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SOME ASPECTS OF POPULATION DYNAMICS OF *HELIOTHIS ARMIGERA* AT ICRISAT CENTER

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Population dynamics studies of *Heliothis armigera* are complicated because this insect has a wide host range. At ICRISAT Center, Patancheru, Andhra Pradesh, this insect attacks all the Institute's mandate crops: pigeonpea, chickpea, sorghum, pearl millet, and groundnut. The populations of this pest have been studied over a number of years by surveying eggs and larvae on the host plants, and by recording the numbers of moths in traps at ICRISAT Center and at other locations. The progress of these studies and the problems involved are summarised and the factors influencing populations, including migration, discussed.

INTRODUCTION

Heliothis armigera (Hb.) (Lepidoptera : Noctuidae) is an important pest of several crops in the semi-arid tropics of the Old world. A search of the literature revealed that this pest has been recorded as damaging 60 cultivated plant species and 67 other plant species, belonging to 39 families (**Reed & Pawar** 1982). There is little doubt that an intensive survey would greatly increase this host list. On and around ICRISAT Centre (18 N 78 E) in India, larvae have been recorded to feed on 98 species of plants, including ICRISAT's mandate crops: sorghum, millet, groundnut, pigeonpea, and chickpea (**Bhatnagar & Davies** 1978). This pest feeds and breeds throughout the year in Southern India, but its population varies greatly across the seasons; besides, there is an obvious relationship between the populations of the insect and the availability of its host plants.

We need to monitor the population dynamics of this pest so as to understand the factors involved in its build-up and suppression. Such basic knowledge is essential for planning an effective pest-management strategy that will help our farmers benefit financially without the risk of long-term problems, including resurgence. We require quantitative population data from the major host plants throughout each year at a number of different locations covering the pest's geographical range. Such data, gathered over a period of time, should enable us to have an understanding of the over all incidence of this pest in this region. Such studies were recommended by the group of experts that met at the International workshop on *Heliothis* Management organised by ICRISAT in November 1981. This paper describes briefly some of our studies on *H. armigera* populations, particularly at ICRISAT Center.

Populations of eggs and larvae:

H. armigera populations are normally assessed by counting the eggs and larvae on plant samples or in small field areas. The eggs, small and usually well distributed over the plant surface, are not easy to count. Counting of the larvae is even more difficult. The first and second instars are almost impossible to detect on plants in the field. Most recorders spot and count the medium and large larvae on the plants, missing many of the smaller ones. This is partly because, the damage caused by the larvae catches the eye first; the larvae feeding on or near the damaged plant tissues are spotted later. Damage caused by small larvae is inconspicuous. Even the third and fourth instars are not easy to detect, particularly if they are green. Beating the plants to dislodge the larvae for counting is ltot a very satisfactory method since small larvae are quite difficult to dislodge.

Although larval counts are not an accurate record of the total population present on the crop, they at least provide approximate estimates of those populations. Such counts can be used to compare populations across seasons and years, assuming that the counting method employed remains constant and that a similar proportion of the available larvae is counted on each occasion.

Plant Protection Surveillance team at ICRISAT records every week the number of *H. armigera* and other pest lavae on crop plants in all the fields in the pesticide-protected area, which accounts for 90% of the total cultivated area of the Institute's farm. These counts are used primarily to determine whether pesticide application is needed. These records have been summarised for weekly mean estimates of the total populations over a 4-year period in Figure 1. The patterns if onfestation on our crops over each year were found consistent, with most arvae feeding on groundnuts in July: on sorghum and millet in August and Sepember; on pigeonpea and chickpea from October till February; and on rabi groundnut, sorghum, and millet from February till April (**Bhatnagar** *et. al.*, 1982). During May there is virtually no larval population on ICRISAT farm because the month is observed as a closed season, when plants that can act as hosts for *H. armigera* are all destroyed. Outside ICRISAT boundaries, however, the larvae of *H. armigera* survive this hot.dry period on a variety of weeds(**Bhatnagar & Davies** 1978) and on irrigated tomatoes (ICRISAT, 1982). Although this insect has been recorded to enter pupal diapause in northern India (**Lal** *et. al.*, 1983), we have evidence of this at ICRISAT Center.

