W. of Tauranga city and were unsprayed with no known history of insecticides. The vines (cv. 'Bruno') were large, dense and T bar-supported permitting "inner" and "outer" regional sampling with treatment replication on a single vine.

Proc. 31st N.Z. Weed and Pest Control Conf.

Horticultural Crops

Additionally, the relationship between vine aspect and insect density was a parameter in each season as the vines were on a north-south axis, which allowed separate sub-sampling in west and east regions.

Spray applications in each season were by motorized knapsack delivering about 4 600 litres/ha at 2 400 kPa. Fungicides were applied to each vine as per MAF, Tauranga, recommendations (Anon 1974), and a wetting agent was incorporated into the penultimate and ultimate insecticidal applications. The concentration of each insecticide appears in Table 1.

Evaluation

In the first season, two *in situ* field samplings (14/1/76, 1/3/76) of random fruit clusters, six per vine quarter, were examined for lepidopteran larvae or their damage. At harvest (11/5/76) a case of fruit from each vine aspect was examined for a determination of damage factors.

A single field sample was undertaken during the 1976-77 season (17/1/77) to assess the same damage factors when 18 clusters were examined in each of "inner" and "outer" vine regions and at harvest (9/5/77) 9 kg of fruit was assessed from four vines in Trial 1.

One hundred (1975-76) and 40 (1976-77) older leaves were picked, at random, from each vine at various time intervals to assess the insect and mite fauna present.

Statistical analysis

Statistical procedures demonstrated that all insect species were aggregated, to some extent, between and within vines and between blocks. Thus, prior to analysis, each season's datum was transformed to base log ($x + 1$), or log x , except lepidopteran counts (arc sin). If an analysis of variance F test indicated significance, means were compared using Duncan's multiple range tests at 5% significance level. Figures shown in tables were calculated from the raw data.

RESULTS AND DISCUSSION

TABLE 1: Percent lepidopteran* damage and number of fruit from 48 fruit clusters (field) and 4 cases (harvest) from each of five regimes, 1975-76

Sampling date (location)	14/1/76 (field)		1/3/76 (field)		11/5/76 (harvest)	
Days post spray/ No. applications	22/1		7/3		19/5	
Treatment (g/100 litres)	% Damage	No. fruit	% Damage	No. fruit	% Damage	No. fruit
azinphos-methyl (50)	7.4 b	171 a	1.9 c	225 a	18.4 c	544
phosmet (110)	20.3 ab	180 a	14.9 b	206 a	34.1 b	610
chlorfenvinphos (25)	28.1 ab	167 a	16.1 b	199 a	-	-
chlorfenvinphos (50)	22.6 ab	139 a	17.8 ab	180 a	33.9 b	558
untreated	32.3 a	134 a	34.4 a	215 a	55.3 a	494
CV%	52.7	48.6	43.5	19.6	21.4	

* includes leaf roller (mainly *C. obliquana*) and *S. skelloni*

Horticultural Crops

Azinphos-methyl gave consistently superior lepidopteran control on fruit, although in two samplings the damage level was unacceptably high (Table 1). Spray application dates were: 22/12/75, 18/1, 23/2, 6/4 and 22/4/76. All fruit had set by 5 December 1975 which gave a minimum of 17 days before sprays were applied. During this time the fruit were unprotected and resultant damage was reflected in the 14/1/76 sampling. No leaf roller larvae were found on fruit in the azinphos-methyl regime and *S. skelloni* larvae were absent from this and the phosmet treatment.

The apparent reduction in damage in all treatments on 1/3/76 was probably a result of the fruit callousing minor injury which had been recorded during the previous sampling. Unlike the pip fruit situation, kiwifruit windfalls were rarely seen.

Increased fruit damage occurred in all regimes at harvest. Damage on control vines was at least 50% higher than that concurrently recorded from three unsprayed sites in the Bay of Plenty (Ferguson unpublished), hence indicating severe attack. Adult *S. skelloni* were seen on 1/3/76 and their offspring may have attacked the fruit in March when a period of 43 days elapsed between sprays. Surrounding feijoa (*Feijoa sellowiana*) trees were attacked by leaf rollers in early March but only two larvae were recorded from control vines (*Cnesphasia jactatana* and *C. obliquana*). Although leaf roller larvae were found in unsprayed harvested fruits (3 second instar *C. obliquana*, 1 third instar *C. jactatana*) the post-spray period was sufficiently brief for treated fruit to remain protected.

Therefore it appears that a March *S. skelloni* flight was responsible for the large damage increase recorded at harvest. Regular field monitoring of insect numbers has subsequently confirmed a March flight (Wearing 1977).

Three leaf samplings in February and March were assessed for leaf roller injury but as the only difference was between treatments and control ($P < 0.01$, CV% 24.5) this approach would appear unsatisfactory for assessment of efficacy differences between insecticides. In contrast, leaf sampling for leaf rollers is a technique for screening insecticides on pip fruit (Thomas pers comm).

A pre-spray leaf sampling for greedy scale on 21/12/75 showed no treatment differences (CV% 29.4). After one spray, a similar assessment on 14/1/76 demonstrated a significant between-treatment difference ($P < 0.05$) caused by chlordfenvinphos (25 g/100 litres) where the reduction was low (44%). By 6/3/76 (Table 2) this regime had suffered serious re-invasion from second generation crawlers.

When this became evident a single application of cypermethrin, at 30 g/100 litres was substituted on 6/4/76. Observations from three leaf samples after this spray showed that most insect and all mite species, including beneficial mites, were killed. Although in most cases death was slow, (3-9 days), vine damage was unlikely to have ensued as the insects were moribund. Reports have been cited showing variable mite control using cypermethrin which may be due to cross resistance from previously applied chemicals. Therefore, attention is drawn to the lack of previous pesticide usage on this block in relationship to the excellent control recorded. Although greedy scale survival was similar to the untreated and pre-spray (26/3/76) figures, a resultant population density decline was detected. Presumably this resulted from increased mortality of later-emerging second generation crawlers.

