THE EFFICACY OF CHLORPYRIFOS IMPREGNATED POLYETHYLENE FILM IN CONTROLLING LEAFROLLERS

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SUMMARY

The insecticidal effect of chlorpyrifos-impregnated polyethylene film (CIPF) was tested on light brown apple moth (*Epiphyas postvittana*), brownheaded leafroller (*Ctenopseustis obliquana*) and greenheaded leafroller (*Planotortrix excessana*) as a potential method for eliminating these species as a quarantine risk on 'Granny Smith' apples exported to North America. After 30 days of regular coolstorage, the highest rate of chlorpyrifos film used exceeded the maximum allowable residue limit for chlorpyrifos in apples to North America, and failed to give complete kill of leafroller species.

INTRODUCTION

The New Zealand Apple and Pear Marketing Board requested that Entomology Division evaluate the insecticidal effect of chlorpyrifos-impregnated polyethylene film (CIPF) on a number of insect species as a potential control method for leafrollers on apples. Interceptions of leafrollers by United States Department of Agriculture inspectors in New Zealand have occurred in the past leading to exclusion of 'Granny Smith' exports to North America. In 1984, 72,000-90,000 cartons were excluded due to the presence of leafrollers (I.D. Wilson, pers comm). The leafroller species of quarantine importance on apples are light brown apple moth (LBAM), brownheaded leafroller (BLR) and greenheaded leafroller (GLR).

This paper reports on a trial that evaluated leafroller mortality on 'Granny Smith' apples due to CIPF after 30 days exposure to the film during regular coolstorage at 0.5 °C. The apples were coolstored for 30 days to simulate the loadings, sea transport, and unloading time period to the east coast of North America.

METHODS

Leafrollers were reared on artificial diet in single test tubes as described previously (Batchelor *et al* 1983). Most of the larvae used in these trials were third and fourth instars and reared at 25.0 °C. The larvae were pre-conditioned at 12 °C for 6 days prior to being placed on insecticide-free 'Granny Smith' apples obtained from Kumeu Research Orchard, Auckland.

A further five boxes of 'Granny Smith' apples were obtained from a commercial orchard in the Nelson district that had used a full programme of chlorpyrifos sprays. This fruit was used in the CIPF trial to obtain information on chlorpyrifos residues deposited in the fruit. Thus, the residues represented a "worst case" where apples were sprayed pre-harvest with chlorpyrifos and treated post-harvest with CIPF.

The number of larvae placed in each box varied according to supply and to the treatments applied (Table 1). Each box was lined with a fine nylon net bag (except Box B1 in the residue trials) which could be tightly sealed at the top with a drawstring to prevent larvae escaping. A standard commercial polyliner with sixteen holes of 6 mm diameter was used in treatments C and E. Treatment E aimed to evaluate the mortality of BLR on each layer of apples when CIPF was placed only on the top and bottom layers. This was replaced by the CIPF in treatment D. The CIPF polyliner was 80 x 180 cm in size. Treatments B, C and E had layers of CIPF (30 x 50 cm) placed between

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layers of 'Granny Smith' apples. Twenty apples were placed on each of the five layers per box using a standard, commercial '125-Friday tray'.

The chlorpyrifos content of the film was validated by the manufacturers Ivon-Watkins Dow (IWD) at 0.74% w/w prior to the experiments. The film was stored for 2 days prior to the trials in foil bags at approximately 0.5 °C. The normal chlorpyrifos content of the film is 1.0% w/w, but the film content was considered sufficiently high to warrant investigation for leafroller mortality (R. Buchanan pers. comm.).

The infested fruit was stored at ambient temperature (15-20 °C) for 4.5-12 h prior to being placed at 12.0 °C for 11 h. Chlorpyrifos may be released at high temperatures more rapidly than at low temperatures. The control boxes without CIPF were stored separately at 12.0 °C to avoid contamination with chlorpyrifos. The period at 12.0 °C was considered a practical compromise between coolstorage after 1 h in an 'efficient' orchard packing shed, and the more usual 24 h delay prior to coolstorage (F. Gill pers. comm.). After storage at 12.0 °C for 11 h, the apples were transferred to commercial coolstorage at 0.5 °C at the New Zealand Apple and Pear Marketing Board coolstores, Henderson.

