EFFECT OF DELAYED MATING AND SEX RATIO ON BIOLOGICAL PERFORMANCE OF ALMOND MOTH, *Ephestia cautella* (WALKER) (LEPIDOPTERA : PYRALIDAE)

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Abstract

The Almond moth, *Ephestia cautella* (Walker) is an important and dangerous pest in stored products especially cereal and grain. No comprehensive study of delayed mating and sex ratio on *E. cautella* is currently available. The delayed mating experiment was conducted in four treatments including 0 (no delayed), 1, 3, and 5 delayed days. Sex ratio experiments were conducted in five different treatments, single male:single female (control), 1:2, 1:3, 2:1, 3:1. Additionally, biological studies and sex determination are available from these studies. Delayed mating of *E. cautella* caused decreasing of egg fecundity rate as increased as delayed days, which may cause female physiological conditions. Sex ratio showed that increasing number of males increases fecundity rate of eggs. Increasing of egg fecundity may caused by fluid energy transfer during copulation from male to female which affected embryo developments. The biological performances of *E. cautella* under artificial diet during 50 days treatments are described as follow egg hatching period 4-5 days, male larvae are 12 days and female 9 days, pupal period of males are 12 days and female 10 days, while adult life span of males are 6 days and female 8 days. The sex of *E. cautella* determined by availability of brown dark coloring marked in abdomen part in larval and pupal stage. Adult stage sex determined cone shape of abdomen tips in male while female determined by thin forked abdominal tips.

Keywords: copulation, sex ratio, fecundity, *Ephestia cautella*

Introduction

Almond moth, *Ephestia cautella* (Walker) is one important stored product pest in the world. It a common cosmopolitan pest in the most of temperate world as well as in warmer areas. *E. cautella* have been recorded by various experts caused huge losses and qualitative damages of dry fruits, stored food grains and their derivative products (Boshra, 2007). Morphology of *E. cautella* are similar in many characters with *Plodia interpunctella*. In case of *P. interpunctella*, their fecundity depend on several factors, including type of food, size of the female, provision of drinking water, and physiological condition of adult female moths (Mohandass, 2007). The Food availability and quality naturally will affect life-history of organism such as *E. cautella* and other moths. Many pyralid moths have non-feeding adults, and therefore dependent on larval food quality and quantity to determine adult gamete production (reproductive investment), fat reserves and muscle tissue. The almond moth *E. cautella* is a typical indoor pest, has a non-feeding adult with functional mouthparts that are used to drink liquids (Ryne, et al 2004). Biological performance and life cycle of *E. cautella* merely with *E. elutella*, where *E. elutella* having adults stage up to 3 weeks, depending on temperature and body size, and morphology of males shorter than females. In *E. cautella* the single female laid 150 – 200 eggs except in some case over 300 eggs. Eggs Incubation of *E. cautella* 6-7 days under 25 °C temperature. These species larvae develop through six instars and 2 - 3 months inside the food storage. The duration of the
pupal stage is affected by temperatures, according to Ashworth (1993) it can be reach 45 days at 15 °C and only 10 days at 30 °C. Delayed mating an organism including *E. cautella* is affected pheromone. The pheromone communication system of moths has developed so that males can find females over a relatively large area in certain day, even when the population density of the females is quite low. Pheromones are typically consisted 2-5 components that occur in relatively constant ratios. If the pheromone blend is altered, inactivity or a reduced response may occur (Jones, Anon; Mozūraitis, 2006). Mating was influence by pheromones, in *E. cautella* presence of high concentration of sex pheromones generated by the females population, sexually excited males of this species will attempt mating with any moths. It therefore appears likely that synthetic female sex pheromones will limit reproduction effectively in *E.cautella* only in at very low adults population densities (Barrer, 1976). No comprehensive study of *E.cautella* are currently available from around the world. The present experiments are designed to study effect of delay mating and sex ratio copulation on biological performance of *E.cautella*. These experiments be expected effective method in future for controlling stored pest included *E.cautella*.

**Materials and Methods**

**Biology study**

A single fresh egg from the culture was put on 9 cm Petridish with small amount of artificial diet. All treatments were conducted in Entomology Laboratory, Plant Protection Department, King Saud University. Daily observation was conducted till the individual death and be tabulated (incubation, larval, pupal, and adult period). Observation consisting of morphological appearance and behavior during all stages. Thirty replications were applied during experiments. Diet replacement treated only for larval stage and carry out every two days.

**Sex Determination**

Sex determinations of *E. cautella* were applied for three main stages, larvae, pupa and adults. Each stage consisted ten replications with daily observation. Sex determination of larval stage was determined by appearance of testis in dorsal of abdomen and black coloration. The Male was identified with black or brown dark spot otherwise female identified without dark spot on dorsal of abdomen (Figure 1). In Pupal stage, male was identified with dark spot lines appearance while, female had no spot on the dorsal part closed to the head part (Figure 2). In adult stage, male identified with the tip of abdomen forked and slender and female with tip tube like appearance (Figure 3).

![Figure 1. Male and female of larva *E. cautella*](image1)

![Figure 2. Male and female of Pupae *E. cautella*](image2)
Delay mating

The delayed mating of *E. cautella* was conducted to observe biological performance such as fecundity and hatch ability of eggs. The male and female adults in same age were prepared for delayed mating in one, three and five days. In the series of day (1, 3 and 5 days) male and female were mated together in a 250 ml jar covering with muslin cloth (Figure 4). After 24 hours, they were separated into a single container and observed the eggs production daily until the female and male died. The eggs hatchability were observed daily.

