



Biology of Rust-Red Flour Beetle, *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae)

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ABSTRACT: A laboratory study was undertaken on the biology of *Tribolium castaneum* on wheat flour at an average room temperature 29°C and 59% R.H. during January to July 2013. The daily egg laying was observed on the first day of oviposition on the wheat flour. No. of eggs laid per day by a female was 24 eggs. Incubation period was 4 to 5 days and grub underwent seven instars and total developmental period of the immature stages ranged from 70 to 83 days with an average of 76.5 days. Pupation takes place in the flour. The pupal period ranged from 6 to 9 days with an average of 7.5 days and the unmated male and female adult period ranged from 45 to 67 days and 75 to 89 days respectively. The total life cycle of a beetle was 164-194 days.

Keywords: Room temperature, Humidity, Average duration, Life cycle, *T. castaneum*.

INTRODUCTION

The red flour beetle, *T. castaneum* (Herbst) is worldwide and most destructive pest of stored products and is cosmopolitan in distribution. It is the most common pest of wheat flour. It also causes serious damage upon dried fruits, pulses and prepared cereal foods, such as cornflake, pasta, biscuit, beans, nuts, etc. It is an often the most common species in the pest complex attacking stored wheat although its pest status is considered to be secondary, requiring prior infestation by an internal feeder, it can readily infest with or other grains damaged in the harvesting operation. Both larvae and adults feed on grain dust and broken grain, but not the undamaged whole grains and spend its entire life cycle outside the grain kernels (Karunakaran *et al.*, 2004). In severe infestation, the flour turn greyish and has a pungent, disagreeable odour- making it unfit for human consumption. This insect causes substantial loss in storage because of its high reproductive potential (Prakash *et al.*, 1987). They may cause an allergic response (Alenko *et al.*, 2000) but are not known to spread disease. These beetles can breed throughout the year in warm area. So, the present work is undertaken to study the morphological measurement of the different developmental stages of this pest to suggest suitable management option.

MATERIALS AND METHODS

A study on the morphological measurement of *T. castaneum* was conducted in the Laboratory of Entomology, D.M. College of Science, Imphal, India during the period of January to July, 2013 at 29.14

±2.0°C and 59.4± 3.0%RH. (at room temperature and humidity). *T. castaneum* was collected from grocery market of Imphal west. The culture was maintained on sterilized wheat flour which kept in plastic jar of 3 kg capacity. Male and female of equal sex ratio were released in each jar and covered with muslin cloth for mating. The adult females were observed regularly at interval of eight hours for their oviposition. After mating, the female moth laid eggs on the wheat flour. On the following day for collecting eggs, a 50 mesh sieve was used to separate the adults and eggs from the flour. Collected eggs were taken in petri dish and observed the incubation period and hatching percentage of eggs were daily recorded. Then the newly hatched first instar grubs were carefully collected with the help of soft camel hair brush and were individually transferred in glass vials containing 3 mg of wheat flour supplied as food in each vial. Duration of each stage, grub stage and pupal period and adult longevity were recorded. For morphometric parameters 5 specimens were taken for measuring the length and width of different stages of *T. castaneum* with the help of digital calliper. The experiments were conducted using standard mean deviation with five replications.

RESULTS AND DISCUSSION

A. Life cycle of *T. castaneum*

The details of the developing stages were presented in Table 1. The different stages of *T. castaneum* from egg to adult were shown in Fig. 1. From the laboratory data, the life cycle of *T. castaneum* were being made.

Table 1. Numerical data of morphological measurement of different stages *T. castaneum*.

