Biological Studies on Red Palm Weevil Rhynchophorus ferrugineus (Olivier) Coleoptera: Curculionidae

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ABSTRACT

Three different diets (sugar cane slices, semi-artificial diet and palm heart) were tested for rearing red palm weevil Rhynchophorus ferrugineus and to investigating the effect of diets on some biological aspects under laboratory conditions. Larval duration of different instars was significantly affected by different diets, except for the 7th, 8th, 9th and 10th larval instars. The larvae fed on sugar cane slices slowly developed to exhibit the longest duration of 179.19 days. Meanwhile, the larvae fed on the other diets showed a gradual shortage in larval periods to give means of 127.24 and 125.98 days with semi artificial diet and palm heart, successively. Feeding on different diets had insignificant effect on the prepupal period. Insignificant differences in the means of pupal period were statistically obtained between the tested diets. Mean of pre-emergence period from cocoon of red palm weevil was significantly influenced by feeding on different diets. Longevity of males emerged from larvae fed on the different tested diets insignificantly varied, but in case of females this effect proved to be statistically significant. The sex ratio of emerged adults was not significantly impacted by variations in the type of larval food. The generation interval showed highly significant differences between the tested diets. Mean number of eggs deposited by emerged females from larvae fed on different diets was high significantly varied according to the diet used. The mean of incubation period of egg laid from adult fed on three tested diets appeared to be not significantly affected. Hatchability percentage proved to be statistically insignificantly impacted by different diets.

Key words: Biological aspects, three different diets, Red palm weevil, Rhynchophorus ferrugineus

Introduction

The date palm, Phoenix dactylifera (Palmae) is the most common and widely cultivated plant in the arid regions of the Middle East and North Africa where, in many areas, its fruit has provided the carbohydrate food of local people for nearly 5000 years (Purseglove, 1972; Jones, 1995).

Red palm weevil (RPW) Rhynchophorus ferrugineus (Olivier) (Coleoptera: Curculionidae) was first described in India as a serious pest of coconut palm (Lefroy, 1906) and later on it was reported on date palm (Lal, 1917; Buxton, 1918).

During the last decade of the 20th century, a new most serious insect pest, namely the red palm weevil, R. ferrugineus was firstly recorded in date palm plantations in Egypt (Saleh, 1992; and Saleh and Gouhar, 1993).

It is likely that the origin of this pest was South East of Asia, mainly in Pakistan, India, Burma, Bangladesh and Indonesia, as have been reported by International Institute of Entomology in London (Liver, 1969) and spreaded later in many other counties where date palms are grown such as Iran and Arabian countries; Iraq, Saudi Arabia, Emirates and recently in Egypt. This weevil has been reported on 19 palm species belonging to 15 different genera (Barranco et al., 2000; EPPO, 2008 and Dembilio et al., 2009).

Insect eggs are laid in the injured leaf petioles of date palm trees. Hatching grubs (larvae) tunnel through the soft wood into the heart of the trunk and feed voraciously causing destruction of the palm where they complete their life cycle. Many generations can be passed in the same palm. Therefore, neither grubs nor damage caused can be seen directly. At times, a brownish viscous liquid can be seen oozing from small holes in the crown or trunk. Often, the attack by the weevil is discernible only when the palm has been extensively damaged. Timely action for the control of this insect is very difficult by the absence of any visual symptoms of infestation. By the time, the insect attack becomes discernible and irreparable damage would already have been done (Nirula, 1956).

Laboratory rearing of insects is very important to maintain purity, age and sex based selection for carrying out lab and field test for improving the control strategies. The knowledge of insect biology, behavior,
population dynamics and availability of various stages in bulk amount facilitates in keeping many factors unbiased (Shahina et al., 2009).

The aim of this study was evaluating the effect of rearing red palm weevil using three different diets (sugarcane slices, semi-artificial diet and palm heart) on some biological aspects of this pest under laboratory condition.

