**Bionomics and morphometic study of** *Rhyzopertha dominica* Fabricius **on stored wheat**

**ABSTRACT**

The biology of the lesser grain borer, *R. dominica* on stored wheat (Lok-1) was conducted at Regional Research Station, AAU, Anand. The average incubation period and egg hatching percentage of lesser grain borer was 5.40 ± 0.50 days and 80 per cent, respectively. The average length, breadth and duration of 1st, 2nd, 3rd and 4th instar larvae was 0.71 ± 0.01 mm, 0.18 ± 0.00 mm, 4.30 ± 0.72; 1.22 ± 0.06 mm, 0.40 ± 0.02 mm, 3.50 ± 0.31; 2.18 ± 0.06 mm, 0.63 ± 0.04 mm, 4.60 ± 0.56 and 2.68 ± 0.02 mm, 0.98 ± 0.02 mm, 6.80 ± 0.92 days, respectively. The average duration of pre-pupa and pupa was 1.00 ± 0.00 and 3.85 ± 0.87 days, respectively. The average pre-oviposition period was 2.50 ± 0.60 days. The average oviposition period was 22.50 ± 2.23 days. The average post-oviposition period was 6.85 ± 1.32 days. The average male and female lifespan were 59.93 ± 3.86 and 63.55 ± 4.88 days, respectively. The average fecundity and sex ratio was 191 ± 40.5 eggs and 1 : 1 (male : female), respectively.

**Keywords:** Bionomics, morphometic, lesser grain borer and wheat

**INTRODUCTION**

Wheat (*Triticum aestivum* Linnaeus) belongs to Poaceae family which is the second maximum produced grain among cereals after maize (Anonymous, 2014). It is one of the most important cereals grown globally and one of the critical staple meal of almost 2.5 billion population. It is called as "king of cereals". Globally, it is the main source of plant-based protein (12 %) in the human diet. In 2022-23, 781.31 million metric tons of wheat was produced worldwide (Shahbandeh, 2023). India is the second largest wheat producer in the world. In 2022-2023, the crop was cultivated on 30.54 million hectares (14 % of the global area) to produce the highest ever production of 112 million metric tons of wheat (13.64 % of world production) with average record productivity of 3371 kg/ha. In the financial year 2022-23, over four million metric tons of wheat was produced in 1.2 million hectares in Gujarat with productivity of 3172.41 kg per hectare (Anonymous, 2022). The wheat production target is projected to be around 140 million tons by 2050, taking into account the growing demand for consumption and trade in India (Anonymous, 2020). Storage pests can cause post-harvest losses estimated up to 9 % and 20 % in developed and developing countries, respectively (Phillips and Throne, 2010). In India, post-harvest losses caused by unscientific storage, insects, rodents, microorganisms *etc*. account for about 10 per cent of all food grains. Storage wheat is heavily infested by various insect pests *viz*., lesser grain borer (*Rhyzopertha dominica* Fabricius), rice weevil (*Sitophilus oryzae* Linnaeus), red rust flour beetle (*Tribolium casteneum* Herbst.), granary weevil (*Sitophilus granarius* Linnaeus), maize weevil (*Sitophilus zeamais* Motschulsky), angoumois grain moth (*Sitotroga cerealella* Olivier) and rice moth (*Corcyra cephalonica* Stainton) (Ileke and Oni, 2011). Among these insect pests, *R. dominica* (Coleoptera: Bostrichidae) and *S. oryzae* (Coleoptera: Curculionidae) are the primary pests of stored wheat and feed internally as well as externally on both whole kernel grains and cereal products (Burges, 2008 and Mark *et al*., 2010). Lesser grain borer is a pest which starts its infestation from field and also damage stored grains and this may cause economic damage during storage (Adedire, 2001). It is known to be originated from India (Pruthi and Singh, 1950). It is active in a wide range of humidity and may feed on grains with less than 9 per cent moisture content, under which other stored grain insect pests normally do not survive or stop feeding (Edde, 2012). The knowledge on identification, habit and life cycle of this pest will help to formulate appropriate management strategies.

