PESTICIDES FOR USE CLOSE TO AND DURING HARVEST OF PERSIMMONS

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SUMMARY

In a survey of the pest incidence on persimmons (*Diospyros kaki*) mealybugs, thrips and leafroller larvae were the most common insects. There was a high incidence of leafroller damage. Fungal feeding and predatory mites were very common but plant feeding species more sporadic. The effectiveness of a single late season application of various insecticides was reduced due to the calyx protecting pests. Chlorpyrifos and fenitrothion significantly reduced the proportion of infested fruit but residual activity means they can only be recommended for early season use. Dichlorvos, carbaryl and dimethoate were less effective but can be used within 3-7 days of harvest.

INTRODUCTION

Persimmons are a relatively new crop to New Zealand but have an exciting potential as an exported fruit to Japan. One of the major production barriers limiting exports is preharvest invertebrate contamination of fruit. Approximately 90% of exported fruit was fumigated on arrival in Japan in the 1987 harvest season (A.D. Clarke, pers comm.) with increased costs passed on to the growers. The most frequent contaminants were mealybugs, leafrollers, thrips and mites. Insects and mites hide under the calyx and in deep cracks on the fruit and are difficult to control with conventional sprays. There are also a number of passenger invertebrates not associated with the crop but which move from the leaves to hide under the calyx in autumn and early winter as the leaves drop from the tree. These contaminants create a quarantine problem to importing countries.

The Ministry of Agriculture and Fisheries recommended spray programme for persimmons was originally designed from overseas data but refined under New Zealand conditions (Sale 1985, 1986; Steven and Sale 1985). Spray schedules using either chlorpyrifos, phosmet, diazinon and/or carbaryl insecticides are generally effective (Steven and Sale 1985) if used correctly by growers and according to a schedule of approximately 3 week spray intervals. As no spraying is recommended 2-3 weeks prior to harvest and harvest may last for up to 6 weeks opportunity exists for insects and mites to damage or contaminate fruit by hiding in cracks and under the calyx. This 6-8 week gap in the spray schedule gives a spectrum of contaminants the opportunity to survive post-harvest treatments prior to arrival in the importing country.

The objectives of this study were to survey the incidence of contaminants on fruit and to screen a range of pesticides which may be used close-to and during fruit harvest. As part of this work, pesticide residue testing was undertaken to ensure compliance with overseas requirements.

METHODS

Grower survey

Twenty five growers who were considering exporting fruit in 1988 from the major persimmon growing areas were targeted to provide fruit at harvest for insect and mite assessment. Fruit were chosen at random, packed into boxes and sent to Ruakura Agricultural Centre. In the laboratory, the calyx of each fruit was removed and the area under the calyx was examined for the presence of live invertebrates and feeding damage using a binocular microscope at 160x magnification.

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Field trial

A block of persimmons cv. Fuyu at the Blands Horticultural Research Station, Hamilton was used as a trial site. Each treatment was replicated four times with single tree plots in randomised block design. Guard trees on either side of the treated trees reduced the likelihood of insecticide contamination between treatments. The whole orchard had been sprayed according to the MAF recommendations for export persimmons with the last application of carbaryl, 100 g/100 litres water, on 21 April 1988. The experimental single spray treatments (Table 1) were applied on 5 May 1988 to runoff with a motorised sprayer.

The effectiveness of the treatments was assessed 5 days after pesticide application by sampling 10 fruit per tree (40 fruit/treatment). In the laboratory the calyx on each fruit was removed and the area under the calyx was examined for contaminating insects and mites as above.

For pesticide residue analysis, 4-6 fruit were picked from each tree on days 1, 4, 7, 14, 21, and 28. Fruit from replicate 1 plus 2, and 3 plus 4, were bulked to give two duplicate samples for residue testing. All fruit were deep frozen and stored at -18°C . Samples were analysed by a standard multi-residue method (Holland and McGhie 1983). Fruit were finely chopped, subsampled and compounds extracted in methanol. Following purification and concentration of the extracts, levels of each pesticide were determined by gas chromatography.