Catches of *H. armigera* moths in light traps:

The use of light traps to catch many insects that fly at night is well known. We have been recording, since 1974, the numbers of *H. armigera* and other insects caught in light traps (modified Robinson type) at ICRISAT Center (**Bhatnagar & Davies** 1979). Between 1977 and 1983, we operated three light traps on our farm

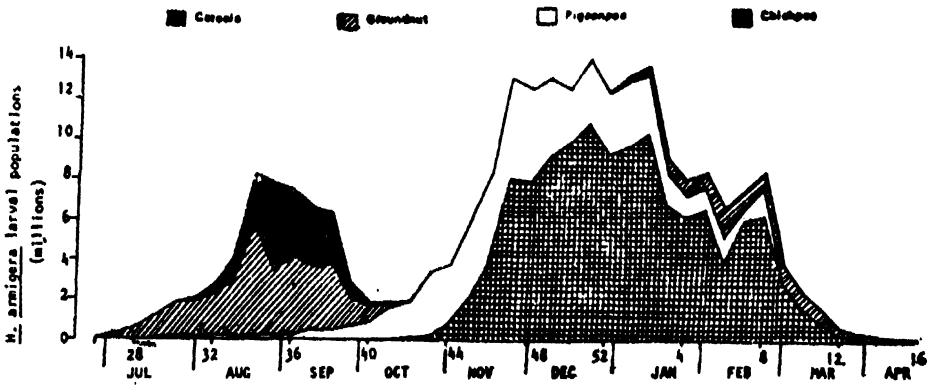


Fig. 1 Populations of *Heliothis armigera* larvae on crops in pesticide treated areas at ICRISAT Centre. Mean data of four years 1979-80—1982-83

Recently we discontinued the use of one of these traps because the sorting of catches needs skilled and experienced recorders, and takes considerable time.

Male and female moths are recorded separately. The females are dissected to determine their mating status (**Bhatnagar** 1980). We intend to use these data to supplement our migration studies. The average monthly catches recorded in our light traps from 1977 are shown in Figure 2. Although the catches differ from year to year, well defined peaks of activity occur at similar times in most years. Usually, there are three peaks in a year: August-September, November-December, and March-April. The August-September peak is when the moths emerge from larvae feeding on our groundnut, sorghum and millet; and the November-December peak is associated with larvae feeding on our pigeonpea, and chickpea (compare Figure 1). We have, however, no convincing explanation for the large number of moths often obtained in traps in April each year.

We have attempted to encourage the operation of a network of standard light traps across India, in cooperation with national entomologists. Our efforts have been only partly successful, since the irregular power supply in some research farms, and difficulties involved in sorting large catches of insects each day, have discouraged many potential collaborators. The monthly mean catches of *H. armigera* moths from light traps operated by ICRISAT staff at Hissar (29 N), Gwalior (26 N) and at ICRISAT Center (18 N) are compared in Figure 3. It can be seen that the peak catches at Gwalior and Hissar are in March-April, with secondary peaks in September at Hissar and in November at Gwalior. These data

