EFFECT OF POSTHARVEST WATER BLASTING ON FRUIT PESTICIDE RESIDUES

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ABSTRACT

Water blasting has been shown to remove surface contaminants such as copper and pollen on fruit. It has been suggested that pesticide residues may also be reduced, allowing greater flexibility in orchard cultural practice. The efficacy of a commercial packhouse water blaster installation in reducing residues was determined experimentally. Samples of fruit from four orchards, with different spray histories, were tested for pesticide residue with and without water blasting. Water blasting reduced residues by up to 90% when residue levels were above the detection limit on the control fruit. The technology was also able to reduce some residue levels to below the detectable limit. The results were inconsistent between orchards and the level of removal achieved was variable. Water blasting is an inconsistent method of reducing residue levels and should not be relied upon to ensure market assess requirements for residue levels are met.

Keywords: carbaryl, chlorpyrifos, malathion

INTRODUCTION

Water blasting technology was initially developed as a phytosanitary treatment for avocados in New Zealand with the assistance of a grant from Technology New Zealand (TAP 1975034; OPC 801) over a period of three years (Woolf *et al.*, 1998; 1999; 2000). Postharvest water blasting of avocados has been shown to remove surface contaminants such as pollen, copper residues, insects and insect egg rafts. (Woolf *et al*, 1999). There have been several Investigations into the effectiveness of water blasting in reducing postharvest rots and the results suggest that water blasting does not provide a reliable method of reducing postharvest rots (Woolf *et al.*, 1999, 2000; Pak and Dixon, 2001).

It has been suggested that water blasting might be effective in removing pesticide residues on avocado fruit. Reducing pesticide levels may assist with meeting food safety requirements and allowing greater flexibility in orchard cultural practice.

An investigation, with the objective of measuring both the effectiveness and reliability of commercial water blasting in removing pesticide residues, was undertaken. Ten fruit samples from orchards that had applied non-systemic insecticide were passed over a water blaster to remove residues. Control fruit were passed over the water blaster, with the water jets disengaged. Fruit were analysed for residues using a multi-residue pesticide screen provided by R J Hill laboratories Limited in Hamilton.

MATERIALS AND METHODS

Four orchards were selected that had applied at least one non-systemic insecticide within one third of the withholding period for the USA market for the spray selected. Export spray diaries were collected from growers to confirm recent spray histories. Time since non-systemic insecticide spray application ranged from 1 to 380 days, with the aim of obtaining a range of residue levels on harvested fruit. Fruit were sampled from four orchards in the Bay of Plenty region, North Island, New Zealand (37°S, 176°E) on the 5th of March 2002 and stored in single layer trays at ambient temperature of 14-20°C for 24 hours. Each orchard was replicated three times, where each replicate consisted of 20 fruit in a single layer tray.

Ten fruit from each tray were passed over a commercially installed water blaster with the water jets not operating, before moving onto operational drying brushes to obtain control fruit. The remaining ten fruit in each tray were sent over the same water blaster and brushes with both the water blaster and brushes operational. Fruit remained on the brushes for approximately two minutes and were removed before the grading table. Each treatment, from each orchard had three replicates consisting of a 10 fruit sample. Samples were sent to R J Hill laboratories Limited in Hamilton for a multi-residue pesticide screen.

RESULTS

Three insecticide residues were detected in the four orchards sampled, chlorpyrifos (Lorsban®), carbaryl and malathion, in concentrations ranging from less than 0.01 mg/kg to 0.74 mg/kg.

Table 1. Mean residue levels for all control replicates and the number of days since the last application of chlorpyrifos, carbaryl and malathion for four orchards in the Bay of Plenty. na = Not applied within previous two seasons

	Carbaryl		**Chlorpyrifos**		**Malathion**	
Orchard	Mean residue (mg/kg)	Time since last application (days)	Mean residue (mg/kg)	Time since last application (days)	Mean residue (mg/kg)	Time since last application (days)
A	0.02	na	0.09	35	0.01	na
B	0.58	1	0.01	85	0.14	1
C	0.02	385	0.01	59	0.01	171
D	0.01	380	0.01	34	0.00	178

Orchard B had carbaryl and malathion applied one day before being sampled and had residue levels for these pesticides above the detection limit. The mean residue level found on control fruit was 0.58 mg/kg and 0.14 mg/kg for carbaryl and malathion respectively. Water blasted fruit had lower mean residues with 0.053 mg/kg and 0.013 mg/kg for carbaryl and malathion respectively, a decrease of 90% for both pesticides (Table 2).

Table 2. Influence of water blasting on the mean residue level of three pesticides from selected orchards and a comparison between minimum residue level (MRL) for export markets and residue levels detected.