Materials and Methods

Effect of different diets on some biological aspects of *R. ferrugineus*

**Duration of egg stage**

Adult insects were obtained from cocoons collected from infested date palm trees at Qassasin district in Ismailia Governorate. The study was conducted in Yousry El-Sebay Research Laboratory of Red Palm Weevil at Qassasin, Ismailia Governorate, Plant Protection Research Institute under constant conditions of 29±1°C and 85 ± 5% relative humidity. For this purpose, a huge number of cocoons were brought and put in an oblongate opaque-white plastic boxes (30 x 20 x 15 cm.) with press on tight-fitting lids and muslin covers. These cocoons were kept till adult emergence. The newly emerged adults (20 pairs of newly emerged male and female weevils) were collected and reared in an oblongate opaque-white plastic boxes (40 x 30 x 20 cm.) with press on tight-fitting lids and muslin covers. The insects were left for one week to copulate and the boxes were provided with grated sugarcane as adult food and oviposition substrate. The food was changed daily by new fresh one. Afterwards the deposited eggs were carefully removed daily using a soft hair brush no zero. Many newly laid eggs almost of the same age (0.0 - 24 hours old) were available to initiate the insect first generation. These eggs were placed on a relatively small perforated plastic cover that based on the inner lid of cylindrical plastic box (9.5 x 5.0 cm.) which filled with 50 ml. of distilled water. Then, the box was tightly covered with imperforated cover to allow a relative humidity of about 90% in order to obtain high percentage of eggs hatchability. These boxes were put on an incubator in the laboratory and inspected daily to observe eggs hatching. Thus, newly hatched larvae of almost the same age (0.0 -24 hrs.) were available to the experimental work.

The newly hatched larvae were examined daily and the food (sugarcane slices, semi-artificial diet and palm heart) was changed every day up to the fourth larval instars. From the fifth larval instar, food was increased and was changed every 2-3 days. Semi-artificial diet contents were as follows: 1 kg. of sweat potatoes, 250 g. carrot, 20 g. glucose, 4 g. agar, 250 g. cereals, vitamin B (1 mg.) and vitamin D (0.2 mg.). These components were dissolved in half liter of water (El-Sebay, 2003)

**Number and duration of larval instars**

To study the number of larval instars as well as the duration of each instar, 150 newly hatched larvae were used by introducing each larva in small square piece of each diet (1.5 x 1.5 cm.) by using a soft hair brush no zero. Each piece was introduced in a plastic box (2.0 x 5.0 cm.) and tightly covered with a perforated cover. These boxes were placed on an incubator in the laboratory and the food (sugarcane slices, semi-artificial diet and palm heart) was changed every day. Larvae were inspected daily by using a stereomicroscope during the first three instars to record the date of moulting by observing exuvia, whereas during other instars larvae were large in size and their exuvia were easily distinguished by naked eyes. When larvae arrived to the tenth instar were put in a cylindrical plastic box (9.5 x5.0 cm.) and tightly covered with a perforated cover and reared on small pieces of each diet (2 - 3 cm. in thickness and 40 g. in weight) and changed every 4 – 5 days.

**Pupal stage**

When larva completes its development during the last instar, it begins to prepare itself to transform to pupal stage. This period is known as a prepupal period in which larva moves slowly and refuses food as well as begins to spin a cocoon from date fibers mixed with an adhesive saliva. The remaining food was removed from rearing boxes and an opening was made in the middle of cocoon to notice the development of prepupa to adult

**Adult stage**

After adult emergence from cocoons, adults were taken and put in the previously mentioned cylindrical plastic boxes and tightly covered (one pair/ box). These boxes were provided with rasper shreds of sugarcane pieces and inspected daily to record the date of laying the first egg as well as the daily number of eggs deposited till the end of female life in order to determine female fecundity, male and female longevity and
generation interval. When the first newly emerged female began to lay eggs, the second generation was initiated on this date, and so on.

**Results and Discussion**

*Effect of different diets on the duration of larval instars*

Data compiled in Table (1) show the duration of larval instars during the first generation of red palm weevil, *R. ferrugineus* fed on different diets (sugarcane slices, semi artificial diet and palm heart).

