**International Journal of Zoology Studies**
**ISSN: 2455-7269**
**Impact Factor: RJIF 5.14**
**www.zoologyjournals.com**
**Volume 3; Issue 2; March 2018; Page No. 213-217**

# Relevance of temperature and host plants on the life cycle of *Henosepilachna vigintioctopunctata* (Fab.)

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**Abstract**
Each insect species has an optimum temperature at which it will develop at its fastest rate, and this can vary for each stage of its life cycle. The present study was conducted to know the accurate data for total duration of life cycle of the pest *Henosepilachna vigintioctopunctata* on its preferred host plant *Solanum melongena*. For this study, matured adult beetles were collected from the brinjal field and the experiment was carried out at room temperatures of 28.9±0.73ºC. During the study, total fecundity, incubation, larval, pupal, pre-oviposition, oviposition, post oviposition periods, male and female longevity and morphometrics of eggs, grubs, adults were also noted. The total life cycle duration was recorded as 20-26 days with an average of 22.5±2.01days. According to other similar research articles, the temperature 28-30ºC would be an optimum temperature for the development and density of this pest population. The result revealed that the duration of the life cycle was completely related with temperature and the preference of host plant.

**Keywords:** *H. vigintioctopunctata*, life cycle, morphometrics, optimum temperature, *Solanum melongena*

## Introduction

*Henosepilachna vigintioctopunctata* (Fabricius) or spotted leaf-eating beetle, belongs to the Family Coccinellidae of Order Coleoptera. Epilachna beetle cause damage to the Solanaceous and Cucurbitaceous crops [1]. It is a polyphagous pest, having a wide host range, with brinjal as the most preferred one [2]. Both grubs as well as adult beetles feed voraciously on the green matter of the leaf and skeletonize it leaving the upper epidermal tissue intact [3, 4]. The growth and development of the plants are greatly hampered and the yield is markedly reduced by the attack of Epilachna beetle [5].

Insects are poikilothermic animals that change their activity visibly depending on the temperature of the surrounding environment [6, 7]. Hence, besides food plants, climate conditions are basic factors that form insect range [8]. The basic climate parameters are temperature and humidity which influence insects both directly and indirectly [9]. Temperature plays an important part in the life cycle of insects. Higher temperatures tend to increase the speed of an insect's life cycle. That means insects will mature, mate and reproduce in a shorter span of time than normal. At each stage of an insect's life cycle a certain amount of heat is needed to complete the development of that stage. Increasing the temperature to the thermal optima level causes acceleration of the insect metabolism [10, 11]. Scientists working on *Henosepilachna vigintioctopunctata* on the same host plant has done similar work but the duration of the lifecycle is different. This could be due to temperature variation. The present study was conducted to know the morphometrics and total time taken by *Henosepilachna vigintioctopunctata* species to complete its life cycle based on temperature.

## Materials and Methods

To study the morphometrics and lifecycle of *Henosepilachna vigintioctopunctata*, the adults were collected from the brinjal field (MCC farm) during the month of January 2018 and were kept in glass rearing jars maintained under laboratory condition. The mean room temperature was 28.9±0.73ºC (minimum 28ºC to maximum 30ºC). Mating pairs were kept separately in transparent glass petridishes (100 x 15mm) and provided fresh leaves of *Solanum melongena* every day. Thus, fifteen pairs were tested to get an enough brood throughout the study.

Females laid eggs in clusters which were monitored daily. The laid egg clusters were counted and then transferred to another petridish for hatching. The duration of incubation period was recorded. After hatching, the grubs were reared and morphometrics for each instar were recorded. A visible exuviae was used as the evidence of moulting in each instars of larval period. Observations regarding the prepupal, pupal stages and adults were also recorded. A new male was replaced whenever a male died. In this case, females had alternative males for mating during lifetime. The length and breadth of eggs, different instars of grub, pupa and adult were measured by using a binocular compound microscope, fitted with an ocular micrometer calibrated with a stage micrometer. The data gathered during the experiment was analysed statistically for calculating mean, standard deviation, standard error and range.

