The Seasonal Abundance and Impact of Predatory Arthropods on *Helicoverpa* Species in Australian Cotton Fields

by

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Abstract

The problems of assessing the predatory impact of one species of arthropod upon another have been addressed for over 50 years, and still remain largely unsolved. The literature is reviewed and principles derived from it are applied to the case of generalist arthropod predators on *Helicoverpa* spp. (Lepidoptera: Noctuidae) in Australian cotton. Theoretical aspects discussed include the validity of functional and numerical responses as indicators of field predation rates and some current ideas on the survival behaviour of predatory insects, along with their implications for the desirable properties of biological control agents.

The production of cotton in Australia relies heavily on the use of broad spectrum insecticides to control two key pests, *Helicoverpa punctigera* (Wallengren) and *Helicoverpa armigera* (Hübner). The potential loss of two of these insecticide groups, the synthetic pyrethroids and endosulfan, because of resistance in *H. armigera* and environmental concerns respectively, has rekindled the search for ways of utilising alternative sources of pest mortality. An appealing possibility is that endemic predators and parasites can maintain pest populations below economic thresholds. However the extensive use of insecticides throughout the history of Australian cotton production means that the potential of endemic natural enemies to control *Helicoverpa* spp. is not normally realised.

Trials using realistic field sizes were being conducted by Auscott Pty. Ltd. (a large corporate farming group at 'Midkin', near Moree, N.S.W.) to broadly assess the prospects of growing cotton without using endosulfan and synthetic pyrethroids. This presented an opportunity to examine the predatory impact of arthropod populations which could reasonably be expected to increase under these 'softer' insecticide strategies. Pioneering efforts in 1993 by Coulton Farming (based at Goondiwindi and North Star, N.S.W.) to grow organic cotton provided further opportunities to examine predator populations under reduced insecticides practices in cotton fields isolated from regional insecticide drift.

The experimental sections of this thesis report the abundance of all the arthropods, especially predators, collected in suction samples from the different treatments used at these farms. The treatments included: no insecticides, organically certified treatments, perceived softer insecticide options (essentially avoiding endosulfan, synthetic pyrethroids and organophosphates) and conventional broad spectrum insecticides.

Surveys were conducted using visual methods and a variety of suction samplers, the main one being a backpack-styled suction sampler similar to the D-vac designed by Dietrick (1961). The method of sampling was different from those previously reported in the literature, and from those used in the Australian cotton industry at the time of the study. Preliminary studies compared the effectiveness of different suction sampling methods and this is discussed along with an overview of sampling methods previously used for the evaluation of predatory impact. A large D-vac styled sampler collected many more arthropods (especially towards the end of the season) than a smaller one which was in common use in the cotton industry. The diurnal patterns of catchability using suction samplers were traced over three 24 hour experiments. The effect of sampling from higher compared to lower in the cotton crop canopy was briefly investigated and established that sampling which concentrated on the terminal sections of plants may fail to indicate the presence of considerable populations of predatory species.

Attempts were made to establish the impact of predators on *Helicoverpa* spp. by identifying spatial correlations between these arthropods. Higher numbers of predators, as species or groups, were present where overall prey was more abundant. However, there was no clear evidence that these areas corresponded to lower *Helicoverpa* spp. density. Furthermore, no particular predatory species, except perhaps *Geocoris* spp., appeared to specialise on this prey. In all cases the abundance of predators failed to explain enough of the variation in *Helicoverpa* spp. density to suggest a controlling impact.

Chlorfluazuron and thiodicarb were included in soft option insecticide treatments but were found to be not as soft on beneficial arthropods as expected. The converse was found for endosulfan. The regional use of insecticides appeared to cause a general decline in predator abundance throughout the latter half of the cotton growing season, even where fields were not directly treated with insecticide. The reduction in local predator source areas, insecticide drift and the movements of predators into treated fields are possible explanations.

Laboratory prey consumption trials were conducted which showed considerable potential for predator control of *Helicoverpa* spp. However field cage studies provided considerably lower and probably more realistic estimates of prey consumption. For the predator species tested, these experiments showed a very limited impact on *Helicoverpa* spp. at the commonly experienced densities of these predators and pests. These trials revealed the

difficulties in establishing real field predation rates on pests of relatively low density, especially when abundant alternative prey were present. The lessons learned, especially regarding the evaluation and interpretation of predator functional responses, are discussed.

Brief introductory experiments were conducted, using existing antibodies, to develop a serological (ELISA) protocol to identify predators which had fed on *Helicoverpa* spp. Predation was detectable in immediately prepared, fresh samples of a predatory beetle, *Dicranolaius bellulus* (Guérin-Meneville). However samples which had been snap frozen in liquid air produced false positives by disrupting the specificity of the biotin-avidin link commonly used in ELISA procedures.

The overall conclusion reached from all these studies is that the impact of predators on *Helicoverpa* spp. in cotton, as it is currently produced in Australia, is uncertain and generally low. However, recent advances in the management of *Helicoverpa* spp. are compatible with the conservation of predators. This should reduce the reliance on broad spectrum insecticides, thus permitting a more effective role for predators.

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