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Paladugu Tejasvi
 Department of Entomology,
 College of Agriculture, Junagadh
 Agricultural University,
 Junagadh, Gujarat, India

BV Patoliya
 Office of the Registrar,
 Junagadh Agricultural
 University, Junagadh, Gujarat,
 India

MK Ghelani
 Department of Entomology,
 College of Agriculture, Junagadh
 Agricultural University,
 Junagadh, Gujarat, India

YH Ghelani
 Office of the Registrar,
 Junagadh Agricultural
 University, Junagadh, Gujarat,
 India

Corresponding Author:
Paladugu Tejasvi
 Department of Entomology,
 College of Agriculture, Junagadh
 Agricultural University,
 Junagadh, Gujarat, India

Biology of *trogoderma granarium* everts on wheat grain

Paladugu Tejasvi, BV Patoliya, MK Ghelani and YH Ghelani

Abstract

Studies on biology of khapra beetle, *Trogoderma granarium* Everts on wheat grain showed that the Pre-oviposition, oviposition and post oviposition periods were 2.83 ± 0.75 , 6.93 ± 0.91 and 6.10 ± 1.52 days respectively. Fecundity of female varied from 24 to 66 eggs with an average of 39.73 ± 10.53 eggs. Incubation period varied from 4 to 9 days with an average of 5.97 ± 1.43 days. Hatching percentage of eggs of *T. granarium* ranged from 53.67 to 71.33 per cent with an average of 63.78 ± 7.11 . The larva passed through five instars with mean duration of 4.97 ± 0.85 , 5.77 ± 1.19 , 6.50 ± 1.31 , 7.97 ± 0.81 , 8.57 ± 0.94 days for 1st, 2nd, 3rd, 4th and 5th instar, respectively. Mean total duration of the larva was 33.77 ± 2.46 days. Pupal period ranged from 6 to 9 days with an average of 7.43 ± 0.82 days. Longevity of male ranged from 10 to 17 days with a mean of 13.70 ± 1.97 days, while that of female was 11 to 19 days with a mean of 14.50 ± 2.32 days.

Keywords: Khapra beetle, *Trogoderma granarium*, wheat grain, biology

Introduction

The *T. granarium* Everts is one of the world's most damaging pests of whole and ground cereals, oilseeds, dry fruits and other stored products. Beside the quantitative loss, the insect infestation in wheat grains reduce germination and produce unpleasant odour, dirty appearance and abhorrent taste due to contamination with insect fragments and excrement (Khare *et al.*, 1974) ^[5]. The insect first of all eats away the germ portion resulting in reduced viability as well as nutritive value of the grain. They can feed on dried products with as little as 2% moisture contents (GISD, 2015 and Lindgren *et al.*, 1955) ^[2, 6]. In India it is a serious pest of wheat (Rahman, 1942) ^[9]. The larval stage is generally responsible for damage and adults do not normally feed or feed on whole grains (Hadaway, 1956) ^[3]. They can cause weight loss between 5-30% and may be extent up to 70% in severe cases (GISD, 2015) ^[2]. In addition, it is pest of health concern, its exuviae, hairs and other body parts may cause respiratory diseases and skin irritation (Pruthi and Singh, 1950 & Morison, 1925) ^[8, 7]. With increased infestation, the attacked grains stock is reduced to a mixture of weevilled grains and large number of larval exuviae. It not only fed on food grains but also affect the nutritional quality as well as germination capacity. Karnavar (1977) ^[4] found that *T. granarium* feeds primary on wheat germ and reduces the germination capacity of the damaged seed.

Hence, the study on biology was carried out to provide better insight into the pest's activity, its behavior and duration of different stages for efficient planning of its management.

Materials and Methods

Preparation of stock culture of *T. granarium*

The culture of *T. granarium* was prepared from the collections of larvae made from culture maintained at Department of Entomology, Junagadh Agricultural University, Junagadh and rearing them in glass jars (20 cm x 15 cm) for two generations in the laboratory of Department of Entomology, JAU, Junagadh on wheat grain (variety GW 496) at room temperature (32-35 °C) during June-July (2019). From the stock culture, samples of adult insects were drawn for studying different aspects of insect biology. A pair of adults was released per rearing jar containing 500 g wheat grain keeping 6 repetitions. Open end of a jar was covered with muslin cloth fastened with elastic bands. Before releasing the insect, the wheat grain was cleaned by removing broken/damaged grain, weeds seeds, dirt and other extraneous material, and kept in oven (60 ± 5 °C) for eight hours to eliminate both apparent and hidden infestation, if any. Such jars were placed in an incubator kept at 30 ± 2 °C and 65 ± 5 per cent relative humidity to maintain uniform moisture level in the samples.

