International Journal of Farming and Allied Sciences
Available online at www.ijfas.com
©2013 IJFAS Journal-2013-2-14/417-422
ISSN 2322-4134 ©2013 IJFAS

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

Hamideh Pourbehi[1*], Ali Asghar Talebi[2], Abbas Ali Zamany[3], Shila Goldasteh[4], Naser Farrar[5] and Nasrin Niknam[6]

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 ºC, 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 increases 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 ºC (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 ºC and the 50-60%, relative humidity duration for hatching eggs was minimum 2 and maximum 3 days (Marzban, 1997). In laboratory condition at 27 ºC 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 ºC 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 ºC 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 the development 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 ºC and 28 ºC, 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 ºC, 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 ºC 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 12**×**13cm for each cultivar separately. Adults and larvae were reared in culture dishes under temperature of 27**±**2ºC, 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 & Shahabi 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).

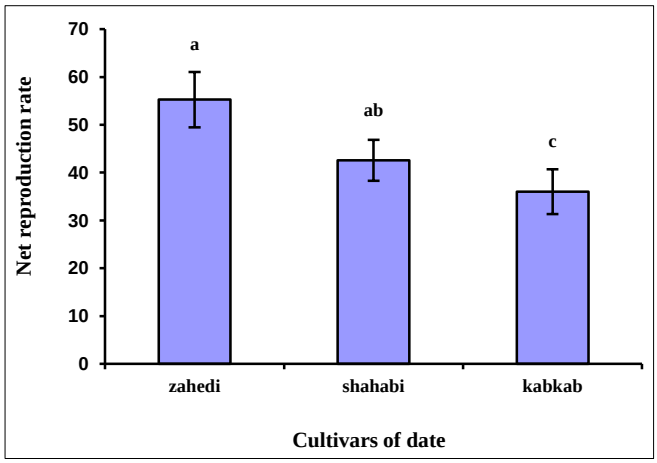

Figure 1. Comparison of Net reproduction rate of *P. interpunctella* on three cultivars of date

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).

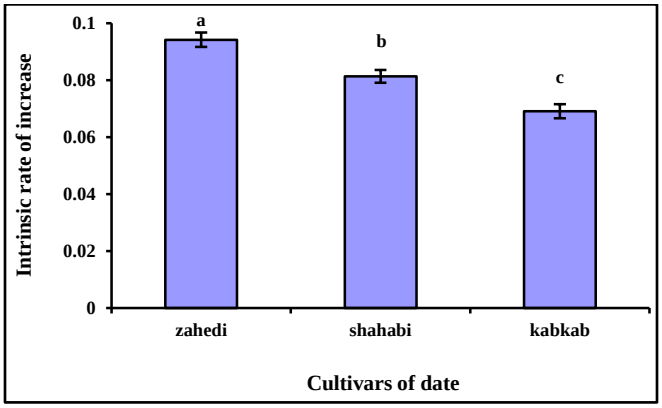

Figure 2. Comparison of Intrinsic rate of increase of *P. interpunctella* on three cultivars of date

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±0/0001, 1/0846±0/0001 and 1/0714±0/0001 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± 0/003, 1/11±0/003, 1/06± 0/003 and 1/018± 0/002 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).

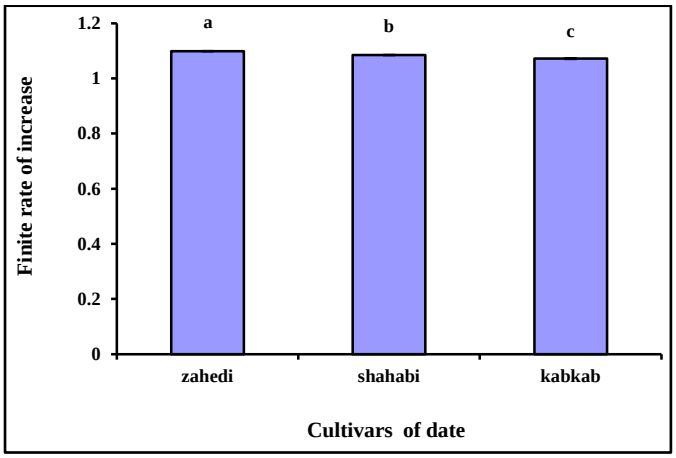

Figure 3. Comparison of Finite rate of increase of *P. interpunctella* on three cultivars of date

