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EFFECT OF LOW TEMPERATURE ON DIAPAUSE EGGS OF *Dysdercus cingulatus* (*Hemiptera*: *Pyrrhocoridae*)

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Abstract

Dysdercus cingulatus (Red cotton bugs) is the most damaging pest of cotton in India and many parts of Asia which reduces yield of cotton. Observing the damage caused to crop the present study designed to know the insect's diapause in relation with abiotic factors. It deals with the diapause termination in eggs of D. cingulatus, when the eggs were incubated at 5ºC for number of days and then transferred to optimal temperature (25ºC), the percentage of hatching decreases as the day increase. Thus temperature play an important role in diapause induction and termination.

Key words*: diapause, diapause termination, Dysdercus cingulatus.*

INTRODUCTION

In nature abiotic factors such as temperature, light and humidity are important factor to limit the survival and development process of species. Insect can survive only in optimal temperature; light and rainfall, if any of these aspects are unfavourable, insects undergo an arrest state called diapause. Diapause is a delay in development due to adverse environmental condition. Diapause in arthropods is a dynamic process; the term diapause suggested by Andrewartha (1952) is a period of arrest in which development comes to a complete rest. Andrewartha (1952) coined the term "diapause development" to refer to the ongoing progression of events that occur during diapause and eventually results in termination.

According to (Du, Chen, 2011; Koštal, 2006) temperature is one of the significant environmental stimuli controlling the termination of diapause.

When exposed to extreme temperatures, most insect employ behavioural, physiological or genetic adaptation mechanisms to adjust their body temperature to which they can with- stand (McMillan et al., 2005; Overgaard, Sorenson, 2008; Nyamukondiwa, Terblanche, 2009; Karl et al., 2011).

The finding of (Heming, 2003) reveals that eggs are the primary stage of insects' life cycles, and they have an upper and a lower temperature limits that they can tolerate. The temperatures outside of the limits would retard or completely inhibit the insect's development or kill the insects.

When embryonic development of insect eggs is stressed by environmental factors, especially temperature, consequent development and reproduction could be affected. However, how the thermal environment experienced in early ontogeny affects biological characteristics of both sexes and thermal tolerance capacities in later development stages is not well-studied (Bowler, Terblanche, 2008).

As observed in onion maggot, completion of diapause occurred at a wide range of temperature (4-25ºC): The optimal temperature was approximately 16ºC (Ishihawa, 2000) and diapausing temperature of *Sorghum midge* were in the range from 20 to 30ºC, which were optimum for diapause termination and adult emergence, moisture acted to initiate diapause termination, but photoperiod had no significant effect on the termination of larval diapause (Baxendale, Teetes, 1983).

In recent study on *R. Irregulariter dentatus* the optimal temperature for development was around 15ºC. A relatively high temperature of 25ºC prevent from hatching within 210 days which showed that diapause development were slow or arrested (Yamaguchi, Nakamura, 2015). It was observed that on the cold termination of diapause in the eggs of the silkworm *Bombyx mori*, the physiological mechanism of termination process was attributed to the conformational change of a specific protein named Time-Interval-

Measuring-Enzyme (TIME), which is regulated by the time-holding peptide (PIN) (Ti et al., 2004).

The present study on laboratory experiments is designed to know the insect's diapause in relation with abiotic factors i.e. temperature which plays significant role in termination of diapause in the eggs of *Dysdercus cingulatus*.

MATERIALS AND METHODS

Dysdercus cingulatus population was established from approximately 20-25 individual bugs originally collected from the field of cotton in Aurangabad city (19°32'N / 75° 14' E). They were reared at 22± 3°C and L: D 10: 14 photoperiod in glass bottle with muslin cloth and rubber band tied at the bottle mouth.

The bugs were fed with water soaked cotton seeds, changing the feed on every alternate day. The adult male and female were separated and kept pairs in Petridish of 9 cm diameter and whatmann no.1 filter paper placed at the bottom.

After copulation and breeding, female lays eggs in batches of 90-140 approximately. Freshly laid eggs were collected with the help of painting brush.

Batches of 10 eggs each were made and exposed to different temperature to observe hatchability. Group of 10 eggs in each batch were made and incubated at low temperature i.e. 5ºC for diapause induction for 10 days, 20 days and 30 days under darkness L:D 0:24 respectively, and then returned to 25ºC under darkness L:D 0:24 the diapause termination was recorded.

RESULTS AND DISCUSSIONS

The effect of different temperature on hatchability was observed and found that at 25ºC 100% hatchability so it was taken as optimal temperature for hatchability shown in Table 1 and Figure 1.

