REDUCING PESTICIDE RESIDUES ON KIWIFRUIT

P.S. STEVENS[1], D. STEVEN[1], C. MALCOLM[2] and P.T. HOLLAND[2]

[1] *HortResearch, Mt Albert Research Centre, Private Bag 92 169, Auckland*
[2] *HortResearch, Ruakura Research Centre, Private Bag 3123, Hamilton.*

SUMMARY

An approach to reducing pesticide residues on kiwifruit without compromising fruit quality has been validated. Late season spray decisions were based on field monitoring of armoured scale insect populations at 12 sites during March and April. The final insecticide sprays could be omitted as scale numbers on leaf samples from all sites never exceeded an 8% spray threshold. Fruit from vines receiving reduced spray programmes had lower residues than fruit receiving a full season programme. There were no significant increases in scale infestation or leafroller caterpillar damage on fruit at harvest. A residue model was able to accurately predict levels of four organophosphate insecticides on fruit at harvest but the model underestimated permethrin residue levels.

Keywords: kiwifruit, pesticide residues, armoured scale

INTRODUCTION

New Zealand kiwifruit is currently marketed as the 'world's finest' kiwifruit but the industry must continually search for ways to enhance fruit quality and increase market acceptance. Reducing the levels of insecticide residues on fruit is an important step towards this goal as pesticide residues are a very significant issue to consumers and have the potential to be used as non-tariff barriers to trade. This challenge has been taken up as a focus for pest management research. The trials reported here aimed to reduce residues by omitting the final sprays applied before harvest. The rationale behind concentrating on the final sprays was that these are the sprays that contribute most to the residues found on fruit at the time of harvest. Pesticide residue decay on kiwifruit often follows a biphasic pattern with fast initial decay being followed by a slower long term decay (Holland *et al.* 1984). A simple model based on these parameters can predict residues from various spray programmes for pesticides applied at both short and long term withholding periods. Early season sprays of organophosphorus insecticides of low persistence lead to very low to non-detectable residues at harvest due to decay plus fruit growth dilution of residues.

Most of the insecticides applied to kiwifruit are for the control of the armoured scale insects greedy scale, *Hemiberlesia rapax* (Comstock), latania scale *H. lataniae* (Signoret), and oleander scale *Aspidiotus nerii* (Bouche). The recommended spray programme essentially consists of three-weekly to monthly insecticide applications from December to April. In this research, the decision as to whether to apply each of the two final sprays was based on an armoured scale monitoring system, with a spray action threshold. Monitoring ensured that orchards with high pest pressure continued to receive insecticides when needed, while those where scale levels were low could omit the final one or two sprays.

A leaf sampling technique for evaluating scale populations and tested spray action thresholds has been developed over the last 5 years. An insecticide is only applied if the percentage of leaves with live scale exceeds the spray threshold. These studies showed that both 4% and 8% thresholds, used for all sprays from the third post-flowering on, reduced the number of insecticide sprays applied, without compromising the fruit quality and quarantine requirements for export. In applying the research to whole properties, as has been done in the "Residue-Free" or "Kiwi Green" trials

Proc. 46th N.Z. Plant Protection Conf. 1993: 62-66

(Anon. 1992), a conservative threshold of 4% was used, while in this trial a more liberal threshold of 8% was considered adequate.

METHODS

The trial was carried out on 10 properties in several kiwifruit growing regions. The orchards were located in Kerikeri, the western Bay of Plenty, Opotiki, Gisborne, and Takaka. The experiment was replicated twice in two of the orchards making a total of 12 test blocks in the trial. The trial commenced in March 1992 when each co-operating grower was ready to apply their second to last scheduled spray. In some cases this proved to be the last spray because the fruit was harvested earlier than was expected. Leaf samples were assessed before both the penultimate and the final spray. At each site two blocks were chosen which were of similar age and management history. One of the blocks was designated as a 'control' and received the standard spray programme used by that particular grower. The other block was the test or threshold block. A sample of approximately 100 leaves was collected from each block (one leaf per vine) in March and April 1992 and assessed microscopically for the presence of live armoured scale. Each grower was advised to spray the threshold block only if the scale count from the assessment exceeded the 8% threshold.