Statistical analysis of data reveals that the larval duration was significantly affected according to different diets, except with the 7th, 8th, 9th and 10th instars where the differences proved to be insignificant. The duration of early three instars ranged between 1.47 (semi artificial diet) to 2.37 (sugarcane slices), 1.79 (palm heart) to 3.52 (sugarcane slices) and 1.85 (semi artificial diet) to 4.61 days (sugarcane slices) for the 1st, 2nd and 3rd instars, respectively. The duration of the 4th, 5th, 6th and 7th larval instars slightly prolonged to record means of 2.63 (semi artificial diet) to 5.04 (sugarcane slices), 2.55 (semi artificial diet) to 5.22 (sugarcane slices), 3.93 (palm heart) to 6.65 (sugarcane slices) and 5.56 (semi artificial diet) to 8.01 days (sugarcane silences), successively. The prolonged duration of the 8th and 9th larval instars ranged between 8.00 (palm heart) to 9.71 (semi artificial diet) and 14.72 (semi artificial diet) to 16.79 days (sugarcane slices). The duration of the 10th, 11th and 12th instars ranged between 19.31 (sugarcane slices) to 21.17 (palm heart), 17.6 (semi artificial diet) to 28.74 (palm heart) and 20.63 (sugarcane slices) to 31.6 (palm heart), respectively. Larvae feed on semi artificial diet and sugarcane slices only gave the 13th instar, the duration was 22.73 and 26.23 days, consecutively. The 14th larval instar was attained only in the larvae fed on sugarcane slices (32.28 days). Sugarcane stem was found to be the best medium for the development of all larval stages to pupa in under conditions. All materials and diet (sugarcane, apple and cotton wools having 60% honey solution) showed significant difference among each other (Shahina *et al.*, 2009). On the other hand, Jaya *et al.*, (2000) recorded seven larval instars reared on sugarcane stem.

<table>
<thead>
<tr>
<th>Different diets</th>
<th>Mean duration of larval instars (days)</th>
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<tbody>
<tr>
<td></td>
<td>1st</td>
</tr>
<tr>
<td>Semi artificial diet.</td>
<td>1.47b</td>
</tr>
<tr>
<td>Sugarcane slices.</td>
<td>2.37a</td>
</tr>
<tr>
<td>Palm heart.</td>
<td>1.69b</td>
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<tr>
<td>F test</td>
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<tr>
<td>LSD 0.05</td>
<td>0.58</td>
</tr>
</tbody>
</table>

*Mead in the same column followed by the same letter are not significantly different (P<0.05) Duncan’s multiple range test.*

**Effect of different diets duration of larval stage**

Data in Table (2) show that feeding on different diets had a highly significant effect on the duration of larvae, since the larvae fed on sugarcane slices slowly developed to exhibit the longest duration of 179.19 days. Meanwhile, the larvae fed on the other diets showed a gradual shortage in larval periods to give means of 127.24 and 125.98 days with semi artificial diet and palm heart, successively. However, (Kaakeh *et al.* 2001) reported that red palm weevil completed its larval period from 50-80 days Salama & Abdul Razek (2002) stated that red palm weevil was successfully reared in diets having high sugar contents.

According to L.S.D. value, the differences between any two means of larval period were significant with the exception of those between semi artificial diet and palm heart which appeared to be not significant at 0.05 level of probability.

**Prepupal period**

With regard to the effect of the previously mentioned feeding treatments on the prepupal period, wherein the full grown larva remain in cocoon immediately before pupation, the obtained results (Table 2) clearly indicate that statistically insignificant differences were detected between means of the three tested diets. The longest mean of 5.77 days that occurred on sugarcane slices, whereas the shortest one (4.26 days) was obtained with palm heart. The prepupal stage was completed in 2-3 days and pupal period last up 20 – 30 days as stated by (Shahina *et al.* 2009).

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Duration of pupal stage

Respecting pupal periods of the red palm weevil (Table 2), statistical analysis of results showed insignificant differences between the tested diets. The longest mean of pupal period (11.05 days) was recorded with pupae resulted from larvae fed on sugarcane slices. It was gradually shortened to 10.03 and 10 days with semi artificial diet and palm heart, respectively. Sugarcane stem was suitable for pupation because larval stages require fiber and failed to construct cocoon in any other diet (Kakeeh et al., 2001).

