



Effect of different temperature on the metamorphic development stages of insect stored grain pest *Tribolium castaneum*, Herbst (Coleoptera: Tenebrionidae)

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Abstract

Pulses and cereals have great nutritional value in the daily human diet. Infestation of stored grain is a serious issue caused by several types of insect pests. Insects degrade the quality of stored grains and products, resulting in economic losses. The storage of grains has been linked to a high number of insect infestations. Stored grain insect pests have remarkably high multiplication rates and may destroy 10-15 % of grains. *Tribolium castaneum*, (Herbst) is a most destructive insect pest of grains and its products. Adult and larva of *Tribolium castaneum*, (Herbst) feeding on many different kinds of food i.e., polyphagous feeding habit. Both adults and larva of *Tribolium castaneum* (Herbst) cause damage, and loss of stored grains and their product. The experiments on the effect of different temperature (between 10°C - 40°C) on the metamorphic development stages of *Tribolium castaneum* (Herbst) were conducted in the laboratory condition. The life cycle of the *Tribolium castaneum*, (Herbst) was studied under controlled conditions. Temperature is the most important abiotic factor for the survival of life. Temperature treatments for storage of pulses and cereals are very effective, priceless and responsible for killing the different life stages i.e. Larval, pupal and adult stages of insect stored grain pest *Tribolium castaneum*, (Herbst). This paper gives an overview of the effect of different temperature on the metamorphic development stages of *Tribolium castaneum* (Herbst) and experimental observations as well as results of this study might be useful as an eco-friendly control of insect stored grain pest *Tribolium castaneum*, (Herbst) (Coleoptera: Tenebrionidae).

Keywords: *Tribolium castaneum*, metamorphic development, temperature, Infestation

Introduction

As per research data number of Coleoptera and Lepidoptera insect pests have been observed and noted to be associated with stored grains. Most insect pests belong to the order Coleoptera and Lepidoptera. *Tribolium castaneum* (Herbst) is considered a most important and major insect pest of stored food grains (Howe, 1965) [3]. *Tribolium castaneum*, (Herbst) (Insecta: Coleoptera: *Tenebrionidae*) also known as the red flour beetle, is a harmful and destructive insect pest that belongs to the order Coleoptera. Pulses and cereals are the most important part of the daily human diet, they have great nutritional value. Agriculture is a crucial sector in the world because the economy of a nation depends on the agriculture sector. Most of the income is generated from this sector, but agriculture faces many different problems. One of the prime problems is insect pest damage. Insect pest creates a huge loss of production, on the other side population increases continuously which also create pressure on agriculture to increase food production. Post-harvest losses of stored food grains are caused by a variety of reasons, the most serious of which are pulses and cereals infested with insects. According to reports, insect infestation alone on stored food grains ranges from 5 to 30 percent of global agriculture production. Improper storage of stored grains results in high losses in grains. The capital value of losses is more than fifty thousand crores per year (Singh, 2010) [7].

Farmers use a variety of chemical pesticides on the crop to reduce the pest damage. This pesticide chemical residue accumulates in the environment and causes negative effects on non-target organisms. Stored grain pests damage the grains and infest more stored grains than they consume. The contaminated products are not suitable for consumption. It is recorded that about 10-30% of food grain losses are due to stored grain infestation by pests. Third world reported insects and rodents are responsible for damaging as well as creating infestations up to 10 to 25 percent of the total harvested food (Matthews, 1993) [5].

Various scientific literature already documented the control methods against storage grain pests. Biopesticides & physical control (includes light, temperature, moisture, humidity, mechanical methods and different structural methods) are most useful and important as alternatives to synthetic chemical pesticides. Biopesticides kill and repel the insect pests, and affect insect growth, development and metamorphosis. Biopesticides are plant-based chemicals commonly called phytochemicals prepared from different plant parts that can control insect pests by the eco-friendly mechanism. Phytochemicals are non-toxic to a human and possess biodegradable properties so they reduce agricultural toxicity (Patel *et al.*, 2021) [6].

