ASSASSIN BUGS
A POTENTIAL BIOLOGICAL CONTROL AGENT FOR HELIOTHIS AND MIRIDS IN COTTON

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Summary

The Assassin Bug, *Pristhesancus plagipennis* is a natural enemy that is showing considerable promise in controlling Heliothis (*Helicoverpa* spp.) and plant-sucking bugs in cotton. This paper is based on the collective results from several experiments where we examined the potential of this predator as a biological control agent in cotton. In recent field experiments, assassin bugs provided significant levels of heliothis and mirid control and suggest that this predator may be a useful tool within an IPM program.

Description & Significance

Assassin bugs are endemic to Queensland and parts of New South Wales (James 1994). These predators have an elongated body with grasping forelegs and a pronounced head equipped with a powerful proboscis for stabbing their prey (see Fig.1). Adult insects are brown in colour and reach a length of 20-25 mm. In contrast nymphs are black with brightly coloured orange abdomens. Adult females lay several clusters of 50-90 orange eggs that take 14-16 days to hatch during summer. After hatching, the wingless nymphs pass through five growth stages before reaching adulthood. Nymph development takes approximately 65-95 days depending on temperature and availability of insect prey. As adults, assassin bugs may live for a further 6-10 months.

Assassin bugs feed on many different insects and are commonly referred to as generalist predators. Generalist predators, particularly predatory bugs have been largely ignored for their pest management potential in cotton production systems (King & Powell 1992). However, in a monoculture environment where the main pests, *Helicoverpa* spp. and *Creontiades* spp. are characterised by migratory behaviour and a multi-voltine lifecycle (Zalucki *et al.* 1986; Miles 1995), generalist predators can have a survival advantage over host-specific or specialist natural enemies by being able to switch prey types during fluctuations in host availability.

Like many predatory insects, assassin bugs are typically scarce in crops at critical times. A solution to this problem is to mass-rear and release nymphs into crops as required for the control of insect pests (Grundy & Maelzer 2000; 2002).

