SUSCEPTIBILITY OF THREE APPLE CULTIVARS TO PETROLEUM-DERIVED SPRAY OILS APPLIED IN LATE BLOSSOM

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Summary

Applications of the horticultural mineral oil Biopest at 2 L 100 L^{-1} and 1 L 100 L^{-1} at four days after full bloom or the dormant oil, Winter Spray Oil (2 L 100 L^{-1}) at six days after full bloom, were made to compare the amount of fruit injury to Granny Smith, Fuji and Braeburn apples that might result if these treatments had been applied to control *Panonychus ulmi* (Koch) (Acarina: Tetranychidae). Across all varieties, injury to fruit on the oil-treated trees was no greater than for the untreated trees, which had 6.0% injury. Injury to Granny Smiths (8.2%) was significantly greater ($P<0.10$) than Fuji and Braeburn apples. The 3.0% fruit injury from Biopest 2 L 100 L^{-1} was significantly less ($P<0.10$) than the other oil treatments and the unsprayed control. Implications for resistance management of *P. ulmi* are discussed.

Keywords: European red mite, *Panonychus ulmi*, horticultural mineral oil, resistance management

INTRODUCTION

European red mite, *Panonychus ulmi* (Koch) (Acarina: Tetranychidae) is a pest of apple trees in the cooler regions of south-eastern Australia. Several acaricides are registered and are recommended for its control (Hetherington *et al*. 2003) although the range of effective products has been reduced through development of resistance (Penrose *et al*. 2000).

Eslick *et al*. (2002) showed that *P. ulmi* was effectively controlled using petroleum-derived spray oil (PDSO) (2 L 100 L^{-1}) applied to cv. Red Delicious apple trees at full bloom. There was no negative effect on the resultant crop although the oil spray caused petal burn. No further control of *P. ulmi* was required even though mite numbers increased late in the season. The authors later demonstrated that delaying the PDSO spray until just after full bloom on cv. Gala apples avoided petal burn while still giving control of *P. ulmi*. The strategy has a place within apple integrated pest and disease management (IPDM) programs (Thwaite *et al.* 2002) but its principal value is in acaricide resistance management.

Two factors limited the adoption of this management strategy: the lack of registration on any PDSO product label for this specific use, and the absence of information on the risk of phytotoxicity to apple cultivars other than Red Delicious and Gala. This paper provides plant safety data for three additional cultivars.

MATERIALS AND METHODS

We used a block of apple trees at the Orange Agricultural Institute, planted in 1999 at 5 m intervals in rows 5 m apart. Rows were orientated east-west and were one of three cultivars, Granny Smith (GS), Braeburn and Fuji rotated systematically throughout the block. Treatments were randomised within a cultivar row of eight trees to allow a buffer tree between each. Similarly, a buffer row of untreated trees separated each treatment row.

There were four treatments: Biopest® (SACOA Pty. Ltd., Perth Western Australia) active constituent 815 g L^{-1} paraffin oil, unsulphonated residue ≥ 98.0%, used at 1 L 100 L^{-1} as a dilute spray and 2 L 100 L^{-1}, Ampol Winter Spray Oil (Caltex Australia Petroleum Pty. Ltd., Sydney NSW) 861 g L^{-1} petroleum oil at 2 L 100 L^{-1}, and an unsprayed control.

Treatments were replicated four times for each cultivar as single tree plots except that for Fuji, pairs of trees were used as plots because there was insufficient blossom on single trees. Sprays were applied four to six days after full bloom using a hand lance, pump pressure 1725 kPa, with adequate hydraulic agitation in the 600 L trailer-mounted spray vat (Hardi Pumps and Sprayers, Sydney NSW). Spraying was conducted early in the morning while conditions were calm to avoid spray drift between plots. Details are recorded in Table 1.

