Comparison of population growth parameters of the *Plodia interpunctella* Hübner (Lepidoptera: Pyralidae) on Zahedi, Shahabi and Kabkab cultivars of date

Hamideh Pourbehi1*, Ali Asghar Talebi2, Abbas Ali Zamany3, Shila Goldasteh4, Naser Farrar5 and Nasrin Niknam6

1. Graduated student (Msc), Entomology Department, Islamic Azad University, Arak Branch, Arak, Iran
2. Entomology Department, Agricultural faculty, Tarbiat Modares University, Tehran, Iran
3. Plant Protection Department, Razi University, Kermanshah, Iran
4. Entomology Department, Agricultural faculty, Islamic Azad University, Arak Branch, Arak, Iran
5. Agriculture and Natural Resources Research Center of Bushehr
6. Graduated student (Msc), Department of Agronomy, Faculty of Agriculture, Yasouj University, Iran

**Corresponding author Email:** poorbehi_h@yahoo.com

**ABSTRACT:** The Indian meal moth, *Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae) is one of the most commonly reported pests of stored date in Iran. The population growth parameters of *P. interpunctella* were studied on three cultivars (Zahedi, Shahabi and Kabkab) of date. The experiments were conducted in laboratory conditions at temperature of 27±2 °C, relative humidity of 45±5% and a photoperiod of 16L: 8D hours. Data were analyzed according to Jackknife method with SAS and SPSS statistical software. The net reproduction rates were 55.28±5.80, 42.58±4.26 and 36.03±4.67 females per female per generation on Zahedi, Shahabi and Kabkab cultivars, respectively. The intrinsic rate of increase on Zahedi, Shahabi and Kabkab cultivars were estimated 0.0941±0.002, 0.0813±0.002 and 0.0691±0.002 females per female per day, respectively. There was significant difference between intrinsic rate of increase, finite rate of increase, doubling time and mean generation time on different cultivars of date. The longest and shortest mean generation time was obtained on Kabkab (51.984±0.004 days) and Zahedi (42.655±0.005 days) cultivars, respectively.

**Keywords:** *Plodia interpunctella*, Cultivars of date, population growth parameters

**INTRODUCTION**

*Plodia interpunctella* Hubner (Indian meal moth) belongs Lepidoptera order, Ditrysia suborder, Pyraloidea superfamily, Pyralidae family, and Phycitinae sub-family (Borror et al., 1989). The Indian meal moth is a world-wide insect pest of stored-products and processed food commodities. It can infest a variety of products and is perhaps the most economically important insect pest of processed food (Mohandass et al., 2007). This pest is monotype, polyphage and cosmopolite and is important pests of nuts (Marzban, 1997). The insect to be found all regions of Iran especially in south of Iran in storage of date (Sepasgozarian, 1975) and larvae of its is feeding from most of food stuffs that have plant source (Bahgeri zenoz, 1973) and attacking wide range of stored products including dried vegetable commodities (Na and Ryoo, 2000). All activities of this moth take place overnight and in darkness and during the day they stay in different shelters such as cranny, door and window seams, and other shelters with no movement (Bahgeri zenoz, 1973). The single male can mate with 6-7 females during its life time and a single female on an average can mate with 4 males (Brower 1975). Mating occurred within the first 24 hours (Silhacek et al., 2003) and Adult females began to lay eggs within 12–48 h after mating (Mendoza and Pena, 2004). Egg-laying usually takes place at night (Ebeling, 2002). Fecundity of this pest differs greatly from one study to another and is
Factors, such as type of food, size of the female, provision of drinking water, and physiological state of the female moths, temperature, humidity are the important influential factors on Indian meal moth oviposition and maximum fecundity occurred at 30 °C (Mbata, 1985). At 15°C and 70% relative humidity, larvae do not hatch from the eggs as all the eggs die due to cold temperature (Bell, 1975). Eggs are laid on or near the food surface (Mullen and Arbogast, 1977) individually or in 12 to 30 batches (Sepasgozarian, 1975). Duration of oviposition lasted for 1 to 8 days. The most oviposition is in early days, and the number of oviposition gradually decreases. Number of eggs varies according to the types of food. In the condition of 27 °C and the 50-60%, relative humidity duration for hatching eggs was minimum 2 and maximum 3 days (Marzban, 1997). In laboratory condition at 27 °C and 45 ±5% relative humidity, each female moth lays about 40 to 275 eggs throughout their lifetime and lay on 150 eggs in average, and after 6 to 7 days eggs on walnut are opened (Bahgeri Zenoz, 1973). The egg hatch varies from 88% and 96%, on pistachio and almond respectively (Johnson, et al., 1992) and 82%-95% on fresh garlic seed (Mendoza and Pena, 2004). The incubation period of P. interpunctella reared on a wheat diet at 25 °C and 70% relative humidity varied from 4 to 6 days and from 3 to 5 days in field and laboratory strains, respectively (Bell, 1975). Adults moths are short lived (7-9 d) and do not cause any direct damage to stored food (Sambaraju, 2007). Allotey and Goswami (1990) specified the duration from egg phase to adult emerge of Indian meal moth in temperature 30 °C and relative humidity of 76% about 25.7 and 46.1 days on broken sorghum and wheat respectively. Also, the Development times from egg hatch to adult emergence for P. interpunctella on fresh garlic seed ranged from 42 to 47 days, with an average of 46.0±8/0 days (Mendoza and Pena, 2004). Na and Ryoo (2000) found that when the moth was reared on onions, the average development time was 54.1±6.0 and 43.7±4.8 days respectively at 25 °C and 28 °C, and at 70–80% relative humidity. The mean number of degree-days for time of egg hatch was 28.2±5.0 on fresh garlic seed and the mean number of degree-days from egg hatch to adult development was 364.0±6.9 (Mendoza and Pena, 2004). The experiment on dry pistachio with the temperature of 20 to 32.5 °C, relative humidity of 50±5% and 16 hours of lighting round the clock has specified that the minimum temperature requirement for Indian meal moth is 13.1 °C and the total temperature need for the completion of life cycle of this insect is 526.3 degree-days (Basirat and Mehrnejad, 2004). Pest contamination is the main problem of storage products especially on date, and since date is significantly consumed annually in the country or exported abroad due to its special quality, therefore studying the biological characteristics of this pest could have an important role in business and cause the increase of quality of date product. The purpose of this research is to compare biological characteristics, the parameters of life table, reproduction and population growth of Plodia interpunctella on Zahedi, Shahabi and Kabkab cultivars of date. It can use the obtained results in the integrated pest management of date.

