SPRAY PROGRAMMES FOR PEST AND DISEASE CONTROL IN TAMARILLOS

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SUMMARY

Four spray programmes were investigated in a mature tamarillo (*Cyphomandra betacea*) orchard. During the summer powdery mildew (*Oidium* sp.) was well controlled by dinocap, triadimefon and triforine, with bupimarate being less effective. Aphids (principally *Myzus persicae*) were completely controlled by acephate, while diazinon chlorpyrifos and pirimiphosmethyl/permethrin were less effective. Acephate or pirimiphosmethyl/permethrin gave excellent control of looper caterpillar (*Chrysodeixis eriosoma*). During the autumn/winter period powdery mildew was controlled better by benomyl or triadimefon than by triforine or bupimarate. A residue level of 1 mg/kg was never exceeded by any of the chemicals. Only acephate and permethrin had half lives on the fruit exceeding 7 days.

INTRODUCTION

Tamarillos are attacked by a number of insect pests including aphids, looper caterpillar and whitefly (*Trialeurodes vaporariorum*) (Fletcher, 1979). Due to the vigorous growth habit of the plant it is doubtful that serious impairment to fruit production is often caused by these pests. However, aphids can act as transmission vectors for several serious virus diseases of tamarillos (Mossop 1977). Sooty mould growing on honeydew secretions from aphids or whitefly can cause downgrading of fruit. All insect pests pose quarantine problems for export fruit even though most are only adventitiously found on fruit.

Powdery mildew can affect a high proportion of the leaves of tamarillos. Plant vigour is reduced particularly if severe infestations arise early in the growing season.

Recommendations for spray programmes to control pests and diseases are limited because few chemicals have residue tolerances for tamarillos in the major export markets. A trial programme has been initiated to provide residue and effectiveness data for a range of alternative pesticides on tamarillos to those currently recommended by MAF.

METHODS

A 3 year old block of tamarillos (Golden variety) at Katikati, Bay of Plenty, was used in the trial. Two rows of trees with a guard row between were divided into five 6.1 m plots, each containing 4 trees with a guard tree between each plot. A randomised block design with two replicates was laid out with four treatments and an unsprayed control. The treatments are listed in Table 1. During the main growing season (November to April), seven spray applications were applied at 3 weekly intervals. Over the harvest period (May — July) three applications were made at 4 weekly intervals. Mixed sprays were applied to run-off with a hand-gun using a D4 nozzle without swirler. Mean volume per application over the season was 5,600 litres/ha.

Assessments were in March and July, 40 leaves being taken at random from each of three trees in each plot and classified as affected (greater than 1% leaf area) or unaffected by viable powdery mildew. Numbers of apterous aphids and looper windows (characteristic large holes eaten in the leaves by the caterpillars) were counted on 20 leaves per tree (March assessment only). Ten fruit per tree (July assessment only) were examined for caterpillar egg clusters and chewing damage.

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Fruit samples for residue analysis were collected on a series of days (Table 3) following the April spray (July for dimethoate). Samples were stored at -18°C prior to analysis. Ten representative fruit were quartered and extracted twice with methanol. Acephate and dimethoate were determined directly in the methanol extract using gas chromatography with flame photometric detection. Chlorpyrifos, diazinon, pirimiphos-methyl, triadimefon, and bupimate were determined by gas chromatography with alkali flame ionisation detection following partitioning of the methanolic extract into toluene. Permethrin and dinocap were determined by gas chromatography with electron capture detection of toluene partitioned extracts that had been cleaned up on a carbon column. Triforine was determined in the methanol extract by degradation to chloral (Bourke *et al* 1977). Benomyl and dichlorvos residues were not measured. Recoveries, determined by spiking untreated fruit prior to extraction, were better than 90% except for triforine and dinocap which gave 75% and 73% respectively. The results are uncorrected for recovery.

RESULTS

The assessments for powdery mildew (Table 2) showed that dinocap, triadimefon and triforine gave excellent control during the main season but that bupimate was less effective. Over the winter harvest period, benomyl or triadimefon gave significantly better control ($P < 0.05$) than triforine (D) or bupimate (C) with the latter being virtually ineffective.

TABLE 1: Tamarillo spray programmes.

Treatment	Pesticide	Formulation	Applied	Rate (g/100 litres)
A	dinocap	25% WP	m	20
	diazinon	50% WP	m	50
	benomyl	50% WP	h	12.5
	dichlorvos	108% EC	h	50
B	triadimefon	5% WP	m,h	2.5
	chlorpyrifos	50% WP	m	25
	dimethoate	20% WP	h	40
C	bupimate	25% WP	m,h	12.5
	pirimiphos-methyl/ permethrin	50% EC	m,h	24/1.2
D	triforine	20% EC	m,h	20
	acephate	75% WP	m,h	75

m = main growing season, 3 weekly intervals, November — April
h = harvest period, 4 weekly intervals, May — July

The performances of the insecticides against looper caterpillars were assessed by the number of 'windows' in the leaves because the caterpillars drop off the leaves when disturbed. This makes caterpillar counts unreliable in the dense tamarillo foliage. The window technique gives a useful guide to cumulative damage. Pirimiphos-methyl/permethrin or acephate were both effective at controlling looper caterpillar with diazinon or chlorpyrifos giving significantly poorer control (Table 2). Acephate was very effective against aphids but diazinon or pirimiphos-methyl/permethrin only provided 50% control. Chlorpyrifos was rather less effective than these last two materials ($P < 0.1$). Fruit assessment at harvest showed that untreated fruit could be a significant quarantine risk with egg-clusters or caterpillar damage on 10% of the fruit. Programmes C or D (Table 1) provided clean fruit. Insect numbers on the leaves in July were too low for assessment.