Other plant protection sprays were applied using an air-blast sprayer to all trees in the block. Fifteen separate pesticide applications were made between 8 September 2003 and 29 January 2004. Average spray volume was 1625 L ha^{-1} (range 1400 to 1825). Pesticides applied were the fungicides copper hydroxide (Kocide®), cyprodinil (Chorus®), penconazole (Topas®), ziram and the insecticide fenoxycarb (Insegar®). The nutritional material calcium nitrate was applied for bitter pit management.

Fruit assessments were carried out three weeks post treatment by one observer (MAE) examining 100 fruits on each tree (cv. GS and Braeburn) and all fruits on the pair of Fuji trees. Fruits with evidence of russet were recorded. Further examination of the fruit in February 2004 revealed that there was no obvious change to the amount of fruit injury and that a repeat of the detailed assessments was not justified. Foliage was also examined for evidence of damage at the time of the first fruit assessment. None was observed, so no formal assessments of foliage injury were carried out.

Statistical analysis was performed using a weighted linear mixed model analysis on the transformed variable $Z = \sqrt{(Y / n)}$ where Y is the number of apples on the tree with injury and n is the number of fruit examined. The model included variety and treatment effects and a possible interaction between the two.

Also included in the model were random row effects as varieties were 'applied' to the rows. The weights in the model were n as the variance of Z is approximately proportional to (1/n) for low incidences of injury. The model was fitted using ASREML (Gilmour *et al.* 1999). This package includes Kenward and Roger (1997) adjustments for approximating the appropriate denominator degrees of freedom for testing fixed effects.

RESULTS

Damage to each cultivar caused by each treatment is given in Table 2. All treatments, including the unsprayed controls (5.99%) had fruit injury. Statistical analysis of the data showed that Biopest at 2 L 100 L^{-1} significantly decreased ($P<0.10$) the level of injury compared with the controls. Of the three cultivars evaluated, GS (8.19% injury) suffered significantly more damage ($P<0.10$) than Fuji and Braeburn. There was no significant interaction between treatments and cultivars.

Table 1. Details of oil spray applications to apple trees, 21 and 23 October 2003. Average temperature and wind speed are for the 30 min period prior to the end time.[1]

Treatment	Date (2003)	Time		Average temp (°C)	Average wind (km h^{-1})	Spray volume (L $tree^{-1}$)
		Start	End			
Biopest 1 L 100 L^{-1}	21.10	0630	0700	12.2	11.8	5.8
Biopest 2 L 100 L^{-1}	21.10	0730	0800	13.4	15.6	6.6
Winter oil 2 L 100 L^{-1}	23.10	0630	0700	10.6	2.7	7.0

[1]From automatic weather station, Orange Agricultural Institute (data courtesy DI Pickering).

Table 2. Number fruit injured (number of fruit examined) observed 18 November 2003 on three apple cultivars, 26-28 days after application of three petroleum-derived spray oil treatments at 4-6 days after full bloom. See text for statistical differences.

Treatment	Apple cultivar			Treatment mean (%)
	Granny Smith	Fuji	Braeburn	
Biopest 2 L 100 L^{-1}	15 (400)	12 (402)	9 (400)	3.00
Biopest 1 L 100 L^{-1}	36 (400)	12 (314)	8 (400)	5.03
Winter Spray Oil 2 L 100 L^{-1}	35 (400)	9 (389)	12 (400)	4.71
Untreated	45 (400)	7 (218)	9 (400)	5.99
Cultivar mean (%)	8.19	3.02	2.38	4.62

DISCUSSION

It was necessary to split the oil spray applications over two mornings (Table 1) to avoid the risk of spray drift between plots. On 21 October 2003, the second spray (Biopest 2 L 100 L^{-1}) was completed by 07:45 and for the 30 minute period up to 07:30, the average wind speed was 15.6 km h^{-1}. During the next 30 minutes, it had increased to an average of 23.9 km h^{-1}. Conditions on 22 October remained unsuitable but improved on 23 October to allow the third spray treatment (Winter Spray Oil) to be applied. This unavoidable split application of treatments did not detract from the findings of this study.