Doubling time (DT) of population of *P. interpunctella* to be 7/353±0/199, 8/514±0/235 and 10/016±0/366 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±0/199 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±5.82 on date (Norozi, 2007), which is more than the results obtained from the present research.

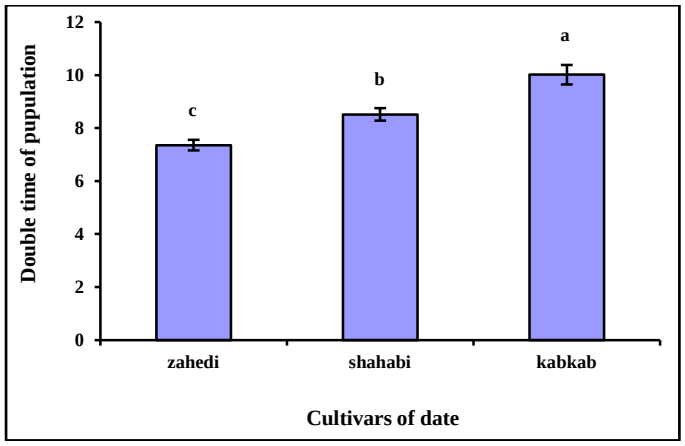

Figure 4. Comparison of Doubling time of *P. interpunctella* on three cultivars of date

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).

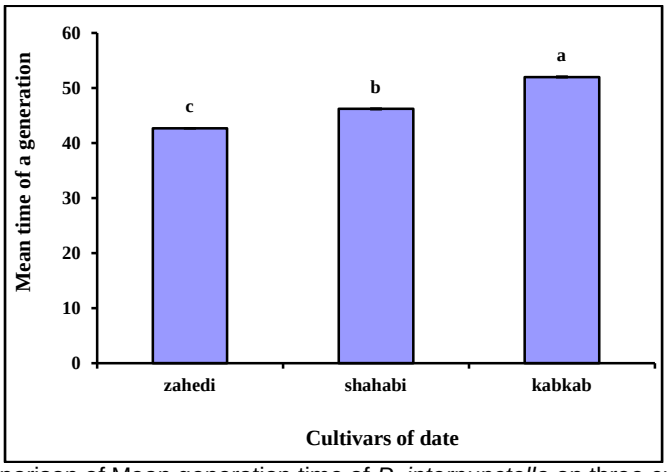

Figure 5. Comparison of Mean generation time of *P. interpunctella* on three cultivars of date

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

	Cultivars of date			
Parameters	Zahedi	Shahabi	Kabkab	Unit
Net reproduction rate	55/28±5/80 [a]	42/58±4/26 [a b]	36/03±4/67 [b]	Females/female/generation
Intrinsic rate of increase	0/0941±0/0025 [a]	0/0813±0/0022 [b]	0/0691±0/0024 [c]	Females/female/day
Finite rate of increase	1/0986±0/0001 [a]	1/0846±0/0001 [b]	1/0714±0/0001 [c]	day
Doubling time	7/353±0/199 [c]	8/514±0/235 [b]	10/016±0/366 [a]	day
Generation time	42/655±0/005 [c]	46/178±0/006 [b]	51/984±0/004 [a]	day

* Same letters in each row are not significantly different at 5% level

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

Allotey, J. and Goswami, L. 1990. Comparative biology of two phyctid moths, *Plodia interpunctella* (hubn.) and *Ephestia cautella* (wlk.) on some selected food media. Insect and Science its Application 11:209–215.

