# Effects of Pesticides Used on Table Grapes on the Mealybug Parasitoid *Coccidoxenoides peregrinus* (Timberlake) (Hymenoptera: Encyrtidae)

V.M. Walton[1] and K.L. Pringle[2]

1) ARC-Fruit, Vine and Wine Research Institute, Nietvoorbij Centre for Vine and Wine, Private Bag X5026, 7599 Stellenbosch, South Africa

2) Department of Entomology and Nematology, University of Stellenbosch, Private Bag X1, 7602 Matieland (Stellenbosch), South Africa

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**The effects of regularly used table grape insecticides and fungicides on 1-day-old adults of the parasitoid *Coccidoxenoides peregrinus* (Timberlake) of vine mealybug, *Planococcus ficus* (Signoret), were determined in the laboratory. The insecticides chlorpyrifos, endosulfan and cypermethrin were highly toxic to the parasitoid, while the fungicides penconazole and mancozeb were not. These results suggest that the insecticides may be detrimental to a biological control system using *C. peregrinus* while the two fungicides tested should be compatible with augmentative releases of *C. peregrinus.***

Table grape production in South Africa currently relies heavily on pesticides for the control of key pests such as vine mealybug, *Planococcus ficus* (Signoret), the weevils *Phlyctinus callosus* (Schönherr) and *Eremnus cerealis* (Marshall), the fruit flies, *Ceratitis rosa* (Karsch) and *C. capitata* (Wiedemann). In addition, preventative spray programmes against fungal diseases like powdery mildew, *Uncinula necator* (Schwein) Burrill, downy mildew, *Plasmopara viticola* (Berk & Curt) Berlese & De Toni, and *Botrytis cinerea* Pers.: Fr. are also applied in commercial vineyards. With increasing focus on integrated pest management (IPM) and more stringent export requirements regarding insecticide residues on fruit, the use of natural enemies will become more important. This is particularly relevant in the case of *P. ficus*, as this insect can be largely suppressed by biological control. The use of natural enemies can include time augmentative releases of the insectary reared parasitic wasp, *Coccidoxenoides peregrinus* (Timberlake), a parasitoid of *P. ficus*. Therefore, the effects on *C. peregrinus* of three insecticides and two fungicides commonly used on table grapes were evaluated to identify those suitable for use in an integrated pest management programme.

## MATERIALS AND METHODS

*C. peregrinus* was reared using the method described by Hattingh & Tate (1996). A range of concentrations of commercial formulations of five chemicals was used. The insecticides were chlorpyrifos, endosulfan and cypermethrin, and the fungicides were penconazole and mancozeb (Table 1).

Assays with each range of concentrations included a control of distilled water. The bioassays were conducted in Munger cells described by Hassan (1992). The pesticides were sprayed onto the glass plates using a standard Potter's precision spray tower. The glass plates were allowed to dry for ten minutes, after which the Munger cells were assembled and an average of 157 1-day-old *C. peregrinus* adults were introduced into the cells. All Munger cells were ventilated with air at 70 - 80% relative humidity and kept in a cooled incubator at 24,5±1°C, and mortality was recorded after 6 hours.

The data were analysed using probit analysis (Finney, 1952) and the computer programme, POLO PC (LeOra Software 1987, 1119 Shattuch Avenue, Berkeley, California 94707).

## RESULTS AND DISCUSSION

The slopes for all chemicals except mancozeb were significantly positive. This indicated that for all pesticides except mancozeb there was an increase in mortality with an increase in concentration (Table 2, Figs 1 & 2).

The indices of significance for potency estimation (g) for the three insecticides chlorpyrifos, endosulfan, and cypermethrin were considerably less than 1 (chlorpyrifos 0,189; endosulfan 0,059; cypermethrin 0,013). Therefore, the estimates of the fiducial limits of the $LC_{50}$ and $LC_{90}$ values (Table 3) were reliable (Finney, 1952).

In the case of penconazole, the value for g (0,79) approached 1. Therefore, although the $LC_{50}$ and $LC_{90}$ values were estimated, estimates of the fiducial limits could not be made (Finney, 1952) and are therefore not given. Since no relationship between concentration and mortality was evident for mancozeb, no attempts were made to estimate the $LC_{50}$ and $LC_{90}$ values for this pesticide.