TABLE 1: Summary of treatments and rates of application

Treatment	Pesticide	Formulation	Rate	(g ai/100 litres H ₂ O)
A	untreated			
B	carbaryl	Ispray carbaryl	80% WP	120
C	diazinon	Basudin 50	50% WP	50
D	carbaryl + diazinon	as above	as above	120 + 50
E	dichlorvos	Vapona C	100 EC	60
F	dimethoate	Rogor 20W	20% WP	20
G	chlorpyrifos	Lorsban 50W	50% WP	35.5
H	fenitrothion ¹	Caterkil	60 EC	30

¹applied on 6/6/1988.

RESULTS

Only nine of the 25 growers targeted to participate in the pest survey responded by sending fruit (Cyclone Bola damaged many orchards and contributed to poor grower response). Most fruit sent to Ruakura were infested with insects and mites (Table 2). The majority of contaminants were found under the calyx and in cracks on the fruit. Mealybugs (*Pseudococcus affinis*, *P. calceolariae*, *P. longispinus* and *P. graminosus* in decreasing occurrence) and thrips (probably *Heliothrips haemorrhoidalis*) were common on fruit. Leafroller larvae were generally at low levels except for one orchard. The most important leafroller species observed was the brownheaded leafroller (*Ctenopseustis obliquana*), but the light brown apple moth (*Epiphyas postvittana*) was also recorded. Many fruit (5-55%) had leafroller damage. Fuller's rose weevil (*Asynonychus cervinus* (Boheman)) was an important problem on one property with over 50% of fruit infested, although damage was usually restricted to the sepals of the calyx. A few greedy scale (*Hemiberlesia rapax*), oleander scale (*Aspidiotis nerii*) and black scale (*Saissetia oleae*) were observed and there was little indication of sooty mould on the fruit.

Mites represented an important problem in most orchards. Four growers had mites on all fruit examined. 'Passenger' mites, i.e. those grouped as fungal feeders (Families Oribatidae, Tydeidae, Acaridae and Tarsonemidae) and predatory (Bdellidae, Stigmaeidae, Eupodidae and Phytoseiidae) were common. Budmite (*Colomerus vitis* (Pagenstecher)) was found on fruit from four growers and one grower had fruit infested with two-spotted spider mite (*Tetranychus urticae* (Koch)).

TABLE 2: Invertebrate contamination of persimmon fruit sent by growers.

Grower Region*	1 BOP	2 Keri	3 Wai	4 BOP	5 Hastings	6 Wai	7 BOP	8 BOP	9 Waik
No. fruit examined	20	20	20	18	20	20	20	20	20
Date	16/5	1/7	16/6	27/5	20/6	16/5	16/6	30/5	7/6
Mites:									
Plant feeders	0	10	2	2	0	0	0	7	5
Fungal feeders	13	5	15	9	16	17	9	14	5
Predatory	1	14	4	12	8	12	18	17	4
Mealybugs	18	0	3	0	7	1	0	4	8
Thrips	3	2	1	6	0	2	0	3	3
Leafroller larvae	0	0	1	0	1	1	0	0	2
Leafroller damage	3	6	11	7	6	10	3	1	3
Psocids	0	0	8	0	2	0	1	4	1
Scale	0	0	0	1	1	0	0	2	1
Spiders	1	0	1	0	0	2	0	0	0
Others	1	0	0	0	11	0	0	1	2
					Fullers rose weevil				
% Fruit with live insects and mites	95	100	90	85	100	100	100	90	65
									95
									60
									90

*BOP = Bay of Plenty, Keri = Kerikeri, Wai = Waikato

TABLE 3: The percentage of fruit with live insects and mites assessed 5 days after treatment application.

Treatment ¹	A	B	C	D	E	F	G	H
Total no. fruit sampled	40	30	40	40	30	40	30	20
Mites:								
Plant feeders	0	0	3	3	0	3	0	0
Fungal feeders	67	87	75	65	80	80	47	31
Predatory	98	27	10	13	39	19	27	10
% Fruit with mites	68	89	78	70	94	89	55	40
Mealybugs	9	8	3	12	4	6	4	0
Thrips	24	16	6	6	12	12	8	7
Leafroller	9	4	9	7	8	4	0	0
Psocids:								
adults/nymphs	13	0	0	0	13	0	15	0
egg batches	9	25	30	3	11	6	8	7
Scale	2	0	5	2	2	0	11	2
Spiders	0	0	0	0	3	0	0	0
Other insects	3	0	0	0	3	0	0	0
% Fruit with live insects and mites	88	97	86	81	96	98	65	44

¹Alphabetical codes correspond to treatments in Table 1.

