

## Early season insecticide applications can induce aphid outbreaks.

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### Summary

The relationship between early season insecticide use and later outbreaks of aphids was investigated in three field experiments. Outbreaks of *Aphis gossypii* occurred in cotton treated with thiodicarb, but not that treated with endosulfan or dimethoate. All insecticides caused significant reductions in predator abundance. Significant negative relationships were found between the abundance of predators early in the season and the final abundance of aphids. Predation is implicated as an important factor influencing the early season survival of aphids.

### Introduction

The cotton aphid, *Aphis gossypii*, is an important pest in cotton, capable of reducing yield and of contaminating cotton lint with honeydew (Forrester and Wilson, 1988; Leclant and Deguine, 1994). In other cotton systems, early season use of broad-spectrum insecticides often leads to outbreaks of aphids, possibly due to reductions in the abundance of natural enemies and/or indirect effects such as improved plant quality (Bartlett, 1968, Kerns and Gaylor, 1993). In Australia a range of broad spectrum insecticides are used on cotton through the early season (pre-flowering) which may affect predators of aphids and influence the development of aphid populations. In this study we tested if aphid populations developed more rapidly in cotton treated during the early season with either thiodicarb, dimethoate or endosulfan compared with untreated cotton. We also determined the effects of these insecticides on natural enemies of aphids and tested for correlations between the abundance of natural enemies and aphids.

### Materials and Methods

Experiments were conducted at the Australian Cotton Research Institute (ACRI) in 1993-94, 1995-96 and 1996-97 (experiments 1 - 3 respectively). Experiments were planted in early October to the cultivar 'Deltapine 90' using fungicide treated seed. Four treatments were compared in experiments 1 and 2; an untreated control, or treatment with either dimethoate (140 g ai/ha), thiodicarb (750 g ai/ha) or endosulfan (735 g ai/ha). In experiment 3, only the untreated control and thiodicarb treatments were included. A randomised block design with four replicates was used for all experiments. Plots were 24 rows (1 m spacing) by 20 m. The central 8 rows of the treated plots were sprayed with insecticide five times at 7 to 10 day intervals (depending on weather), beginning in early November.

Aphid and predator abundance was assessed using garden leaf blowers modified for use as suction samplers. Though this is not an optimal sampling system for aphids, it provides a reliable estimate of the relative abundance of aphids between treatments. Aphids and predators were sampled 24 h before the first insecticide application, and at one to three times between consecutive applications, with the exception of experiment 1 where aphid abundance was assessed once at the end of the experiment. Insects collected were killed using chloroform and the abundance of aphids and aphid predators (described below) was recorded.

Predators of aphids in cotton, as indicated in Pyke & Brown (1996) and Rude & Clark (1984), were combined into two groups;

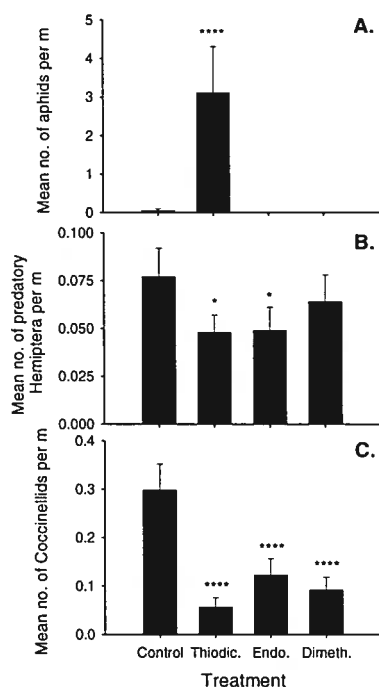
- (i) Coccinellidae consisting of adults and larvae of *Adalia bipunctata*, *Coccinella transversalis*, *Coelophora inaequalis*, *Harmonia testudinaria* and *Harmonia conformis*,
- (ii) Hemiptera consisting of adults and nymphs of *Deraeocoris signatus*, *Geocoris* sp., *Orius* spp. and *Nabis* sp.,

Numbers of other potential predators or parasitoids of aphids were too few to analyse, even when pooled, and results for these groups are not presented.

Analysis of variance was used to test for differences between treatments in the final abundance of aphids since their abundance through the most of the experimental period was very low. Regression analysis was used to test if there was a significant relationship between mean abundance of each beneficial insect group and final aphid abundance. Data for endosulfan and dimethoate treated cotton were excluded from the regression analysis as they are aphicidal (British Crop Protection Council & the Royal Society of Chemistry, 1994).