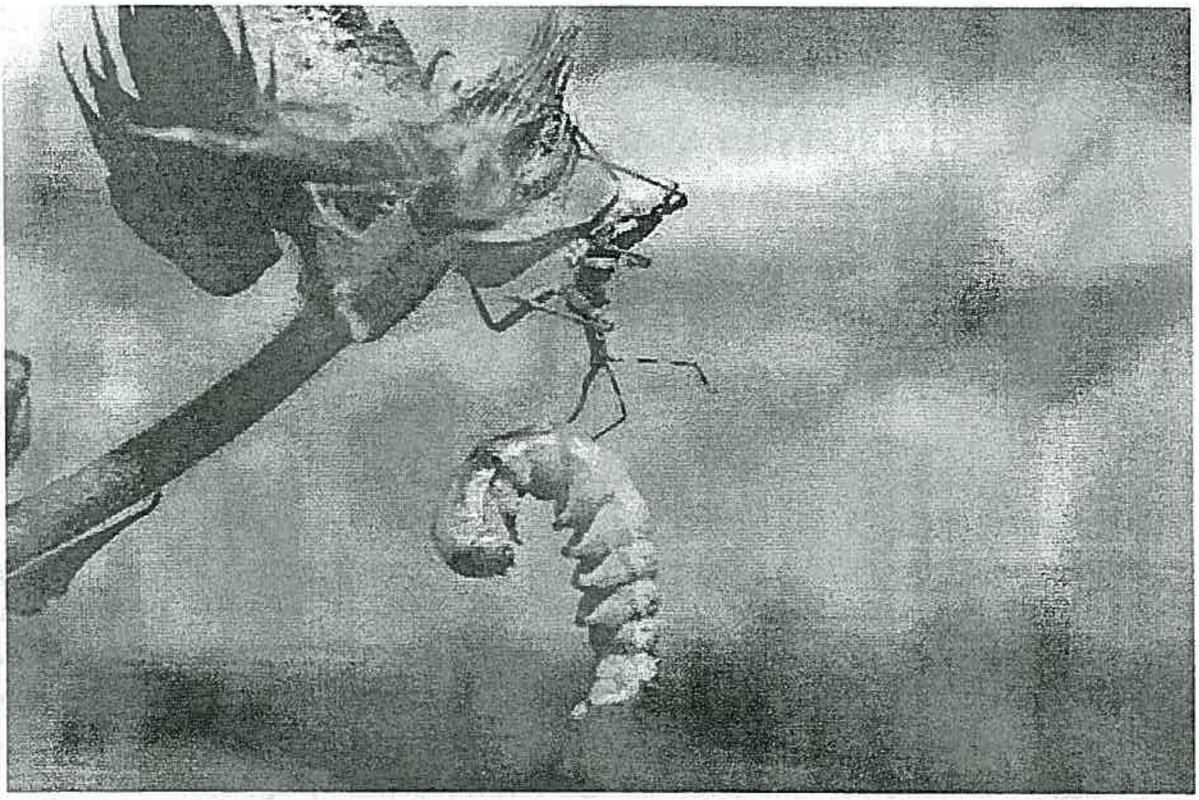

Figure 1. A fifth instar assassin bug feeding on Heliothis larvae.

Mass Production of Assassin Bugs for Release

An obvious solution to predator scarcity within crops at critical times is to mass-rear and release natural enemies to places where they are required. However, the mass-production of predatory insects is no easy task due to inherent problems such as predator cannibalism and inefficiencies associated with handling and the production of host insects as a predator food source. After two years of testing various host insects and handling techniques, an assassin bug rearing method was developed. Mealworms were identified as a suitable and cost effective host food source that could be fed to both the nymph and adult stages, greatly improving rearing efficiency (Grundy *et al* 2000a).

With financial assistance from AusIndustries, a commercial rearing program for assassin bugs is currently being developed by Pisces Enterprises Pty Ltd, a Brisbane based insect producing business. This company has recently commenced the production of these predators and hopes to develop the bugs into a commercial product for a range of uses. The commercialisation of this predator has presented significant challenges when scaling-up production phases. Mechanised production systems and artificial feeding programs take time to develop and Pisces Enterprises envisage that it will take 3-4 years to overcome these challenges and be able to supply commercial quantities of this insect for industry.

Assassin Bugs as a Tool for Cotton Pest Management

Experiments have shown that biological control provided by mass-releases of assassin bugs into cotton can provide significant crop protection. Compared to other natural enemies, assassin bugs have a number of advantages.

Tolerance to Insecticides

Pesticide use is a major factor contributing to the low occurrence of natural enemies in cotton. However to completely abstain from using these products is impractical or impossible for a majority of situations. In the current cropping context, the likelihood of assassin bugs being exposed to insecticides is high, therefore the effects of a number of traditional insecticides were tested on assassin bugs to measure their tolerance to various compounds. Surprisingly there were distinct differences between products in their toxicity to assassin bug nymphs. Carbaryl, esfenvalerate and endosulfan were slightly toxic and deltamethrin, maldison and dimethoate were of low toxicity (Fig 2). Methidathion, chlorpyrifos, methomyl, cypermethrin and monocrotophos were of moderate to high toxicity (Fig 2) (Grundy *et al.* 2000b). The tolerance of assassin bug nymphs to some of these products sets them apart from many other highly sensitive natural enemies.

Over the next 12 months we will be testing the other insecticides and miticides registered in cotton with the aim of identifying products that are suitable for integration with assassin bugs within an IPM program.

