Manner of use of ethoprophos granules against the Childers canegrub *Antitrogus parvulus* Britton (Coleoptera: Scarabaeidae)

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Summary

In a bioassay ethoprophos was toxic at 1 mg kg^{-1} to second instars of the canegrub *Antitrogus parvulus*. In field experiments Mocap granules (100 g kg^{-1} ethoprophos) applied to the surface and watered in did not reduce larval numbers. When applied behind a coulter and watered, Mocap reduced *A. parvulus* numbers by up to 86%. Irrigation or rain following application is necessary to give maximum kill. An amount of 25 kg Mocap per hectare is recommended for use against *A. parvulus* larvae.

Introduction

Whitegrubs (larvae of melolonthine scarab beetles) are the most important pests of sugarcane in Australia. In 1988 they cost the Queensland industry $A7 million in lost production and insecticide (Bureau of Sugar Experiment Stations unpublished data). In southern Queensland, the Childers grub *Antitrogus parvulus* Britton is the dominant whitegrub species on heavy clay soils (Cherry and Allsopp 1991). The species has a 2-year life cycle, the third instars causing the most damage in their second summer.

A. parvulus larvae can be controlled for up to three years with a controlled-release formulation of chlorpyrifos (suSCon Blue, 14% a.i.) (Allsopp and Hitchcock 1987). This product is expensive at about $A220 ha^{-1}, and can be applied only as a prophylactic treatment at or shortly after planting. An insecticide that can be applied once canegrubs are detected in a recently-harvested ratoon crop gives growers flexibility. This study outlines the development of granular ethoprophos (Mocap) for use against *A. parvulus* larvae in sugarcane.

Materials and methods

Insecticide

We tested the efficacy of ethoprophos as the Rhône-Poulenc product Mocap (10% g kg^{-1} a.i. granular formulation).

Bioassay

To determine if ethoprophos is toxic to *A. parvulus* we tested it at 0, 0.5, 1 and 5 mg kg^{-1} in a laboratory bioassay at 25°C. Mocap granules were ground to a fine powder and appropriate quantities mixed with 10 g of air-dry 1 mm sieved sand. This was then mixed in a concrete mixer with 10 kg of red volcanic soil at 25% gravimetric moisture. One second instar *A. parvulus*, 600 g of treated soil and a quartered piece of sugarcane stalk were placed in each jar (filling the jar) and the jar sealed and held at 25°C in the dark. Ten larvae were tested at each concentration. Larvae were inspected at 7–15 day intervals to determine mortality and the sugarcane stalk replaced. Corrected mortalities were calculated using Abbott's (1925) correction for control mortality.

Field trials 1 and 2

During late 1984 two unreplicated trials at Bundaberg tested Mocap in the field against *A. parvulus* larvae. Both were in young second-ratoon crops of cultivar Q110.

Trial 1 was grown on brown earth. Mocap granules were applied at 32 kg product ha^{-1} in a 250 mm band over the row and were covered immediately with 50–75 mm of soil. Spray irrigation equivalent to 20–25 mm of rain was applied 13 days after application and 35 mm of rain fell two days later. An untreated portion five rows wide and 30 m long was left adjacent to 13 treated rows.

Trial 2 was grown on red volcanic loam. Mocap granules were applied at 30 kg product ha^{-1} in a similar way to trial 1. Spray irrigation of 25 mm was applied within two hours of application and 33 mm of rain fell 12 hours later. The treated area was five rows wide and 100 m long and was bordered by 16 rows of untreated crop.

Numbers of third-instar larvae were determined in Trial 1 at 29 days and 43 days after application and in trial 2 at 23 days and 58 days after application. At each sampling, ten 30 cm cubes of soil were taken from the rows over a stool in each of the treated and untreated areas and the number of live *A. parvulus* larvae counted. As population counts were not normally distributed ($P<0.01$, Wilk-Shapiro test), they were compared using the Mann-Whitney U statistic (Conover 1981).

Field trial 3

This tested Mocap at 0, 25, 29.4 and 36.6 kg product ha^{-1} applied behind a coulter into the middle of the row of sugarcane at a depth of 80–100 mm to about the level of the cane stool. The crop was a young second ratoon crop of cultivar CP44-101 grown on red volcanic soil. All but two plots received 50 mm of spray irrigation seven days after application. Plots were four rows wide and 18 m long and each treatment was replicated four times in a randomized block design.

Numbers of third-instar larvae were determined 34 days after application by removing five 30 cm cubes each over a stool from the middle two rows of each plot and counting larvae. As counts were not normally distributed ($P<0.01$, Wilk-Shapiro test), they were normalized by the ln(X+1) transformation before analysis of variance. Means were compared using the least significant difference test.

Results

Bioassay

All of the larvae exposed to 1 or 5 mg kg^{-1} ethoprophos died by 49 days post-treatment (Figure 1). At 0.5 mg kg^{-1} the corrected mortality stabilized at 50–60%. Control mortality did not exceed 10%

Field trials 1 and 2

In both assessments of both trials there was no significant difference ($P>0.05$) between larval numbers in the treated and untreated areas (Table 1).

