ACTIVITY OF OILS AGAINST LIGHTBROWN APPLE MOTH (*EPIPHYAS POSTVITTANA*) LARVAE

C. THOMSON, A.R. TOMKINS and D.J. WILSON

*Horticultural & Food Research Institute of N.Z. Ltd,
Ruakura Research Centre, Private Bag, Hamilton*

SUMMARY

Laboratory bioassays investigated the larvicidal activity of petroleum oils against lightbrown apple moth (*Epiphyas postvittana*) on kiwifruit leaves. A range of oils of different molecular weights, but otherwise similar chemistry were evaluated. Neonate larvae were exposed for up to 7 days to oil residues 0, 2, 7 and 14 days after sprays were applied to kiwifruit leaves. All oils tested had residual activity lasting at least 14 days, with heavier oils having greater activity. More than 1 day of exposure to residues was needed for a full expression of activity.

Keywords: lightbrown apple moth, petroleum oil, larvae, residual activity, kiwifruit

INTRODUCTION

Petroleum oils have recently been adopted to control pests on kiwifruit, primarily armoured scale insects (Anon. 1992). However, when petroleum oils are used in a full season programme on kiwifruit, fruit damage by lepidoptera is also reduced (Tomkins *et al.*, in preparation). Laboratory studies have shown that oils can provide good ovicidal activity against leafrollers (Tomkins and Thomson 1992). The ovicidal activity of oils has been exploited for many years to control leafroller eggs overwintering on apple trees in the United States. Oils do, however, also possess activity against lepidoptera larvae (Ebeling 1945). Rock and Crabtree (1987) found that fresh residues of a petroleum oil were highly toxic to neonate larvae of two leafroller species giving uncorrected mortalities of 95 - 99%. As their study involved placing leafroller larvae on treated apple leaves, the larvicidal activity of the oils was probably by contact or ingestion, whereas oils mostly kill insects and mites by smothering sessile stages. For larvicidal activity to be of any value, an oil needs to have sufficient persistence on treated leaf surfaces to have a reasonable period of residual activity. The persistence of oils on any plant surface will be affected by the molecular weight of the oil fractions which are indicated by the distillation midpoint of the oil. The lower the midpoint, the more suited it is for use as a summer spraying oil. Heavier oils, while being more persistent, have a greater likelihood of causing phytotoxicity and are generally more suited for use during plant dormancy. A balance must therefore be found between an oil with sufficient molecular weight to provide good persistence, but not so heavy as to cause phytotoxicity.

This paper reports on an investigation of the activity of residues of four petroleum oils of differing molecular weights on kiwifruit (*Actinidia deliciosa* cv. Hayward) leaves to neonate larvae of lightbrown apple moth (LBAM).

METHODS

LBAM used in these bioassays were obtained from HortResearch, Auckland. For each treatment ten large kiwifruit leaves from different vines were sprayed to runoff using a hand held Cambrium sprayer at the rate of 1% and 2%, with a range of horticultural oils (Sunspray) that had been emulsified ready to use.

The oils used in the trial were ultrafine, 7E, 9E and 11E, which have distillation midpoints of 212C, 224C, 235C and 243C, and SUS Viscosities of 75, 85, 98 and 112 respectively.

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When the leaves had dried (approximately 30 minutes), they were protected from rainfall by individually covering them with large plastic bags split open down the back and raised above the leaf surface. Leaves were sampled 0, 2, 7 and 14 days after spray application. On each sample date, five 20 mm diameter leaf discs were cut from each leaf. In the laboratory, half of each leaf disc was placed in a 50 x 10 mm glass vial with a single neonate leafroller larvae, giving 10 larvae per leaf and 100 larvae for each treatment. The vial was then stoppered with damp cotton wool. Each tube was examined after 1, 4 and 7 days and larvae were assessed as live, dead or moribund.