Pre-oviposition, oviposition and post-oviposition period

Freshly emerged adults were used in these studies. To obtain fresh adults 30 pupae from the stock culture were isolated and put in a Petri dish. These were kept under observation till the emergence of adults. As soon as the adults emerged, these were paired for mating and kept in separate vials (having 1g wheat flour) @ 1 pair per vial. These vials were kept in an incubator maintained at 30 ± 2 °C and 65 ± 5 per cent relative humidity. There were six replications each for pre-oviposition, oviposition, and post-oviposition period.

Fecundity

For recording fecundity, each adult pair was examined daily by placing the vial content in a petri-dish. The vial content was sieved (mess sieve size 100) to separate out eggs. The eggs were counted under stereo microscope with 10 X magnification and put in separate vials with the help of wet camel hair brush. The vial content i.e. flour as well as insect pair were returned back to the vial and kept in the incubator for further observations. The process was repeated till the female died. Record of daily egg laying by the female was maintained. Total life span of the adult was recorded.

Incubation period

Period from egg laying to hatching of larvae was taken as incubation period. Samples of 300 eggs were observed for recording incubation period.

Egg hatchability

A part of the powdered content of stock culture was removed and examined under the stereo microscope (10 X) and put in Petri dish. This content was examined under microscope to separate out eggs. These eggs were removed and collected with the aid of a microscope and a wet camel hair brush. A sample of 300 eggs was put into a Petri dish and kept under observation till hatching. This experiment was repeated six times examining 1800 eggs in all. Hatched and unhatched eggs were counted and per cent hatching was worked out.

Larval duration

To study the duration of different larval instars, initially 30 first instar larvae were kept individually in separate 30 glass vials containing wheat flour @ one larva per vial. The criterion used for determining change of larval instar was the presence of exuviae in the vial. Duration of different larval instars was recorded. During this period the larval food (i.e. wheat flour) was replaced with fresh food with the change of instar. Total larval duration was worked out on the basis of observation of 20 larvae which reached up to the final instar.

Duration of Pupa

Thirty glass vials were provided with freshly formed pupae @ one pupa per vial. The pupal duration was recorded from the day the larva transformed into the pupa until the emergence of the adult from it. Data was recorded on daily basis and total pupal duration was worked out based on a sample of 20 pupae.

Adult Longevity

For recording the total adult duration freshly emerged adults were separated into different vials carrying the healthy grain of wheat and data was recorded daily till death of the adult.

Results and Discussion

Results of different biological parameters of *T. granarium*

recorded under laboratory conditions are presented in (Table 1 to 4). Looking to the data (Table 1), it can be seen that the pre-oviposition period varied from 2.0 to 4.0 days with an average of 2.83 ± 0.75 days, oviposition period varied from 5 to 9 days with on average 6.93 ± 0.91 and post oviposition period varied from 4 to 9 days with an average 6.10 ± 1.52 days. Present studies results are more or less concurring with Yadav *et al.* (2018) ^[10] who studied on the biology of *T. granarium* on wheat (variety WH 711) revealed that pre-oviposition, oviposition and post oviposition periods were 2.93 ± 0.28 , 4.83 ± 0.41 and 2.33 ± 0.29 days, respectively.

Fecundity of female varied from 24 to 66 eggs with an average of 39.73 ± 10.53 eggs (Table 2). The present findings are corroborated with reports of Chaudhary and Kapil (1976) ^[11] who studied the reproductive biology of *T. granarium* at 35 °C temperature and 55 % RH on broken Kalyan-sona wheat. The average fecundity per female was 52.6 eggs, in one male-female mating, as compared with 29.8 eggs when one male mated with 4 females. The rate of oviposition was inversely proportional to the age of males and females, but the age of females had a pronounced effect.

Incubation period

The data given in (Table 3) indicated that the incubation period under laboratory condition varied from 4 to 9 days with an average of 5.97 ± 1.43 days. The incubation period of *T. granarium* reported by Yousif *et al.* (1992) ^[11] was 4.1 days in June and 13.5 days in October.

Egg hatchability

It can be seen from (Table 4) that the hatching percentage of *T. granarium* varied from 53.67 to 71.33 per cent with an average of 63.78 ± 7.11 . The present findings are more or less similar with the findings of Yadav *et al.* (2018) ^[10] who studied on biology of *T. granarium* on wheat (variety WH 711) results showed that a female laid 57.83 ± 4.31 eggs during its life span with 63.77 percent egg hatchability.