Physical control like temperature is the most important abiotic factor for the survival of life. Temperature treatment for storage of Pulses and Cereals are very effective, priceless and responsible for killing the different life stages

i.e. larval, pupal and adult stages of insect at a time. Generally, stored grain insect pests cannot tolerate extreme temperature (cooling as well as heating). They show a high mortality ratio at 55-56 °C for 10 to 12 hrs. duration and can effectively kill the different life stages i.e. larval, pupal and adult of stored grain insect pest species. Low temperature of less than 12°C also reduces insect growth, and metamorphic development (metamorphosis) (Carrillo *et al.*, 2006) [2]. Reproductive performance of *Tribolium castaneum*, (Herbst) depends on various conditions like temperature, food media, and genetic variations (Arnaud *et al.*, 2005). Elevated temperature of more than > 50°C shows high mortality in *T.castaneum* life stages was reported (Mahroof *et al.*, 2003) [4].

The red flour beetle (*Tribolium castaneum*, Herbst) has a developed chemosensory organ (Barrer, 1983) [1]. *T. castaneum* adults do not prefer light and high as well as low temperature. Thus, if storage areas were lid-covered with these sources, *Tribolium castaneum* (Red flour beetle) could be managed without the use of insecticide. Physical controls like temperature & humidity are two physical variables that are most useful and important as alternatives to synthetic chemical pesticides for the management of stored grain pests, they neither harm the farmers nor the natural enemies. High as well as low temperature affects the metamorphosis or life cycle of insects. The present study was undertaken to determine the effect of different temperature on the metamorphic development stages of *Tribolium castaneum*, (Herbst).

Material & Method

Collection of insect pest

Based on the problem associated with farmers and insect-stored grain pest (red flour beetle) *Tribolium castaneum* (Herbst) was selected for the study. The larva & adults of this pest were identified and collected from locally infested stored maize field Dist. Nandurbar.

Culture Media

The culture of *Tribolium castaneum*, (Herbst) was maintained in mixed flour of wheat & maize, with adding 5% brewer's yeast under laboratory conditions.

Rearing of insect pest

The test experimental insect population of *Tribolium castaneum* (Herbst) was reared in laboratory conditions as per the literature procedure. The insects were collected and kept in wide jars covered with a muslin cloth. The insect was held in laboratory condition for two months for rearing. Then adult was placed in a breeding container in the medium of uninfected mix flour of wheat & maize supplemented with 5% brewer's yeast. Then samples were placed in an incubator for 24 hrs. Then the insects were transferred from the jars to new sterile containers. The stock culture of *Tribolium castaneum* (Herbst) was maintained in grains and mixed flour of wheat & maize grains supplemented with 5% brewer's yeast under laboratory condition, which can be used for studies. Effect of different temperature on the metamorphic development stages of insect stored grain pest *Tribolium castaneum*, Herbst (Coleoptera: Tenebrionidae) were observed.

Temperature control

All experiment was carried out in incubators as well as a refrigerator at a different temperature range between 10°C - 40°C. Temperature controlled by thermostat.

Exposure of Temperature

The *Tribolium castaneum*, (Herbst) was reared in the laboratory & used for experimentation. 10 gm. of the whole pest-free mix flour of wheat & maize was taken in each sterile plastic bottle with the help of a fine pointed brush. One bottle will be maintained as control. Randomly 10 pairs of insects, 20 larvae, 20 pupas & eggs (eggs are attached to the surface of food grains) from stock were poured into each of the separate experimental bottles. The bottles were covered entirely with a piece of muslin cloth to prevent escape. The whole experiment will be conducted in a laboratory environment, as mentioned above. The metamorphic development was recorded every 24 hours. All experiment was carried out in incubators as well as a refrigerator at different temperature (range between 10°C - 40°C).