**MATERIALS AND METHODS**

A laboratory study on bionomics of lesser grain borer, *Rhyzoperta dominica* on wheat (Lok 1) was conducted at Regional Research Station, AAU, Anand. To initiate the breeding, around 300 adults were collected from the local market of Anand. The adults of lesser grain borer were introduced into a plastic jar (15 cm x 8 cm) containing 1 kg wheat grains previously sterilized in hot air oven at a temperature of 55˚C for 4 hours. The jar was covered using muslin cloth tightened by rubber band to prevent the escape of adults. This biological material was reared and maintained within the laboratory both for population growth and development at 30 ± 2 ˚C temperature and 75 ± 5 % relative humidity. Thus, adults of the new generation obtained from the laboratory culture were used to study the bionomics.

Twenty freshly laid eggs were kept in Petri plates and examined for studying their colour, shape and size. Hatching percentage was calculated from the number of eggs hatched out of total number of eggs (n=20) kept under observation. With the help of Zeiss stemi 2000-C stereozoommicroscope and Axiovision Rel. 4.8 software, the length and breadth of eggs, larvae, pupae, and adults were measured.

With a view to determine the number and duration of different larval instars, twenty freshly hatched larvae were reared individually by placing them on partially dissected wheat grains (Lok 1 variety) in plastic vials (5 cm x 4.5 cm). The observation on change of instar was done daily till they attained last instar. The larval instar was studied for their colour, shape and size. The total larval period was calculated from egg hatching to the appearance of pre-pupa. The pre-pupal period was worked out from the day when last instar larvae became sluggish, stops feeding, slightly curved, contracted and started formation of pupae. Twenty larvae were observed for recording pre-pupal period. The pupal period was calculated from the day of formation of pupae to the day of emergence of adults. Emerged pupae were collected from all the vials and were examined for their colour, shape, and size.

The emerged adults (n = 10) were also paired for a day and then kept individually in vials (5 cm x 4.5 cm). The life span of each adult was recorded by counting the period from emergence of adult from pupa till death. Duration between emergence of adult to oviposition by female was considered as pre-oviposition period. Duration of egg laying was considered as oviposition period. To determine fecundity, eggs laid by females were collected and counted daily in the morning. The total number of eggs laid during life span of female adult was considered as fecundity. Duration between oviposition period to death of adult was considered as post-oviposition period. The adults were examined for their colour, shape and size. Male and female was differentiated by locating pale yellow colour in the abdominal segments of female adult. Number of males and females were counted to find sex ratio.

**RESULTS AND DISCUSSION**

The morphometry (mm) and duration (days) of the lesser grain borer, *R. dominica* on stored wheat are presented in Table 1 & 2. The research study found that the adults of *R. dominica* laid oblong, white and opaque eggs in group or singly among the mixture of damaged grain and frass, at bottom of the storage container and rarely, singly on grain surface. Similar results were confirmed with Kucerova and Stejskal (2008) who reported that the eggs were opaque, whitish in colour with a waxy appearance and laid in clusters on grain or singly among the frass. The incubation period and egg hatching of lesser grain borer eggs ranged from 5 to 6 days with an average of 5.40 ± 0.50 days and 80 per cent, respectively. The present findings were more or less similar to previous studies carried out by Chintala *et al*. (2017) and Kumawat (2007) who recorded the incubation period ranging from 5 to 6 days and 5.3 to 9.4 days, respectively. The length of egg ranged from 0.46 to 0.55 mm with an average of 0.51 ± 0.04 mm and breadth of egg ranged from 0.18 to 0.23 mm with an average of 0.19 ± 0.01 mm respectively. Morphometry data investigated on eggs were found similar to the results from previous studies conducted by Chintala and Virani (2018) who reported that average length and breadth of egg was 0.56 ± 0.06 mm and 0.23 ± 0.04 mm, respectively.

