

Some biological characteristics of the *Batrachedra amydraula* Meyrick (Lepidoptera: Batrachedridae) on main varieties of dry and semi-dry date palm of Iran

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Abstract

Although Iran is the leading producer of dates in the world, only 10% of its product is exported. One of the factors which limits exportation is postharvest pests. Lesser date moth (*Batrachedra amydraula*) is one of these postharvest pests. This pest is found in all date palm plantations of Iran. The biology of this pest has not been studied under laboratory conditions on main varieties of stored date in Iran. In this research some biological characteristics including survivorship, developmental time, fecundity, oviposition and postoviposition period, and longevity of adults on date palm varieties Zahedi, Ghasb, Rabbi, Deyri and a semi-artificial diet were studied. All experiments carried out at constant temperature room (30 ± 0.5 °C and $55 \pm 5\%$ r.h.). Highest survivorship of egg and combined larval and pupal stages were 86 and 85% respectively on semi-artificial diet. Shortest total development time from egg to adult was 43 days for males and 43 days for females on semi-artificial diet. Longest total development time was 69 days for male and 65 days for female on Ghasb variety. The highest (45 eggs per female) and lowest (25 eggs per female) fecundity occurred on the Deyri variety and semi-artificial diet, respectively. Results of this study would be useful for making pest management decisions in date palm storage.

Keywords: Lesser date moth, *Batrachedra amydraula*, Biology, Date palm

1. Introduction

Iran is the leading producer of date palm, *Phoenix dactylifera* L. (Arecales; Arecaceae) in the world, but only 10% of its production is exported. Some factors such as postharvest pests limit exportation. Because of the length of storage period in stores (almost one year), damage caused by stored-products pests to semi-dry and dry stored date palm is considerable. Also most stores of date palm in Iran are located in regions where climatic conditions (temperature and humidity) are suitable for development of stored-products pests. Since according to Codex standards for date palm, maximum allowance for defects shall be a total of six percent by count of date palms (Barreveld, 1993), a major concern after harvesting of date palm is to prevent or control insect infestation.

One of the pests of date palm is lesser date moth, *Batrachedra amydraula* Meyrick (Lepidoptera: Batrachedridae). It starts its activity in date palm plantations, is then transmitted into storage with infested dates and can go through multiple generations within stored dates. *B. amydraula* has existed in date palm plantations within Iran for many years (Gharib, 1968), but was reported as a stored date palm pest in Iran for the first time in 1998 (Shayegan et al., 1998). Wiltshire (1957) reported that *B. amydraula* attacked stored date palm and he collected it from a warehouse in Baghdad. Based on Dowson (1982), this pest damages immature date fruits and stored date palm. *Batrachedra amydraula* is distributed from Pakistan to North of Africa and Middle Eastern countries such as Iran, Iraq, Saudi Arabia, Bahrain, Yemen, Egypt, Tunisia and Libya (Martin, 1972; Hussain, 1974; Abdul-Jabar, 1982; Rohani, 1988; Riedl, 1990; Howard et al., 2001). This pest is distributed in all date palm plantations of Iran (Gharib, 1968, 1991; Modarres-Awal, 1994).

The biological characteristics of this pest vary among regions with different climatic conditions in which they are distributed. *B. amydraula* can produce several generations per year in storage (Shayegan et al., 1998). Howard et al. (2001) reported two generations per year for this pest, but based on Hussain (1974) and Damghani (1998) this pest has three generations in date palm plantations of Iraq and Iran per year. Collected samples of infected dry date palm (Ghasb variety) from traditional stores and date palm

plantations in Kerman (shahdad region) and other varieties from Bushahr, Khuzestan, Jiroft, and Bam showed that *B. amydraula* can produce continuous generations when temperature is above 20°C (Shayegan et al., 1998).

Since there is a little information about the biology of *B. amydraula* on dry and semi-dry date palm varieties in Iran and other date growing countries, the main objective of this study was to compare life history parameters and fecundity of *B. amydraula* on dry and semi-dry date palm varieties of Iran. The information provided by this study could help us in developing IPM programming for pests of stored date palms.

