SURVIVAL OF <u>HELIOTHIS</u> SPP. PUPAE IN FIELD CAGES ON THE DARLING DOWNS

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INTRODUCTION

Heliothis punctigera Wallengren and *H. armigera* (Hübner) are major pests of field crops in Australia. Since *H. armigera* developed resistance to DDT, and more recently to pyrethroids, *Heliothis* spp. have demanded an increased research emphasis. In the past much of the *Heliothis* research has been directed at immediate management solutions, rather than obtaining a thorough understanding of their life systems with the aim of providing an ecologically sound management approach. We need to know why *Heliothis* spp. are pests and how best can we go about reducing their population levels.

One of the important characteristics elevating *Heliothis* spp. to major pest status is the ability to enter facultative diapause. Diapause maintains populations during periods when hosts are unavailable or conditions are not conducive to reproduction and population survival. Development resumes in spring with the onset of warmer temperatures and moth emergence becomes concentrated.

Survival of overwintering populations and the contribution of this carry over of moths to the development of populations the following season are not well established in Australia. Overwinter survival studies for *H. punctigera* and *H. armigera* were conducted in south-east Queensland to investigate differences between the two species. The objectives were:-

1) to investigate the survival of autumn-developing pupal populations,

2) to determine the temporal incidence of diapause,

and 3) to determine the pattern of spring moth emergence.

MATERIALS AND METHODS

Continuous cultures of H. punctigera and H. armigera were maintained in an outdoor insectary at Toowoomba. Mature larvae were released at Kingsthorpe Research Station, 20 km west of Toowoomba, into cages located in a field of raingrown sunflower growing in a black cracking-clay soil. Cages were of two types; one metre square pyramid cages and 7.5 cm diameter 15 cm deep wire gauze cages set into soil to a depth of about 10 cm.

Fifty mature larvae (usually 25 of each species) were released into the pyramid cages while larvae were released singly into the small wire cages. Releases were made each week during the period March to May inclusive in 1986 and 1987, using one pyramid cage and 50 small wire cages per release. Cages were inspected daily for emerged moths, then in early summer soil in the cages was excavated to determine depths of pupal cells and apparent cause of death for non-emergents e.g. moths trapped in the soil.

RESULTS AND DISCUSSION

Survival

When data were pooled for species and cage type in each season, 72.1% and 52.2% of larvae pupated successfully in 1986 and 1987 respectively (Table 1). These survival values do not reflect field survival for this stage because of unnatural losses which occurred. Invariably there were some larvae that escaped. Ants preyed on prepupae confined in cages in both years, especially in the individual cages. Mice caused losses of prepupae in some of the pyramid cages in 1987.

Survival of pupae to eclosed moths was high; 91.3% in 1986 and 91.6% in 1987. Differences between species were not great. Predation of pupae was negligible, and not unexpected since the cages excluded most predators. A pathogen, probably Beauvaria bassiana (Balsamo), also caused some pupal death. In both seasons 7.8% of pupae died from unknown causes. These dead pupae had no obvious deformities nor signs of predator or pathogen attack.

Table 1. Survival of Heliothis spp. in field cage releases at Kingsthorpe in 1986 and 1987.

Year	1986	1987
No. larvae released	1242	1692
No. pupae formed	896	884
% larva to pupa	72.1	52.2
No. dead pupae		
Cause unknown	70	69
Predation	4	1
Pathogen	4	4
No. eclosed moths	818	810
% pupa to eclosed moth	91.3	91.6
No. moths trapped	84	111
% eclosed moths trapped	10.3	13.7
No. emerged moths	734	699
% pupa to emerged moth	81.9	79.1
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% survival - larva to emerged moth	59.1	41.3

Although most moths successfully eclosed from pupae, some moths were trapped in the soil in the emergence tunnels. This is a common cause of mortality. Field tests have shown that soil factors at the time prepupae tunnel into the soil to construct their pupal burrows and subsequent rainfall affect the survival of eclosed moths. Where prepupae tunnel into moist soil the emergence tunnel retains its integrity, but if the soil is loose and dry, subsequent rainfall will significantly reduce moth emergence.

The high overall survival of pupae to produce moths - 81.9% in 1986 and 79.1% in 1987 - is in contrast to the low overwinter survival reported for H. zea (Boddie) and H. virescens (F.) in the United States. The survival value reported here is for autumn populations of pupae, and is not solely that of overwintering pupae. This is because it was not possible to accurately determine whether dead pupae and dead moths were non-diapausing or diapausing. The late season releases produced predominately diapausing pupae and their survival was similar to survival of earlier releases in which individuals were mostly non-diapausing.

Moth emergence

The temporal incidence of diapause was determined from the moth emergence data for the respective release dates. H. punctigera differed from H. armigera in the pattern of diapause incidence, but for both species diapause increased from low levels in March to high levels in May (Figure 1). More diapause was recorded earlier in the season for H. armigera than for H. punctigera.