Data for the percent mortality for each leaf were analysed by ANOVA before and after angular transformation. The control (water sprayed) treatment was omitted from the analyses because the mortality was zero except for sample day 2. The SEDs given in the tables can be used to compare treatments with the untreated control. Analyses were performed to investigate the effects of different oil products and rates separately and in combination. Untransformed data are presented in tables.

RESULTS

All of the oils had larvicidal activity, although the level of activity differed between the products tested. In contrast the water only treatments showed zero mortality after 7 days for sample days 0, 7, and 14, and 5.7% mortality for sample day 2. There were no significant interactions between oil type and rate.

Ultrafine and 11E oils gave the highest mortality, and 7E and 9E the lowest (Table 1).

TABLE 1: Percent mortality of neonate lightbrown apple moth larvae on kiwifruit leaves treated with various oils after 7 days exposure. 1 and 2% results pooled.

Treatment	% Mortality			
	Age of residue in days			
	0	2	7	14
Control (Water)	0	5.7	0	0
Ultrafine oil	81.9	100	93.0	53.3
7E oil	66.4	83.8	62.9	29.2
9E oil	72.1	92.9	73.4	30.5
11E oil	89.4	98.8	91.0	38.5
SED	6.67	3.18	5.89	7.61

Larval mortality increased when the period of exposure to oil residues was increased from 1 up to 7 days for all of the oils tested (Figure 1). For the oldest residues (Day 14), significant differences in the level of mortality were only found between oil products when larvae were exposed to the residues for 7 days.

TABLE 2: Percent mortality of neonate lightbrown apple moth larvae after 7 days exposure to kiwifruit leaves treated with different rates of oils. Results pooled for all oil types.

Rate of oil	% Mortality			
	Age of Residue in days			
	0	2	7	14
1%	72.8	92.5	71.8	27.6
2%	82.1	96.0	88.3	48.2
SED	4.72	2.12	4.17	5.38

Residues of all of the oil products still had some activity 14 days after application (Tables 1, 2). Overall, two day old residues caused the highest level of mortality.

Larval mortality increased for all of the oils when a higher rate was used (Table 2). However, significant differences ($P < 0.01$ or < 0.001) were only found between the two rates when residues were 7 days or older, with exposure periods of 4 and 7 days.

Figure 1: Percent mortality of neonate leafroller larvae exposed for varying periods to 2 day old residues of petroleum oils.

DISCUSSION

Our studies confirmed that oils have activity against leafroller larvae (Rock and Crabtree 1987), and we also found that activity may be sufficiently residual to provide some useful control under orchard conditions. Significantly higher mortalities were observed in all treatments on day 2 than on day 0. The reasons for this are unclear, but may arise from the oils possessing an antifeedant property that initially masks the mortality but declines rapidly after application through volatilization and leaf adsorption of oil components. It should however be noted that these bioassays were conducted in late summer when temperatures were cool (average mean daily temperature at the trial site during the sampling period was 11.6°C (range 7.7-14.5°C)). Oils are volatile and their residual activity is therefore likely to be shorter during mid-summer. This may be one of the factors explaining why field trials have found that one of these oils will reduce fruit damage by caterpillars, but not to a level achievable with more conventional broad spectrum insecticides (Tomkins *et al.* in prep.). Another reason for the field results may be the slow rate of activity of oils found in these bioassays. Although the rate of larval death is comparable with that caused by *Bacillus thuringiensis*, unlike *B. thuringiensis*, oils do not appear to have any lasting antifeedant or jaw paralysis effects. Therefore leafroller larvae dying from lethal doses, or adversely affected by sublethal doses of oil may still continue to feed and cause fruit damage.

Oils may have another property which will improve their performance under field conditions. Studies with other insects have shown that oil residues may be repellent to some insects (Sale 1972). During the course of these and other bioassays we have conducted with leafroller larvae we have observed repellent effects, and this will be investigated further in future.

In conclusion, the larvicidal activity of oils in conjunction with their ovicidal activity means that they can make a useful contribution to leafroller control when used on kiwifruit, although they may not be able to provide good control at all times of the season and probably cannot be relied on by themselves full season.

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