Bagheri Zenoz, A. 1973. *Plodia interpunctella* et ses ennemis naturels. Journal of Entomological Society of Iran 1 (1) 23-40.

Bell, C. H. 1975. Effects of temperature and humidity on development of four pyralid moth pests. Journal of Stored Products Research 11:167-175.

Basirat, M. and Mehrnejad, M. 2004. The study of lower threshold temperature and thermal constant for two insect pests of stored nuts *plodia interpunctella* (Lep.: Pyralidae) and *Apomyelois ceratoniae* (Lep.: Pyralidae). Journal of Entomological Society of Iran 24 (2): 19-34.

Borror, D. J., Triplehorn, C. A. and Johnson, N. F. 1989. An introduction to the study of insects. Saunders College publishing 6ed, 875 pp.

Brower, J. H. 1975. *Plodia interpunctella*: effect of sex ratio on reproductivity. Ann. Entomol. Soc. Am 68: 847-851.

Ebeling, W. 2002. Pests of stored food products. Uraban Entomology. Chapter 7.

Johnson, J.A., Wofford, P.L. and Whitehand, L.C. 1992. Effect of diet and temperature on development rates, survival and reproduction of the Indian meal moth (Lepidoptera: Pyralidae). Journal of Economic Entomology. 85: 561–566.

Maia, A. H. N., Luiz, A. J. B. and Campanhola, C. (2000) Statistical inference on associated fertility life table parameters using Jakknife technique: Computational aspects. Journal of Economic Entomology 93(2):511-518.

Marzban, R. 1997. Biological control of *Plodia interpunctella* in nuts (pistachio, walnut and almond) by *Bacillus thuringiensis* bacteria. M.Sc thesis, Tarbiat Modares University, 119 pp.

Mbata, G.N. 1985. Some physical and biological factors affecting oviposition by *Plodia interpunctella* (Hubner) (Lepidoptera: Pyralidae). Insect Science and its Application 6: 597-604.

Mendoza, J. P. and Pena, M. A. 2004. Development, reproduction, and control of the Indian meal moth, *Plodia interpunctella* (Lep.: Pyralidae) in stored seed garlic in Mexico. Journal of Stored Products Research 40: 409-421.

Mohandass, S., Arthur, F. H., Zhu, K. Y. and Throne, J. E. 2007. Biology and management of *Plodia interpunctella* (Lepidoptera: Pyralidae) in stored products. Journal of Stored Products Research 43: 302-311.

Mullen, M.A. and Arbogast, R.T. 1977. Influence of substrate on oviposition by 2 species of stored product moths. Environmental Entomology 6: 641-644.

Na, J.H. and Ryoo, M.I. 2000. The influence of temperature on development of *Plodia interpunctella* (Lep.: Pyralidae) on dried vegetable commodities. Journal of Stored Products Research 36: 125-129.

Norozi, A. 2007. Influence of four food sources (pomegranate, pistachio, fig and date) on demography parameters of *Ectomyelois ceratoniae* (Lep.: Pyralidae) in laboratory conditions. M.Sc Thesis, Tarbiat Modares University, 99 pp.

Rahmani, Sh., Marouf, A., Abolhassani, A. and Amir maafi, M. 2008. Demography of *Batrachedra amydraula* (Lep.: Batrachedrridae) under laboratory conditions. Appllied Entomology and Phytopathology 76 (1): 79-89.

Sambaraju, K. 2007. Studies on factors affecting behavior, ecology and reproductive success of the Indian meal moth, *Plodia interpunctella*. Thesis (Phd).142 pp.

Sepasgozarian, H. 1975. storage pests of Iran and the their control. Tehran University publication, 212 pp.

Silhacek, D., Murphy, C. and Arbogast, R.T. 2003. Behavior and movements of indian meal moths *Plodia interpunctella* (Hubner) during commodityinfestation. Journal of Stored Products Research 39: 171-184.