2. Materials and methods

2.1. Collection and identification of *B. amydraula*

Originally, infected dry date palms (Ghasb variety) were collected from traditional stores in Shahdad region (30° 25' N, 57° 42' E) in Kerman province. Infected date palms were kept under controlled conditions at 30±5°C, 55±5% (r.h.) and photoperiod of 14:10 (L:D) h in a constant temperature room. Adult moths were anesthetized with CO₂ and *B. amydraula* specimens were separated based on morphological characteristics. One pair (male+female) of adult moths was transferred to a plexiglass box (14×8×4 cm) containing dry date palm. Adults of F1 were used in identification of species (*B. amydraula*). Earlier method offered by Badr et al. (1990) was used for this purpose.

2.2 Mass rearing of *B. amydraula* in laboratory

Mass rearing of *B. amydraula* was carried out on introduced semi-artificial diet (400 g powder of dry date Ghasb variety, 400 g whole wheat flour, 150 g honey, 25 g yeast and 120 mL glycerin) developed by Marouf et al. (2004). Fifty unsexed adult moths were released on 35 g semi-artificial diet in a plexiglass box (14×8×4 cm) and the boxes were kept in a constant temperature room as described above. Before starting experiments, insects had been reared for one generation on date palm varieties.

2.3. Biology of *B. amydraula* on different varieties of date palms

Biology of *B. amydraula* was studied on four dry and semi-dry date palm varieties (Ghasb, Zahedi, Deyri, Rabbi) and on semi-artificial diet. Half of one date palm fruit or 1.5 g of semi-artificial diet were placed in plastic Petri dishes (diameter, 6 cm; depth, 1 cm) with a hole in the lid covered with a fine mesh net for ventilation. Then 80 one day old eggs (each egg was considered as a replication) were transferred individually into the plastic Petri dishes containing date palm or semi-artificial diet.

All Petri dishes were placed in a constant temperature room under environmental conditions described above. The Petri dishes were checked every day and egg incubation period and the duration of other developmental stages were recorded. Last instar (fifth instar) *B. amydraula* larvae before start of pupal stage produce a yellow silk cocoon around their bodies so determination of the start of pupal stage was very difficult. Therefore, in this study, duration of larval and pupal stages were recorded together. The ratio between the percentage of individuals completing development and the average time required to complete development was taken as the development index (Singh and Rembold, 1988). All Petri dishes were checked daily and after adult emergence, a pair of female and male moths were introduced into plastic Petri dishes (diameter, 6 cm; depth, 1 cm) on same date or semi-artificial diet as they had developed on. Oviposition period, daily fecundity, total fecundity and adult longevity were recorded daily until the death of the last female in the cohort.

One-way ANOVA was used to variance analysis and compare of means performed by Duncan's multiple range tests.

3. Results

3.1. Development time and longevity

Mean development times and adult longevity of *B. amydraula* on different varieties of date palm and semi-artificial diet is shown in Table 1. Incubation period showed significant differences among the date palm varieties and semi-artificial diet. Incubation period was longest on Ghasb, Zahedi, and Rabbi varieties and shortest on semi-artificial diet. No significant difference was observed for larval+pupal period among Zahedi, Deyri and Rabbi varieties. Longest and shortest larval+pupal period was on Ghasb variety and semi-artificial diet, respectively. Total development time on Ghasb variety and semi-artificial

diet showed significant differences with other date palm varieties. Total development time was longest on Ghasb variety and shortest on semi-artificial diet.

As showed in Table 1, the total development time of *B. amydracula* was generally shortest on semi-artificial diet and longest on Ghasb. The whole lifespan of *B. amydracula* significantly affected by variety of date palms. The whole lifespan of males and females was longest when the larvae were reared on Ghasb, Zahedi, and Deyri varieties and Ghasb, and Rabbi varieties, respectively, and shortest on semi-artificial diet.

Table 1 The mean (\pm SE) development stages and adult longevity of *Batrachedra amydracula* on different date varieties