Observations

Tribolium castaneum (Herbst) (Coleoptera: Tenebrionidae) undergoes a complete type metamorphosis which encompasses or consists of four stages of the life cycle i.e. eggs, larva, pupa and adult. The adult of *Tribolium castaneum* (Herbst) is flat, 5 mm to 6 mm long and the body is reddish-brown. The head, thorax, and abdomen are distinct and antennae are well developed, of which the last segment is abruptly much more significant than the preceding ones. Females are polyandrous in mating behavior. Female adults lay eggs on the grains and debris. Eggs are small round and cylindrical at both ends, sticky in nature, whitish in colour and microscopic so they cannot be perfectly or seen by the naked eye. The incubation period is 5-12 days to hatch. The larva is very active, cylindrical and pupates after 3-4 weeks. The larvae are always found in the food. The length of the larval period is from 25 to more than > 40 days. Pupation takes place on the grain surface, which lasts for 5-8 days. The life cycle required 7 to 12 weeks. Adult and larva of *Tribolium castaneum* (Herbst) cause damage. It is a major pest of stored grains, leading to a considerable loss of quality and viability of stored grain. These beetles are external feeders, that feed on seeds that have already been damaged or infested by other insects or broken mechanically. *Tribolium castaneum* (Herbst) larva & adults are more infested with food grains or materials than they consumed. Infested food materials or grains are unfit for human consumption.

Results

1. Effect of temperature on the eggs stage

Eggs are stuck to the surface of grains & media so they are technically very difficult to separate from the food materials and also very small in size so they are not seen by the naked eye. Eggs of experimental insects are seen only with the help of a magnifying glass and under the microscope. The optimum temperature is 30°C-35°C. Experimental studies have reported that the eggs of *Tribolium castaneum*, (Herbst) did not hatch at below < 15°C.

Table 1: Effect of diff. temperature on the metamorphic development stages of eggs.

Temperature(°C)	Length of Eggs hatching period (Days)
10	No hatching
15	No hatching
20	10-12 days
25	6-7 Days
30	3-4 Days
35	5-6 Days
40	12-13 days

*The Values are the average of three experimental results.

2. Effect Of temperature on the larval stage

The larva of *Tribolium castaneum* (Herbst) is more sensitive than eggs to heat and cold. The optimum or favorable temperature for larval metamorphic development is 35°C. At that temperature Less than or below < 20°C & more than > 40°C temperature affects the process of metamorphic development of the larval stage of insects. No larva pupated at a temperature of < 15°C.

Table 2: Effect of diff. the temperature on the metamorphic development stages of larva.

Temperature (°C)	Length of Larval period (Days)
10	No pupation
15	No pupation
20	42-44 Days
25	40-42 Days
30	25-27days
35	28-30 Days
40	38-40 Days

*The Values are the average of three experimental results

3. Effect of temperature on the metamorphic development stages of pupa. (Emergence of Adult)

The time duration of the pupal period is affected by temperature. The optimum or favorable temperature for the metamorphic development pupal stage is between 35°C-40°C. Below < 15°C temperature no emergence comes from the pupa.

Table 3: Effect of diff. temperature on the metamorphic development stages of pupa

Temperature (°C)	Length of pupal period (Days)
10	No emergence
15	No emergence
20	20-22 Days
25	12-14 Days
30	7-8 Days
35	5-6 Days
40	6-8 Days

*The Values are the average of three experimental results.

Conclusion

As per experimental observations and results *Tribolium castaneum* (Herbst) prefers temperature between 30°C- 35°C for metamorphic development (complete life cycle) at relative humidity. The result of the experimental study is optimum temperature for *Tribolium castaneum* (Herbst) fitness lies between the ranges of 30°C-35°C. These beetles are not breeding at lower temperatures < 15°C. Experimental studies have reported that the eggs of *Tribolium castaneum*, (Herbst) did not hatch at below < 15°C. The results of this study might be useful as an eco-

friendly control of insect-stored grain pest *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae).

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