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SHORT COMMUNICATION

Effect of Thermo-period on pupal diapause intensity in *Gnorimoschema operculella*

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ABSTRACT
Regulation of diapause thermo-period has been reported to significantly influence the pupal development of G. operculella. During the pupal stage, the insect remains inactive and fixed to the leaf surface at a single location until the adult emerges. The duration of the pupal stage varies depending on temperature. Experimental observations indicate that at lower temperatures the pupal period becomes shorter, whereas it is prolonged at higher temperatures. Immediately after pupation, the pupa appears bright brown in colour, which gradually changes to dark brown over time. However, under winter conditions (low temperature), the pupae tend to develop a brown to black coloration.
Keywords: *Thermo-period , Regulation, Pupal period*

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INTRODUCTION

The *Gnorimoschema operculella* (potato tuber moth) is one of the most destructive insect pests of potato crops worldwide, causing significant losses both in the field and during storage. The larvae feed on potato leaves, stems, and tubers, creating tunnels that reduce crop quality and yield. Because of its high reproductive potential and adaptability to different climatic conditions, the pest has become a major concern for potato-growing regions [1].

In insects, environmental factors such as temperature, photoperiod, and humidity play a critical role in regulating development, survival, and seasonal life cycles. Among these factors, temperature is one of the most influential parameters affecting insect physiology. The daily fluctuation of temperature, often referred to as the thermo-period, can significantly influence growth rate, metabolic activity, and developmental timing. Thermo-periodic variations are particularly important in regulating diapause, a physiological state of arrested development that allows insects to survive unfavorable environmental conditions [2].

Diapause is a common adaptive strategy in many insects and may occur at different developmental stages, including egg, larval, pupal, or adult stages. In lepidopteran insects, pupal diapause is frequently observed and plays an important role in synchronizing the life cycle with seasonal environmental conditions. The intensity and duration of diapause are largely influenced by temperature patterns and their fluctuations, which can either induce, maintain, or terminate diapause.

In the case of *Gnorimoschema operculella*, the pupal stage represents a critical phase in its life cycle where environmental cues determine the continuation or suspension of development. Variations in thermo-period may affect the rate of pupal development and the intensity of diapause, ultimately influencing population dynamics and seasonal abundance of the pest. Understanding the relationship between thermo-period and pupal diapause intensity is therefore important for predicting pest outbreaks and developing effective management strategies [3,4].

The present study documents the effect of thermo-period on the pupal development of *G. operculella*. Thermo-periodic interactions were observed to influence the seasonal biology of the pupal stage.

From a climatic perspective, extensive research on the role of thermo-period in regulating diapause is essential. In the present investigation, the duration of the pupal stage influenced by thermo-periodic effects was studied under laboratory conditions.

MATERIAL AND METHODS

Larvae of *Gnorimoschema operculella* were collected during March to April 2024 from the leaves of *Solanum tuberosum* grown in the agricultural fields of Shikohabad village. The collected larvae were maintained in the laboratory on an artificial diet for further observation. As the larvae approached the end of their development, they became sluggish and gradually ceased feeding. The final moulting of the larval stage resulted in the formation of the pupal stage.

The pupae obtained during different months were studied under varying environmental conditions. The maximum and minimum temperature ranges during each observation period were recorded, and the duration of the pupal stage was noted until the emergence of the adult insect. These observations were used to evaluate the relationship between temperature variation and pupal development.

RESULT AND DISCUSSION

The duration of the pupal stage ranged from 6 to 20 days, with an average duration of 12.5 days. A comparatively longer pupal period was observed from December 2024 to June 2025, when the temperature was higher than during the winter months. The maximum pupal duration (20 days) was recorded in May 2025, when the maximum temperature reached 38.4°C and the minimum temperature was 20.6°C. In contrast, the shortest pupal period was recorded between August 2024 and October 2024, when the maximum temperature ranged from 31.9°C to 33°C and the minimum temperature varied between 23°C and 24.2°C.

Table 1: Showing the duration of the pupal stage in different months of the year 2024-2025

Month	Range of Temperature		Date of pupation	Date of emergence of adults	Total Pupal stage (days)	Pupal
	Max °C	Min °C				
2024						
July	34.8	26.2	20.07.2024	26.07.2024	7	6
August	31.9	24.2	19.08.2024	24.08.2024	6	9
September	33.4	24.8	17.09.2024	22.09.2024	6	9
October	33.0	23.0	16.10.2024	21.10.2024	6	8
November	28.2	19.8	24.11.2024	02.12.2024	9	7
December	23.7	5.0	26.12.2024	09.01.2025	15	5
2025						
January	21.6	4.8	26.01.2025	11.02.2025	17	3
February	25.2	7.8	21.02.2025	07.03.2025	15	4
March	32.6	12.4	22.03.2025	09.04.2025	19	8
April	36.8	18.0	02.04.2025	17.04.2025	16	3
May	38.4	20.6	02.05.2025	21.05.2025	20	2
June	40.4	25.0	01.06.2025	15.06.2025	14	2
				MEAN	**12.5**	

The observations indicate that diapause development was enhanced within the temperature range of 23°C to 38.4°C. These results suggest that the thermo-period exerted a measurable influence on diapause induction.

Several earlier studies have also reported the influence of temperature on insect development and behaviour. For example, Kalushkov et al. [5] reported the thermal effect on diapause intensity in the alfalfa weevil. Atkins [3] studied the thermal influence on the behaviour of *Dendroctonus pseudotaugals*. Similarly, Amman [2] investigated the effect of temperature on oviposition in the mountain pine beetle. Further studies by Kurban et al. [6] also highlighted the role of thermal and other environmental factors on the biology of Helicoverpa armigera, an insect belonging to the family Noctuidae of the order Lepidoptera.

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