Life stage	Duration	Length (Mean±SE) mm	Breadth (Mean±SE) mm	Average Temperature		Average Relative Humidity (%)
				Min	Max	
Egg	9-15	0.59±0.02	0.23±0.02	5.8	22.3	60.26
1 st instar grub	16-18	0.96±0.02	0.19±0.02	4.3	28.8	46.11
2 nd instar grub	10-14	1.83±0.08	0.26±0.03	13.4	29.14	47.21
3 rd instar grub	8-10	2.44±0.13	0.49±0.03	15.4	33.7	55.3
4 th instar grub	8-10	3.27±0.09	0.55±0.02	14.87	30.5	62.37
5 th instar grub	8-10	4.68±0.13	0.83±0.04	14.8	31	54.3
6 th instar grub	8-10	5.27±0.09	1.87±0.12	16.4	32.2	54.3
7 th instar grub	9-11	6.22±0.06	1.07±0.03	16.2	30.5	63.4
Pupa Male	6-7	3.81±0.03	1.07±0.03	17.57	31.14	56.14
Pupa Female	7-9	4.12±0.01	1.15±0.01	15.8	33.5	60.22
Adult Male	45-50	3.06±0.03	1.12±0.03	17.86	29.2	77.3
Adult Female	75-80	3.70±0.01	1.28±0.30	19.93	30.6	76.5

Egg. Freshly laid eggs were very small, whitish, cylindrical microscopic and often have bits of flour stuck to their surface and harden, making them difficult to see. The incubation period ranged from 4 to 7 days. Beeman *et al.* (2012) reported that the duration of egg ranged from 3 days at 30°C and 2 days at 34°C. The length of eggs ranged from 0.54 to 0.68 mm with a mean of 0.59±0.02 mm, while the width ranged from 0.18 to 0.29 mm with a mean of 0.23±0.02 mm. The average length of egg was found to be 0.42 mm, and width was 0.13 mm. It was contrast to our finding. Leelaja *et al.* (2007) reported that the eggs measured 0.61 mm × 0.3 mm, and fluoresce under long wave (365 nm) UV radiation. The average minimum, maximum temperature and humidity were 5.8°C, 22.3°C and 60.26% respectively.

First instar. Body creamy white in colour, translucent, light brown head with dark brown eye and six legs. The last abdominal segment was partly or completely concealed ventrally with a pair of pseudo pods. The duration of first instar ranged from 16 to 18 days. The length of grub ranged from 0.94 to 0.99 mm with a mean of 0.96±0.02 mm, while the width ranged from 0.18 to 0.25 mm with a mean of 0.19±0.02 mm respectively. The average minimum, maximum temperature and humidity were 4.3°C, 28.8° C and 46.11% respectively.

Second instar. Body yellowish white, slender, and cylindrical and covered with fine hairs. The head was pale brown and the last segment of abdomen had two

upturn dark, pointed structures. The duration of second instar ranged from 10 to 14 days. The length of second instar ranged from 1.57 to 2.16 mm with a mean of 1.83±0.08 mm, while the width ranged from 0.27 to 0.41 mm with a mean of 0.26±0.03mm respectively. The average minimum, maximum temperature and humidity were 13.4°C, 29.14°C and 47, 21% respectively.

Third instar. The third instars were structurally similar to second instars except in size. The duration of third instar ranged from 8-10 days. The dark brown patches were developed in last two-three abdominal segments. The length of third instar grub ranged from 1.89 to 2.79 mm with a mean of 2.44±0.13 mm, while the width ranged from 0.40 to 0.65 mm with a mean of 0.49±0.03 mm respectively. The average minimum, maximum temperature and humidity were 15.4°C, 33.7°C and 55.3% respectively.

Fourth instar. After third moulting, the fourth instar grub come out of the exuviae of the third instar larvae. The fourth instar larvae were similar to third instar in colour but they differ in size and shape as well. The duration of fourth instar ranged from 8 to 10 days. The body length of fourth instar ranged from 3.10 to 3.42 mm with a mean of 3.27±0.09 mm, while the width ranged from 0.50 to 1.16 mm with a mean of 0.55±0.02 mm respectively. The average minimum, maximum temperature and humidity were 14.87°C, 30.5°C and 62.37% respectively.