The larvae of *R. dominica* passed through four instars and fed inside the grain. The larvae entered the grain after hatching by creating tiny bored holes. Once entered, it started feeding on kernel and embryo from inside without no conspicuous sign visible outside the grain. The first instar larvae appeared tiny, translucent, whitish with hairy body and brownish head and its duration varied from 4 to 6 days with an average of 4.30 ± 0.72 days. The length of larvae varied from 0.68 to 0.75 mm with an average of 0.71 ± 0.01 mm and breadth varied from 0.15 to 0.19 mm with an average of 0.18 ± 0.00 mm. The second instar larvae was marked by an increased size, reduced translucency, hairy whitish body, improved visibility of abdominal segmentation except at the posterior portion which remained voluminous and lustrous. Its duration varied from 3 to 4 days with an average 3.50 ± 0.31days. The length and breadth varied from 1.10 to 1.40 mm with an average of 1.22 ± 0.06 mm and 0.36 to 0.47 mm with an average of 0.40 ± 0.02 mm, respectively. The third instar larvae were scarabeiform (C- shaped), opaque, with white robust body and marked by clear body segmentation with hairs. The duration ranged from 4 to 5 days with an average of 4.60 ± 0.56 days, whereas the length and breadth varied from 1.98 to 2.34 mm with an average of 2.18 ± 0.06 mm and 0.56 to 0.75 mm with an average of 0.63 ± 0.04 mm, respectively. The fourth instar larvae were similar to the previous instar, but with an enhanced size and pigmentation of head and mandibles. The duration varied from 4 to 8 days with an average of 6.80 ± 0.92days. The length and breadth varied from 2.58 to 2.72 mm with an average of 2.68 ± 0.02 mm and 0.89 to 1.03 mm with an average of 0.98 ± 0.02 mm, respectively. Findings from present studies are more or less similar to results from previous studies by Chintala and Virani (2018) who reported that average length and breadth of different larval instars. The total larval development varied from 20 to 29 days with an average of 24.35 ± 2.83 days. Findings from present studies are more or less similar to results from previous studies by Ajaykumara *et al*. (2018) who reported that average larval duration was 31.28 days.

The pre-pupal duration was one day. However, the pupal period was varied from 3 to 6 days with an average of 3.85 ± 0.87days. The results from current studies are nearly matching with the previous studies by Kumawat (2007), Naik *et al*. (2016) and Chintala *et al*. (2017) who reported a pupal period ranging from 5 to 6.7 and 3 to 5 days, respectively. The adult had a dark brown body with length ranging from 2.36 to 2.54 cm with average of 2.45 ± 0.03 and breadth ranging from 0.84 to 0.90 cm with an average of 0.88 ± 0.01. The elytra of adults were longitudinally pitted, pronotum was hood like, covering the head region and antenna was clubbed with ten segments. The sex of adults was determined based on presence of pale-yellow colour on the last few abdominal segments of female. The sex ratio was found to be 1:1 (male: female). The average period of pre-oviposition was 2.5 ± 0.60 days with a minimum and maximum pre-oviposition period of 2 to 4 days, respectively. The average period of oviposition was 22.50 ± 2.23 days with a minimum and maximum oviposition period of 20 to 25, respectively. The average period of post-oviposition was 6.85 ± 1.32 days with a minimum and maximum post-oviposition period of 5 to 9, respectively. The data on pre-oviposition and oviposition period was supported by Chintala *et al*. (2017) which is more or less similar to the results of present studies. The total male and female life span were varied from 49 to 67 days and 50 to 70 days, respectively with an average male and female life span of 59.93 ± 3.86 and 63.55 ± 4.88 days, respectively. The present investigation was fairly supported by previous works of Kumawat (2007) and Chintala and Virani (2018) who reported that the average life span of female and male was 32.75 ± 2.82, 25.85 ± 2.12 days, respectively. The fecundity was varied from 120 to 250 eggs with an average 191 ± 40.5eggs. The present findings are in close agreement with Kumawat (2007) who revealed that fecundity ranged from 60.0 to 307.3 eggs per female and Win and Rolania (2020) who observed that fecundity ranged from 123 to 215 (170.8 ± 16.08) eggs in winter and 285 to 398 (306.8 ± 16.36) eggs in the rainy season.

**CONCLUSION**

From the present study, it can be concluded that the average incubation period and egg hatching percentage of lesser grain borer, *R. dominica* on stored wheat was 5.40 ± 0.50 days and 80 per cent, respectively. The average length, breadth and duration of last larval instar was 2.68 ± 0.02 mm, 0.98 ± 0.02 mm and 6.80 ± 0.92 days, respectively. The average duration of pre-pupa and pupa was 1.00 ± 0.00 and 3.85 ± 0.87 days, respectively. The average pre-oviposition period was 2.50 ± 0.60 days. The average oviposition period was 22.50 ± 2.23 days. The average post-oviposition period was 6.85 ± 1.32 days. Average male and female life span were 59.93 ± 3.86 and 63.55 ± 4.88 days, respectively. Average fecundity and sex ratio was 191 ± 40.5 eggs and 1 : 1 (male : female), respectively.

