

Evaluating the toxicity of insecticides on immature and adult *Trichogramma pretiosum*.

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Introduction

Beneficial insects play a vital role in the cotton ecosystem and are a realistic management tool in Integrated Pest Management (IPM). Protecting and enhancing natural predators and parasitoids can greatly reduce pest levels. Secondary pest outbreaks can also be reduced when selective insecticides are used in conjunction with natural enemies in cotton. Additionally, time between spraying can be extended therefore reducing insecticide resistance.

Numerous laboratory and field studies have shown that adult *Trichogramma* wasps are highly susceptible to most broad-spectrum insecticides, in particular synthetic pyrethroids.

Trials assessing the influence of insecticides on immature stages of *Trichogramma* spp. developing within the host egg have shown that the egg protects the parasitoid from toxic compounds. However Suh *et al.* (2000) noted that the first wasp to emerge from an egg has an increased chance of being killed by the insecticide residue on the egg surface as it chews through the chorion. Therefore wasps that emerge from the egg once the exit hole has been made, may avoid insecticide ingestion, thereby increasing their survival rate.

The aim of this study is to evaluate the toxicity of insecticides on adult and developing *Trichogramma pretiosum*.

Methods

The trial was undertaken at Toowoomba entomology laboratories of the Department of Primary Industries.

Insecticide Procedure

The insecticides were prepared on the day of dipping/bioassay. Each insecticide was measured using disposable syringes, and placed into a 1000 mL volumetric flask. Water with a pH of 7 was then added to make 1000 mL of solution; it was then shaken to ensure it was thoroughly mixed. Approximately one third of the solution was placed into a plastic disposable container, which was then sealed and labelled. Between chemicals, all

equipment was washed in a bleach solution and then triple rinsed with water. A control (water) was also included in the trial.

Since there were numerous chemicals tested, the egg dipping (Trials 1 and 2) and bioassay (Trials 3 and 4) were conducted on separate days.

Chemicals Used in the Trials

Trade Name	Insecticide	Concentration of Active Ingredient	Rate/L	Trial Number
Affirm	Emamectin	19.2g/L	7ml	2,3
Agrimec	Abamectin	18g/L	3ml	3
Bulldock	Beta-cyfluthrin	25g/L (EC)	8ml	1
Chess	Pymetrozine	-	3g	2,4
Confidor	Imidacloprid	350g/L	1.43ml	1,4
Decis	Deltamethrin	27.5g/L (EC)	7ml	1
Dibrom	Naled	900g/L	5.5ml	1
Dipel	<i>Bacillus thuringiensis</i>	-	2ml	1
Electra	Methomyl	225g/L	1ml (ovacide) 2.4ml (larvacide)	2,3
Folimat	Omethoate	800g/L	2.8ml	1,4
Gemstar	NPV	-	5ml	1
Intrepid	Chlorfenapyr	360g/L	11ml	2,3
Karate (zeon)	Lambdacyhalothrin	250g/L	6ml	4
Larvin	Thiodicarb	375g/L SC	20ml	1
Marshal	Carbosulfan	250g/L (EC)	15ml	4
Mustang	Zeta-cypemethrin ethion	Zeta-cypemethrin 20g/L ethion 360g/L	25ml	4
Ovasyn	Amitraz	200g/L	20ml	2,3
PBO	Piperonyl butoxide	800g/L	3ml	3
Pegasus	Diafenthiuron	500g/L	8ml	2,4
Pirimor	Pirimicarb	500g/kg (WG)	7.5g	2,3
Predator	Chlorpyrifos	300g/L	17.5ml	3
Prodigy	Methoxyfenozide	-	25ml	1
Regent	Fipronil	200g/L	1.25ml	1
Rescue	Chlorpyrifos-methyl	500g/L	20ml	1
Rimon	Novaluron	100g/L	7.5ml	1,4
Steward	Indoxacarb	150g/L	8.5ml	1,4
-	Pyridalyl	500g/L	5ml	2,3
Syngenta (x)	Lufenuron	-	20ml	2,3
Talstar	Bifenthrin	100g/L	6ml	2,4
Thiodan	Endosulfan	350g/L (EC)	21ml	1
Tracer	Spinosad	480g/L	2ml	1,4

Effects on Immatures (Trials 1 and 2)

One day old *Helicoverpa armigera* eggs laid on paper towel were cut into manageable pieces (15 x 15cm) and placed in two sealed 1L glass jars with gauze lids for ventilation. The eggs were exposed to several hundred *Trichogramma pretiosum* wasps for two hours, therefore avoiding superparasitism. The paper towel was removed from the jars, and placed into separate ventilated glass jars that were held in a control temperature (CT) room (25°C, relative humidity 70%).