Life Cycle of Red flour beetle *T. castaneum*.

Figure 1: A) Eggs. B) First instar grub. C) Second instar grub. D) Molting stage of second instar grub E) Third instar grub F) Mature stage of grub G) Pre- pupal stage : male and female ventral view. H) Post- Pupal stage : male and female dorsal view. I) post -pupal stage ventral view of male and female J) Initial stage of adult. K) Dorsal view of adult male and female. L) Ventral view of adult female and male.

Fifth instar. The duration of fifth instar ranged from 8 to 10 days. The body length of fifth instar ranged from 4.34 to 5.16 mm with a mean of 4.68 ± 0.13 mm, while the width ranged from 0.73 to 0.96 mm with a mean of

0.83 ± 0.04 mm respectively. The average minimum, maximum temperature and humidity were 14.8°C , 31°C and 54.3% respectively.

Six instar. The duration of sixth instars ranged from 8 to 10 days. The body length of fully grown grubs ranged from 5.06 to 5.63 mm with a mean of 5.27 ± 0.09 mm, while the width ranged from 0.68 to 0.96 mm with a mean of 0.87 ± 0.12 mm respectively. The average minimum, maximum and humidity were 16.4°C, 32.2°C and 54.3% respectively.

Seven instar. The duration of seventh instar ranged from 9 to 11 days. Before pupation the last instar grub stopped feeding. The length of seventh instar ranged from 5.12 to 6.37 mm with a mean of 6.22 ± 0.06 mm, while the width ranged from 0.82 to 0.84 mm with a mean of 1.07 ± 0.03 mm respectively. The average minimum, maximum temperature and humidity were 16.2°C, 30.5°C and 63.4% respectively.

In contrast to Dhaliwal (2006) we found that the grub period last on an average from 70 to 83 days to reach the pupal stage. William (2000) reported that the length of the larval period varied from 22 to more than 100 days. From our finding the data suggested that the larval period was depending upon food supply, temperature and humidity as compared with William (2000).

Pupa. Shortly before pupation the pupa have dark wings, sclerotized legs and fully developed eyes. The pupa did not have a cocoon and initially it was white at first day and then gradually turned to yellowish at second stage then finally turned into brown in colour. Its dorsal side was covered with fine hair. At this stage the pupa was dormant and not eating. The male and female pupal period ranged from 6-7 days for male and 7-9 days for female. William (2000) reported that the pupal period was about 8 days. The length of male pupa was 3.81 ± 0.03 mm and width was 1.07 ± 0.03 mm. The length and width of female pupa was 4.12 ± 0.01 mm and 1.15 ± 0.01 mm respectively. The average minimum, maximum temperature and humidity were 15.8°C, 33.5°C and 60.22% respectively.

Adult. Adult beetles were reddish-brown in colour, flattish curved-sided body. The head was visible from above, did not have beak and the thorax had slightly curved sides. The antennae were enlarged at the tip (capitates) with the last three segments wider than preceding segments. Male have a setiferous patch on the posterior side of the fore femur, while females have no such setiferous patch. The longevity of unmating adult male and female period ranged from 45-50 days and 75-80 days. The length of male was 3.06 ± 0.03 mm and width was 1.28 ± 0.30 mm where as the length and width of female beetle was 3.70 ± 0.01 mm and 1.28 ± 0.03 mm respectively. The average minimum, maximum temperature and humidity were 19.93°C, 30.6°C and 76.5% respectively. From our study we observed that under the laboratory condition *T. castaneum* had a long life cycle from January to June and it took six month depending on the food supply, temperature and humidity.

Rebecca and Thomas, (2003) reported that the life cycle last from 40-90 days and adult could live for three years. (Dhaliwal *et al.*, 2006) reported that the developmental period of the egg to the adult was 26-30 days in summer, but it was longer under unfavourable condition of temperature and food. This beetle could breed throughout the year

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