Pesticide	Orchard	MRL (mg/kg)		Mean residue level (mg/kg)		Percentage reduction	Significance
		USA	AUS	Control	Water blasted		
Carbaryl	B	0	10.0	0.577	0.053	90.8 %	P < 0.01
Chlorpyrifos	A	0	0.5	0.093	0.067	28.6 %	NS
Malathion	B	8.0	2.0	0.140	0.013	90.5 %	NS

Orchard A had chlorpyrifos applied 34 days before being sampled and control fruit had a mean chlorpyrifos residue level of 0.093 mg/kg. Water blasted fruit had 28% less chlorpyrifos residue, with a mean concentration of 0.067 mg/kg (Table 2).

Positive results for the presence of residues was found in several control treatments, despite these chemicals either having not been applied in the respective orchards, or after such a period had elapsed that no residues would be expected (H.Pak, pers comm). These included Carbaryl residue on fruit from orchards A, C and D and Malathion residue on fruit from Orchard A. Residue levels were from 0.01 to 0.02 mg/kg (Table 1). Control fruit from orchard A were passed over the brushes before control fruit from orchard B, precluding orchard B as a source of contamination of Carbaryl and Malathion.

DISCUSSION

Removal of pesticide residues by water blasting was found on all samples where control fruit were well above the detection limit. However, none of these replicates had residues completely removed by water blasting. In practice, if fruit with residue levels well above the detection limit were water blasted, it is expected that the fruit will have residue levels that are much reduced, but still present.

Many pesticides currently in use on avocados in New Zealand, including carbaryl and chlorpyrifos, have no minimum residue level (MRL) for some export markets. Therefore the variation in efficacy of water blasting in reducing residue levels to zero is an important factor in determining the potential use of water blasting technology.

Reductions in mean residue levels of up to 90% were measured when residue levels were well above the detection limit. A similar response could be expected when residue levels are grossly in excess of a given MRL.

Carbaryl residue was detected on samples from orchards C and D, even though Carbaryl had not been applied to orchards C and D for 385 and 380 days before harvest, respectively. No detectable residues of carbaryl would be expected on avocados 180 days after pesticide application (H. Pak, pers comm). Fruit samples from orchard A had detectable levels of Carbaryl and Malathion residue. The spray history from orchard A indicates that neither Carbaryl nor Malathion had been applied in the past two seasons. Cross contamination of pesticide residue is the likely cause of the unexpected results in orchards C and D.

The method and source of cross contamination have not been identified, but could potentially include transfer from the drying brushes. Directly after being water blasted, fruit were dried on revolving brushes for approximately 2 minutes. During this time pesticide residue could potentially be removed and re-deposited on later samples.

The three pesticide residue concentrations and reductions examined in Table 2 (carbaryl and malathion in orchard B and chlorpyrifos in orchard A) were sufficiently great to remain valid despite the cross contamination that occurred. However, cross contamination precludes the possibility of drawing conclusions about the efficacy of water blasting in removing pesticide residues at concentrations near the detection limits for each pesticide (0.01 to 0.02 mg/kg).

The three spray residues found, carbaryl, chlorpyrifos and malathion, have a non-systemic action. The efficacy of water blasting in reducing residue levels by up to 90%, and in reducing some residue levels to zero, suggests that the majority, if not all the residue for the three pesticides was located on the fruit surface. Other pesticides, particularly those with a systemic action, could be expected to have residues both on the fruit surface and within the fruit, reducing the efficacy of water blasting in removing residues. Further research into a wider range of pesticides would be required to determine any variation between pesticide types.

Sampling for multi-residue testing requires a sample of 10 fruit from a single orchard line in the packhouse, typically consisting of thousands of fruit. Factors such as uniformity of spray coverage, position of fruit within the tree canopy and the extent of exposure to sunlight and rainfall influence the rate at which the pesticide is degraded on an individual fruit. Hence the sample may not accurately reflect the 'average' residues present on a line of fruit.

Control fruit in the experiment were passed over drying brushes. Taylor and Bush (2002) found that packhouse drying brushes could reduce carbaryl and other pesticide residue levels from the surface of peach fruit by up to 94%. An experiment with two control treatments, the first receiving no pack house treatment and the second receiving only drying brushes would identify the extent to which drying brushes remove pesticide residues from avocados.

CONCLUSIONS

Water blasting reduced residues by up to 90% when residue levels were above the detection limit on the control fruit and was also able to reduce some residue levels to below the detectable limit. The results were inconsistent between orchards and the level of removal achieved was variable. Water blasting is an inconsistent method of reducing residue levels and should not be relied upon to reduce residue levels below any given MRL.

Cross contamination precludes the possibility of drawing conclusions about the efficacy of water blasting in removing pesticide residues at concentrations near the detection limits for each pesticide (0.01 to 0.02 mg/kg).

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