The two field concentrations of chlorpyrifos registered on table grapes (Table 1, Fig. 1) were both considerably higher than the $LC_{50}$ and $LC_{90}$ for this pesticide, making chlorpyrifos the most toxic to *C. peregrinus* of those tested.

Chlorpyrifos is a broad spectrum, relatively persistent insecticide (Croft, 1990). However, if applied to a limited extent as spot and stem barrier treatments against ants (Schwartz, 1997), this insecticide will have little effect on *C. peregrinus* as contact with the parasitoid will be minimised or avoided. In addition, augmentative releases of *C. peregrinus* during summer will not be affected if chlorpyrifos cover sprays are applied before budding as recommended for *P. ficus* control. Organophosphates have been found to be highly toxic to *C. peregrinus* (Searle, 1965).

The field concentration at which endosulfan is used on table grapes was between the $LC_{50}$ and $LC_{90}$ values (Table 1, 3, Fig. 1).

TABLE 1
Pesticides tested, formulations, field concentrations, pests/diseases used against and range of concentrations tested.

| Pesticides tested | Formu-lations | Field concentrations | Pest/disease used against | Range of concentrations tested (mL/100L,g/100L) |
|---|---|---|---|---|
| chlorpyrifos | EC 480 g/L | 100-200 mL/100L<br>400mL/100L | *Planococcus ficus* (mealybug)<br>*Formicidae* (ants) | 0,008; 0,0093; 0,0162; 0,0256; 0,027; 0,04; 0,045; 0,075; 0,128; 0,2; 0,64; 1; 1,31; 1,71; 2,24; 2,94; 3,2; 3,85; 5; 16 |
| endosulfan | SC 475 g/L | 125 mL/100L | *Colomerus vitis* (erinose mite) | 0,2; 1; 5; 25; 34,8; 40; 41,8; 50,2; 60,2; 64; 72,3; 86,8; 102,4; 104,1; 125; 150; 163,8; 180; 216; 259,2 |
| cypermethrin | EC 200 g/L | 10mL/100L | *Phlyctinus callosus, Eremnus cerialis* (weevils) | 0,0095; 0,016; 0,019; 0,039; 0,078; 0,08; 0,156;, 0,312; 0,4; 0,652; 1,25; 2; 2,5; 5; 10 |
| penconazole | EC 100 g/L | 30-45 mL/100L | *Uncinula necator* (powdery mildew) | 0,032; 0,048; 0,16; 0,24; 0,8; 1,2; 4; 6; 8; 16; 20; 30; 32; 64; 128; 256; 512; 1024 |
| mancozeb | WP 800 g/kg | 200 g/100L | *Plasmopara viticola* (downy mildew) | 0,32; 1,6; 8; 40; 200; 400; 800; 1600; 3200 |

TABLE 2
Probit regression parameters estimated from bioassay data from exposing *Coccidoxenoides peregrinus* to residues of five chemicals.

| Pesticide | Intercept (±standard error) | Slope (±standard error) | D.F.* |
|---|---|---|---|
| chlorpyrifos | 5,37 (±0,026) | 0,88 (±0,042) | 18 |
| endosulfan | 0,24 (±0,25) | 2,69 (±0,12) | 18 |
| cypermetrin | 5,08 (±0,033) | 0,85 (±0,041) | 7 |
| mancozeb | 4,12 (±0,1) | -0,17 (±0,052) | 7 |
| penconazole | 4,13 (±0,075) | 0,30 (±0,043) | 16 |

*Degrees of freedom

TABLE 3
Field concentrations, $LC_{50}$ and $LC_{90}$ of four pesticides tested against *Coccidoxenoides peregrinus*.

| Pesticide | $LC_{50}$ (mL/100L) | 95% Fiducial limits | $LC_{90}$ (mL/100L) | 95% Fiducial limits |
|---|---|---|---|---|
| chlorpyrifos | 0,38 | 0,06-0,83 | 10,95 | 4,43-121,24 |
| endosulfan | 58,71 | 45,18-70,31 | 175,89 | 142,39-246,12 |
| cypermethrin | 0,81 | 0,62-1,06 | 26,34 | 16,01-49,97 |
| penconazole | 762,14 | – | 1391000 | – |