Varieties	Incubation period (days)	Larval + Pupal period (days)	Development time (days)	Adult longevity (days)		Whole lifespan (days)	
				Female	Male	Female	Male
Ghasb	7.77 \pm 0.07a	59.65 \pm 2.05a	67.35 \pm 2.04a	9.92 \pm 0.55ab	9.71 \pm 0.39ab	75.31 \pm 2.96a	78.89 \pm 2.73a
Zahedi	7.60 \pm 0.12a	51.91 \pm 1.99b	59.56 \pm 2.04b	8.67 \pm 0.64bc	10.07 \pm 0.47a	64.60 \pm 2.15bc	71.57 \pm 3.10ab
Deyri	6.30 \pm 0.15b	53.03 \pm 2.03b	59.28 \pm 2.04b	10.70 \pm 0.55a	9.60 \pm 0.49ab	63.25 \pm 3.23c	71.67 \pm 3.72ab
Rabbi	7.82 \pm 0.14a	53.28 \pm 1.43b	61.02 \pm 1.42b	9.86 \pm 0.33ab	8.67 \pm 0.66bc	71.09 \pm 2.27ab	69.44 \pm 1.91b
Semi-artificial diet	5.84 \pm 0.07c	37.25 \pm .39c	49.09 \pm 0.39c	8.06 \pm 0.34c	7.89 \pm 0.26c	51.09 \pm 0.68d	51.03 \pm 0.72c

Means with same letter(s) in each column are not significantly different at $P>0.05$

3.2. Oviposition period and fecundity

The oviposition period and fecundity of *B. amydracula* adults from larvae reared on different varieties of date palm are summarized in Table 2. Significant differences were observed in the pre-oviposition period of *B. amydracula* on different date palm varieties. The preoviposition period was shortest on Zahedi and longest on semi-artificial diet. The oviposition period was significantly shorter on semi-artificial diet than on any of the date varieties, which did not differ from each other. Also the shortest post-oviposition period was observed on semi-artificial diet, although the Rabbi variety was not different from the semi-artificial diet.

The daily and total fecundities per *B. amydracula* individual are given in Table 2. There were no significant differences among the different varieties of date palms as larval food on the daily number of eggs laid per female. However, the total fecundity of females was significantly higher on Deyri and Rabbi than on Ghasb or semi-artificial diet.

Table 2 The mean (\pm SE) pre- and post-oviposition and oviposition periods and fecundity of *Batrachedra amydracula*

Varieties	Pre-oviposition period (days)	Oviposition period (days)	Post-oviposition period (days)	Fecundity	
				Daily	Total
Ghasb	2.53 \pm 0.26 (15)b	4.13 \pm 0.32 (15)a	2.80 \pm 0.47 (15)a	8.35 \pm 0.58a	28.33 \pm 4.03b
Zahedi	1.77 \pm 0.23 (13)b	4.62 \pm 0.18 (13)a	2.69 \pm 0.48 (13)a	8.53 \pm 0.80a	36.07 \pm 4.37ab
Deyri	2.31 \pm 0.21 (13)b	4.62 \pm 0.35 (13)a	3.31 \pm 0.59 (13)a	9.78 \pm 1.91a	45.23 \pm 5.78a
Rabbi	2.50 \pm 0.31(14)b	4.36 \pm 0.31 (14)a	2.43 \pm 0.26 (14)ab	10.09 \pm 1.10a	41.43 \pm 3.59a
Semi-artificial diet	3.43 \pm 0.25 (28)a	2.39 \pm 0.23 (28)b	1.43 \pm 0.20 (28)b	8.70 \pm 0.99a	24.97 \pm 2.75b

Means with same letter(s) in each column are not significantly different at $P>0.05$; Numerals in parentheses are the number of Petri dishes for each varieties including one pair of male and female

3.3 Mortality and development index

The percent mortality and development indices of *B. amydracula* on some varieties of date palm are given in Table 3. The lowest percentage of egg incubation period mortality was on Ghasb variety and semi-artificial diet (14%) and the highest was on Deyri variety (34%). In larval+pupal development stage, the lowest (1.3%) and the highest (20%) percent mortality were on semi-artificial diet and Rabbi variety, respectively. The lowest percent mortality during total development time (egg to adult) was on semi-artificial diet (15%) and the highest was on Deyri and Rabbi varieties (50%).

Among the different varieties of date palm used in this study, the highest development indices for egg, larval+pupal and overall immature stages of *B. amydraula* were on semi-artificial diet. The lowest development indices of egg incubation, larval+pupal and overall immature stages of *B. amydraula* were on Rabbi, Ghasb and Rabbi, respectively (Table 3).