At harvest 300 fruit were collected from both the threshold and standard blocks and examined under a stereo microscope for the presence of scale and for leafroller damage. As with the leaf samples, fruit samples were collected by row. A sample of 10 fruit from each 300 fruit sample was analysed for insecticide residues using a multi-residue method capable of determining all the insecticides to detection limits of 0.02-0.05 mg/kg (Holland *et al.* 1983). All results are expressed on a fresh weight basis and are not corrected for recovery which is estimated to be between 85-100%. A TurboPascal implementation of the residue model (Holland *et al.* 1989 unpublished commercial report) was used to calculate predicted residues for each spray programme.

TABLE 1: Percentage of leaves with live armoured scale (AS) used to determine whether a spray should be applied.

Region	Site No.	Sample date	% leaves with live AS	
			Threshold	Control
Kerikeri	1	10.3.92	2.5	2.5
		15.4.92	0	2.6
Tauranga	2	27.3.92	0.9	1.8
		24.4.92	1.1	1.0
Katikati	3a	3.3.92	2.0	1.8
		31.3.92	1.9	5.9
	3b	3.3.92	0.9	4.0
		31.3.92	3.0	2.0
	4	20.3.92	6.0	7.0
	5	19.3.92	0	0
		8.4.92	0	0
	6a	12.3.92	1.0	1.9
		8.4.92	4.9	0
	6b	12.3.92	1.0	0.8
		8.4.92	2.2	1.8
Opotiki	7	25.3.92	4.1	1.0
Gisborne	8	11.3.92	0.8	0
		3.4.92	0.8	0.9
	9	11.3.92	2.0	2.0
		3.4.92	2.5	0
Takaka	10	24.3.92	0	0

RESULTS AND DISCUSSION

None of the leaf samples from either the threshold or control blocks had more than 8% of leaves infested with live armoured scale at any time (Table 1). Thus late sprays were not applied to threshold blocks which remained unsprayed for 45 -111 days prior to harvest versus 22-56 days for the control blocks.

The infestation levels in the first sample from both the threshold and control blocks were not significantly different (t-test on arcsine transformed percentage of leaves infested with armoured scale). This was expected since up to this point both had received the same insecticide programme used by that grower. There was some variability, e.g. sites 4 and 9, but this was well within the range expected given the relatively small sample sizes, and the fact that scale levels will differ even between adjacent blocks (Steven and Stevens, unpublished data).

In general there was no increase in scale numbers on leaves from threshold blocks which were not sprayed between the two leaf samples (compare the scale infestations in the first and second leaf samples from the threshold blocks in Table 1).

Insect presence or damage on the fruit samples taken at harvest is summarised in Table 2. There were no fruit sampled from site 10 (Takaka), as the crop was destroyed by frost. Apart from this, all lines of fruit successfully reached export standards when graded through commercial packhouses.

TABLE 2: Armoured scale presence and leafroller damage found on fruit after microscopic examination. (Thr = threshold block; Ctl = control spray programme).

Site	Days since last spray		% fruit with AS		% fruit with leafroller damage	
	Thr	Ctl	Thr	Ctl	Thr	Ctl
1	75	36	1.9	0	0.9	1.5
2	78	22	0.3	0	2.0	2.3
3a	111	56	0.3	0	1.3	0
3b	111	56	1.6	0.7	1.6	0.7
4	98	53	5.0	3.9	0.7	0.4
5	45	31	0	0	1.0	1.0
6a	78	30	0.4	0	1.1	0.4
6b	78	30	0	0	1.1	0.6
7	80	52	0	0	3.0	3.9
8	89	54	0	0	3.7	1.7
9	50	23	0.3	0.3	2.0	2.0
Mean	81.2	40.3	0.9	0.4	1.7	1.3

A t-test was performed on arcsine transformed percentages of fruit infested with armoured scale, and there was no significant difference ($P<0.05$) between those from the threshold and the control spray programme. There was an increase in scale insect presence in 6 of 11 samples produced using the threshold spray programme, but the small differences were of no practical significance. Site 4 (Katikati), which had the highest percentage of scale-infested fruit on both threshold and control blocks, also had the highest infestation levels on the leaves (Table 1). Site 7 (Opotiki) and 6a (Katikati), which had the next highest scale levels in leaf samples, had negligible levels on the fruit.

