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Effect of feeding, ageing and diapausing on longevity and oviposition in the adult females of the army worm, *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae)

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Abstract. Adult females are fed at regular intervals after emerging from the puparium, then forced to diapause at temperatures ranging from 5–10°C. Longevity, oviposition and the diapausing period are recorded. Ageing is indirectly proportional to the diapausing ability and directly proportional to the maturation of the gonads and oviposition.

Keywords. Diapause; feeding; longevity; oviposition; *Spodoptera litura*; Noctuidae.

1. Introduction

The army worm, *Spodoptera litura*, a polyphagous insect is a serious pest of several crops (Garard *et al* 1985). Moussa *et al* (1960) reported that the army worm feeds on 112 cultivated plants belonging to 44 families all over the world. Food plants play a vital role in development, survival and reproductive potential of insects (Painter 1951). In this communication, we report the relationship between the feeding and the diapausing ability, feeding-ageing and the oviposition effect and feeding-diapausing and the longevity period of the adult. The significance of the survival of the diapaused insect is also discussed.

2. Materials and methods

The culture of *S. litura* was reared from the soybean fields of Asian Vegetable Research and Development Center (AVRDC), Taiwan, ROC, in 1986. The colony was maintained in a growth chamber, fabricated by the Long Light Co., Taiwan. They were maintained at 28 ± 1°C, 60 ± 5% RH and 12 h photophase. The artificial diet for *S. litura* was obtained from Bioserve Inc., French Town, New Jersey, USA (Bio-Mix 9787). Among the adults which emerged from the puparium, only females were used for the experiment. Each female was placed in a plastic container and was fed with 10% honey solution. Feeding of the females was carried out according to the purpose of the experiment.

Experiment-I: A total of 20 females were divided into 4 groups of 5 insects each. The first group was fed daily with 10% honey solution for 3 days. After 3 days, they were made to diapause between 5 and 10°C temperature. After the diapausing period of 7 days (which was kept constant for all the experimental insects), they were brought to room temperature to find out if they are diapausing or not. Then they were maintained in the growth chamber and fed as before. Diapausing period, longevity, oviposition and mortality were recorded. The same procedure was followed for the second group of females. The procedure for the third and fourth

groups was adopted except the females which were fed on alternative days. The females of the third group were fed on the 1st, 3rd, 5th and 7th day and the females of the fourth group were fed on the 1st, 3rd, 5th, 7th and 9th day. For the oviposition, tissue paper was introduced into rearing containers.

Experiment-II: Ninety adult females of *S. litura* were divided into 6 groups, each containing 15 females. The zero day group was not fed and they were made to diapause on the same day of emergence. The females of 1, 2, 3, 4 and 5 days were made to diapause after they had completed their respective days in the growth chamber where they were fed once a day with 10% honey solution. The diapausing period was not predetermined and was 5–10°C temperature. When they were diapausing, they were brought to room temperature once a day to find out if they are alive or not.

3. Results

Figure 1 shows results for the females which are fed daily for 3 days. From the results it is clear that two females lived beyond 4 days after diapause and one of them also laid eggs (which is shown in figure 5), while two others lived 2 and 4 days respectively after diapause. The remaining two females died during diapausing period.

Figure 2 shows results for the females which are fed daily for 5 days. Among them, one female lived beyond two days after diapause, while another lived just for one day after diapause. Mortality of the remaining 3 females occurred during diapausing period.

Figure 3 shows the results for the females which are fed on alternative days viz. on the 1st, 3rd, 5th and 7th day before they were forced to diapause. The mortality of all females occurred during the diapause period, but 3 of them laid eggs (figure 5) 1 h after they were forced to diapause and consequently died during diapause.

