Effects of temperature on the development of *Callosobruchuschinensis* L. (Chrysomelidae: Coleoptera)

Comment [MF1]: Evolution includes all the stages of the insect or only the eggs?

Abstract:

This study investigated the impact of constant temperatures (-15°C, 7°C, 28°C, and 35°C) on *Callosobruchuschinensis* L. (Chrysomelidae: Coleoptera). The results indicated that temperatures outside the control temperature of 28°C i.e. (-15°, 7°, and 35°C) significantly affected the biological parameters of *C. chinensis*. Specifically, adult emergence and egg hatching rates were most favourable at 28°C compared to the other temperatures tested. These findings emphasize the temperature sensitivity of *C. chinensis* and highlight 28°C as optimal for its developmental processes.

Keywords: **C. chinensis*,* *Temperature, *Adult emergence, *Egg hatching.

Introduction:

Pulses plays an important role as an energy supplier for human beings with a significant amount of carbohydrates and fats.They hold a significant position in global agriculture and food systems, ranking as the second most crucial group of food crops alongside cereal crops in various ways(Grahams and Vance, 2003). They also play an important role in sustaining soil fertility. Chickpea, Black gram and Green gram are highly nutritious pulses cultivated throughout the world. But in many developing countries the pulses are suffered to heavy qualitative and quantitative losses from the attack of pulse beetle, i.e., *C. chinensis*.Larval feeding causes leguminous seeds to lose some of their nutritional value in addition to decreasing their ability to germinate. For farmers and traders, the biggest financial concern is the loss of leguminous seeds while they are being stored (Rees, 2004). The pulse beetle is one of the most destructive pests of stored products, particularly chickpea, black gram and green gram.

Temperature is a crucial environmental factor that influences the development and growth of insects. Heat treatment have received increased interest in recent years as a mean to disinfest storage commodities and this approach is expected to continue to continue with the impending removal of restrictions on Methyl bromide usage (Mahroof*et al.* 2003; Roesli*et al.* 2003).

However, the expense of maintaining a storage temperature above 40°C or below 14°C is significant and not a cost-effective means of pest control. At high temperatures the metabolism rate is increased and at low temperature, insect development is slow and fecundity is reduced (Flinn and Hagstrum,1990). Also, temperatures below 14°C resulted in death for certain insect pests, particularly immature stages (Ghosh and Durbey,2003). It has long been established that exposure to extreme temperatures can protect stored products by killing insect pests. Heat can affect the physiology of insects in many ways and ability of individual insects to survive and ability to reproduce.

Therefore, the present study aims to evaluate the effect of 4 selected ranges of temperature on adult emergence and to develop a strategy for managing *C. chinensis.*

Materials and methods:

Insect cultures

The beetles of *C. chinensis*used in the experiment were obtained from the laboratory of the seed centre that is present adjacent to college of TNAU and RI. 10 pairs of *C. chinensis* adults of about one day old were introduced into the plastic jar each containing 500 g green gram seeds. The jars were then covered with fine mesh cloth fastened with rubber bands to prevent the escape of insects and allowed to mate. The present culture was available with seeds containing eggs were left until the emergence of new adults, which were later use in current experiment. The effect of different temperatures on the adult emergence of 2 pairs *C. chinensis* adults i.e., male and female selected of 24h old age adults from insectary cultures. The selected ones are inoculated with green gram seeds of quantity 50 g in each small Petri dishes covered with muslin cloth and left aside in order to allow them to mate inside the petri dishes itself on green gram seeds.

After a few days *i.e.*,5to7 days the adults lay eggs and die. The dead adults are removed. In this manner, we have taken 3 replications for each treatment. For each replication of the treatment adults are released as mentioned in above manner.

Now the petri dishes of each treatment are kept under different temperature set ups like -15°C and 7°C are kept under the refrigerator that is available in the laboratory. Other two treatment temperatures i.e., 28°C and 35°C we managed to keep 28°C replications under room temperature conditions where as for 35°C the replications were kept under sunlight for 3hrs duration during bright sunshine hours. To facilitate observation, we have taken the observation every 4 days in cases of -15°C and 7°C, whereas for 28°C and 35°C the observation is taken every 2 days.

Comment [MF2]: The researcher did the statistical analysis?

Results:

At -15°C:

At this range of temperature, the hatching of eggs and the emergence of adults was not observed at all.

At 7°C:

The result is similar as in this case of temperature. No hatching of eggs and emergence of adults is observed.