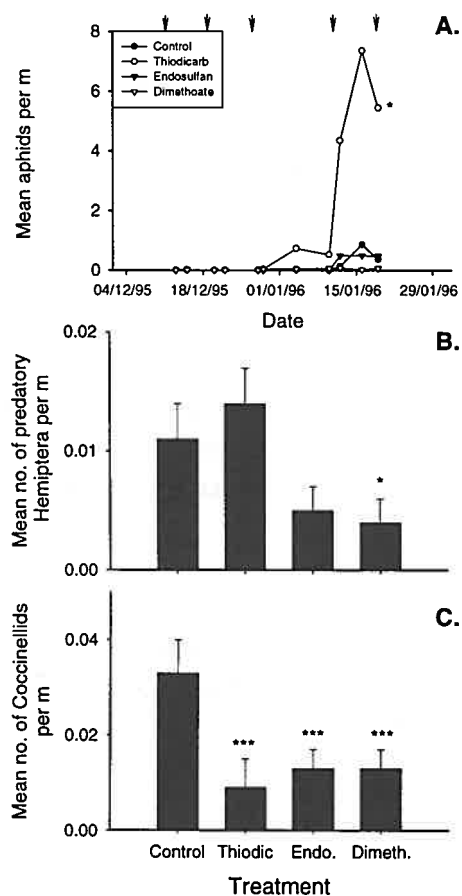
## Results

Cotton treated with thiodicarb developed significantly higher numbers of aphids than the control, endosulfan or dimethoate treatments (figs 1-3). Endosulfan and dimethoate caused significant reductions in the abundance of Hemiptera in one of two experiments and of Coccinellidae in both. Thiodicarb caused significant reductions in the abundance of Coccinellidae in all three experiments and of Hemiptera in two of three experiments.

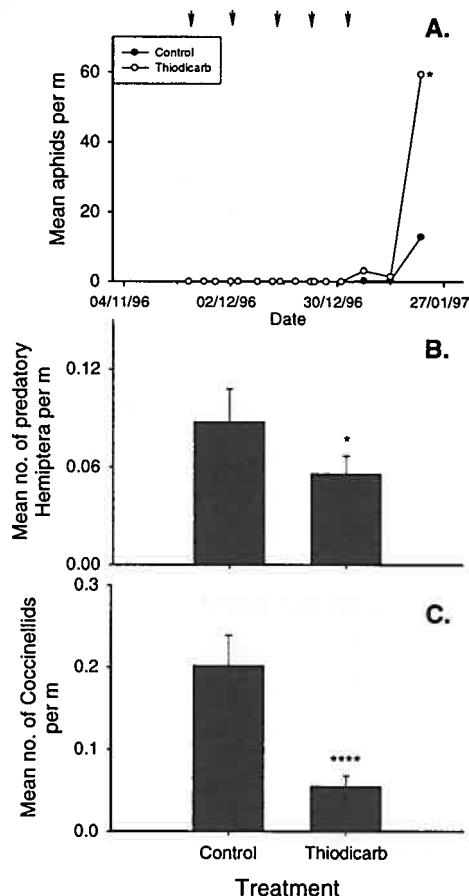


**Figure 1.** Mean final abundance of aphids (A) and mean abundance of predatory hemiptera (B) and coccinellids (C) for experiment 1, 1993-94. \*\*\*\* indicates significant difference from control at  $p < 0.005$ .

Reduction in predator numbers was correlated with higher numbers of aphids. Final aphid abundance was significantly correlated with numbers of Coccinellids ( $P = 0.03$ ) and Hemiptera ( $P = 0.014$ ) with a coefficient of determination ( $r^2$ ) of 0.73. The negative slopes of both predator groups (Coccinellids, -4.59; Hemiptera, -18.59) indicated that aphid abundance was higher in cotton with fewer predators.



**Figure 2.** Mean abundance of aphids on each sample date (A) and mean abundance predatory hemiptera (B) and coccinellids (C) for the duration of experiment 2, 1995-96. Arrows indicate dates of insecticide applications. Asterisks indicate significant difference from control at \*,  $p < 0.05$ ; \*\*,  $p < 0.01$ ; \*\*\*,  $p < 0.005$ ; \*\*\*\*,  $p < 0.0001$ .



**Figure 3.** Mean abundance of aphids on each sample date (A) and mean abundance predatory hemiptera (B) and coccinellids (C) for the duration of experiment 3, 1996-97. Arrows indicate dates of insecticide applications. Asterisks indicate significant difference from control at \*,  $p < 0.05$ ; \*\*,  $p < 0.01$ ; \*\*\*,  $p < 0.005$ ; \*\*\*\*,  $p < 0.0001$ .

## Discussion

Final abundance of aphids was higher in cotton treated with thiodicarb than in untreated cotton. Significant negative relationships were found between final aphid abundance and the abundance of coccinellids and Hemiptera, suggesting that the outbreaks of aphids in thiodicarb treated cotton developed because of the reduced abundance of predators, particularly coccinellids. Insecticides may cause outbreaks of aphids through mechanisms other than reductions in predator abundance. For instance, Kerns & Gaylor (1993ab) found that cotton treated with sulprofos had higher levels of amino acids than untreated plants, which may lead to improved host quality for aphids. The possible influence of thiodicarb on plant quality cannot be discounted since it was not tested here.

The low early season abundance of natural enemies more specific to aphids, such as syrphids and braconids (Room and Wardhaugh 1977), probably reflects the low abundance of prey (aphids) through this period. Similarly, no larvae of coccinellids were recorded during this study, confirming the observation of Room (1979) that coccinellids will only reproduce when aphids are available as food.

Low numbers of aphids occurred in cotton treated with endosulfan or dimethoate, reflecting the aphicidal activity of these insecticides. Nevertheless, both insecticides caused reductions in the abundance of generalist predators which may feed on other pests such as *Helicoverpa* spp. and spider mites. The results highlight the need for information on the effect of insecticides on target pests, on beneficial insects and on key secondary pests for the continuing development of integrated pest management systems in cotton.

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