## Results and Discussion

**Table 1:** Total lifecycle duration of *H. vigintioctopunctata* on brinjal

| Stages | Range (days) | Mean ± SD | S Error |
|---|---|---|---|
| Incubation | 3-4 | 3.75±0.42 | 0.109 |
| I instar | 3-4 | 3.7±0.48 | 0.124 |
| II instar | 2-4 | 2.95±0.49 | 0.128 |
| III instar | 2-4.5 | 3±0.70 | 0.182 |
| IV instar | 3-4 | 3.1±0.31 | 0.081 |
| Total larval period | 11-16 | 13.6±1.34 | 0.348 |
| Prepupa | 1-2 | 1.85±0.33 | 0.087 |
| Pupa | 2-4 | 2.95±0.59 | 0.154 |
| Total Pupal period | 4-6 | 4.9±0.73 | 0.19 |
| Total life cycle | 20-26 | 22.5±2.01 | 0.519 |

The duration of the lifecycle of *H. vigintioctopunctata* differs in relation to temperature. From this study, when the average room temperature was being 28.9ºC (28ºC -30ºC) and the host plant was *Solanum melongena*, the pest *Henosepilachna vigintioctopunctata* completed its lifecycle from egg to adult in 20 to 26 days with an average of 22.5 ± 2.01days respectively. Mean incubation, larval and pupal period lasts for 3.75±0.42, 13.6±1.34 and 4.9±0.73 days (Table 1). The results were confirmed with Jamwal *et al*. who conducted the experiment under laboratory condition (Room temperature 29±1ºC). Epilachna beetle, *H. vigintioctopunctata* were reared on eight different host plants to investigate the host biology interactions of the pest species. Effect of eight major host plants on all the biological parameters of the test insect included in the study revealed that grub and pupal development, survival, longevity and fecundity of *Epilachna vigintioctopunctata* on given host plants under laboratory conditions differ significantly. Among that, the pest species completed its total life cycle on *Solanum melongena* 22.5±1.91 days (mean incubation, larval and pupal periods were 3.60±0.11, 14.10±1.02 and 4.80±0.70 days).

Bumpy and Arora reported that the incubation, larval and pupal period decreases with rise in temperature and $CO_2$ concentration. *H. vigintioctopunctata* were reared using brinjal leaves under four different temperature regimes along with three $CO_2$ concentration maintained. When the average temperature was 25.83ºC, 27.08ºC, 28.75ºC and 30.00ºC, the total lifecycle was completed in 29, 27, 25 and 22days. Mean incubation, larval and pupal periods were 3.76±0.26, 19.43±0.15 and 5.00±0.09; 3.58±0.10, 17.96±0.30 and 4.44±0.05; 3.46±0.04, 16.51±0.27 and 4.33±0.01; 3.41±0.01, 13.80±1.21 and 3.72±0.14 days.

According to Atwal and Dhaliwal, *Epilachna vigintioctopunctata* was subjected to different temperatures as 25ºC, 30ºC and 35ºC. The total duration taken to complete its life cycle was approximately 36, 19 and 15 days respectively. Mean incubation, larval and pupal periods were 5, 17.8 and 13.4days; 3.3, 8.7 and 6.7days; 2.9, 7.1 and 5.1days.

Srinivasa Reddy and Mandal who conducted the experiment in two different seasons once during November-December and then during March-April under laboratory conditions 27±1ºC on brinjal leaves. Total duration from egg to adult was 26.90±1.33days during Nov-Dec, 21.45±0.88 days during March-April (mean incubation, larval and pupal periods were 5.07±0.47, 15.10±1.02 and 4.60±0.75 days; 3.28±0.22, 13.20±0.65 and 3.30±0.48 days respectively).

When the pest, *H. vigintioctopunctata* were reared on *Lycopersicum esculentum* Mill. At ±24ºC, the average lifecycle extended up to 41.44 days respectively [16]. Similarly, the average lifecycle duration was recorded on *L. esculentum* as 26.10±1.86 days under the temperature of 29±1ºC [12].

The life cycle of *H. vigintioctopunctata* on *Momordica charantia* was approximately 33 days at a temperature ±24ºC. The mean incubation, larval, prepupal and pupal periods were 7.8±2.58, 13.2±5.43, 1.6±0.89 and 4.4±0.89 days. When the same experiment was conducted under 29ºC it was 28.75±1.59 days [12].