Duration of adult stage

After the pupal development has been completed, new adults are formed from pupae after moulting and remain for sometimes inside cocoons. This period is known as a pre-emergence period. Data presented in Table (2) show that this period had been influenced by feeding on the three tested diets indicating the longest mean period of 9.06 and 8.64 days for adult emerged from larvae fed on semi artificial diet and palm heart. On the contrary, the shortest periods of 6.34 days for adult were detected in case of larvae fed on sugarcane slices. As regards adult longevity of both sexes emerged from larvae fed on the different tested diets, the present results obviously reveal that the type of diet had insignificant effect on the longevity of males, but in case of females this effect proved to be statistically highly significant. The longest means of longevity, 94.6 days for males and 91.2 days for females were obtained with adults emerged from larvae fed on semi artificial diet. The corresponding shortest means of 86.2 days for males and 81.5 days for females were recorded with adults emerged from larvae fed on sugarcane slices.

Sex ratio

Statistical analysis of the results given in Table (2) revealed that the sex ratio of emerged adults (as % emerged females) was not significantly impacted by variations in the type of larval food. The highest mean percentage of adult females (55.62) occurred with larvae fed on palm heart, whereas the lowest one (52.19%) was obtained in case of semi artificial diet.

Generation interval

Statistical analysis of results in Table (2) showed highly significant differences between the tested diets. From the present results, it can be concluded that the shortest mean period of 226.39 days was recorded with females fed on palm heart, whereas the longest one of 275.00 days was obtained with sugarcane slices.

Female fecundity of eggs

Statistical analysis of the results given in Table (2) exhibited that the number of eggs deposited by emerged females from larvae fed on three tested diets was high significantly varied according to the diet used. From the obtained results, the insect fecundity can be arranged descendingly as follows: 225.6, 209.3 and 172 eggs / female resulted in larvae fed on semi artificial diet, palm heart and sugarcane slices, respectively.

When the individual comparisons between the different means of the treatments were made using L.S.D. value, it is clearly to show that the differences between any two means proved to be statistically significant.

Mean incubation period of egg

Data in Table (2) show that feeding on different diets had insignificant effect on the incubation period, the longest mean of incubation period was 3.27 days in larvae fed on sugarcane slices, while the shortest one was 3.06 in larvae of red palm weevil fed on semi artificial diet.

Hatchability percentage

Statistical analysis of the results given in Table (2) revealed that the hatchability percentage of egg was not significantly impacted by variations in the type of larval food. The highest mean percentage of hatchability (87.9 %) occurred with larvae fed on palm heart, whereas the lowest one (83.1%) was obtained in case of semi artificial diet. Results obtained by Kaakeh et al., (2001). Proved that no significant difference was observed in egg percent hatchability of RPW in cotton wools having honey solution and Petri dish lined with moist filter paper as compared to other diets.
**Table 2:** Effect of different diets on some biological aspects of the red palm weevil, *R. ferrugineus* under laboratory conditions; (29±1°C, 85±5% R.H.1)

<table>
<thead>
<tr>
<th>Different diets</th>
<th>Mean period (days)</th>
<th>Mean incubation period of egg (days)</th>
<th>Hatchability percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Larva</td>
<td>Pre-pupa</td>
<td>Pupa</td>
</tr>
<tr>
<td>Semi artificial diet.</td>
<td>127.24b</td>
<td>5.14</td>
<td>10.03</td>
</tr>
<tr>
<td>Sugarcane slices.</td>
<td>179.19a</td>
<td>5.77</td>
<td>11.05</td>
</tr>
<tr>
<td>Palm heart.</td>
<td>125.98b</td>
<td>4.26</td>
<td>10</td>
</tr>
<tr>
<td>F test</td>
<td>*</td>
<td>N.S.</td>
<td>*</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>12.99</td>
<td>N.S.</td>
<td>2.119</td>
</tr>
</tbody>
</table>

Mean in the same column followed by the same letter are not significantly different (P>0.05) Duncan’s multiple range test.

**References**


Lefroy, H.M., 1906. The more important insects injurious to Indian Agriculture, Govt. Press, Calcutta, India.


Saleh, M.R.A. and K.A. Gouhar, 1993. Red palm weevil attacking date palm trees in limited areas of Egypt at the present time and how can be eradicated from these areas. Report of Plant Protection Department, Fac. of Agric. Zagazig Univ., pp. 20.