If you are participating in the presentations this year, please provide a written report and a copy of your final report presentation by 31 October. If not, please provide a written report by 30 September.

Part 1 - Summary Details

Please use your TAB key to complete Parts 1 & 2.

CRDC Project Number: **DAQ134**

Project Title: Managing cotton aphids with parasitoids

Project Commencement Date: 01/07/05 **Project Completion Date:** 31/03/09

CRDC Program: 3 Crop Protection

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Part 3 – Final Report Guide (due 31 October 2008)

The cotton aphid, (*Aphis gossypii*), is a pest of increasing concern in Australian cotton. Cotton aphid is considered a pest due to yield reduction if a heavy and persistent infestation occurs. Cotton aphid honeydew is frequently a problem late in the growing season due to honeydew contamination of boll lint. Further cotton aphid is a vector of cotton bunchy top, a disease of cotton that under certain conditions can cause serious yield loss.

Cotton aphid is typically managed by using insecticides, however over time cotton aphid has developed resistance to insecticides used against it, most recently to neonicotinoids (Confidor).

A more sustainable approach to aphid management would be to use beneficial arthropods like ladybirds, hoverflies and parasitoids to reduce aphid populations. Unfortunately little is known about the biology and ecology of these natural enemies so it is difficult to include their presence in cotton fields into pest management practices.

This project focused on understanding more about the biology and ecology of the aphid parasitoid *Lysiphlebus testaceipes.* This parasitoid wasp was introduced to Australia in 1982 but wasn't detected in large numbers in cotton districts until 1997. Overseas the parasitoid is considered an important biological control agent, but in Australia there is limited information on its importance as a natural enemy of cotton aphid.

To improve our understanding of the biology, ecology and biological control potential of *L. testaceipes* experiments were completed in the following areas:

1. Effect of adult food on the lifespan and fecundity of *L. testaceipes*.
2. Host acceptance behaviour of *L. testaceipes*
3. Host stage and fitness of *L. testaceipes*
4. Host switching behaviour of *L. testaceipes*
5. Host plant effects on fitness of *A. gossypii* and *L. testaceipes*

These five objectives will make up the research chapters of my PhD thesis.

Adult parasitoids typically require a source of carbohydrates in order to maximise fecundity and lifespan. Carbohydrates utilised by parasitoids include nectar sources from flowering plants, extra floral nectaries as found on cotton leaves or alternatively they may feed on honeydew produced by aphids or whiteflies. I investigated whether aphid honeydew was a sufficient carbohydrate source for *L. testaceipes* by comparing lifespan and fecundity of wasps feed on honeydew, buckwheat nectar, honey and water. Lifespan of wasps fed on the 3 carbohydrate diets was not different and all lived longer than wasps fed water. Fecundity of wasps on the 3 carbohydrate diets were similar to each other but higher than wasps restricted to water. This study suggests *L. testaceipes* is unlikely to benefit from adding carbohydrate sources to cotton fields, either food sprays of strips of flowering plants as aphid honeydew provides them with sufficient nutrition.

The remainder of this study focused on the biology and ecology behind the concept of using an alternative host aphid to breed local populations of parasitoids to control cotton aphid. For example mungbeans which host cowpea aphid (*Aphis craccivora*) could be grown nearby to cotton and *L. testaceipes* could establish in this crop then move into the cotton. This concept is based on the fact that cotton aphid has an extremely high intrinsic rate of increase and for biological control to be effective, predator or parasitoid populations need to be well established locally and respond to the presence of cotton aphid.

The first experiment looked at the host acceptance behaviour of *L. testaceipes* when offered *A. gossypii* and *A. craccivora* on several host plants. This study showed *L. testaceipes* has a significant preference for *A. craccivora* and mungbean. I also looked at aphid instar preference and found that *L. testaceipes* has a preference for older instars (4^{ths} and adults) over younger instars (2^{nds}).

A follow up experiment investigated host stage and its effect on parasitoid fitness (size, lifespan & fecundity). This experiment showed wasps that developed in *A. craccivora* had significant fitness gains over wasps that developed in *A. gossypii.* When parasitising *A. craccivora,* parasitoid fitness increases if the wasp develops in older instars (3^{rds} & 4^{ths}) compared to younger instars (1^{sts} and 2^{nds}).

To determine if *L. testaceipes* would readily move from an alternative host (*A. craccivora* & mungbean) to the target host (*A. gossypii* and cotton) a switching experiment was conducted. *Lysiphlebus testaceipes* was released into cages that had varying densities of *A. craccivora* and *A. gossypii* to test if it would positively switch to the aphid with the highest relative density. This experiment showed that *L. testaceipes* would preferentially parasitise *A. craccivora* on mungbean even at low densities rather than attack higher population densities of *A. gossypii* on cotton. This indicates that *L. testaceipes* is a negative switcher and has a strong preference for *A. craccivora.*

Aphis gossypii exhibits phenotypic plasticity (variability in body size) in response to host plant and environmental stimuli. If overcrowded or on poor quality hosts, *A. gossypii* produce "yellow dwarfs" in contrast on high quality hosts and under certain environmental conditions large dark morphs are produced. To understand how the variable body size of *A. gossypii* may affect fitness of *L. testaceipes* an experiment was conducted that looked at parasitism and fitness when *L. testaceipes* attacks *A. gossypii* on two host plants, cucumber and cotton. During this experiment high parasitism of *A. gossypii* was recorded on cotton and fitness of progeny was higher in wasps developing on cotton than cucumber. Fitness of aphids on cucumber was most likely affected by powdery mildew that grew on the caged leaves during the trial.

Three experiments showed *L. testaceipes* has a preference for, parasitised more and has improved fitness from cowpea aphid (*A. craccivora*) compared to cotton aphid (*A. gossypii*). Observational data suggest this could be partly due to aphid defence against parasitism. When attacked both species produce a chemical secretion from their cornicles (siphuncles), however the cornicle secretion of *A. gossypii* is sticky and can glue the parasitoid's appendages together (e.g. antennae stuck to forelegs). As a result contacting the cornicle secretion during oviposition can debilitate the wasp and prevent it from attacking any more aphids.

The conclusion from the study of the biology and ecology of *L. testaceipes* is that cotton aphid (*A. gossypii*) is a poor quality host. My results suggest it is unlikely *L. testaceipes* will provide effective biological control against *A. gossypii*, however it is possible under certain conditions the parasitoid could be present in large numbers in cotton. Also anecdotal field

reports (T Smith, pers comm.) indicate *L. testaceipes* can be abundant and provide effective control of *A. gossypii* in cotton. Upon successful completion of my PhD a copy of my thesis will be provided to CRDC.

Part 4 – Final Report Executive Summary

The cotton aphid (*Aphis gossypii*) is a pest of increasing concern in Australian cotton, causing yield reduction, lint contamination from honeydew, and vectoring cotton bunchy top disease. My study aimed to improve our understanding of the biology, ecology and biological control potential of *L. testaceipes* for control of cotton aphid on cotton. The conclusion from the study is that cotton aphid (*A. gossypii*) is a poor quality host and it is unlikely *L. testaceipes* will provide effective biological control of *A. gossypii* on cotton.