The integration of the parasitoid *Microplitis demolitor* Wilkinson (Hymenoptera: Braconidae) into integrated pest management systems in Australian cotton

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Declaration

I certify that the contents of this thesis have not been submitted for any other degree and are not currently submitted for any other degree.

I certify that all sources of information used have been acknowledged in this thesis.

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Robert Annetts.

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Abstract

Cotton production in Australia, the ecology of the key pests of Australian cotton, *Helicoverpa* spp., and integrated pest management (IPM) in Australian cotton were reviewed. *Microplitis demolitor* Wilkinson (Hymenoptera: Braconidae) is a key beneficial and a critical component for the success of IPM in Australian cotton. The ecology of *M. demolitor* and effects of insecticides on the life stages of *M. demolitor* were studied, in an attempt to promote conservation and increase the role of *M. demolitor* in IPM.

This study showed that *Helicoverpa* spp. larvae parasitised by *M. demolitor* cause insignificant damage compared to unparasitised larvae, with a parasitised larva consuming approximately 5% of that consumed by a healthy larva. This means that parasitised larvae should be tolerated and not counted in larvae checks to determine spray decisions. *M. demolitor* larvae took 10 days to complete larval development at 25°C, 60-70% relative humidity and a 14:10 light: dark photoperiod. These data contribute to the basic understanding of the ecology of *M. demolitor*.

M. demolitor was the dominant larval parasitoid in southeast Queensland and was present in the cotton crop at the critical stage of the crop's development. *M. demolitor* appeared in the crop early November to December, and occurred in significant numbers in the crop from early to mid December until the end of the season. High rates of parasitism of *Helicoverpa* spp. (between 50% and 90%) of second to third instar *Helicoverpa* spp. larvae by *M. demolitor* were recorded. Relatively large numbers of *M. demolitor* adults were found in sprayed fields compared to unsprayed fields.

Methods of monitoring *M. demolitor* adults and the impact of *M. demolitor* on *Helicoverpa* spp. larvae in the field were studied. It was determined that an estimate of percent parasitism, sticky traps baited with virgin females and direct observations were useful tools for research or for ongoing monitoring of *M. demolitor*. Suction sampling, yellow coloured water traps and traps baited with *H. armigera* larvae proved unsuccessful at monitoring *M. demolitor*.

The diurnal behaviour of *M. demolitor* adults was studied. Large numbers of adult *M. demolitor* were observed in the field. Both male and female *M. demolitor* were inactive early in the

morning and late evening, but were equally active throughout the day. There was a distinct diurnal pattern in catches from sticky traps baited with virgin females. Males were caught most often early in the morning, declining during the afternoon. None were captured during the night. Disruptive insecticides should be applied when *M. demolitor* are inactive. In a monitoring program, adult *M. demolitor* could be monitored at any time of the day without biasing results.

A mark-recapture study estimated the *M. demolitor* population in an unsprayed cotton field. The population of *M. demolitor* males present in the 5 ha. block of unsprayed cotton was estimated to be between 1503 and 2421 (ca. 300-484 wasps/ha.), and the female population was estimated at 365 by extrapolating from the ratio of male wasps to female wasps at the time of the study numbers. At the time of the study there was approximately 60% parasitism of *H. armigera* larvae. This study showed that a small number of female *M. demolitor* in the field contributed to high parasitism rates of the host. This indicates that inundative releases of female *M. demolitor* may be a economically feasible control option for *Helicoverpa* spp. The mark-recapture method used in this study is useful for investigating the effects of pesticide treatments, by allowing estimation of the population present before and after insecticide application.

A release-recapture study of male *M. demolitor* was carried out. This study showed that fluorescent powder could be successfully used in a release-recapture study of *M. demolitor*, and most likely any medium sized Hymenoptera. This study showed that catch efficiency of the sticky traps baited with virgin females was reduced after 2 days in the field. Male *M. demolitor* were most likely to be caught in the closest sticky trap baited with virgin female, with male *M. demolitor* males not moving very far in response to these traps. This study showed that there was a large natural population of male *M. demolitor* wasps (ca. 62.5 male *M. demolitor* adults/ha.) present in a field sprayed only with biologically active insecticides.

M. demolitor prefer to parasitise second and third instar *Helicoverpa* spp. larvae. In order to study the interactions between *M. demolitor* larvae, host larvae and insecticides, baseline dose-response data were generated on second instar *Helicoverpa* spp. larvae. The IGR compounds, chlorfluazuron and lufenuron, as well as the MAC compound, methoxyfenozide, and Naturalyte, spinosad were the most effective stomach (ingestion-active) compounds tested against *H.*

armigera. These data are a useful reference tool and were used in the study on the interactions between *M. demolitor* larvae, host larvae and insecticides. The results are significant for IPM. The sub-lethal data generated in this trial show that although affected larvae do not die, their weights are significantly reduced, demonstrating reduced damage in the crop. This means that larvae affected by sub-lethal doses will cause negligible damage in the crop, and may be suitable sources of food for predators or hosts for parasitoids. The implications for insecticide resistance management are discussed.

A study examining the affects of commonly used cotton insecticides on *M. demolitor* throughout its life cycle was carried out. It was found that adult *M. demolitor* is tolerant of some insecticides. The toxicities of tested compounds for adult *M. demolitor*, in ascending order, were: chlorfluazuron = methoxyfenozide < primicarb < endosulfan ≤ dimethoate ≤ cyhalothrin < profenofos < deltamethrin ≤ bifenthrin < spinosad. This study showed that *M. demolitor* was relatively more tolerance of certain insecticides during its larval and pupal stages. *M. demolitor* pupae were protected from the effects of insecticides, except the pyrethroids. This study showed *M. demolitor* larvae developing within parasitised host larvae were unaffected by insecticide applications. However, larval parasitoids were indirectly affected by insecticides through host mortality. Larval parasitoids did not increase the susceptibility of their host to the insecticides, and parasitisation actually reduced the susceptibility of the host larvae to stomach insecticides, and to a lesser degree to contact insecticides.

This study showed that only the IGR compounds and the carbamate, pirimicarb, were of lower toxicity to the parasitoid than the larval pest. None of the other insecticides tested in the present study were acceptable for use in an IPM program. However, targeting insecticide applications when *M. demolitor* is in the pupal or larval stage will reduce the impact of most disruptive insecticides. The use of insecticides with slow rates of kill may promote parasitism by allowing parasitoid larvae enough time to complete development.