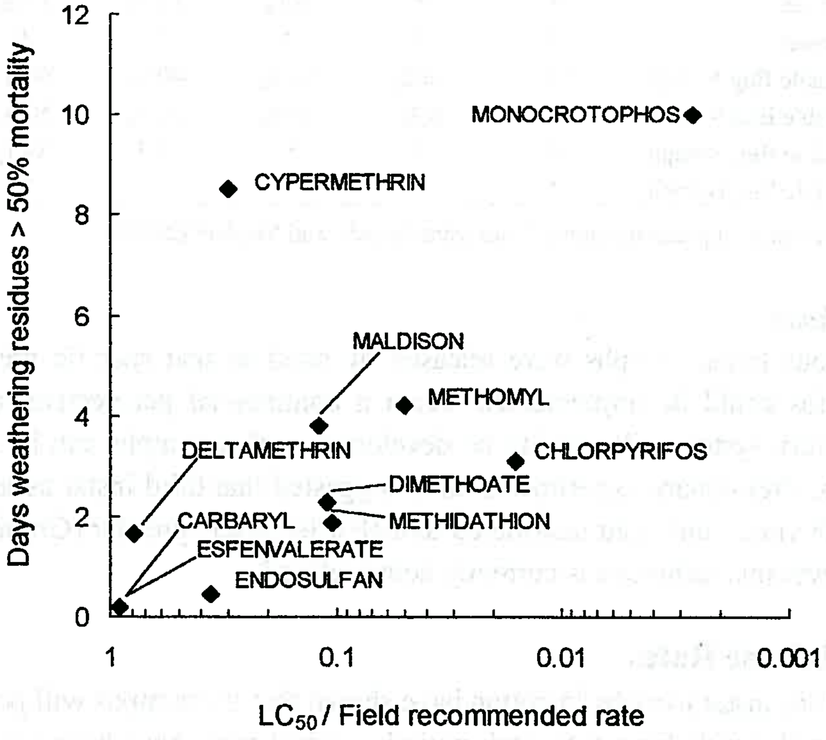

Figure 2. The residual toxicity plotted against the acute toxicity. Residual toxicity was calculated as the period of time taken for the weathering residues of each product to degrade to a level that caused 50% nymphal mortality (RT_{50}). Acute toxicity is defined as the LC_{50} expressed as a fraction of the field recommended rate. Products at the top right (i.e. monocrotophos) are highly toxic where as products in the bottom left corner are least toxic.

Predatory Potential

Assassin bugs have a lengthy lifespan and during their development consume significant quantities of prey. The table below shows the number, size and type of prey eaten by each assassin bug nymph stage during its development in the laboratory. In these experiments assassin bug nymphs failed to feed on late instar Heliothis. However, assassin bugs are often observed in the field feeding on these late stages which suggests that the bugs are better able to capture large heliothis larvae whilst they are feeding on plants as opposed to walking around a plastic laboratory test container.

Table 1 Mean predation by each assassin bug nymphal stage on each instar of the prey species Heliothis and green vegetable bugs.. First instars vegetable bugs were not used as prey. Treatment means for each species marked with different letters are significantly different ($P<0.05$).

Prey Species & Instar	**Mean and SE of prey consumed per predator; for each assassin bug nymph stage**					
	I	**II**	**III**	**IV**	**V**	**Total**
1st Heliothis Larvae	7.2_a	13.2_a	28.2_a	54.2_a	117.1_a	219.9
2nd Heliothis Larvae	5.9_b	9.9_b	22.2_b	40.2_b	83.7_b	161.9
3rd Heliothis Larvae	*	*	8.0_c	14.7_c	34.8_c	57.5
4th Heliothis Larvae	*	*	6.1_d	11.7_d	17.8_d	35.6
5th Heliothis Larvae	*	*	*	*	*	
2nd Green Vegetable Bug Nymph	5.8_a	10.2_a	24.4_a	49.2_a	94.8_a	184.4
3rd Green Vegetable Bug Nymph	*	6.7_b	13.6_b	22.5_b	50.6_b	93.4
4th Green Vegetable Bug Nymph	*	*	*	14.7_c	34.1_c	48.8
5th Green Vegetable Bug Nymph	*	*	*	*	*	

* Failed to feed on prey in predation arena. Data from Grundy and Maelzer (2000b).

Release Methods

During previous trials, nymphs were released by hand so that specific predator to prey treatment ratios could be implemented. From a commercial perspective, a mechanised predator delivery system will need to be developed so that nymphs can be released over sizeable areas. Preliminary experiments have suggested that third instar assassin bugs can be mixed with vermiculite and distributed though a fertiliser spreader (Grundy & Maelzer 2002a), however this technique is currently being refined.