MATERIALS AND METHODS

Contaminated dates were collected from the storage of Bushehr province in summer and transferred to the laboratory, and then Indian meal moth larvae were separated from contaminated dates and were put in culture dishes with dimensions of 12x13cm for each cultivar separately. Adults and larvae were reared in culture dishes under temperature of 27±2°C, 45±5% relative humidity and photoperiod of 16L:8D hours (light: dark) separately on Zahedi, Shahabi and Kabkab cultivars for one generation. Having passed the first generation, from reared insects were took egg separately on each date cultivars. One hundred Petri dish were prepared for each date cultivar. 100 Indian meal moth eggs were put on three date cultivars (Zahedi, Shahabi and Kabkab) in Petri dish. The egg was put in each Petri dish, which contained various date cultivars. To facilitate analysis of larvae aged 1 and 2, different date cultivars were first chopped into small particles to the approximate size of 1 centimeter. During the time and the completion of initial food source, some food were added to the growth medium with regard to the larvae requirements and the wastes of larvae were removed from the culture environment. Insect containers were studied daily from egg phase to the end of the adult’s life.

Survey of population growth parameters of Plodia interpunctella

To calculate population growth parameters, the data obtained from the experiment including age (x), the ratio survival of female insects at age x (l_x) and the mean reproduced female’s egg at age x (m_x) were entered into a table. To analyze the population growth parameters were used SAS (SAS Institute, 2003), Minitab (MINITAB, 2000), and figures were drawing using Excel software. In order to calculate frequency and mean of parameters, jackknife statistical method (Maia et al., 2000) has been used to calculate parameters.
RESULTS AND DISCUSSION

The population growth parameters of *P. interpunctella* on three cultivars of date have been shown in table 1. The net reproduction rate indicates the total produced female of Indian meal moth by a female during its lifetime with the intervention of the survival rate factor. The maximum and the minimum net reproduction rate \((R_o)\) have been calculated to be \(55/28±5/80\) and \(36/03±4/67\) females per female per generation on Zahedi and Kabkab cultivars respectively (Table 1). In this parameter, there has been no significant difference between Shahabi & Kabkab cultivars and Zahedi & Shahahi cultivars, while it is significant difference in Zahedi and Kabkab cultivars \((df=59, F=3. 904, P=0. 026)\) (Figure 1). The Net reproduction rate of *Batrachedra amydraula* has been calculated to be \(9/39\) offspring at temperature of \(30±1ºC\), \(60±5\%\) relative humidity in the complete darkness on prepared artificial food made from Ghasb date powder (400g), wheat flour (400g), honey (150g), yeast (25g) and liquid glycerin (120ml) (Rahmani, *et al.*, 2008) and also the net reproduction rate of *Ectomyelois ceratoniae* was \(3.64±0.59\) on date at temperature of \(30±1ºC\), \(75±2\%\) relative humidity and photoperiod of \(16L: 8D\) (Light: dark) (Norozi, 2007).