The glass jars were inspected daily and neonates were removed to prevent them from feeding on the parasitised eggs. The paper was cut into strips (approximately 5 cm wide) and stapled to A4 paper. The paper was then cut into strips, with each strip containing 10-20 parasitised eggs (5 replicates per treatment). Each strip was labelled and placed into individual glass tubes with gauze lids, and stored in the CT room until dipping day.

Strips were dipped in each treatment for one second on day 5 or 9 after oviposition. Once a strip had been dipped, it was placed on paper towel for one minute and then moved to another piece of paper towel to assist in drying. Once dried, each strip was placed into its original glass tube, and stored in the CT room.

Each egg card was examined, and the number of parasitised eggs, the number of eggs with emergence holes (with and without wasps inside), the number of eggs with a wasp trapped in the egg and the number of eggs that had no emergence were recorded.

Effects on Adults (Trials 3 and 4)

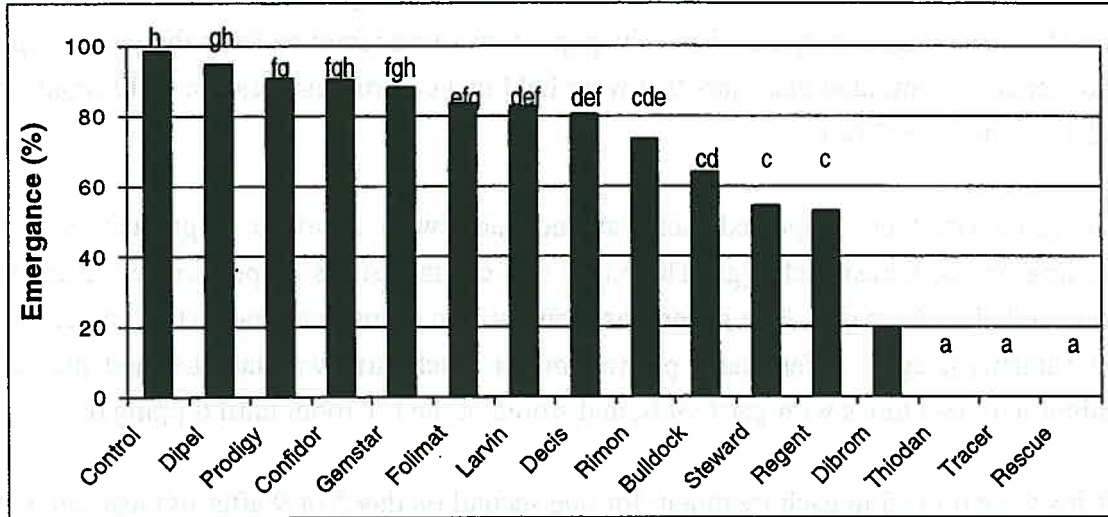
The effects of insecticide residues on the survival of adult wasps were studied in ventilated glass bioassay chambers measuring 4 x 15 cm (Scholz 1994). Grade 1 Whatman filter paper was emersed in each treatment until it was saturated and then allowed to dry (5 replicates in each treatment). The treated filter paper was then used to line the inside of the bioassay tubes, to ensure that the wasps were fully exposed to the treatment.

Approximately 20 newly emerged wasps were placed into each bioassay tube, and exposed for four hours. After exposure the numbers of dead and alive wasps were recorded.

All data were analysed by analysis of variance (ANOVA), and means were compared using Fisher's Least Significant Difference (LSD) technique. All percentage data were arcsine transformed for analysis.