The insect mortality was evaluated at day 30 as described previously (Batchelor *et al* 1985), and the residue tests (after Ambrus *et al* 1981) paralleled the same temperature conditions as the insects. Duplicate samples for residue analyses were taken from treated trays 2 and 4 of the five trays in the carton. The control boxes containing insect-infested apples were coolstored at the Mt Albert Research Centre at 0.5 °C.

RESULTS AND DISCUSSION

Complete mortality was not achieved for any of the three species of leafroller (Table 1). GHL was more resistant to the CIPF than LBAM and BHL. The highest

TABLE 1: Percentage mortality after 30 days coolstorage of mid-instar larvae of *Epiphyas postvittana* (LBAM), *Ctenopseustis obliquana* (BHL) and *Planotortrix excessana* (GHL). Chlorpyrifos residues were recorded after 30 days coolstorage in contact with chlorpyrifos-impregnated polyethylene film.

Treatment	Leafroller Species							
	LBAM		BHL		GHL		Residues† ppm	
	N ⁺	% Mort	N	% Mort	N	% Mort	Duplicates	Average
A. Control no polyliner no film	124	10.5	180	4.4	127	2.4	0.25	0.25
B. No polyliner 5 layers of film	122	57.4	155	58.1	81	39.5	27, 4.3*	3.50
C. Standard polyliner, 5 layers of film	131	58.8	147	56.5	99	25.3	0.9, 2.2	1.50
D. Film polyliner only	126	40.5	114	52.6	95	17.9	0.27, 0.25	0.26
E. Standard	L1.	---	---	32	43.8	---	---	---
polyliner,	L2.	---	---	26	7.7	---	---	---
1 layer	L3.	---	---	28	7.1	---	---	---
of film	L4.	---	---	15	6.7	---	---	---
on L1 and	L5.	---	---	32	28.1	---	---	---
L5	TOT.	---	---	133	21.1	---	---	---

L1-L5 Individual layers within the box; TOT Total numbers; + Number of larvae recovered

* The sample was biased as it was taken from all portions adjacent to the CIPF on one layer, indicating that chlorpyrifos is transferred onto the apple surface.

† Residues from apples sprayed with chlorpyrifos insecticide.

mortality achieved was only 58.8% recorded for LBAM larvae exposed to a layer of CIPF on each of the five levels of the carton enclosed by a standard polyliner (Treatment C).

The chlorpyrifos concentration in the CIPF used in this trial was originally only 0.74% w/w instead of the normal 1.0% w/w. The layers of film used in treatments B, C and E were cut to fit the apple cartons and holes were made in the CIPF used in treatment D. Therefore during this process there may have been a slight further loss of some of the active ingredient in the film, possibly reducing larval mortalities.

Treatment E showed that where layers of CIPF were present insect mortality was increased. However, in some boxes live larvae were found crawling over the chlorpyrifos-impregnated polyethylene film.

Prior to infestation, the apples were not dipped in diphenylamine (DPA) to prevent scald during coolstorage. Previous research has shown that DPA reduces leafroller mortality and was therefore excluded from this preliminary trial (Batchelor and O'Donnell 1984).

The average residues of chlorpyrifos (Table 1) exceeded or equalled the maximum residue permitted on apples to North America (1.5 ppm) except where a CIPF polyliner was used (Treatment D). Treatment D where a CIPF polyliner only was present showed no additional uptake of chlorpyrifos above that of the control background level. The residues for treatment C, where five layers of CIPF and a standard polyliner were used, were expected to be higher. The low residue was possibly due to the plastic polyliner absorbing some of the chlorpyrifos.

CONCLUSIONS

The chlorpyrifos-impregnated polyethylene film did not give a satisfactory kill of leafrollers for the product to be used as a quarantine treatment on New Zealand apples exported to North America as low insect mortality was recorded, and chlorpyrifos concentrations in the apples exceeded the maximum residue limits acceptable in North America.

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