Predator Release Rates

Releases of third instar nymphs in cotton have shown that the nymphs will persist and prey on Heliothis and mirids for a 6-8 week period. Several trials have been conducted in the Lockyer Valley, Darling Downs and Central Queensland in an attempt to determine how many assassin bugs are required to control pest insects in cotton.

Low Release Rates in Cotton

During the 2001-02 season we had the opportunity to test release rates of 0.25, 0.5, 0.75 and 1.0 assassin bug nymphs per metre row in cotton (2,500, 5,000, 7,500 & 10,000 nymphs per hectare respectively). The crop was subjected to an extended period of high *Helicoverpa* spp. egg densities during the month of December and January with a peak of

81.09 ± 2.82 eggs per metre row recorded on 27 December 2001. Mirids were also present in high numbers during the trial.

The effect that the assassin bugs had on these two pests is shown in figures 3 and 4. Significant reductions in the densities of Heliothis and mirids were associated with the assassin bug releases with the best responses coming from the release rates of 0.75 and 1.0 predators per metre row.

The pest reductions associated with the assassin bug releases in this experiment were not sufficient to depress Heliothis larvae numbers to below threshold (Figure 3). However, the reduction that did occur in view of the sustained high egg pressure, unfavourably hot seasonal conditions and abundance of alternative prey types such as mirids for the month of January is encouraging. The next step will be to combine the predation provided by this bug with other soft options during periods of high pest pressure as observed in this experiment. NPVs would have been ideal in this situation where you could expect the biopesticide to remove at least half of the population, leaving the rest to be predated by the assassin bugs.

This was also the first experiment to be inundated with high numbers of mirids on which to make control assessments. The reductions that occurred in the assassin bug plots were significant, a result that again is encouraging particularly when the total amount of available prey available between the two species during the experiment is considered (Figure 4). A soft option for use with the predators may have also been useful in this circumstance.

Future Directions

Much of the research on which this paper is based has been focused on determining the potential for using inundative releases of assassin bugs in the same way that *Trichogramma* spp. and lacewings have been applied in other cropping situations. The research reported here is limited in that the field research has only been conducted over three seasons that were characterised by both very low and high levels of pest activity.

The Cotton Research and Development Corporation have provided funds that will enable us to continue our evaluation and development of this predator and as a potential tool for Heliothis and mirid control within an IPM program. Over the next few seasons we will be investigating a range of issues concerning the integration of these predators into cotton pest management programs. These include developing broad acre delivery systems and identifying soft options such as biopesticides, new insecticides and crop transgenics that may be suited for use with these predators within an IPM program. At this early stage the use of these predators looks encouraging.