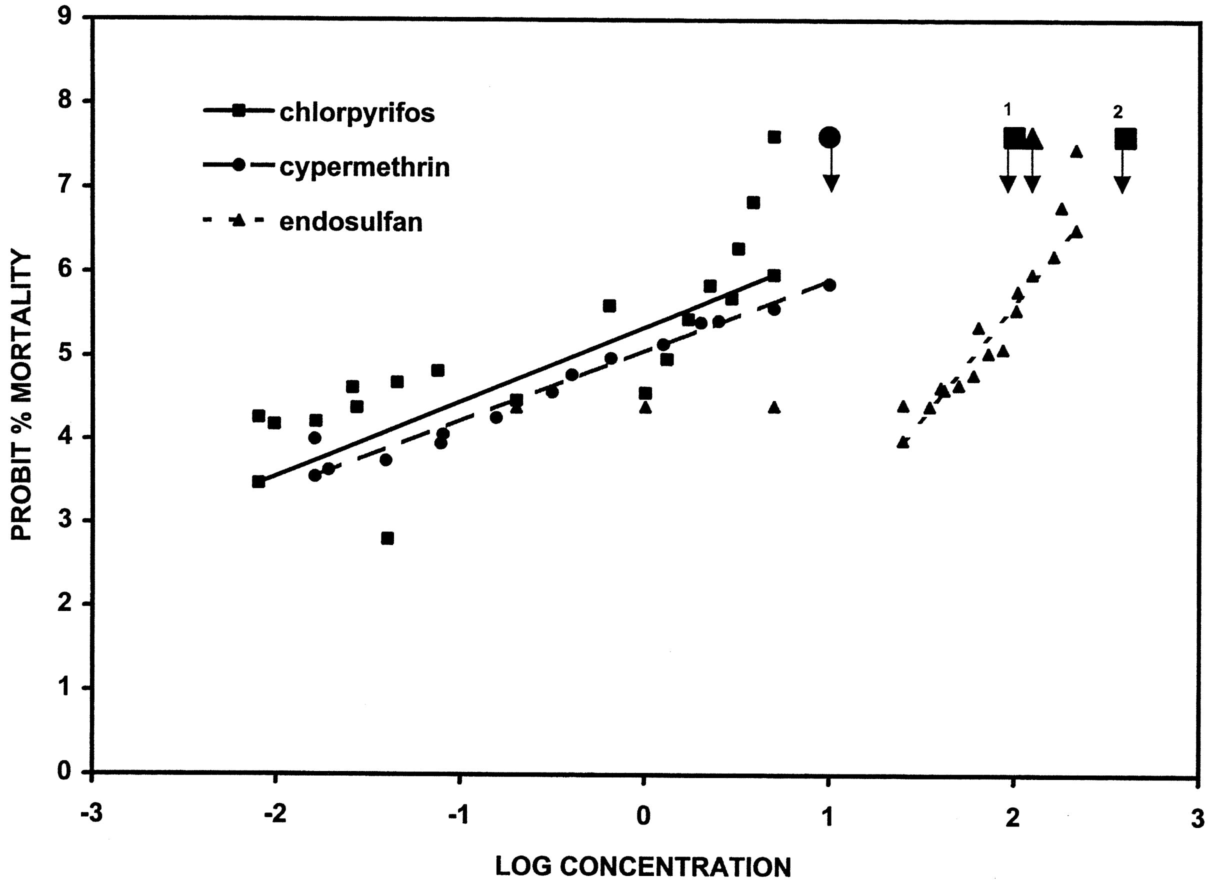


FIGURE 1
Probit mortality on log concentration for the insecticides chlorpyrifos, cypermethrin and endosulfan. The field concentrations are indicated with arrows (■[1] for mealybugs, and ■[2] for ants).