Larval duration

During the present studies, *T. granarium* was observed to pass through five larval instars. The perusal of data presented in (Table 5) revealed that the larval period of *T. granarium* varied from 3.00 to 6.00 days for the first instar, 4.00 to 8.00 days for the second instar, 4.00 to 9.00 days for the third instar, 7.00 to 9.00 days for the fourth instar and 7.00 to 11.00 days for the fifth instar with an average of 4.97 ± 0.85 , 5.77 ± 1.19 , 6.50 ± 1.31 , 7.97 ± 0.81 , 8.57 ± 0.94 days, respectively.

The mean total duration of the larva was 33.77 ± 2.46 days. Present studies on larval period are in accordance with Yadav *et al.* (2018) ^[10], the larva passed through five instars with a mean duration of 3.9 ± 0.23 , 5.05 ± 0.20 , 5.75 ± 0.40 , 6.4 ± 0.41 , and 6.8 ± 0.25 days for 1st, 2nd, 3rd, 4th and 5th instar, respectively. The mean total duration of the larva was 27.9 ± 0.57 days.

Duration of Pupa

Looking to the data (Table 6), it can be seen that the duration of pupal stage varied from 6 to 9 days with an average of 7.43 ± 0.82 days. According to Yadav *et al.* (2018) ^[10], pupal period was 3 to 7 days with a mean duration of 4.8 ± 0.22 days, respectively which is more or less similar to present findings.

Adult Longevity

The data presented in (Table 7) indicated that the longevity of male varied from 10 to 17 days with a mean of 13.70 ± 1.97 days, while that of female it was varied from 11 to 19 days

with a mean of 14.50 ± 2.32 days. Earlier, Yadav *et al.* (2018) ^[10] observed the male and female adult period of *T. granarium* lasted for 11-18 (mean: 14.75 ± 0.53) days.

Table 1: Ovipositional duration of *T. granarium* under laboratory conditions

Oviposition	No. of female adult observed	Duration (Day)		
		Minimum	Maximum	Av.±S.D.
Pre-oviposition	30	2.00	4.00	2.83±0.75
Oviposition	30	5.00	9.00	6.93±0.91
Post-oviposition	30	4.00	9.00	6.10±1.52

Table 2: Fecundity of *T. granarium* under laboratory conditions

No. of female observed	Average no. of eggs / female		
	Minimum	Maximum	Av.±S.D.
30	24.00	66.00	39.73±10.53

Table 3: Incubation period of *T. granarium* under laboratory conditions

No. of eggs observed	Duration (Day)		
	Minimum	Maximum	Av.±S.D.
179	4.00	9.00	5.97±1.43

Table 4: Egg hatchability of *T. granarium* under laboratory conditions

No. of eggs observed	Hatching percentage		
	Minimum	Maximum	Av.±S.D.
1800	53.67	71.33	63.78±7.11

Table 5: Larval duration of *T. granarium* under laboratory conditions

Larval instar	No. of larva observed	Duration (Day)		
		Minimum	Maximum	Av.±S.D.
I instar	30	3.00	6.00	4.97±0.85
II instar	30	4.00	8.00	5.77±1.19
III instar	30	4.00	9.00	6.50±1.31
IV instar	30	7.00	9.00	7.97±0.81
V instar	30	7.00	11.00	8.57±0.94
Total larval period	-	29.00	41.00	33.77±2.46

Table 6: Duration of pupa of *T. granarium* under laboratory conditions

No. of pupa observed	Duration (Day)		
	Minimum	Maximum	Av.±S.D.
30	6.00	9.00	7.43±0.82

Table 7: Adult Longevity of *T. granarium* under laboratory conditions.

Sex	No. of adult observed	Duration (Day)		
		Minimum	Maximum	Av.±S.D.
Male	30	10.00	17.00	13.70±1.97
Female	30	11.00	19.00	14.50±2.32

Conclusion

The results of study on biology *T. granarium* in wheat under laboratory condition revealed that the average pre-oviposition, oviposition and post oviposition period were 2.83 ± 0.75 , 6.93 ± 0.91 and 6.10 ± 1.52 days, respectively. The fecundity was observed to be 39.73 ± 10.53 eggs/female. The average incubation period and hatching percentage were 5.97 ± 1.43 days and 63.78 ± 7.11 per cent, respectively. During the present studies, *T. granarium* was observed to pass through five larval instars. The duration of first, second, third, fourth and fifth instar were 4.97 ± 0.85 , 5.77 ± 1.19 , 6.50 ± 1.31 , 7.97 ± 0.81 , 8.57 ± 0.94 days, respectively. Total grub and pupal period of *T. granarium* were 33.77 ± 2.46 and 7.43 ± 0.82 days, respectively. The longevity of adult male and female *T.*

granarium was 13.70 ± 1.97 and 4.50 ± 2.32 days, respectively. The total life period of female was 14.50 ± 2.32 days. While, in male it was 13.70 ± 1.97 days.

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