Horticultural Crops

TABLE 2: Mean density of greedy scale at 6/3/76 on 200 leaves from each of five regimes, 12 days following the 3rd spray

Treatment (g/100 litres)	Mean No.		% survival	% leaves infested
	per leaf	live per leaf		
azinphos-methyl (50)	0.5 bc	0.2 b	4.0	15.5 bc
phosmet (110)	0.3 cd	0.03 b	10.0	12.0 cd
chlorfenvinphos (25)	0.9 b	0.08 b	8.9	21.0 b
chlorfenvinphos (50)	0.2 d	0.2 b	10.0	7.5 d
untreated	1.6 a	0.68 a	42.5	31.0 a
CV%	14.7	53.8		11.7

Greedy scale activity was also examined on a "percentage of leaves infested" basis from eight samplings during the season. Both untreated vines showed a steady increase (40% to 70-80%) while treated vines, except the lower rate of chlorfenvinphos, remained steady at 10-40%. However, due to a 7-35% inter-vine variation, no between-treatment differences could be detected.

TABLE 3: Mean density of greedy scale on fruit harvested (11/5/76) 19 days following the 5th spray, from four regimes

Treatment (g/100 litres)	Density per 100 fruit	No. alive per 100 fruit	% fruit infestation	Mite sacs of <i>A. baccharum</i>
azinphos-methyl (50)	3.5 b	1.4 b	3.1 b	16 b
phosmet (110)	2.5 bc	0.7 b	1.4 c	10 b
chlorfenvinphos (50 g)	1.3 c	0.4 b	1.0 c	48 b
untreated	19.0 a	8.3 a	8.2 a	119 a
CV%	23.3	52.6	23.0	82.1
aspect relationship	W > E (P < 0.1)	NS	W > E (P < 0.1)	

At harvest (Table 3) untreated fruit had a low density scale population compared with other unsprayed vines (Ferguson unpublished). With regard to aspect, only chlorfenvinphos (50 g/100 litres) significantly reduced the lower density "East" population whereas all treatments reduced the higher "West" population ($P < 0.05$). Aspect had no measurable influence on lepidopteran damage but a significantly greater number of attacked fruit were found on the "inner" vine region compared with the "outer" ($P < 0.05$).

The predacious mite *Anystis baccharum* constructs a cocoon in which to moult. These were counted (Table 3) and the result suggests that the treatments adversely affected survival.

Leaf-inhabiting insects were recorded throughout the season and a typical faunal composition, with regime differences, is presented in Table 4.

Horticultural Crops

TABLE 4: Numbers of insects from 200 leaves from each of five regimes on 26/3/76 32 days following the 3rd spray

Treatment (g/100 litres)	INSECT					
	<i>Eotetranychus sexmaculatus</i>	<i>Tydeus</i> sp.	<i>Amblyseius largoensis</i>	<i>Coccus hesperidum</i>	<i>Brevipalpus obovatus</i> *	<i>Ceroplasts sinensis</i>
azinphos-methyl (50)	271 a	539 a	0	0	101	0
phosmet (110)	10 b	842 a	0	2	94	1
chlorfenvinphos (25)	24 b	650 a	0	1	-	5
chlorfenvinphos (50)	2 b	73 b	0	0	0	2
untreated	93 b	891 a	109	58	62	15
CV%	41.8	9.8				

* sampled on 11/5/1976

The *Eotetranychus sexmaculatus* mite was apparently unaffected by azinphos-methyl and none of the organophosphates tested (except chlorfenvinphos at 50 g/100 litres) had a controlling influence on tydeid mite species. In fact, the insecticidal destruction of the predatory mite *A. largoensis* may have induced, or prolonged, higher mite numbers, e.g. *E. sexmaculatus* following azinphos-methyl application. These findings suggest that application of the recommended chemicals, phosmet and azinphos-methyl, have already disrupted acarine predator-prey relationships; an aspect not currently appreciated in the Bay of Plenty. Both soft brown (*C. hesperidum*) and hard wax (*C. sinensis*) scales were affected adversely by treatments whereas the phytophagous mite *B. obovatus* remained unaffected by each organophosphate except chlorfenvinphos.

CONCLUSIONS

Damage was severe from lepidopterous larvae and azinphos-methyl was the superior chemical for their control. Despite a low scale density, phosmet and chlorfenvinphos (50 g/100 litres) gave superior control to azinphos-methyl which, nevertheless, gave a level of greedy scale acceptable on export fruit because the MAF inspection tolerance was 4% in 1975-76. The higher rate of chlorfenvinphos showed promise as a miticide.

A high level of inter-vine variation was recorded and for future research it is suggested that more vines per regime be utilised in association with sub-sampling.

In this 1975-76 season, periods of fruit damage by larvae were distinct, viz. flowering to post flowering, mid-January, possibly mid to late March, and mid-April to early May, which indicates that the principle of timing of insecticide application for maximum effectiveness could be applicable to kiwifruit.

ACKNOWLEDGEMENTS

We offer our appreciation to the personnel who assisted with this work, particularly Mr A. Wallace, Applied Mathematics Division, DSIR, Christchurch.

REFERENCES

- Anonymous, 1974. Chinese gooseberry spray programme, 1975-76. *N.Z. Minist. Agric. Fish., Tauranga*. 8 pp.
- Rutherford, G. K., 1978. The kiwifruit industry. *N.Z. Ag. Sci.* 12: 5-12.
- Wearing, C. H., 1977. Leafroller. Tauranga Field Day. 16 November. 8 pp.