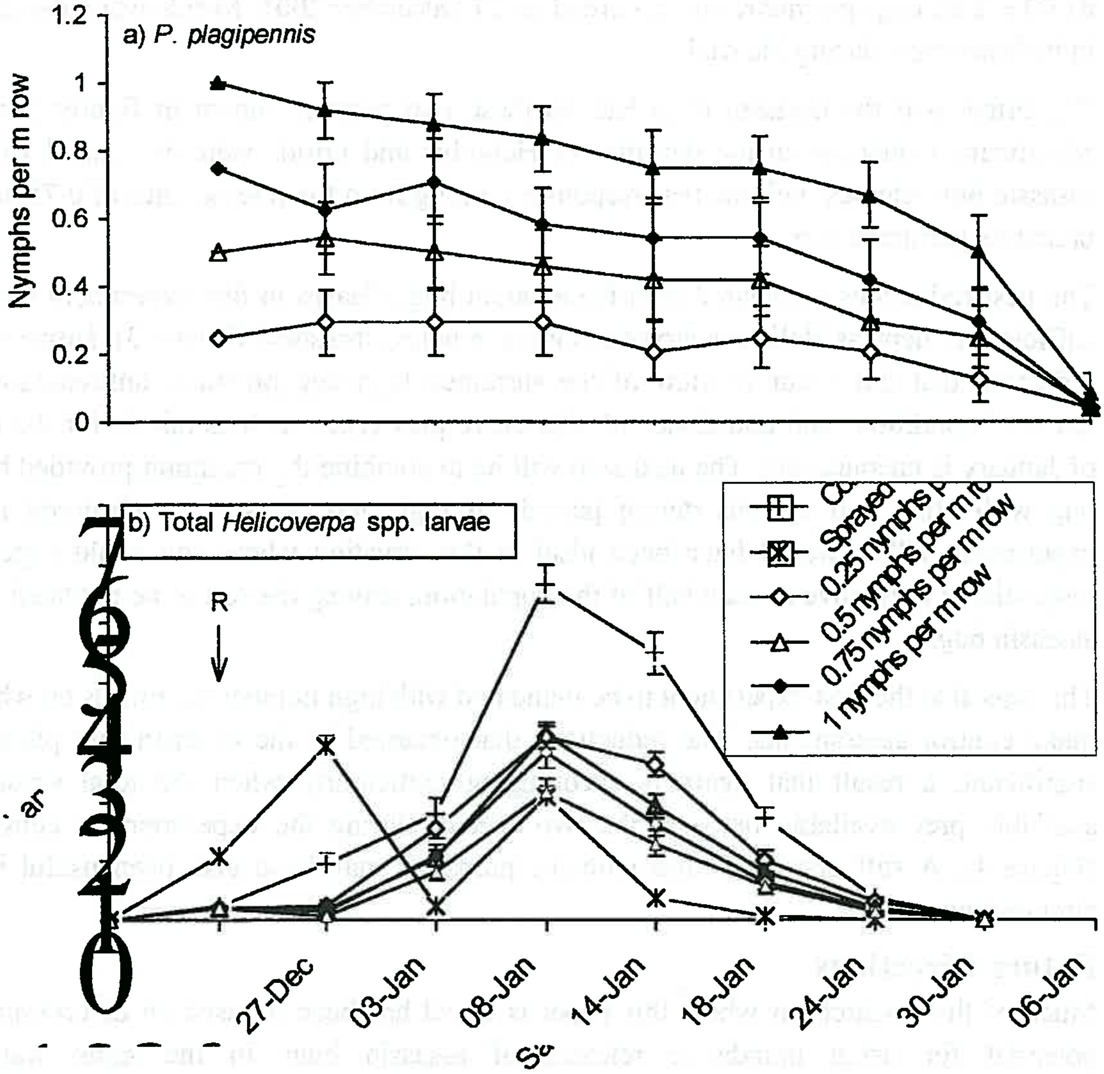

Figure 2. Time series showing numbers per m row of **(a)** Assassin bug nymphs; and **(b)** *Helicoverpa* spp. larvae in cotton plots for the four predator release densities, a sprayed treatment and unsprayed control. The arrow represents the predator release date. The bars denote ± SE. Control represents the unsprayed and *P. plagipennis* nymph free control.

