HELIOTHIS DYNAMICS ON THE DARLING DOWNS

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INTRODUCTION

Heliothis needs no introduction to producers of summer crops in the major agricultural regions of Queensland and New South Wales. As major insect pests of food, fibre, oil and fodder crops, *Heliothis armigera* (Hubner) and *H. punctigera* Wallengren have been the focus of researchers in Australia for many years. Despite the vast quantity and quality of research into these pests, today we are still almost totally reliant on insecticides for their management. One of the associated problems is insecticide resistance.

The economic impact of insecticide resistance is difficult to assess but it casts serious doubt on the long-term viability of the classical insecticide approach. Ultimately alternative tactics and strategies will need to be put in place. In order to refine the insecticide management strategy now in operation and investigate the viability of non-insecticidal methods of pest mitigation, there was first a need for a better understanding of the basic ecology of heliothis. While this offered no guarantee of an appropriate control procedure, such an approach provides a sound basis for the assessment of pest management options.

The purpose of our four-year study on the Darling Downs was 1) to investigate the population dynamics of heliothis and to quantify the significance of the major controlling influences (parasites, predators, pathogens, weather and host plant effects) on population change; and

2) to assess the potential for an area-wide management approach to the suppression of heliothis populations through the practical manipulation of the controlling factors.

In this paper we highlight the major findings of our study and indicate some future directions for heliothis management. Detailed results are not presented but if required, these can be obtained from the authors.

POPULATION DYNAMICS

The seasonal dynamics of heliothis and local variation in densities of their immature stages on different crops were studied by pheromone trapping for adults and routine sampling of medium to large larvae on major crops on the Darling Downs. Chickpeas were confirmed as an early season 'nursery' crop for the first (spring) generation of heliothis. Second generation larval densities peaked in reproductive maize and sunflower, and a third generation peaked in soybean, sorghum and late sunflower. Generally, the proportion of *H. armigera* within collected larvae increased as the season progressed. Natural enemies were detected in most crops but were low in numbers in early season (September to mid October).

EGG AND LARVAL MORTALITY

Factors affecting survival of eggs and larvae were investigated in field studies. Marked individuals were continually observed as they developed on plants up to the time that they pupated in the soil. The observed mortality of individuals was divided into five broad categories, namely that due to parasites, predators, pathogens, weather and host plant effects. The dislodgement of eggs from plants and the disappearance of first instar larvae accounted for the major decrease in heliothis numbers. More detailed results are presented elsewhere (*The Australian Cottongrower*, May 1990).

While parasites, predators and pathogens each had measurable effects on heliothis mortality on most of the crops studied, the size of these effects proved disappointing. This placed emphasis on the roles played by weather and host plant effects in causing mortality.

PUPAL MORTALITY

Heliothis survive the winter as diapausing pupae in the soil. The incidence of over-wintering diapause increased from low levels in mid March to peak in late April or early May. The peak diapause levels in *H. armigera* were higher than those in *H. punctigera*. Decreasing daylength and temperature were important factors influencing the induction of diapause in both species.

In studies on natural pupal populations under crops, average moth emergence (= pupal survival) was 37% (range 12-70%). Average pupal mortality due to parasites was 37% (range 8-62%). Pupal survival and parasitism levels for different crops were highly variable. Pupal mortality from predators and pathogens was generally low.

Under field cages, in the absence of cultivation, and with parasites and predators excluded, survival of pupae (mostly over-wintering) was high (greater than 80%). This demonstrated that pupae could successfully over-winter on the Darling Downs and reinfest crops in the spring. However, substantial spring flights of moths sometimes occurred before local emergence from over-wintering pupae and their origin(s) need to be determined. For more information on diapause and pupal survival see *The Australian Cottongrower*, May 1990.

HOW DOES THIS INCREASED KNOWLEDGE HELP US?

Each year spring moth flights set in motion the generation cycles in heliothis. The importance of migration in local population dynamics and the source(s) of immigrants are critically important in determining management strategy and the relevant control tactics. As immigration appears to be important in early season before the emergence of local moths, the possible effectiveness of area-wide management is decreased. However, as the first spring generation, regardless of its origins, is concentrated in a much smaller cropping area than later in the season, the concept of area-wide management deserves careful consideration and much further research. In the meantime, control will be restricted to finding ways to increase local mortality rates.

The considerable variation in survival rates between crops and between fields of a particular crop grown at different times during a season indicate how rapidly the numbers of heliothis generated in this region can change. Within cropping systems, mortality of heliothis in the egg and early instars is usually very high, but subsequently is low. Whereas this isn't a problem in crops such as sunflower or sorghum where later instars can be effectively controlled before serious plant damage occurs, this is not the case in cotton.

Research areas highlighted by our study which offer prospects for control include the evaluation of biocontrol agents for inundative and/or augmentative release, the enhancement of pathogenic activity in disease organisms suitable for biological insecticide formulations, and continuing development of plant varieties with improved insect-resistant characteristics.

The study reported here is one section of a collaborative program involving researchers from State Departments of Agriculture, CSIRO and Universities, aimed at improving our understanding of the complex heliothis life system. This multidisciplinary research effort is more likely to produce worthwhile results than any fragmented effort.

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