Most fruit sampled in the field trial contained live insects and mites (Table 3). With very few exceptions pests were hiding in deep cracks on the fruit and under the calyces. Chlorpyrifos and fenitrothion treatments significantly ($P < 0.05$) reduced the proportion of fruit infested with insects and mites. None of the other treatments significantly reduced the live pest loading on fruit.

The pesticide residues found on fruit from each treatment and the maximum residue limits (MRL's) for the pesticides in Japan are given in Table 4. The pesticide decay patterns appeared bimodal with a rapid initial decay followed by a slower second phase as has been observed for kiwifruit (Holland *et al* 1984). Apart from dichlorvos the tested insecticides had half-lives for the second phase of 7-14 days. Dichlorvos was virtually non-residual with residues declining below 0.01 mg/kg in 4 days. Carbaryl and dimethoate both decayed sufficiently rapidly, considering their MRL's of 1 mg/kg, that either could be used within 3-7 days of a harvest. Diazinon was also not very residual, but the low MRL means that a withholding period of 21-28 days would be required. Chlorpyrifos and fenitrothion, the most effective insecticides, were also the most residual. Chlorpyrifos would require a 21-28 day WHP for residues to decline below 0.5 mg/kg while fenitrothion still had not decayed below the 0.2 mg/kg MRL at 28 days. Therefore only early season use for these two pesticides can be advised.

TABLE 4: Pesticide residues on persimmons and Maximum Residue Level (MRL) allowed on arrival in Japan.

Pesticide	Residue mg/kg						MRL (Japan)
	1	4	7	14	21	28 days	
carbaryl	2.5	0.70	0.42	0.35	0.16	0.17	1.0
diazinon	1.4	0.54	0.36	0.18	0.09	0.06	0.10
carbaryl	1.2	0.45	0.28	0.14	0.18	0.09	1.0
diazinon	0.88	0.69	0.25	0.10	0.13	0.05	0.10
dichlorvos	0.02	nd	nd	nd	nd	nd	0.10
dimethoate	0.47	0.31	0.26	0.18	0.10	0.07	1.0
chlorpyrifos	0.86	0.54	0.33	0.51	0.35	0.33	0.5 ^a
fenitrothion	2.27	1.61	0.97	0.79	0.37	0.42	0.2

nd = not detected (<0.01 mg/kg)

a = set for general fruit category only

DISCUSSION

Most fruit examined had insects and mites present under the calyx where they were sheltered from pesticide sprays. As the fruit enlarges, the calyx becomes flattened, effectively forming an umbrella covering the pests. Total spray coverage when the fruit are small, and the use of more persistent pesticides early in the season to ensure that pests hiding under the calyx are eliminated is vital to any persimmon pest control package. Once the calyx has formed an umbrella it is very difficult to eliminate pests. Fruit on pollinator trees were much smaller and had more upright calyces than export fruit. These fruit were very clean of insects and mites and had little feeding damage as the pesticide sprays had greater penetration under the calyx and pests could not hide.

In the current trial, the incidence of damaging species was low but the overall infestation was high. Most fruit carried oribatid and tydeid mites which may represent a quarantine hazard. Batchelor *et al* (1985) indicated that it is difficult to eliminate mites with post-harvest fumigation techniques. Early orchard control would be useful, although according to Steven and Sale (1985) oribatid mites are not very susceptible to insecticides.

The pesticide residue data indicates that improved spray recommendations can be made which will also meet residue requirements in Japan. In particular the more persistent pesticides, chlorpyrifos and fenitrothion, could be recommended for early season control on insect pests. These two pesticides generally gave better insect and mite control than carbaryl, diazinon, dichlorvos or dimethoate in the current trials. Further studies are required to incorporate fenitrothion into a spray schedule, primarily for leafroller control, and to obtain further residue data.

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