Biopest is classed as a horticultural mineral oil (HMO) *"safe to use for dormant or summer sprays on most trees…"* while Winter Spray Oil is classed as a dormant oil, *"applied during the dormant or non-growth phase…"* (Beattie *et al.* 2002). Product labels of dormant oil preclude their use after green tip on apples, the stage when the tree begins to break dormancy. We expected that the use of dormant oil on the trees with foliage and newly formed fruitlets would cause damage but that the HMO treatments would not.

Our data show that under the conditions of this investigation, none of the oil treatments increased the level of russet or injury on fruit compared with that on untreated trees (Table 2). This, together with the 6.0% injury on the untreated controls, shows that the injury we observed was induced by something other than oil sprays. There was no foliage injury observed in any of the treatments. We can only speculate as to why Biopest at 2 L 100 L^{-1} reduced the amount of fruit injury compared with the untreated controls. It may have reduced the effect of the cause for the underlying injury or russet observed on the rest of the fruitlets. The failure of the Winter Spray Oil treatment to cause injury is also subject to speculation. Advances in spray oil technology may have improved the formulation such that the product is no longer a risk to trees in leaf and fruit. Eslick *et al.* (2002) found no difference in the effect of dormant oil and HMO on Red Delicious apple trees.

There was no evidence of a reaction between the oil sprays and the pesticide program to control the diseases apple scab or apple powdery mildew and the pest codling moth, *Cydia pomonella* L. (Lepidoptera: Tortricidae). Each of the pesticides cyprodinil, penconazole, ziram and fenoxycarb as well as calcium nitrate was applied within three weeks of the oil sprays. A tank mix of penconazole and ziram was applied the same day as the Winter Spray Oil (Table 1).

Before this trial, it was believed that cv. Fuji was at greatest risk from oil induced injury (Jones *et al.* 1998). Our data show that of the three apple cultivars treated with oil, GS sustained more injury than the other two (Table 2).

The value of applying an oil spray just after full bloom to control *P. ulmi* has been clearly demonstrated (Eslick *et al.* 2002). This investigation set out to extend the number of apple cultivars for which the treatment could be used with minimum risk of injury to the tree and, more importantly, the fruit. We propose that GS, Fuji and Braeburn be added to Red Delicious and Gala as cultivars regarded as safe to be treated with HMO at 2 L 100 L^{-1} just after full bloom. The dormant oil product used in this trial also did not cause foliage or fruit injury, but without further testing of other formulations, we do not advocate the use of dormant oil in this way.

There is still no spray oil product registered by the Australian Pesticides and Veterinary Medicines Authority for the control of *P. ulmi* on apple trees at 2L 100 L^{-1} spray just after full bloom. Winter Spray Oil and its equivalent have a label recommendation for use at this concentration in the dormant period up to bud swell (green tip) (Hetherington *et al.* 2003). This green tip spray was shown by Eslick *et al.* (2002) to be less effective against *P. ulmi* than the spray at full bloom. Biopest and SunSpray® Ultra-Fine™ Spraying Oil (Amtrade International Pty. Ltd., Melbourne) are both registered for use against mites at 1 L 100 L^{-1} as a "*summer (foliar or cover)*" spray. The same products are also registered for use at 2 L 100 L^{-1} on pears for *P. ulmi* "*up to and including petal fall*".

Our finding that fruit injury from both Biopest and Winter Spray Oil applied just after full bloom was no greater than that on untreated controls of the three cultivars tested was a positive result. It should support any attempt by the respective manufacturers to extend the registered uses of Biopest, SunSpray Ultra-Fine and similar HMO products. Such extension might ultimately allow for the use of 2 L 100 L^{-1} HMO just after full bloom or up to petal fall, as currently permitted for pears. If this use pattern becomes registered, then widespread adoption of this strategy by apple growers should result in improved resistance management for *P. ulmi*. This is likely to have a positive impact on the effective life of specific acaricides now used against the pest.

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