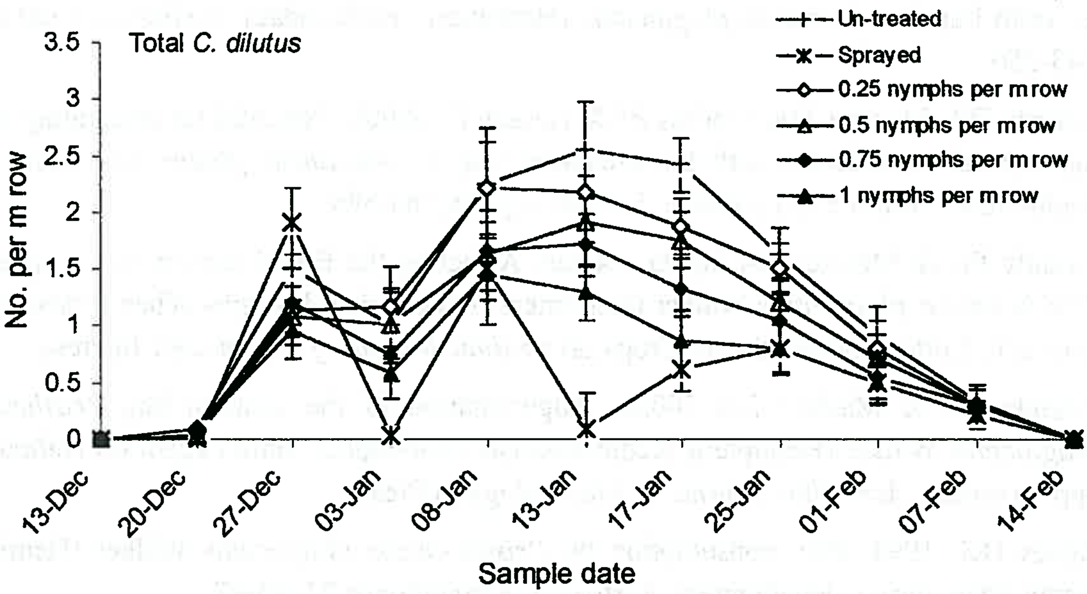

Figure 3. Time series showing numbers per m row of mirids (*C. dilutus*) in cotton plots for the four predator release densities, a sprayed treatment and unsprayed control. The predators were released on 20 December. The bars denote ± SE. Control represents the unsprayed and *P. plagipennis* nymph free control.

Acknowledgements

We thank Jane Savage (GlenShee, Oakey Qld) and Alex Kidd (Pacific Seeds) for providing trial sites used for this research. Gavin Mann (Farming Systems Institute, QDPI) and his team picked and ginned the cotton. Matthew Jones, Tonia Grundy, Roberto Battaglia, Allen Bruce, Ian Taylor, Renee Herde and Nicole Purvis-Smith assisted with predator release, trial assessments and cotton picking. This research has been funded by the Grains Research and Development Corporation (JRF 45), Cotton Cooperative Research Centre (3.2.13AC) and Cotton Research and Development Corporation (DAQ 95C).

References

Grundy P & Maelzer D. 2000a. Assessment of *Pristhesancus plagipennis* (Walker) (Hemiptera: Reduviidae) as an augmented biological control in cotton and soybean crops. *Australian Journal of Entomology* **39**, 305-309.

Grundy P & Maelzer D. 2000b. Predation by the assassin bug *Pristhesancus plagipennis* (Walker) (Hemiptera: Reduviidae) of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) and *Nezara viridula* (L.) (Hemiptera: Pentatomidae) in the laboratory. *Australian Journal of Entomology* **39**, 280-282.

Grundy PR, Maelzer DA, Bruce A & Hassan E. 2000a. A mass-rearing method for the assassin bug *Pristhesancus plagipennis* (Hemiptera: Reduviidae). *Biological Control* **18**, 243-250.

Grundy PR, Maelzer DA, Collins PJ & Hassan E. 2000b. Potential for integrating eleven agricultural insecticides with the predatory bug *Pristhesancus plagipennis* (Hemiptera: Reduviidae). *Journal of Economic Entomology* **93**, 584-589.

Grundy PR & Maelzer DA 2002a. Factors Affecting the Establishment and Dispersal of *Pristhesancus plagipennis* Walker (Hemiptera: Reduviidae) Nymphs When Released onto Soybean, Cotton and Sunflower Crops. *Australian Journal of Entomology* In Press.

Grundy PR & Maelzer DA 2002b. Augmentation of the assassin bug *Pristhesancus plagipennis* Walker (Hemiptera: Reduviidae) as a biological control agent for *Helicoverpa* spp. in cotton. *Australian Journal of Entomology* In Press.

James DG. 1994. Prey consumption by *Pristhesancus plagipennis* Walker (Hemiptera: Reduviidae) during development. *Australian Entomologist* **21**, 43-47.

King EG & Powell J. 1992. Propagation and release of natural enemies for control of cotton insect and mite pests in the United States. *Crop Protection* **11**, 497-506.

Miles MM. 1995. *Identification, Pest Status, Ecology and Management of the Green Mirid, Creontiades dilutus* (Stål) *(Hemiptera: Miridae), a Pest of Cotton in Australia.* PhD Thesis. Department of Entomology. University of Queensland, St Lucia Australia.