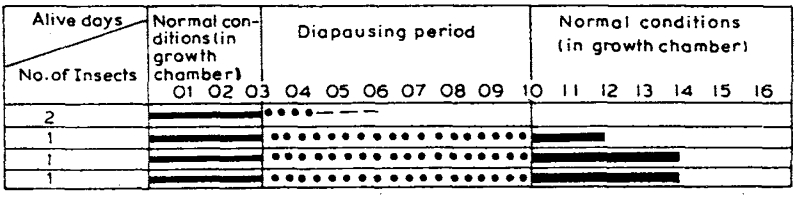

Figure 1. Life longevity tables of daily fed females for 3 days, followed by a week of diapausing period (kept constant for all the females of experiment-I) and to returning normal conditions.

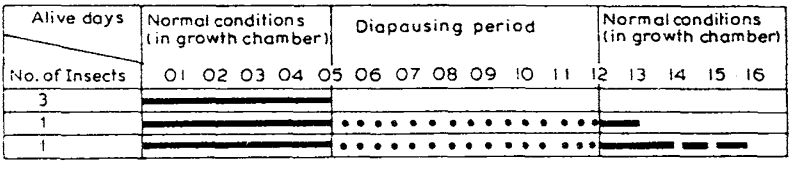

Figure 2. Life longevity tables of daily fed females for 5 days, followed by a week of diapausing period and returning to normal condition.

(3)

Alive days / No. of Insects	Normal conditions (in growth chamber)							Diapausing period						Normal conditions (in growth chamber)		
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
5																

(4)

Alive days / No. of Insects	Normal conditions (in growth chamber)								Diapausing period						Normal conditions (in growth chamber)	
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1																
4																

Figures 3 and 4. Life longevity tables of alternative (1, 3, 5, 7) days fed females with a week of diapausing period and returning to normal conditions.

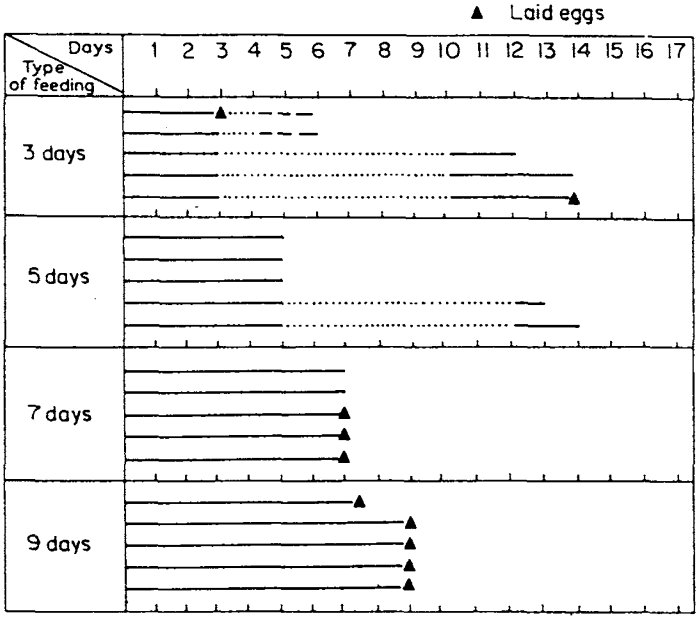

Figure 5. Life longevity tables of all the females involved in experiment-I (figures 1–4) with all the treatments showing oviposition, diapause, longevity and mortality.

(Note: Straight line indicates normal conditions before diapause; dotted line indicates diapause period; dotted-straight line indicates normal conditions after diapause; blank space indicates mortality; broken line indicates alive beyond).

Figure 4 reveals the results for the females which are fed on alternative days viz. on the 1st, 3rd, 5th, 7th and 9th day. Among them, one female laid eggs on the 8th day and died in the growth chamber itself even before diapause. The remaining 4 females were made to diapause. It resulted that all of them laid eggs 1 h after they were put in diapause and consequently died in diapause (figure 5).

Figure 5 overviews all the parameters used in the experiment-I whether it was in the growth chamber or in the diapausing equipment and reports the results. The egg laying behaviour of all the experimental insects are indicated in this figure.

Table 1 reveals the presence of the longest diapausing female in each group. It also indicates the average period of diapause of an insect in each group. It is important to note that the insects that were fed for 3 days have the highest average of diapause (4 days/insect) among 90 females involved in the whole experiment. On the opposite, the lowest average (1·32 days/insect) is held by insects from the zero day feeding group.