Saravanan and Chaudhary revealed that temperature dependent development and degree day model of *Epilachna vigintioctopunctata* on Ashwagandha. Epilachna beetle were reared under four different temperature conditions as 20ºC, 25ºC, 30ºC and 35ºC. At the lowest temperature of 20ºC, the lifecycle was completed in 36.8 days. At 25ºC, the complete development took place in 27.5 days in *E. vigintioctopunctata*. At 30ºC, it took a least time of about 19.4 days to complete its life cycle. At higher temperature (35ºC), very less eggs were hatched and the grubs died early, therefore, total development at this temperature was assumed as zero.

Faster development and shorter larval duration with rise in temperature on *H. vigintioctopunctata* has been reported by Kwon *et al*. These authors recorded the total larval duration of 50.9±6.3, 28.3±2.8, 24.7±2.5, 14.7±1.1 and 11.3±0.5 days at constant temperature of 10, 15, 20, 25 and 30ºC, respectively. Similarly, Kang *et al*., observed the total developmental period of *H. vigintioctopunctata* from egg to adult stage on *Lycium chinense* to be 42.7, 26.3, 18.4 and 19.4 days at constant temperature of 15, 20, 25 and 30ºC, respectively.

Every insect also has a minimum and maximum temperature range, outside of which there is no development of immature stages. Insects will develop faster when they spend most of the time within their threshold temperatures for development. Less development occurs on days when the temperature becomes either too hot or too cold for part of the time. No development occurs if the temperature does not reach the lower threshold [20].

### Morphometrics

Egg: Eggs are elongate in shape. Female lays its eggs in a cluster form with a minimum of 6 to maximum of 65eggs. Freshly laid eggs were bright yellow in colour which then

changed into dark yellow (Fig 1-A). Under laboratory condition, the reared adults laid their eggs on both the surfaces of leaves. The female laid as many as 104 to 308 eggs during their life span with an average of 179.7±14.48 eggs in 5-10 clusters. Mean number of eggs laid per female was 114.80±52.85 on brinjal plant [21]. The size of an egg ranged from 1.19 to 1.31mm in length (Av. 1.24±0.04) and 0.38 to 0.49mm in breadth (0.44±0.02). Similarly, the average length and breadth of the eggs on brinjal and bitter gourd was recorded as 1.11±0.004 and 0.42±0.01; 1.09±0.01 and 0.39±0.01mm [22]. Varma and Anandhi reported that the average length and width of egg was 1.13±0.10mm and 0.41±0.07mm.

I instar: From every egg clusters, the first instar starts to hatch out most probably during morning hours (7-9am). Length of first instars has to be from 1.03 to 1.49mm, breadth of 0.37 to 0.58mm. On the first day, first instar had an average length of 1.15±0.05 mm and breadth 0.38±0.01mm. When they mature, the average length reached up to 1.35±0.09 mm and breadth 0.53 ±0.03. When they hatched out, the spines over the body surface was light colour later changed into dark colour. The average duration of first instar lasts for 3.7±0.48 days.

II instar: The size of second instars ranged from 1.36 to 3.18 mm in length and 0.58 to 1.03mm in length. The average length and breadth of a newly emerged out second instars 1.87±0.25mm and 0.68±0.05mm. The matured one reached up to 2.61±0.32mm in length and 0.90±0.12mm in breadth. The average duration of second instars was 2.95±0.49 days.

III instar: Body length and breadth of third instars ranged from 3.05 to 4.93mm in length and 1.29 to 2.40mm in b readth.

The measurements taken on first and last day of development of third instars were 3.33±0.16mm length and 1.42±0.08mm breadth; 4.36±0.43 in length and 2.19±0.12mm in breadth. The average duration of third instars was recorded as 3±0.70 days.

IV instar: Length and breadth of fourth instars ranged approximately 4.54 to 9.79mm in length and 2.07 to 3.89mm in breadth. The average length and breadth measurements on first and last day of development of fourth instars were 5.49±0.73mm; 2.54±0.35mm and 8.35±0.78mm; 3.22±0.53mm respectively (Table 3).