![Figure 1. Comparison of Net reproduction rate of *P. interpunctella* on three cultivars of date](image1)

Intrinsic rate of increase is consisting of increase rate per each female under specified condition and without limiter factor. The intrinsic rate of increase of this moth has shown significant difference on three date cultivars \((df=59, F=26. 813, P=0.00)\). The maximum value of this parameter on Zahedi cultivar has been specified to be \(0/0941±0/0025\) females per female per day and the minimum value of this parameter on Kabkab cultivar is equal to \(0/0691±0/0024\) females per female per day (Figure 2). There has been no significant difference between the intrinsic rate of increase of *E. ceratoniae* on pomegranate \((0/107±0/013)\) and pistachio \((0/100±0/003)\) but these two sources were significantly higher than fig \((0/055±0/003)\) and date \((0/018±0/002)\), Also a significant difference was observed between fig and date food sources (Norozi, 2007). The intrinsic rate of increase of *B. amydraula* has been calculated to be \(0/039\) (day/1) on prepared artificial food (Rahmani, *et al.*, 2008).

![Figure 2. Comparison of Intrinsic rate of increase of *P. interpunctella* on three cultivars of date](image2)
The finite rate of increase indicates that the population growth increases per day as compared to the previous day. The value of this parameter has been calculated to be $1/0986\pm0.0001$, $1/0846\pm0.0001$ and $1/0714\pm0.0001$ on Zahedi, Shahabi and Kabkab cultivars respectively (Figure 3). The finite rate of increase of this moth has shown significant difference on Zahedi, Shahabi and Kabkab cultivars ($df=59$, $F=9682.273$, $P=0.00$). The finite rate of increase of *E. ceratoniae* to be $1/11\pm0.003$, $1/11\pm0.003$, $1/06\pm0.003$ and $1/018\pm0.002$ on pomegranate, pistachio, fig and date respectively (Norozi, 2007) and the Finite rate of increase of *B. amydraula* has been calculated to be $1/0398$ (day/1) on prepared artificial food (Rahmani, et al., 2008).

Doubling time (DT) of population of *P. interpunctella* to be $7/353\pm0.199$, $8/514\pm0.235$ and $10/016\pm0.366$ days on Zahedi, Shahabi and Kabkab cultivars respectively, which shows the population of this moth on Zahedi cultivar has been doubled in a shorter period as compared with other two cultivars. This means that the Indian meal moth on Zahedi cultivar needs $7/353\pm0.199$ days for its population to be doubled (Figure 4). This parameter has shown a significant difference on Zahedi, Shahabi and Kabkab cultivars ($df=59$, $F=23.417$, $P=0.00$). Doubling time of population of *E. ceratoniae* has been calculated to be $37.46\pm5.82$ on date (Norozi, 2007), which is more than the results obtained from the present research.

The mean of generation time ($T$) of *P. interpunctella* has shown a significant difference on three cultivars ($df=59$, $F=852213.606$, $P=0.00$) (Figure 5). The maximum and the minimum mean of generation time have been calculated on Kabkab and Zahedi cultivars respectively (Table 1). The mean of Generation time of *B. amydraula* is $57/37$ days on prepared artificial food made from Ghasb date powder (400g), wheat flour (400g), honey (150g), yeast (25g) and liquid glycerin (120ml), which is more than the results obtained from this research (Rahmani, et al.,...
2008) and the mean of Generation time of *E. ceratoniae* is 72/13±1/26 days on date, which is more than the results obtained from the present research (Norozi, 2007).

![Figure 5. Comparison of Mean generation time of *P. interpunctella* on three cultivars of date](image)

**Table 1. Population growth parameters of *P. interpunctella* on three cultivars of date**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cultivars of date</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Net reproduction rate</td>
<td>Zahedi</td>
<td>55/26±5/80</td>
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<tr>
<td>Intrinsic rate of increase</td>
<td>Shahabi</td>
<td>42/58±4/26</td>
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<tr>
<td>Finite rate of increase</td>
<td>Kabkab</td>
<td>36/03±4/67</td>
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<tr>
<td>Finite rate of increase</td>
<td></td>
<td>Females/female/generation</td>
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<td>Finite rate of increase</td>
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<td>Females/female/day</td>
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<td>Finite rate of increase</td>
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<tr>
<td>Generation time</td>
<td>Zahedi</td>
<td>42/65±2/005</td>
</tr>
<tr>
<td>Generation time</td>
<td>Shahabi</td>
<td>46/178±0/006</td>
</tr>
<tr>
<td>Generation time</td>
<td>Kabkab</td>
<td>51/984±0/004</td>
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<td></td>
<td></td>
<td>* Same letters in each row are not significantly different at 5% level</td>
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</tbody>
</table>

**CONCLUSION**

The reared moths have the higher intrinsic rate of increase and the shorter lifetime on Zahedi cultivar and the reared moths have the lowest intrinsic rate of increase and the longest lifetime on Kabkab cultivar. Zahedi cultivar is the most sensitive and Kabkab cultivar is the most resistant cultivars for *Plodia interpunctella* growth. Therefore, it is recommended to use Kabkab cultivar for increasing duration of date storage.

**REFERENCES**