**Table 1: Morphometry of lesser grain borer, *R. Dominica* (n=20)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Stages** | | **Length (mm)** | | | **Breadth (mm)** | | |
| **Minimum** | **Maximum** | **Mean ± SD** | **Minimum** | **Maximum** | **Mean ± SD** |
| **Egg** | | 0.46 | 0.55 | 0.51 ± 0.04 | 0.18 | 0.23 | 0.19 ± 0.01 |
| **Larva** | **I instar** | 0.68 | 0.75 | 0.71 ± 0.01 | 0.15 | 0.19 | 0.18 ± 0.00 |
| **II instar** | 1.10 | 1.40 | 1.22 ± 0.06 | 0.36 | 0.47 | 0.40 ± 0.02 |
| **III instar** | 1.98 | 2.34 | 2.18 ± 0.06 | 0.56 | 0.75 | 0.63 ± 0.04 |
| **IV instar** | 2.58 | 2.72 | 2.68 ± 0.02 | 0.89 | 1.03 | 0.98 ± 0.02 |
| **Prepupa** | | 2.56 | 2.70 | 2.66 ± 0.02 | 0.88 | 1.01 | 0.97± 0.01 |
| **Pupa** | | 2.52 | 2.61 | 2.52 ± 0.02 | 0.94 | 1.00 | 0.96 ± 0.01 |
| **Adult** | **Body** | 2.36 | 2.54 | 2.45 ± 0.03 | 0.84 | 0.90 | 0.88 ± 0.01 |
| **Pronotum** | 0.79 | 0.83 | 0.80 ± 0.03 | 0.75 | 0.79 | 0.77 ± 0.01 |
| **Thorax** | 0.96 | 0.99 | 0.98 ± 0.02 | 0.80 | 0.83 | 0.82 ± 0.01 |
| **Elytra** | 1.75 | 1.78 | 1.77 ± 0.02 | 0.83 | 0.88 | 0.86 ± 0.01 |
| **Antenna** | 0.43 | 0.49 | 0.47 ± 0.03 | - | - | - |
| **Eyes (radius)** | 0.10 | 0.12 | 0.10 ± 0.01 | - | - | - |
| **Head capsule** | 0.51 | 0.53 | 0.52 ± 0.02 | 0.38 | 0.44 | 0.41 ± 0.01 |
| **Abdomen** | 0.85 | 0.90 | 0.88 ± 0.03 | 0.71 | 0.76 | 0.73 ± 0.01 |
| **Average length of each abdominal segment visible** | 0.15 | 0.19 | 0.17 ± 0.03 | 0.64 | 0.69 | 0.66 ± 0.01 |

**Table 2: Duration of various life stages of lesser grain borer, *R. dominica* under   
 laboratory conditions on stored wheat**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Stages** | **Sample size** | **Duration (days)** | | |
| **Minimum** | **Maximum** | **Mean ± SD** |
|
| **Egg** | 25 | 5 | 6 | 5.40 ± 0.50 |
| **Larva** | | | | |
| **I instar** | 20 | 4 | 6 | 4.30 ± 0.72 |
| **II instar** | 20 | 3 | 4 | 3.50 ± 0.31 |
| **III instar** | 20 | 4 | 5 | 4.60 ± 0.56 |
| **IV instar** | 20 | 4 | 8 | 6.80 ± 0.92 |
| **Total larval period** | | 20 | 29 | 24.35 ± 2.83 |
| **Prepupa** | 20 | 1 | 1 | 1.00 ± 0.00 |
| **Pupa** | 20 | 3 | 6 | 3.85 ± 0.87 |
| **Adult** | | | | |
| **Female** | 20 | 27 | 38 | 31.85 ± 3.16 |
| **Male** | 20 | 26 | 35 | 28.23 ± 2.14 |
| **Pre-oviposition period** | 20 | 2 | 4 | 2.50 ± 0.60 |
| **Oviposition period** | 20 | 20 | 25 | 22.50 ± 2.23 |
| **Post-oviposition period** | 20 | 5 | 9 | 6.85 ± 1.32 |
| **Total life cycle** | | | | |
| **Female** | 20 | 50 | 70 | 63.55 ± 4.88 |
| **Male** | 20 | 49 | 67 | 59.93 ± 3.86 |
| **Fecundity** | 20 | 120 | 250 | 191 ± 40.5 |
| **Sex ratio (male :female)** | 20 | 1 :1 | | |
| **Hatching percentage** | 25 | 80 | | |

**REFERENCES**

Adedire, C. O. (2001). Biology, ecology and control of insect pests of stored grains. *Dave Collins Publication*, pp. 59-94.