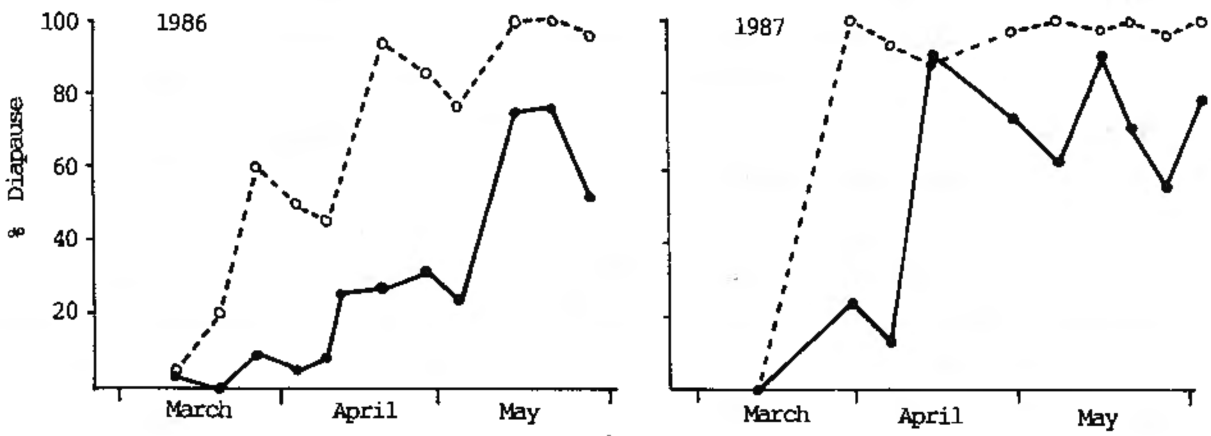

Figure 1. The temporal incidence of diapause for H. punctigera (●——●) and H. armigera (o---o) in field cages at Kingsthorpe.

The sequence of larval releases during March, April and May resulted in a continuum of moth emergence from non-diapausing pupae throughout the autumn and winter months depending on when they entered the soil. Moths emerged from diapause pupae from September onwards irrespective of when they entered the soil, with peak emergence in late-September to early-October (Figure 2). H. punctigera emerged before H. armigera. Time to 50% emergence from diapause was about 12 d earlier for H. punctigera. For each species females emerged before males. Pupal depth also influenced the emergence time - the greater the depth the later the emergence.

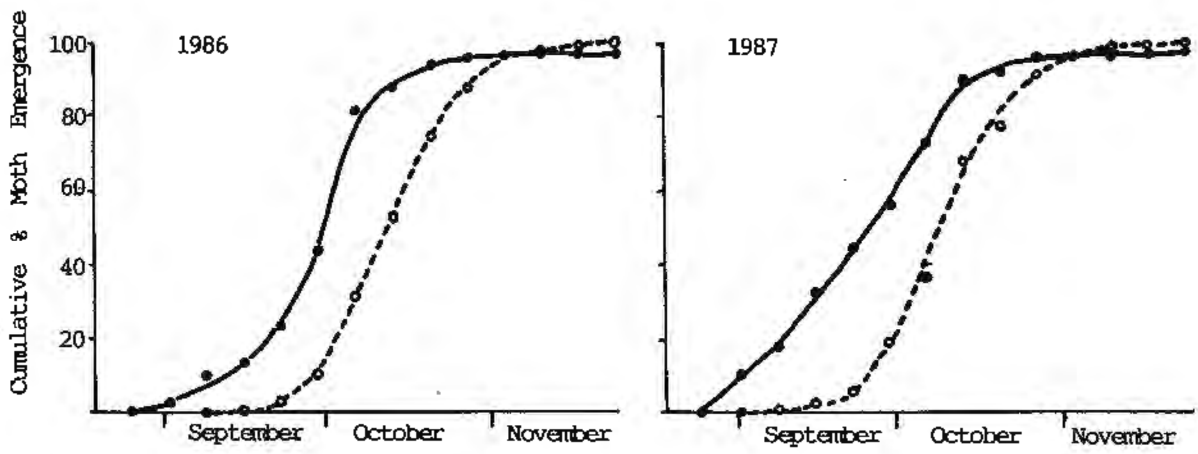

Figure 2. The temporal pattern of spring moth emergence for H. punctigera (●——●) and H. armigera (o---o) in field cages at Kingsthorpe.

Some H. punctigera pupae remained in diapause after the normal spring emergence period and did not emerge until early-summer (December). In contrast, all H. armigera pupae emerged from diapause during the normal spring emergence period.

The catches of moths in pheromone traps during spring and their relationship with moth emergence from the cages were determined. These relationships will be examined for the three years of this study in order to determine the origins of spring infestations of Heliothis spp. on the Darling Downs. Lack of synchronization between moth emergence from diapausing pupae and pheromone trap catches in an area has led researchers of other Heliothis spp. to suggest migration from other areas as the source of spring infestation.

CONCLUSION

Diapause during March is more likely in H. armigera than in H. punctigera, and during April and May both species produce diapausing pupae although the incidence of diapause during this period is greater in H. armigera.

In the absence of major predator, pathogen and parasitoid activity, and where no cultural management takes place e.g. cultivation, survival of autumn-produced pupal populations was high for both H. punctigera and H. armigera. The occurrence of moths trapped in their emergence tunnels by the crusted soil surface indicates that this factor could be important in some seasons. Management practices that disrupt the emergence tunnels probably represent the best approach to reduce overwinter survival.

The success of reducing spring populations in a cropping area by cultivation of fields will depend on whether spring infestations are of local origin or due to source populations elsewhere. This remains a matter of conjecture. If spring flights are of local origin, by how much must pupal survival be reduced in order to make a significant impact on the first spring generation?

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