TABLE 2: Pest and disease assessment on tamarillos.

	Assessment Date	Treatment				LSD (P 0.05)
		A	B	C	D untreated	
Powdery mildew						
% leaves affected	9/3	0	5	13	1	83
	14/7	3	10	75	28	95
Caterpillar damage						
holes/leaf	9/3	1.7	1.5	0.2	0	3.8
Green peach aphid						
aptera/leaf	9/3	2.3	4.6	3.5	0	6.5
Caterpillar eggs						
or damage						
% fruit affected	14/7	6	3	0	0	10

TABLE 3: Pesticide residues on tamarillos.

Days after last spray	Pre-spray	Residue ¹ (mg/kg whole fruit)						
		0	1	3	7	14	20	28
acephate	0.24	0.82	0.94	0.60	0.39	0.46	0.40	0.28
chlorpyrifos	0.01	0.24	0.04	0.03	0.02	0.01	0.01	0.01
diazinon	nd ²	0.19	-	0.02	0.01	nd	nd	nd
dimethoate	0.04	0.18	0.23	0.10	0.07	0.06	0.05	0.04
permethrin	0.02	0.05	0.03	0.04	0.04	0.03	0.02	0.02
pirimiphosmethyl	nd	0.14	0.10	0.03	0.01	nd	nd	nd
bupimarate	nd	0.14	0.11	0.03	0.01	nd	nd	nd
dinocap	nd	0.10	-	0.04	0.03	0.02	0.01	nd
triadimefon	nd	0.04	0.04	0.01	nd	nd	nd	nd
triforine	0.02	0.14	-	0.06	0.03	0.04	0.03	0.02

¹ mean of duplicate analyses² nd = not detected 0.01 mg/kg

The residue levels on the whole fruit at a series of intervals following the last spray are given in Table 3. The pre-spray levels represent the residues from the penultimate sprays 3-4 weeks before. The day 0 levels, taken approximately 1 h after spraying, therefore represent the maximum level of cumulative residues. A level of 1 mg/kg is not exceeded by any of the chemicals at the rates tested and, except for acephate and permethrin, less than 20% of the day 0 residue is left by day 28. The residues of permethrin and triadimefon were always below 0.1 mg/kg due to the very low rates employed. Chlorpyrifos, diazinon, pirimiphos-methyl, and bupimate dissipate very rapidly with half lives of 1-3 days.

DISCUSSION

The effectiveness of dinocap against powdery mildew confirms its place in MAF recommendations. Benomyl maintained complete control during the winter and deserves main season testing. Triadimefon and triforine were also effective, especially in the main season, and could provide acceptable substitutes.

Acephate gave excellent control of aphids and looper caterpillar and was superior to diazinon, the current MAF recommended material, or chlorpyrifos. Pirimiphos-methyl/permethrin was effective against looper caterpillar but did not give acceptable control of aphids. Complete control of aphids is desirable to minimise virus infection of

the tamarillo plants. However, the short aphid feeding time required for acquisition or transmission of virus (Mossop 1977) means that practical field control may be impossible to achieve by spraying. This is particularly so with a perennial crop such as tamarillos. Spraying is also unlikely to affect the nematode-transmitted Arabis mosaic virus (Thomas and Proctor 1972, 1977).

The low value of tamarillos makes intensive spray programmes such as those employed here, of doubtful economic benefit. Growers are more likely to pursue curative rather than preventative spraying. Crop vigour could be maintained by strategic sprays to reduce or eliminate pest or disease infestations early before they develop sufficiently to check growth. Systemic materials such as triadimefon, triforine, acephate and dimethoate are likely to be more effective under these conditions. The maintenance of viable predator populations would also be aided by less intensive spraying and could be an important factor for control of aphids and whitefly which can be difficult to eliminate by spraying.

The production of clean export fruit is another consideration and this is more likely to be achieved by a regular spray programme. The effectiveness of the materials tested here under less frequent spray regimes remain to be tested as do their effects on whitefly which were not found at the trial site. However, even regular spraying is unlikely to completely prevent moths from flying in from outside the crop and laying eggs on the fruit shortly prior to harvest. Dichlorvos is the standard material for use close to harvest due to the rapid dissipation of its residue. Its effectiveness was not established in this trial.

The other consideration for export spray programmes is the need for pesticide residues on the fruit at harvest to be below the tolerance levels (Holland and Watts 1980). Few tolerance levels have been set for tamarillos in most countries and none by the USA. Thus a non-detectable residue level is often the initial requirement. The current recommended materials, diazinon and dinocap, are both undetectable after 28 days. Triadimefon is undetectable after 7 days. The other effective fungicide triforine gives marginally detectable residues at 28 days. The most effective insecticide, acephate, is quite residual. This probably accounts in part for the good results it produced but specific residue tolerances will be required before its use can be recommended on export fruit.

The efficacy and residue data presented here should aid the development of alternative spray programmes for tamarillos. Further information is needed on how much spray programmes can be varied to improve the economics of production of export quality fruit.

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