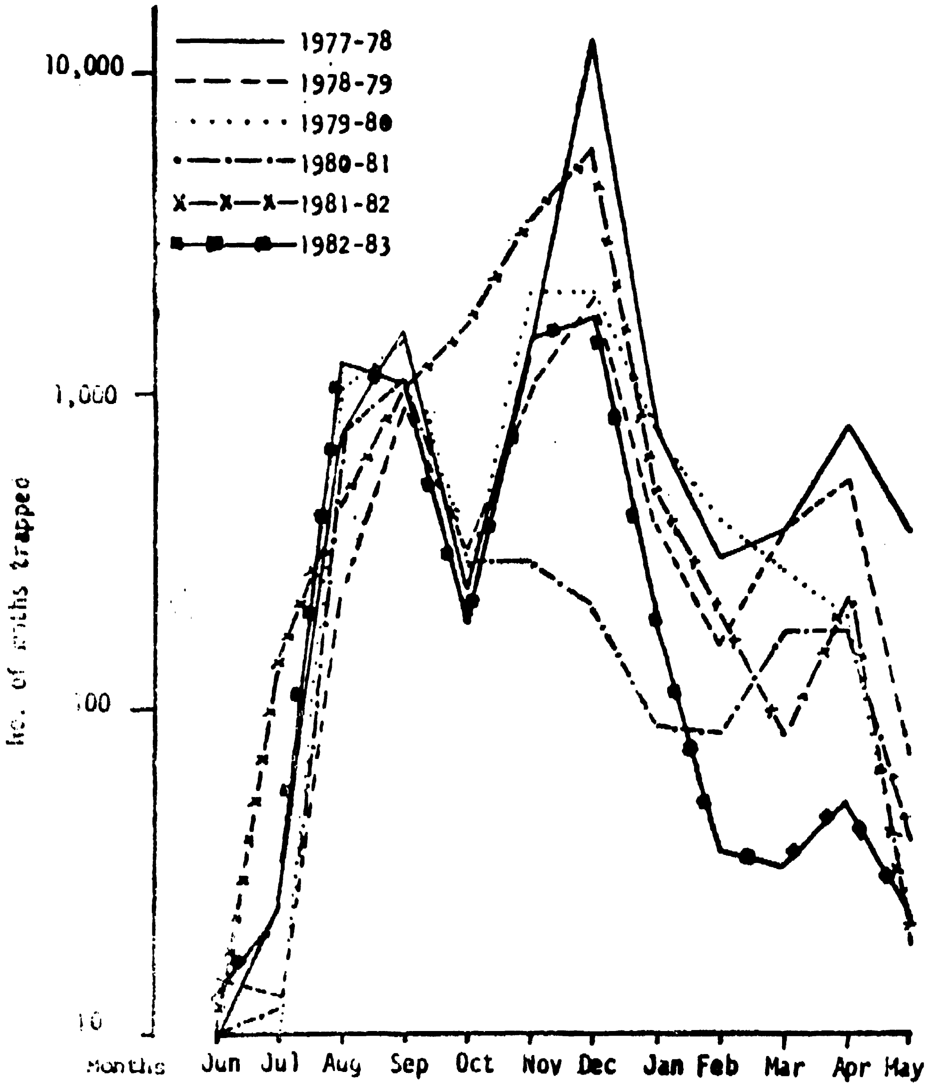
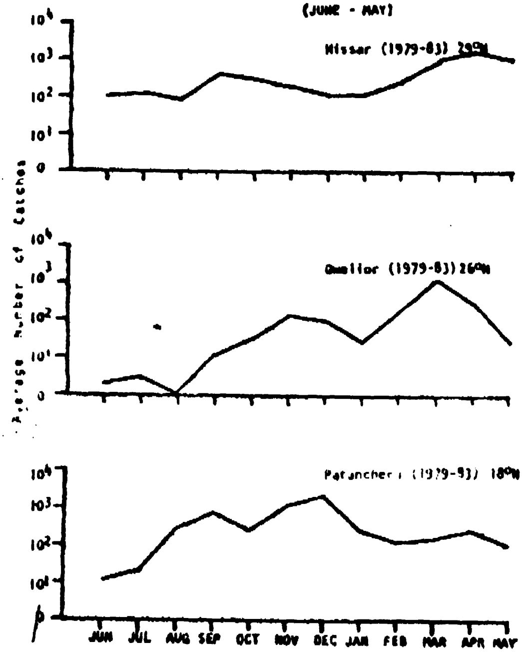


Fig. 2 Monthly catches of *H. armigera* in light traps at ICRISAT Center from 1977-78 to 1982-83 (average of three traps).

indicate that low winter temperature reduces the insect activity from December to February, and the hot dry season leads to a shortage of hosts and, consequently, of insects in June and July. At Hissar the peak in September is probably associated with the pest feeding on cotton and cereals; and the March-April peak with the larvae feeding on chickpea. The November peak at Gwalior is probably associated with the pest feeding on cereals and a number of other hosts; and the March peak with the larvae feeding on pigeonpea and chickpea.

FIG. 3. LIGHT TRAP CATCHES OF HELIOTHIS ARMIGERA AT THREE SITES IN INDIA (JUNE - MAY)



Catches of male *H. armigera* moths in pheromone traps:

In collaboration with Dr. B. F. Nesbitt and other scientists of the Tropical Development and Research Institute, London, we have developed a standard pheromone trap to catch male *H. armigera* moths and a few other insects. Compared to light traps pheromone traps are relatively cheap and do not require a power source. Skilled recorders are also not required for sorting the catches. These traps are now used throughout the year both at ICRISAT Center, and at many locations in India, Pakistan, Bangladesh and Sri Lanka by entomologists in these countries. Since 1981 pheromone traps at ICRISAT Center are being operated in the same areas as light traps for comparing the catches. Two pheromone traps are placed 100 metres away from each light trap. The traps are so positioned as to form a line across the prevailing winds. This arrangement was chosen to reduce the possibility of inter-trap interference. The weekly catches in these traps for 1981-82 are summarised in Figure 4, together with the estimates of the populations of larvae on the farm across that year.

