Research reports

Effect of benomyl on egg production in the predatory mites, *Amblyseius victoriensis* and *Typhlodromus doreenae*

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Summary

The effect of residues of the fungicide benomyl on egg production in the predatory mites, *Amblyseius victoriensis* (Womersley) and *Typhlodromus doreenae* Schicha was examined in the laboratory. Egg production by *A. victoriensis* was significantly lower (0.05–0.3 eggs ♀$^{-1}$ day^{-1} on benomyl-treated leaf discs than on untreated discs (1.0–1.97 eggs ♀$^{-1}$ day^{-1}). Egg production by *T. doreenae* was not significantly different on benomyl-treated or untreated discs in most tests (0.66–0.86 eggs ♀$^{-1}$ day^{-1}). Benomyl is not recommended for use in stone fruit or grapes when *A. victoriensis* is used to control mites, but might be used when *T. doreenae* is the principal predator.

Introduction

Amblyseius victoriensis (Womersley) and *Typhlodromus doreenae* Schicha (Acari: Phytoseiidae) are important predatory mites in stone fruit, grapes and citrus in south-eastern Australia, contributing to biological control of a number of pest mite species (James 1990, James and Whitney 1993a, Smith and Papacek 1991). Information on the compatibility of these predators with pesticides is vital for their effective exploitation in mite management. James and Rayner (1995) presented data on the toxicity of thirty pesticides to *A. victoriensis* and *T. doreenae*, derived from laboratory bioassays.

Whilst toxicity is clearly the most obvious and important impact of pesticides on predatory mites, sub-lethal effects should not be overlooked. For example, the benzimidazolecarbamate fungicide, benomyl, has been reported to reduce the fecundity of at least two predatory mite species, *Amblyseius fallacis* (Garman) (Nakashima and Croft 1974, Hislop and Prokopy 1981) and *Metaseiulus (=Typhlodromus) occidentalis* Nesbitt (Hoy and Standow 1981, Roush and Plapp 1982). Benomyl does not kill adult *A. victoriensis* and *T. doreenae* (James and Rayner 1995), although James (1989) showed that it significantly reduced populations of *A. victoriensis* in an orchard trial.

This note presents data from a laboratory study on the effect of benomyl on egg production in *A. victoriensis* and *T. doreenae*.

Materials and methods

Predators used in these tests were taken from mulberry leaves collected in a garden at Leeton in southern New South Wales (*A. victoriensis*) or from grape leaves collected from a vineyard (Bloodwood Estate) at Orange in the central west of New South Wales (*T. doreenae*). Adult female predators were removed from the leaves and placed singly on 10 grape leaf discs (38 mm diameter), five of which were pretreated with an aqueous suspension of benomyl (0.02% a.i.) and dried. The other five were treated with water. Discs were sprayed with 2 mL of liquid using a Potter Precision Spray Tower with a spray pressure of 50 kPa which delivered 1.6 mg liquid^{-1} cm^{-1}. Discs were placed on saturated cotton wool in trays and each disc was supplied with a small amount of *Typha orientalis* Presl. pollen (James and Whitney 1993b) for food and a fragment of broken cover slip for shelter. The predators were held for seven days at 25°C, 60–70% rh and examined daily for oviposition. Eggs were counted and removed. The test was replicated four times for each species. Data were analysed using t tests and per cent reduction in fecundity (RF%) was calculated by: RF% = [1 - (number of eggs on treated discs/number of eggs on control discs)] × 100.

Results and discussion

Egg production by *A. victoriensis* was significantly lower (0.05–0.3 eggs ♀$^{-1}$ day^{-1}) on benomyl-treated discs than on untreated discs (1.0–1.97 eggs ♀$^{-1}$ day^{-1}) ($P<0.001$) (Table 1). RF% in all tests was 91% or greater. Egg production by *T. doreenae* was not significantly different on benomyl-treated or untreated discs in three tests (0.66–0.86 eggs ♀$^{-1}$ day^{-1}) ($P>0.05$) (Table 2). In the fourth test significantly more eggs were produced by females on the benomyl-treated, than on the untreated discs ($P<0.01$) (Table 2).

The almost total inhibition of egg production in *A. victoriensis* by benomyl residues is similar to that described for *A. fallacis* and *M. occidentalis* (Hislop and Prokopy 1981, Roush and Plapp 1982). Given the apparent low toxicity of benomyl to adult *A. victoriensis* (James and

Table 1. Egg production by *A. victoriensis* on benomyl-treated and untreated leaf discs over seven days. Data derived from five females per treatment per replicate. In each test, means followed by a different letter are significantly different ($P<0.001$, t test).

Test	Mean (±SE) No. eggs ♀$^{-1}$ day^{-1}		Total No. eggs		% reduction in fecundity
	Benomyl	Control	Benomyl	Control	
1	0.30 ± 0.05a	1.97 ± 0.20b	6	69	91.3
2	0.06 ± 0.04a	1.90 ± 0.10b	2	68	97.0
3	0.05 ± 0.05a	1.79 ± 0.20b	2	59	97.0
4	0.10 ± 0.08a	1.00 ± 0.20b	4	44	91.0
All	0.10 ± 0.03a	1.67 ± 0.10b	14	240	94.0

Table 2. Egg production by *T. doreenae* on benomyl-treated and untreated leaf discs over seven days. Data derived from five females per treatment per replicate. In each test, means followed by the same letter are not significantly different ($P>0.05$, t test).

Test	Mean (±SE) No. eggs ♀$^{-1}$ day^{-1}		Total No. eggs	
	Benomyl	Control	Benomyl	Control
1	0.86 ± 0.10a	0.77 ± 0.20a	30	27
2	1.36 ± 0.10a	0.77 ± 0.10b	50	27
3	0.70 ± 0.20a	0.70 ± 0.20a	27	26
4	0.66 ± 0.10a	0.67 ± 0.10a	24	24
All	0.94 ± 0.08a	0.71 ± 0.08a	131	104

Rayner 1995), female sterility is likely to have been the cause of the significant suppression of *A. victoriensis* populations on benomyl-treated trees, reported by James (1989). An unreplicated laboratory test (100% hatch in 50 eggs sprayed with 0.2% benomyl) indicated that benomyl does not have an ovicidal effect on *A. victoriensis*, as was reported for *A. fallacis* (Nakashima and Croft 1974).

Although only a few species of phytoseiid have been examined, *T. doreenae* is the first to show no effect of benomyl on fecundity. Roush and Plapp (1982) showed that the carbaryl-resistant strain of *M. occidentalis* is also cross-resistant against benomyl-induced sterility, however, there was still a 30% reduction in fecundity. The strain of *T. doreenae* (from South Australia) examined by James and Rayner (1995) also showed tolerance to carbaryl and it is possible that benomyl and carbaryl tolerance in this species is another example of carbamate resistance in a phytoseiid. However carbaryl and benomyl have not been used in the vineyard where *T. doreenae* was obtained for this study or in any other vineyard in the Orange district (Stephen Doyle, Bloodwood Estate, personal communication). A study of tolerance levels to carbaryl and benomyl in strains of *T. doreenae* from different viticultural areas related to the use of these pesticides, would clarify the resistance status of *T. doreenae*.

In the light of these results, benomyl can no longer be recommended as a safe fungicide for use with *A. victoriensis* in biological control programs for mites in stone fruit (James 1989,1990) or grapes (James and Whitney 1993a, James and Rayner 1995). However, benomyl is likely to be a safe fungicide for use in mite biological control programs on grapes which are based on *T. doreenae* (James and Whitney 1995).

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