Table 1: Effect of different temperature on percentage hatching of eggs

Sr. No.	No. of Eggs	Temperature (°C)	% of Hatching
1	10	5°C	0 ± 0.6
2	10	15°C	90 ± 1
3	10	25°C	100 ± 0
4	10	30°C	50 ± 1
5	10	35°C	16.6 ± 1
6	10	40°C	0 ± 0

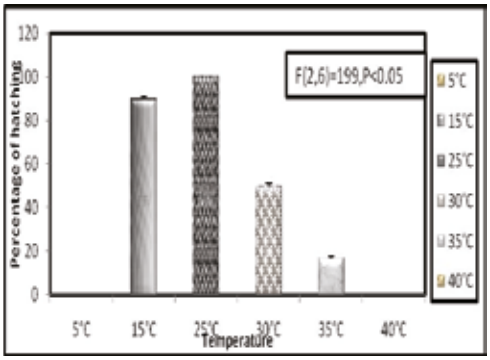

Figure 1. Effect of different temperature on the percentage of eggs hatching

Table 2 showing time taken for hatching of eggs and required for hatching of eggs maintained in laboratory (0:24 LL:DD photo period) at 5°C for 10, 20 and 30 days when transferred to 25°C.

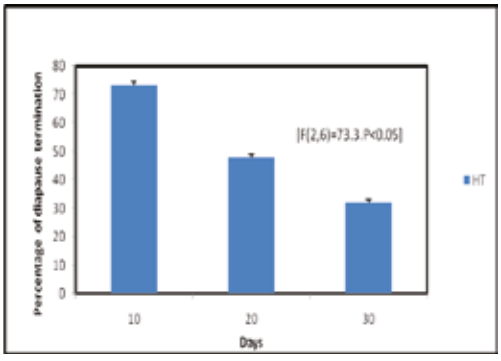

Figure 2. Effect of temperature i.e. 5ºC on diapause termination in eggs of *D. cingulatus*

Table 2. Time taken for hatching of eggs and required for hatching of eggs maintained in laboratory

Sr. No.	No. of days of incubation at 5ºC	Days required for termination at 25ºC	No. of eggs hatched at 25°C	% of Diapause termination	Mean value of day required for diapause termination
1	10	26.33± 3.05	18.33± 1.15	73.3 ± 1.1	26.3± 3.3
2	20	33.33± 2.08	12± 1	48 ± 1	33.3± 2.1
3	30	67.66± 3.05	8± 1	32 ± 1	67.6± 3.0

The effect of low temperature on percentage of hatching was shown in table 2 and figure 2, respectively. The result shows that eggs kept at 5ºC for 10 days were terminated after 26 ± 3.3 days with 73% of hatching. However after 20 days incubation the hatchability of eggs declined with increase in number of days to 33 ± 2.1, similarly after 30 days incubation eggs showed lowest hatchability i.e. 32% in 68 ± 3.0 days.

The effect of low temperature on percentage of hatching was shown in table no.2 and figure 2 respectively. The result shows that eggs kept at 5ºC for 10 days were terminated after 26 ± 3.3 days with 73% of hatching. However after 20 days incubation the hatchability of eggs declined with increase in number of days to 33 ± 2.1, similarly after 30 days incubation eggs showed lowest hatchability i.e. 32% in 68 ± 3.0 days.

As incubation period at low temperature increases, it's result shows decrease in percentage of hatching, which reveals that low temperature effects percentage hatching $F(2,6) = 73.3$, $P<0.05$. Low temperature often plays a role in the termination of winter diapause *Pyrrhocorris apterus* adult, when exposed to 5ºC it undergoes diapause and then transferred to 25ºC a less number terminate from diapause and start ovipositing (Hodek, 1968).

The relationship between temperature, incubation time and the hatching success were studied on *Austrophlebioides marchani* in laboratory conditions (Parnrong, Campbell, 1997). They observed that hatching time and hatching success are temperature dependent. Similar result were observed in temperate Australian mayfly eggs, which hatch between 9-25ºC, whereas European mayfly eggs hatched in an incubation temperature range between 3-25ºC (Giberson, Rosenberg, 1992) while in *Hexagenia rigida* eggs hatching occurs at 12-32ºC and if incubation is done at low temperature and high temperature above 36ºC it enters diapause (Friesen et al., 1979).

CONCLUSIONS

It is concluded from the results that the optimal temperature for egg hatching is 25ºC if the temperature is reduced to 5ºC or less than that eggs enter diapause. The induced diapause eggs get terminated when returned to optimal temperature but it increases duration for hatching. Hence abiotic factor like temperature is a one of the crucial environment factor that affects the biological processes and has major effect on survival of the insects.

To survive in the unfavourable temperature insect eggs induce diapause and terminate from diapause on favourable temperature. Insect greatly vary in their ability to survive low temperature and are considered highly successful animals that respond to seasonal changes by induction and termination of diapause.

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