Field trial 3

The two unwatered plots occurred within the same replicate and had significantly more larvae (mean of 45.5 larvae per five samples) than did the six other plots of the same treatments (mean of 15.7 larvae per five samples) (Student's t-test, $P<0.05$). Hence we omitted this replicate in further analysis of the treatment effects. Analysis of variance of the three remaining blocks

Table 1. Numbers of *A. parvulus* larvae following application of Mocap to the soil surface (standard errors shown in brackets)

	Trial 1		Trial 2	
Treatment	29 days	43 days	23 days	58 days
Untreated	6.1(0.8)	4.1(0.5)	6.3(1.0)	3.8(0.8)
Mocap	5.9(0.9)	4.1(0.5)	5.0(1.0)	2.1(0.5)

showed no significant differences (P>0.05) between larval counts in any of the Mocap treatments, but all Mocap treatments had significantly (P<0.01) fewer larvae than did the untreated areas (Table 2).

Table 2. Numbers of A. parvulus larvae following application of Mocap behind a coulter

Treatment	kg product ha^{-1}	Larvae/sample*
Mocap	25.0	3.5a
Mocap	29.4	2.2a
Mocap	36.6	3.8a
Untreated		15.5b

* Means are untransformed values and those followed by the same letter are not significantly different at P = 0.05.

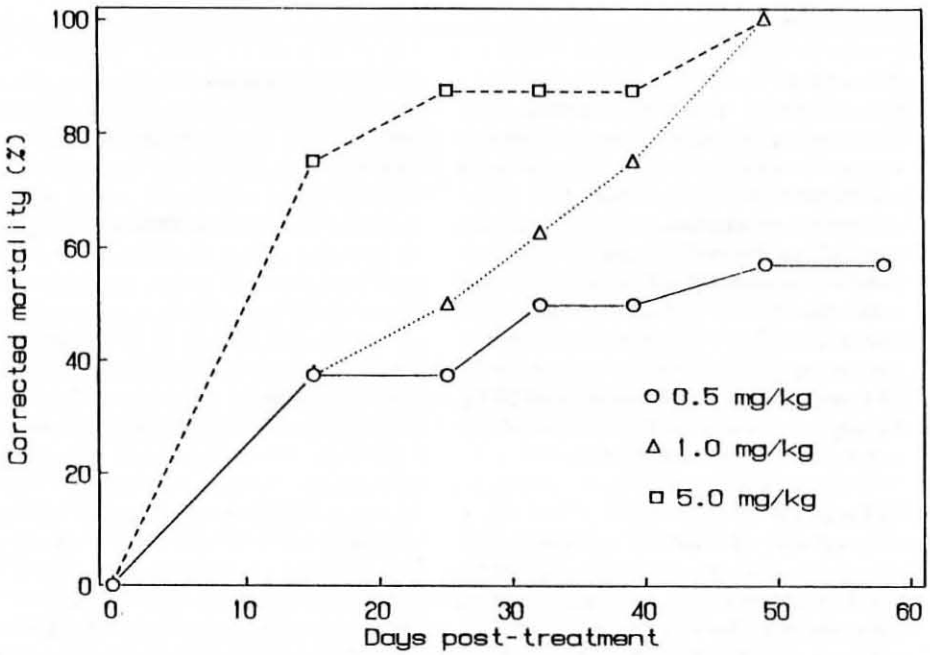

Figure 1. Mortality of second-instar *A. parvulus* larvae exposed to ethoprophos

Discussion

The bioassay shows that ethoprophos at 1 or 5 mg kg^{-1} is toxic to second instar *A. parvulus* larvae. Ethoprophos is toxic to second and third instars of *A. consanguineus* (Blackburn) (= *A. mussoni* (Blackburn)) at 1 and 2 mg kg^{-1}, respectively (Bull 1986). At 2 mg kg^{-1} it is not toxic to third instars of *Lepidiota negatoria* Blackburn and *L. noxia* Britton but it is toxic at 8 mg kg^{-1} (Bull 1986, Bull and Allsopp 1988).

When applied to the soil surface and watered in with at least 25 mm of water, Mocap did not reduce numbers of *A. parvulus* larvae. This contrasts with the efficacy of Mocap applied in a similar manner against field populations of *A. consanguineus* and *L. negatoria* (Bull 1986). *A. parvulus* favours soils low in sand and high in clay (such as the brown earth and red volcanic used in this study) (Cherry and Allsopp 1991), whilst *L. negatoria* and *A. consanguineus* favour sandier soils (Allsopp and Hitchcock 1987; Cherry and Allsopp 1991). Ethoprophos may move more freely in the sandier soils than in the clay soils and/or larvae may be closer to the surface in sandier soils.

The use of coulters to place the Mocap granules into the grub zone gives an effective method for treating *A. parvulus* infestations, reducing numbers by up to 86% in Trial 3. There were no significant differences between the efficacies of different levels of Mocap and thus the lower level of 25 kg product per hectare should be used. As shown by the poorer kill in the unwatered plots, water as rain or irrigation is needed to maximize the mortality achieved even when coulters are used.

Mocap has been used successfully against the canegrubs *L. negatoria*, *L. frenchi* Blackburn, *L. crinita* Brenske, *L. picticollis* Lea and *A. consanguineus* (Allsopp and Hitchcock 1987) and is presently registered in Queensland at 25 kg product ha^{-1} against these species. The first three and *A. parvulus* have 2-year life cycles and are present as damaging third instars in spring when it is possible to use coulters for granular application and it is possible to sample for larvae in recently-harvested fields. Although *A. consanguineus* has a 1-year life cycle, it flies in early spring so larvae are present when the cane is still young and coulters can be used. Mocap has the advantage over the prophylactic insecticide suSCon Blue in that only the area actually infested needs to be treated. However, its use is limited by the need for irrigation and cane may suffer significant damage before growers recognize the presence of larvae and apply the insecticide. It obviously can not be applied after the cane has grown too high to allow coulters to be used.

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