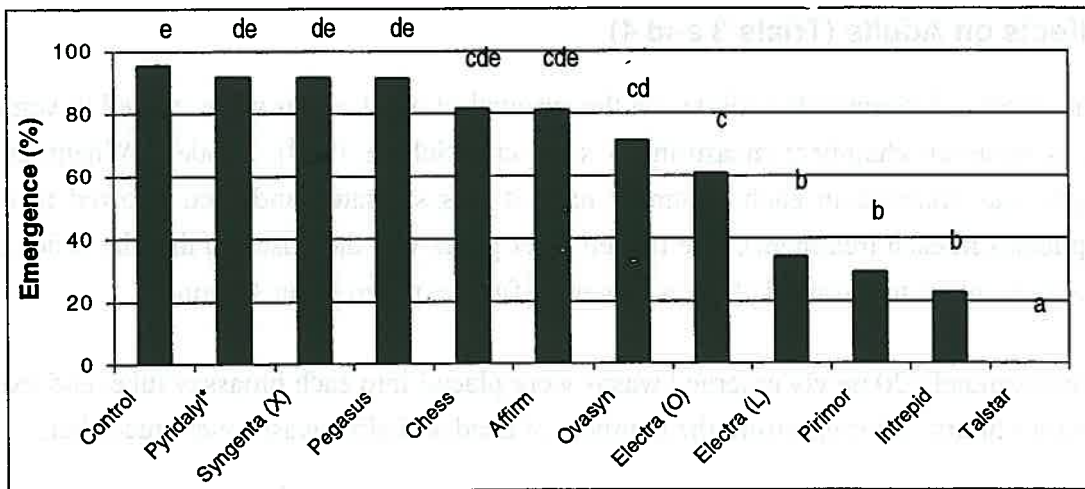
Results

Figure 1: Mean emergence of *Trichogramma pretiosum* after dipping parasitised *H. armigera* eggs in different insecticide solutions (control = water) (Trial 1).



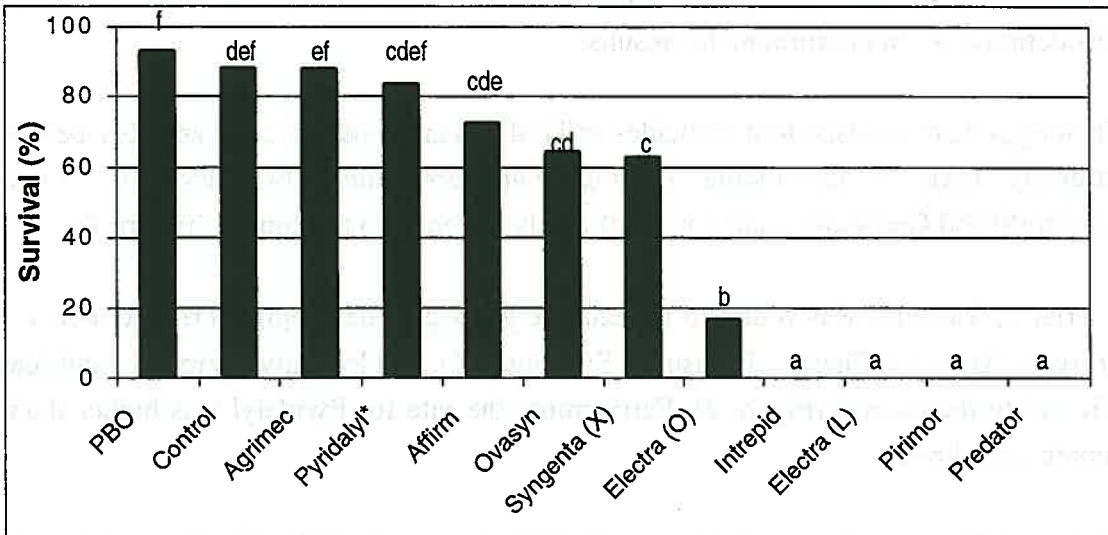
Column means followed by the same letter are not significantly different ($P=0.05$).

Figure 2: Mean emergence of *Trichogramma pretiosum* after dipping parasitised *H. armigera* eggs in different insecticide solutions (control = water) (Trial 2).



Column means followed by the same letter are not significantly different ($P=0.05$).

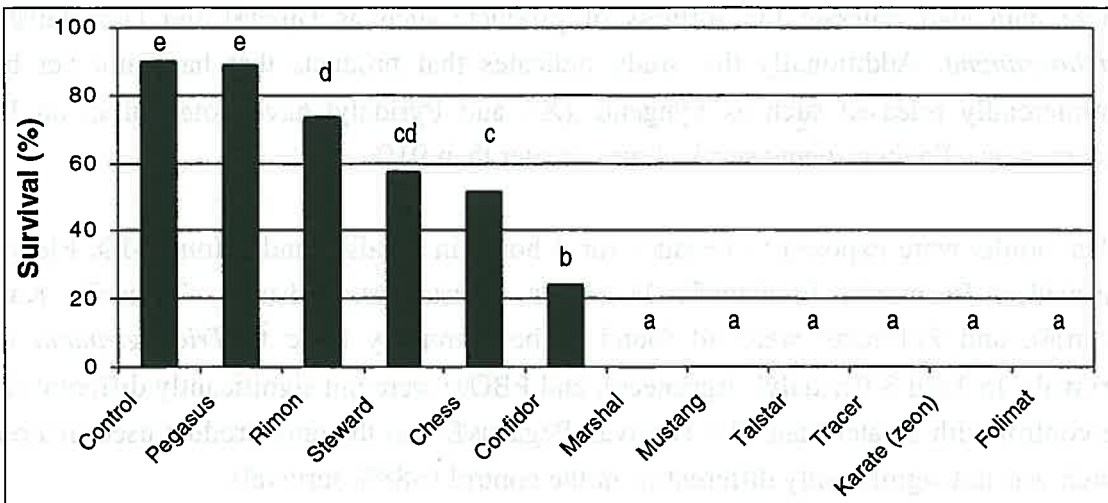
Figure 3: Adult survival of *Trichogramma pretiosum* after exposure to residual insecticides on treated filter paper (control = water) (Trial 3).