Figure 6 shows the longest diapausing female in each group and the average period of diapause of any individual female of that group.

Table 1. Life diapause tables of 90 females for all treatments. showing the longest diapausing period, average diapause period and the mortality of all the females involved in the experiment-II.

Treating days Sum of dead insects Alive days	0	1	2	3	4	5
1	11	3	5	5	2	1
2	3	2	4	0	0	3
3	0	3	1	3	7	7
4	0	0	0	2	1	1
5	0	4	2	0	4	3
6	1	2	2	2	1	
7		1	1	2		
8				0		
9				0		
10				0		
11				0		
12				1		
The longest life	6	7	7	12	6	5
The average period of diapause	1·53	3·66	3	4	3·53	3·13

Temperature range 5°–10°C is kept constant.

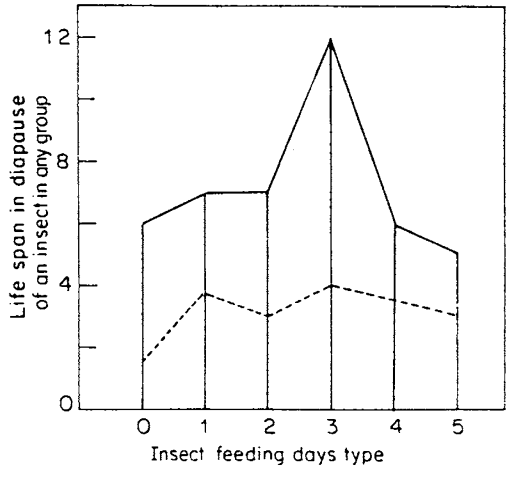

Figure 6. Straight line indicates the longest diapausing period of female of each group while the dotted line indicates the average period of any female of each group.

4. Discussion

Diapause is a time of slowing or stopping development, feeding and all but few maintenance functions. It involves arrest of development and this means in the adult, to prevent the maturation of the gonads (Horn 1976). Diapause may occur in the eggs, larvae, pupae or adult stages, though most commonly it occurs in the egg or pupa. There has been numerous reports of pupal diapause studies in the Lepidoptera species (Jayaraj 1981; Hachett and Gatehouse 1979; Dingle 1978; Roome 1979). Practically, there is very little information available on the adult diapause studies. It has been reported that diapause in the pupae of *Heliothis armigera* has been found to be induced by temperature and short day lengths (Roome 1979). All the females of *S. litura* that were made to diapause were all under low temperature condition i.e. 5–10°C. Feeding has been shown to promote mating and oviposition in *Heliothis* species (Parsons and Marshall 1939; Callahan 1958). Feeding with age leads to maturation of gonads and oviposition in the adult females of *S. litura* (figure 4). The eggs were laid during the feeding period when gonads obviously become mature (figures 3 and 4). Since the females had no chance to mate with the males, they oviposited only unfertilized eggs. It must also be said that all females that had laid eggs died subsequently 1 h after laying eggs. The results (figure 5) clearly indicate that the ability to diapause and be alive afterwards is much higher with the younger females than with the older ones (figures 1 and 2). But feeding with the age has decreased the capacity for diapause. Feeding has evidently been not a factor to increase the diapausing capacity (figures 2–4). In the final analysis it is the age factor of the females that weighed in favour of diapause rather than the feeding factor of the females. Greater the feeding is higher the metabolic activity in the adult, which is a hindrance to diapause of adults. It can be inferred that initial feeding (moderate) is more than sufficient for the diapause. The whole thing can be summed up in this way that aging and feeding is directly proportional to the maturation of the gonads and oviposition effect while the young female (age) with initial feeding is directly proportional to the diapausing capacity. Ageing certainly inhibits the diapausing process.

Mass rearing of insects have been successfully done to enable greater experimental studies in the field of applied entomology. Adult diapausing studies can then be very useful in such experimental studies, especially in delaying the use of insects for varying conditions particularly with respect to temperatures and day and night conditions.

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