At 28°C:

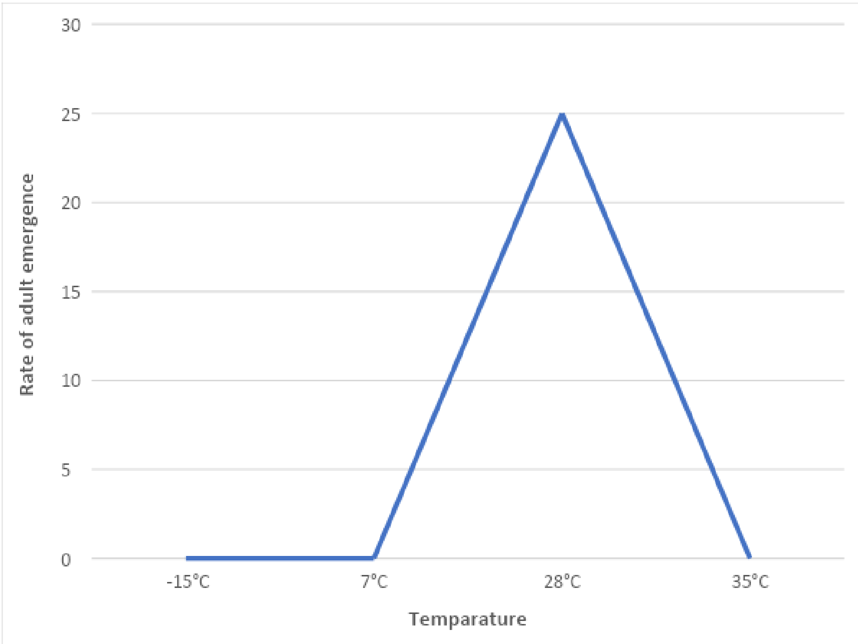
At this temperature, the rate of hatching and emergence is higher when compared to the above temperatures. This confirms us that at temperature 28°C is the most suitable temperature for completion of its life cycle.

At 35°C:

At this temperature the results are different there is no kind of hatching and emergence at this temperature.

I. fig 1 :Rate of adult emergence from different temperatures

Comment [MF3]: The researcher took days as a factor in the study to determine the hatchability rate of eggs, which was not mentioned in the results, especially at a temperature of 28°C



Discussion:

From the above experiment, we came to know there are specific reasons for *C.chinensis*disturbing the life cycle. However, the survival and development of insects are greatly influenced by temperature variation, duration of exposure, species, stage of development, acclimation, relative humidity, and moisture content of the food (Fields, 1992; Evans,1983). Extreme temperatures can affect the enzymatic mechanism and can inactivate enzymes blocking cell cycle development, making the temperature range for embryonic development in insects much narrower than the range of thermal tolerance in adults (Van der Have,2002). Gu*et al*. (2012) found that temperature treatment induced the synthesis of more Juvenile hormone (JH) and Heat shock proteins(hsp). Additional production and function of JH and hsp would consume more energy and result in slower insect development. The effect of low temperature on insects is apparent in reduced metabolism and respiration leading to the loss of more ATP and insect development, and neural functions are greatly influenced during prolonged cold exposure (Robert Michaud *et al*.,2008; Tomanek and Zuzow,2010).Some of the findings suggest that mating duration is also dependent on temperature, and therefore temperature should influence sperm transfer and female remating frequency (Katsuki and Miyatake,2009)

At high-temperature failure of hatching eggs due to desiccation of eggs as the sunlight is directly falling on the surface of the eggs.

Temperature plays a critical role in the survival and development of insects, impacting enzymatic mechanisms and metabolic processes essential for cell cycle development. While adults exhibit broader thermal tolerance ranges, embryonic development in insects is highly sensitive to temperature fluctuations. Extreme temperatures can disrupt enzymatic activity, potentially halting cell cycle processes crucial for embryonic development. Studies by Van der Have (2002) indicate that temperature extremes can lead to enzyme inactivation, thereby narrowing the temperature window suitable for embryonic development.

Moreover, temperature treatments have been observed to induce the synthesis of Juvenile Hormone (JH) and Heat Shock Proteins (hsp) in insects, as noted by Gu et al. (2012). Increased production and activation of JH and hsp consume additional energy, slowing down insect development processes. Lower temperatures, affecting metabolism and respiration rates, result in increased ATP loss and prolonged developmental periods. Studies by Michaud et al. (2008) and Tomanek and Zuzow (2010) emphasize the impact of low temperatures on insect neural functions and overall developmental rates. Additionally, temperature variations influence mating behaviours in insects, affecting sperm transfer and female remating frequencies (Katsuki and Miyatake, 2009).

Conclusion:

From the above experimental study, we concluded that -15**,** 7 and 35°Ctemperatures can be used for managing the *C. chinensis*effectively. Survival, development, and reproductive behaviours of *Callosobruchuschinensis* are intricately linked to temperature variations, highlighting the critical role of temperature in insect life cycles and population dynamics. Extreme temperatures, whether high or low, pose significant challenges to physiological and behavioural changes impacting their biological processes and survival strategies in natural and agricultural ecosystems.

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