Column means followed by the same letter are not significantly different (P=0.05).

* = no trade name available.

Figure 4: Adult survival of *Trichogramma pretiosum* after exposure to residual insecticides on treated filter paper (control = water) (Trial 4).



Column means followed by the same letter are not significantly different (P=0.05).

Discussion

Although this was a laboratory experiment, it was the most efficient way to test a large number of insecticides on a specific group of insects. Consequently this must be taken into consideration when interpreting the results.

When eggs were exposed to insecticides in Trial 1, Thiodan®, Tracer® and Rescue® were extremely toxic to developing *Trichogramma pretiosum* (0% survival). Dipel®, Confidor® and Gemstar® were not significantly different to the control (Figure 1).

In Trial 2, Talstar® was found to be extremely toxic to developing *Trichogramma* (0% survival). Affirm®, Chess®, Pegasus®, Syngenta (X), and Pyridalyl were not significantly different to the control (Figure 2). Furthermore the rate for Pyridalyl was higher than the recommended rate.

Dipping eggs into an insecticide at different stages of development indicated some synthetic pyrethroids are not as toxic as others are. For example Talstar®, Bulldock® and Decis® had 0%, 64% and 80% survival respectively. Field assessments however suggest that synthetic pyrethroids are extremely disruptive to *Trichogramma*, and a field comparison study between different synthetic pyrethroids may need to be undertaken to further examine their disruptiveness. This was also the case with the carbamate group of chemicals, for example Pirimor®, Electra® and Larvin® had 29%, 34% and 82% survival respectively.

These data also reiterate the softness of products such as Dipel® and Gemstar® on *Trichogramma*. Additionally this study indicates that products that have not yet been commercially released such as Syngenta (X), and Pyridalyl have potential in an IPM system, since *Trichogramma* survival was greater than 91%.

When adults were exposed to residues for 4 hours in Trials 3 and 4 Intrepid®, Electra® (larvicide), Pirimor®, Predator®, Marshal®, Mustang®, Talstar®, Tracer®, Karate (zeon)®, and Folimat® were all found to be extremely toxic to *Trichogramma* (0% survival). In Trial 3 Pyridalyl, Agrimec®, and PBO® were not significantly different from the control with greater than 83% survival. Pegasus® was the only product used in Trial 4 which was not significantly different from the control (>88% survival).

Tracer® was extremely toxic (0% survival) on immature and adult *Trichogramma*. Annetts *et al.* (2000) established that Tracer® has ovicidal activity on *H. armigera*, therefore seems likely that the insecticide will also effect developing *Trichogramma*. Suh *et al.* (2000) found that Tracer® had a detrimental effect on *Trichogramma* adults.

In response to the adverse effects of insecticides on adult and developing *Trichogramma pretiosum* it should be noted that the eggs were totally drenched in insecticide solution, consequently receiving the maximum possible dose. The adults were also in a position where they had no choice but to walk on the filter paper which had been drenched in insecticide solution. Under field conditions, eggs and adults may receive a much lower dose depending on where the egg is laid on the plant, or where the adult is on the plant. Therefore further research into the effects of insecticides on *Trichogramma* should focus on the overall effectiveness of the product under field conditions.

Conclusions

- Gemstar®, Dipel®, Pyridalyl, Pegasus®, Syngenta(X), Prodigy®, and Confidor® are relatively safe on developing *Trichogramma* (>85% survival).
- Pegasus®, Agrimec®, and Pyridalyl are relatively safe on adult *Trichogramma* (>80% survival)
- Talstar® and Tracer® had a detrimental effect on both adult and developing *Trichogramma*.
- This is a laboratory experiment and this should be taken into consideration when interpreting the results.
- Further research needs to be conducted under field conditions in addition to looking at wasp behaviour after exposure.

Acknowledgments

The authors thank Dave Murray, Richard Lloyd, Sue Maclean and Gordon Simpson, DPI Toowoomba and Rob Annetts (Dow AgroSciences) for their technical comments and support; Aventis, Syngenta, Crop Care, and Sumitomo for providing insecticide samples.

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