Abstract

The Australian cotton industry relies heavily on pesticides to control key pests. These pests include the immature stages of moths of the genera *Helicoverpa* (formerly *Heliothis*). As a result of heavy pesticide use the cotton industry has been facing continual problems of *Helicoverpa* developing resistance to pesticides and has come under increasing pressure to reduce the contribution of high pesticide usage to environmental pollution. As a result, the Australian cotton industry has put considerable effort into finding alternative ways to reduce the impact of *Helicoverpa* on yield of cotton and reduce the use of pesticides.

One of the alternative ways to control *Helicoverpa* is the use of natural enemies. There is scant information available on whether natural enemies contribute to *Helicoverpa* mortality and even less on the impact that individual natural enemy species have in reducing *Helicoverpa* populations. This thesis investigates the impact of several natural enemy species (predators) on *Helicoverpa armigera* (Hübner) and *Helicoverpa punctigera* (Wallengren) eggs from the Namoi valley in New South Wales, Australia.

The predators *Nabis kinbergii* Reuter, *Dicranolaius bellulus* (Guerin Meneville) and *Coccinella transversalis* (Fabricius) occur in reasonably high numbers throughout the cotton growing season. Adults of these species were selected for experiments that were conducted at the University of New England, NSW, Australia. These species all consume immature stages of *Helicoverpa* but little is known of how many prey they consume or under what circumstances they will feed on *Helicoverpa*.

Using a series of trials in an environment cabinet it was determined that the factors that influenced predation, by the three predator species, were temperature, the position of prey on cotton plants and the hunger status of the predators. The optimal temperature for studying predation rates under artificial conditions was 30.2 °C. At the two extremes of 20°C and 36.8°C consumption of *Helicoverpa* was generally reduced. These temperatures also affected the proportion of individuals within a species finding prey. Placing eggs on the upper surface of leaves of a cotton plant was suitable for studying predation rates. Starvation of predators for different lengths of time prior to their use in experiments caused differences in both the number of prey consumed and the number of predators that found and consumed prey. This was of consequence only when an experimental time of 8 hours as opposed to 24 hours was

used. The optimal conditions determined by these experiments enabled studies on predation rates of each predator species to be done.

Studies on predation rates showed that the predator species *N. kinbergii*, *D. bellulus* and *C. transversalis* fed on an average of 51, 34 and 30 *H. armigera* eggs a day in petri dishes, if no restrictions to accessing prey were provided. However, the number of *Helicoverpa* prey provided on more realistic arenas, such as cotton plants, was found to affect the number of prey consumed in some predator species. In spite of this, at both realistic (low) and high numbers of *Helicoverpa* eggs, all predators exhibited a linear response to increases in prey density. That is, their hunger was not saturated by the number of prey provided. The predators' ability to find prey was hampered in larger search arenas (larger plants). *Nabis kinbergii* consistently consumed more *Helicoverpa* eggs than the other two species.

When alternative prey were included with *Helicoverpa* eggs, *N. kinbergii* preferred *Helicoverpa* neonates to eggs, *D. bellulus* showed an initial preference for neonates but consumed more eggs as neonate numbers declined and *C. transversalis* showed no preference at all. Including aphids of different densities did not reduce the number of *Helicoverpa* eggs consumed by *N. kinbergii* and *C. transversalis*. Only *D. bellulus* appeared to be affected by the presence of aphids, consuming fewer eggs at higher densities of aphids. All the predators tested consumed *Helicoverpa* eggs and early larval stages as well as the aphid *Aphis gossypii* Koch.

The difficnlty in the extrapolation of laboratory results to field conditions led to the use of immunodot assay (a serological technique) to determine if predators feed on *Helicoverpa* directly in the field. A comparison of a monoclonal and polyclonal antibody showed that only the monoclonal antibody was suitable for field trials. The polyclonal antibody cross reacted with predator haemolymph. Immunodot assay using chemiluminescence as a detection substrate provided the best method for determining whether predators had fed on *H. armigera* eggs. The method was tested on *Diomus notescens* (Blackburn), *D. bellulus*, *N. kinbergii*, *C. transversalis*, *Micraspis frenata* (Erichson) and *Harmonia* spp. Smaller predators provided the most consistant results. Trials in the field provided the first direct measurement of predation in cotton in Australia using this technique. A high proportion of the two predator species *D. notescens* (up to 86%) and *Harmonia conformis* (Boisduval) (up to 54%) were found to consume *H. armigera* eggs in the field.

The data presented in this thesis suggest that there are important differences in the factors that affect the consumption of *Helicoverpa* eggs by each predator species. These differences occur as a result of the number of *Helicoverpa* eggs available, the presence of other prey types and environmental parameters, such as temperature. These results verify that it is important to assess predator species individually if they are to be used in future control of *Helicoverpa* in Australian cotton.