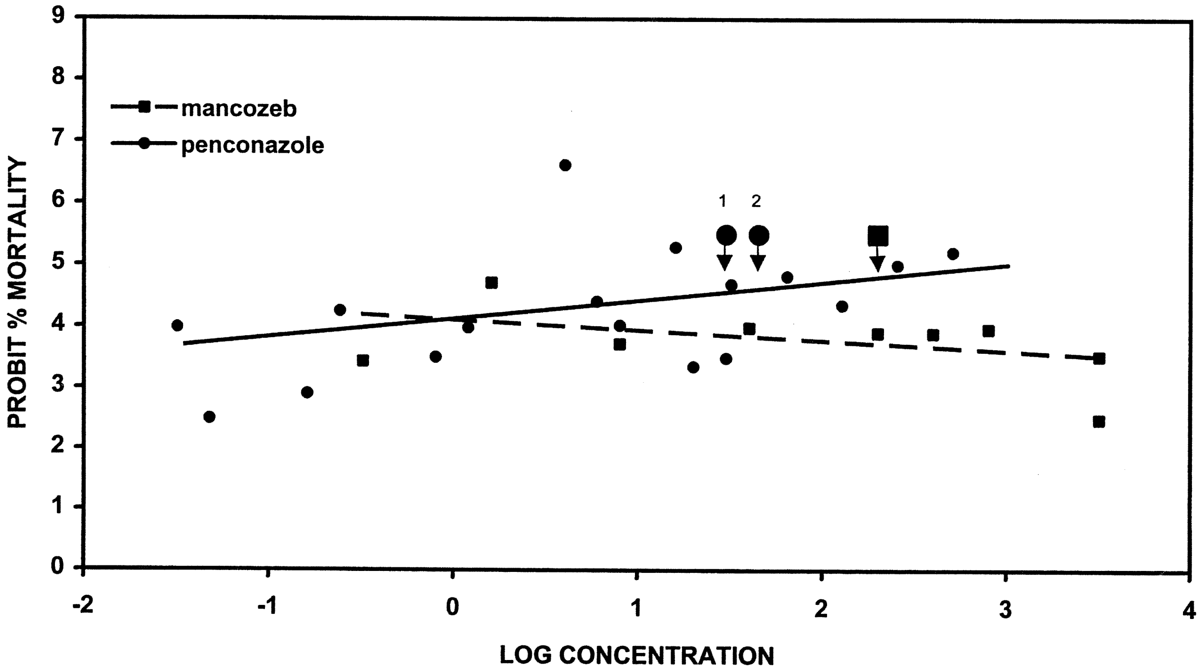


FIGURE 2
Probit mortality on log concentration for the fungicides penconazole and mancozeb. The field concentrations are indicated with arrows (●[1] for 30 mL/100L, ●[2] for 45 mL/100L).

Therefore, it was not as detrimental as chlorpyrifos to *C. peregrinus,* but it has a broad spectrum of activity (Croft, 1990), suggesting that its use in insect pest management systems should be kept to a minimum. A full cover application of endosulfan during summer against erinose mite on table grapes (Krause *et al.*, 1996) will therefore probably influence augmentative releases of *C. peregrinus* negatively.

As in the case of endosulfan, the bioassay showed that cypermethrin was slightly less toxic to *C. peregrinus* than chlorpyrifos, with the field concentration higher than the $LC_{50}$, but lower than the $LC_{90}$ (Table 1,3, Fig. 1). Cypermethrin is registered for use on weevils throughout the season (Krause *et al.*, 1996) and full cover applications of this insecticide during augmentative releases of *C. peregrinus* will probably also be counter-productive. Urban (1983) and Croft (1990) both found cypermethrin to be highly toxic to both Hymenoptera and Coccinellidae.

The $LC_{50}$ of penconazole (Table 3) was seventeen times higher than the field concentration on table grapes (Krause *et al.*, 1996), and it should therefore not be detrimental to *C. peregrinus*. Likewise, mancozeb did not appear to be detrimental to *C. peregrinus*, as there was no increase in mortality of the parasitoid with increasing concentrations of this fungicide (Fig. 2).

## CONCLUSIONS

The data extracted from the bioassays suggest the following: The three insecticides, chlorpyrifos, endosulfan and cypermenthrin were very toxic to adult *C. peregrinus* and may be destructive to a biological control system in table grapes using this parasitoid. The two fungicides, penconazole and mancozeb should be compatible with augmentative releases of *C. peregrinus*. Field confirmation of these results is required before any recommendations can be made.

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