Table 3 Percentage of mortality (\pm SE) and development index (D.I.) (\pm SE) of lesser date moth

Varieties	Egg		Larvae + Pupae		Overall immature	
	Mortality(%)	D.I.	Mortality(%)	D.I.	Mortality(%)	D.I.
Ghasb	13.75 \pm 4.19b	11.35 \pm 0.38b	18.75 \pm 6.39a	1.36 \pm 0.11c	32.50 \pm 5.20b	1.00 \pm 0.08bc
Zahedi	18.75 \pm 3.23ab	10.46 \pm 1.13b	8.75 \pm 3.50ab	1.76 \pm 0.10b	27.50 \pm 3.13b	1.22 \pm 0.07b
Deyri	33.75 \pm 6.79a	10.52 \pm 1.31b	16.25 \pm 3.23a	1.58 \pm 0.09bc	50.00 \pm 7.07a	0.84 \pm 0.11c
Rabbi	30.00 \pm 8.23ab	8.95 \pm 1.02b	20.00 \pm 5.34a	1.50 \pm 0.08bc	50.00 \pm 5.66a	0.82 \pm 0.09c
Semi-artificial diet	13.75 \pm 3.23b	14.77 \pm 0.59a	1.25 \pm 0.25b	2.65 \pm 0.04a	15.00 \pm 3.27c	1.97 \pm 0.07a

Means with same letter(s) in each column are not significantly different at $P > 0.05$

4. Discussion

According to results, the length of incubation period was the shortest (5.84 days) on semi-artificial diet. Rahmani et al. (2008) and Marouf et al. (2004) reported the length of incubation period of this pest on semi-artificial diet as 6.49 and 5.04 days respectively. The mean length of total development time (egg to adult) on semi-artificial diet was 49.09 days which is close to Rahmani et al. (2008) who reported this value as 51.91 days for males and 53.3 days for females. Also it is close to the value reported by Marouf et al. (2004) (52.91 days). Total development time was longest on Ghasb variety (67.35 days). Since one of the main ingredients of semi-artificial diet was powder of dried Ghasb variety, the marked difference between total development time on semi-artificial diet and Ghasb variety shows that other ingredients of semi-artificial diet like honey, yeast, wheat flour, and glycerin increase its nutritional value for *B. amydraula*.

Our results for longevity of males and females on semi-artificial diet (7.89 and 8.06 days) agree with those reported by Rahmani et al. (2008) (7.04 and 8.71 days). Shayegan (1997), however, reported longevity for males and females on semi-artificial diet consisting of baked Ghasb, agar, and date palm pollen as, 3.5 days and 6.67 days, respectively. This variation may be due to the difference between ingredients of two kinds of semi-artificial diet. The difference also can be related to differences in the photoperiod and relative humidity conditions under which the two studies were carried out. Shayegan (1997) did the experiments under complete dark and 40 \pm 5% relative humidity conditions.

Among date palms varieties, shortest development time was observed on Deyri (59.28 days) and Zahedi (59.56 days) varieties. It might indicate that these varieties are preferred by *B. amydraula*. Latifian et al. (2004), also, reported fresh Deyri variety as the most infested and fresh Zahedi as the second most infested among date palm varieties of Khuzestan province.

Mortality of different *B. amydraula* developmental stages on Zahedi, and Ghasb (without considering of semi-artificial diet) was lower than Deyri and Rabbi varieties, and as a result the development index on Zahedi and Ghasb was higher than the other two varieties (Table 3). Higher percent moisture of Deyri and Rabbi varieties in postharvest period comparing to semi-artificial diet, Zahedi, and Ghasb might be one of the reasons of their increased mortality. It was observed that the nectar of Deyri and Rabbi varieties coats eggs and suffocates them. Also some of the larvae of the *B. amydraula* were observed to become trapped on nectar and die. Such mortality was not seen on semi-artificial diet, Zahedi, and Ghasb varieties because of their lower moisture. The highest total development index among date palm varieties was on Zahedi (without considering of semi-artificial diet) (Table 3). Zahedi has a higher exportation value than the other varieties and it also makes up a large amount of the exported dry date palm of Iran, so the results of this study may help in programming measured control and reducing the damage of stored products pest to date palm.

The other point is that no comprehensive study about the suitability of date palm varieties for insect pests of date palm has been done yet, and in Iran the only related study is susceptibility of native fresh fruit date palm varieties of Khuzestan province carried out by Latifian et al. (2004). Considering all these,

more similar studies about susceptibility of main date palm varieties of Iran to date palm pests are needed to design a comprehensive scheme for an IPM program of date palm pests.

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