Ajaykumara, K. M., Thirumalaraju, G. T., & Anjali, A. S. (2018). Seasonal variations in the biology of lesser grain borer *Rhyzopertha dominica* (F.) (Coleoptera: Bostrychidae) on stored maize under laboratory conditions. *Journal of Entomology and Zoology Studies*, 6 (1), 516-522.

Anonymous (2014). United nations, food and agriculture organization, statistics division (FAOSTAT). Retrieved from [https://www.fao.org/faostat/en/#data/QC](https://www.fao.org/faostat/en/%23data/QC%20)

Anonymous (2020). Selected state-wise area, production and productivity of wheat in India. *Indiastat.com.* Retrived from <https://www.indiastat.com/table/Gujarat-state/agriculture/selected-state-wise-area-production-productivity-w/1326556>

Anonymous (2022). Third advanced estimate of area, production and yield of major *kharif*/*rabi*/summer crops of Gujarat state for the year 2022-2023. Retrieved from <https://dag.gujarat.gov.in/estimate.html>

Burges, H.D. (2008). Development of the khaprabeetle, *Trogoderma granarium* (Everts) in the lower part of its temperature range. *Journal of Stored Products Research*, 44 (1), 32-35.

Chintala, S. & Virani, V.R. (2018). Biology and behaviour of lesser grain borer, *Rhyzopertha dominica* (Fabricious) (Coleoptera: Bostrichidae) on stored wheat in laboratory conditions. *International Journal of Agriculture Sciences*, 10 (5), 5231-5234.

Chintala, S., Parekh, K. & Virani, V. R. (2017). Biology and behaviour of lesser grain borer, *Rhyzopertha dominica* (Fabricious) (Coleoptera: Bostrichidae) on stored wheat in laboratory conditions. *Agriculture Update*, 12 (5), 1332-1338.

Edde, P. A. (2012). A review of the biology and control of *Rhyzopertha dominica* (Fab.) the lesser grain borer. *Journal of Stored Product Research*, 48, 1-18.

Ileke, K. D., & Oni, M. O. (2011). Toxicity of some plant powders to maize weevil [*Sitophilus zeamais* (motschulsky) (Coleoptera: Curculiondae) on stored wheat grains (*Triticum aestivum*). *African Journal of Agricultural Research*, 6 (13), 3043-3048.

Kucerova, Z., & Stejskal, V. (2008). Differences in egg morphology of the stored-grain pests *Rhyzopertha dominica* and *Prostephanus truncatus* (Coleoptera: Bostrichidae). *Journal of Stored Products Research*, 44 (1), 103-105.

Kumawat, K. C. (2007). Effect of abiotic factors on biology of *Rhyzopertha dominica* (fab.) on wheat. *Annals of Plant Protection Sciences*, 15 (1), 111-115.

Mark, A. C., Severtson, D. L., Brumley, C. J., Szito, A., Foottit, R. G., Grimm, M., Munyard, K. & Groth, D. M. (2010). A rapid non-destructive DNA extraction method for insects and other arthropods. *Journal of Asia-Pacific Entomology*, 13 (3), 243-48.

Naik, R. H., Mohankumar, S., Naik, S. O., Pallavi, M. S., Srinivasan, M. R., & Chandrasekaran, S. (2016). Influence of food sources on developmental period of *Rhyzopertha dominica*, *Tribolium castaneum* and *Sitophilus oryzae*. *Indian Journal of Plant Protection*, 1 (44), 63-68.

Phillips, T. W., & Throne, J. E. (2010). Biorational approaches to managing stored-product insects. *Annual Review of Entomology*, 55 (1), 375-397.

Pruthi, H. S. & Singh, M. (1950). Pests of stored grain and their control. *Indian Journal of Agricultural Sciences*, 18 (4), 52-58.

Shahbandeh, M. (2023). Wheat: production volume worldwide 1990/1991-2022/2023. Retrieved from <https://www.statista.com/statistics/267268/production-of-wheat-worldwide-since-1990/>

Win, N., & Rolania, K. (2020). Influence of seasonal variation on the biology of lesser grain borer, *Rhyzopertha dominica*, (Fabricius) on wheat. *Journal of Entomology and Zoology Studies*, 8 (5), 285-290.