Sex ratio

The newly emerge of male and female were collected and gathered together until their died. Observations of eggs production were conducted every 48 hours (two days). The sex ratios (male: female) were designed as 1:2; 1:3; 2:1 and 3:1. The eggs hatchability observed every 48 hours. All experiment was conducted under 25±1 °C temperature regime, 16 hours photoperiod and 70 % humidity.

Results and Discussion

1. Biology

The eggs of Almond moth, *E. cautella* were deposited by adult females in varied quantity. In our experiment shown the eggs were laid on the surface of the walls or fell down to the basal of containers. The eggs sometimes attached to the walls or surface for several days. Eggs were laid singly or in a group, with morphology of eggs was sandy white in color when it was laid and turned darker as well as embryo development. Each egg was covered with relative tough shell and be deposited in almost all areas of the container. This indicated that the female behavior were moving frequently during laying eggs were distributed in the container. The eggs hatch in 4 – 5 days after laid on the substrate.
Table 1. Longevity of *Ephestia cautella*

<table>
<thead>
<tr>
<th>sex</th>
<th>Incubation (day)</th>
<th>Larval (day)</th>
<th>Prepupa (day)</th>
<th>Pupa (day)</th>
<th>Adults (day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>4.5±0.52</td>
<td>12.83±14.99</td>
<td>17.33±14.86</td>
<td>12.08±1.38</td>
<td>6.25±1.71</td>
</tr>
<tr>
<td>female</td>
<td>4.53±0.64</td>
<td>9.00±7.23</td>
<td>13.53±7.11</td>
<td>10.93±1.16</td>
<td>8.53±3.38</td>
</tr>
</tbody>
</table>

In our artificial media, prepupal periods were longest period compare with other stages. It means the process to become pupa from the larval are need more time. Its’ may cause from the ingredients of media. The rich protein will make growth faster or optimally including process from larval to pupal stage. Larval develop through five instars, were mostly larvae entering the food and begin to feeding.

Pupal stage period were almost 12 days on male and 10 days on female. The body appearance of pupal stage was light brown to dark brown, as dark as growth of pupae. The males had longer time period compare to female.

The adults male life span of *E. cautella* was six days while female were nine days. The adult life span was quietly different with the larval and pupal stage where, the duration of males was longer than females durations. These results are agreed with Ashworth (1993), which the life span of males adult are shorter than female.

2. **Sex ratio of mating**

Sex ratio of mating in *E. cautella* was affected to the fecundity. The result shown fecundity was decreased as increased number of female. These result was indicated competitions between during mating process, especially in ratio male: female, 1: 2 and 1: 3. Fecundity was also affected by female nutrition, where transferred from male to female during copulation. In these case, the higher number of male were transferred more liquid nutrition so affected to increasing fecundity. These results was conformed with Fox (1995), in his experiment on *Callosobruchus maculatus*. The control was highest fecundity compared to another treatments that may caused by female condition rather than male competition.

Table 2. Fecundity of *E.cautella* different sex ratio male and female

<table>
<thead>
<tr>
<th>Ratio male : female</th>
<th>Number egg/single female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1(control)</td>
<td>250.5±239.17a</td>
</tr>
<tr>
<td>1:2</td>
<td>53±3.54b</td>
</tr>
<tr>
<td>1:3</td>
<td>62±2.83ce</td>
</tr>
<tr>
<td>2:1</td>
<td>98.5±13.44d</td>
</tr>
<tr>
<td>3:1</td>
<td>75±8.49e</td>
</tr>
</tbody>
</table>

a–d Mean values followed by different letters within rows are statistically different (p < 0.05).

Delayed mating

The Fecundity of *E. cautella* after delayed mating for one day was 177±99.3, where lower than control (250.5±239.17) and delayed mating 5 days (296.50±100.69). Compared to delayed mating for 3 days (84.33±48.79), these results was higher. The fluctuated of fecundity showed that condition of adults *E. cautella* were unstable physiologically both males and females. Unstable physiological condition of adults were affected the quality and quantity of eggs production.
Table 3. Fecundity of *E. cautella* under different delayed mating

<table>
<thead>
<tr>
<th>Treatment (delay in days)</th>
<th>Number of egg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>control</td>
</tr>
<tr>
<td>Number egg/female</td>
<td>250.5±239.17a</td>
</tr>
<tr>
<td>Life span</td>
<td>8.5±4.80</td>
</tr>
</tbody>
</table>

a–d Mean values followed by different letters within rows are statistically different (p < 0.05).

Physiological of female was determined the quality of eggs, these agree with Barrer (1976) resulted in his experiment. The egg fecundity was also affected by female life span as shown in five days delayed mating. Life span of adult females were indicate the quality of nutrition inside body.

Conclusion

The biological performance of *E. cautella* in artificial diet was concluded as by egg hatching time, larval period, pupal period and adult period. The hatching time of egg was 4–5 days. The male larval period was longer than female. Pupal period of males was longer than female, while adult life span of males was shorter than female. During these study the life cycle of *E. cautella* was 50 days long. Increasing male number were affected increased egg fecundity of *E. cautella* in sex ratio treatments. The physiological of females were affected of egg fecundity in delayed mating.

Acknowledgment

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