A similar analysis showed that there was no significant difference in leafroller damage between the threshold blocks and the control blocks. This was expected because leafroller damage primarily occurs soon after flowering, rather than late in the season (Steven 1990). More importantly, no fresh damage was recorded under the reduced spray programme. If it had occurred, it would have indicated a significant quarantine risk from leafrollers attacking the fruit close to harvest. However, pheromone trap records for the last few years (Steven unpublished data) indicate that leafroller activity in kiwifruit growing areas was relatively low in the 1991-92 season.

Eliminating the final sprays had a detectable effect on the residue levels on fruit at harvest. Data from the spray diaries from each grower were used to provide input for the computer model and the residue levels predicted were compared with the actual residues detected on the fruit (Table 3).

TABLE 3: Insecticide residue levels detected on fruit. Mean for sites (n) where the pesticide was applied after flowering.

Pesticide	Threshold programme mean residue (mg/kg)			Control programme mean residue (mg/kg)		
	Observed	Predicted	n	Observed	Predicted	n
diazinon	.01 a	.004 a	10	.02 a	.009 a	10
pirimiphos-methyl	.08 a	.026 a	5	.32 b	.31 b	6
permethrin	.05 a	.012 a	9	.12 b	.044 a	10
chlorpyrifos	.05 a	.028 a	2	.07 a	.057 a	5
phosmet	.05	.054	1	not found	.054	1

*values within a row followed by the same letter are not significantly different (Duncans multiple range test, alpha = 0.05)

An analysis of variance found no significant differences in residues detected between the control and threshold spray programmes, except for pirimiphos-methyl where the standard programme had significantly higher residues on the fruit (P=0.0016). However, in all cases except for one, the residues on fruit at harvest from the threshold programme were lower and were approaching or below the detection limits for routine residue screening methods. The levels of the organophosphorus insecticides were less than 5% of maximum residue limits in major markets (Holland *et al.* 1986).

For the pesticides diazinon, pirimiphos-methyl, chlorpyrifos and phosmet there was no significant difference between the predicted and actual residues on the fruit. However, for permethrin, the model significantly underestimated the residues on the fruit. This may have arisen from errors in decay parameters for permethrin which were derived from very limited field trial data. However, the model accurately predicted the reductions in all residue levels when the number of sprays was reduced. The overall accuracy of prediction is remarkably good for the organophosphorus insecticides considering the variety of spray programmes and the low terminal residues (representing 1-10% of the levels expected directly after spray application).

CONCLUSIONS

This trial has successfully demonstrated that it is possible to omit late season insecticide sprays without jeopardizing fruit quality. Insecticide residues on fruit were reduced on the threshold blocks compared to the control blocks and could be accurately predicted by a residue decay model.

ACKNOWLEDGEMENTS

We would like to thank the New Zealand Kiwifruit Marketing Board for financing this research. We would also like to thank all the many growers who helped us with this work, through provision of study sites and for collecting samples. Mark Maunder assisted with the assessment of fruit samples.

REFERENCES

Anon., 1992. Alternative spray programme trial. *N.Z. Kiwifruit March:*18.

Holland, P.T., McGhie, T.K., and Malcolm, C.P., 1983. Multiresidue method for determination of pesticides in kiwifruit, apples and berryfruit. *J. Assoc. Off. Anal. Chem. 66:*1003-1008.

Holland, P.T., McGhie, T.K., and Malcolm, C.P., 1984. Residual life of pesticides on kiwifruit. *Proc. 37th N.Z. Weed and Pest Control Conf.:*136-141.

Holland, P.T., Malcolm, C.P., and Tomkins, A., 1986. Pesticide Residues. *Proc. N.Z. Kiwifruit Authority National Res. Conf.:*28-31.

Steven, D., 1990. Entomology in Kiwifruit. Pp 362-412. *In:* Kiwifruit Science and Management (Eds.) I.J. Warrington, G.C. Weston, R. Richards, Auckland. 576pp.