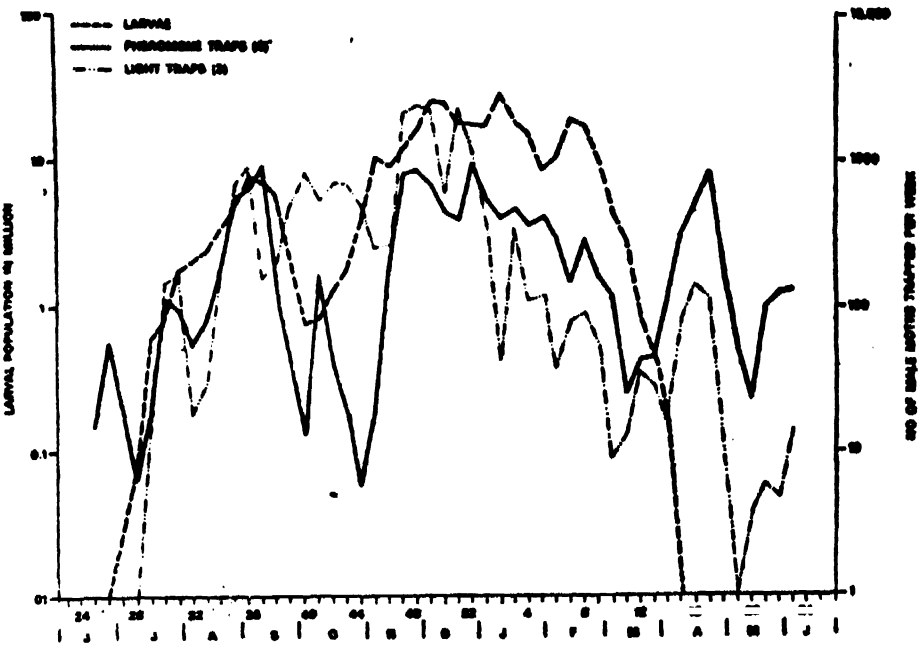


Fig. 4 *Heliothis* population at ICRISAT in traps add on crops 1981-82.

It can be seen that pheromone traps and light traps differ widely in terms of catches obtained. For instance, from April till June, the catches in the pheromone traps were much greater than those in the light traps; but, from September till December catches in light traps were more. Catches in both the types of traps are not strongly correlated with each other, or with the estimated populations of larvae on the crops.

At ICRISAT, we are now analysing climate data in relation to the trap catches in the hope of identifying correction factors. Such corrections, when applied to the trap catches will allow us to obtain much better correlations, therby utilising the traps as direct indicators of population levels. Until such techniques are developed, we cannot consider either kind of trap as really useful for monitoring populations. The traps may, however, help provide rough estimates of population fluctuations across and between seasons.

Discussion

To understand the factors that lead to the build up of *H. armigera* populations to damaging levels, we first need to collect adequate population data across crops, seasons and locations. As discussed earlier, accurate counting of eggs and larvae on crops is not easy; also the available data are inadequate for the purpose. It is easier to arrange for collection of data over years from network of standard traps being operated at several locations. We are trying to collect such data, but we realise they will be of little value until we develop capability to interpret them.

The population levels of *H. armigera* at any location are the end result of complex interactions of many physical and biological factors. It is easy to name and perhaps even quantify the effects of many of these factors; temperature and humidity directly affect the insects' reproductive rate, and indirectly through the host plants. The natural control elements, parasites, predators and diseases also have obvious effects that need to be quantified. However, we know nothing of one major factor that may be migration. Studies in the USA on another species of of this genus (**Raulston** *et. al.*, 1982) indicate that there are probably large-scale movements of moth populations. Until we determine whether *H. armigera* populations are sedentary or migratory, we cannot tell why local population fluctuates. We are hopeful that the studies at ICRISAT will at least clarify this shortly and lay a foundation for predicting the population levels.

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