This study was confirmed with Bindu and Pramanik (2015) who reported that the average length and breadth of 1st, 2nd, 3rd, 4th instars were 1.85±0.25 and 0.88±0.44mm; 3.07±0.39 and 1.58±0.21mm; 4.21±0.14 and 2.15±0.52mm; 5.82±0.52 and 3.19±0.35mm. According to Varma and Anandhi who studied the average length and breadth of 1st, 2nd, 3rd, and 4th instars of grub was 1.14±0.10 and 0.40±0.04mm, 2.33±0.17 and 0.96±0.12mm, 4.70±0.4 and 1.89 ±0.90mm, 6.60±0.40 and 2.73±0.22mm, respectively. Jamwal *et al*. recorded that when the grubs were fed on brinjal leaves, length and breadth of *H. vigintioctopunctata* was differ significantly from bitter gourd leaves. On brinjal 1.80±0.04 and 0.62±0.06mm; 2.93±0.03 and 1.02±0.10mm; 4.81±0.03 and 2.06±0.02mm; 6.34±0.09 and 3.01±0.05mm respectively. The grubs which fed on bitter gourd leaves showed 1.54±0.02 and 0.57±0.02mm; 2.52±0.02 and 0.94±0.01mm; 4.66±0.03 and 2.02±0.01mm; 5.54±0.03 and 2.60±0.03mm respectively.

Pupa: The average length and breadth of prepupal and pupal stage was observed as 6.46±0.69 and 3.75±0.22mm; 6.34±0.67 and 3.50±0.29mm. The range of prepupal and pupal stage of *H. vigintioctopunctata* on brinjal plant were 5.25 to 7.72mm in length; 3.37 to 4.15mm in breadth and 5.45±7.78mm in length; 3.05±3.95mm in breadth (Table 3). Kaur and Mavi carried out the morphometric studies of various stages of *E. vigintioctopunctata* reared on brinjal variety and observed that the pupae were hemispherical in shape with mean length and width as 7.05±0.44 and 4.00±0.41mm, respectively. According to Tayde and Simon, length and breadth of prepupal and pupal stages on *Momordica charantia* was noted as 5.16±0.57 and 2.87±0.40mm; 6.15±0.24 and 3.73±0.38mm.

Adult: The average body length of male and female beetle was 6.01±0.53mm, 6.79±0.51mm and breadth were 4.50±0.23mm, 5.44±0.55mm (Table 3). Bindu and Pramanik, reported that, the body length and breadth of male and female beetles were 5.93±0.54 and 4.35±0.34mm; 6.87±0.59 and 5.23±0.63mm. The measurement of the over all body length of the male beetles was recorded significantly different of the beetles feeding on brinjal and bitter gourd (6.54±0.19 and 5.26±0.12); width (6.05±0.02 and 4.73±0.04mm). female beetles are slightly bigger than male beetle. The length and width of 7.03±0.12; 5.49±0.12mm on brinjal and 6.74±0.04; 5.06±0.08mm on bitter gourd [22].

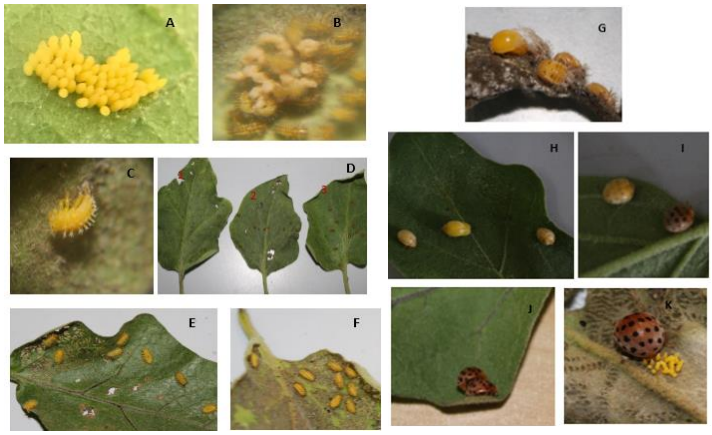


**Fig 1:** A- An egg cluster, B- First instars emerging out from an egg cluster, C- Moulting of second instar, D- 1st, 2nd and 3rd instars, E- Healthy fourth instars, F- Matured 4th instars in a resting state, G- An adult emerging out from pupal case, H&I- Colour changes of elytra, J-Mating process, K- Egg laying.

**Table 2:** Duration of reproductive periods in *H. vigintioctopunctata*

| Stages | Range (days) | Mean ± SD | S Error |
|---|---|---|---|
| Egg batches | 5-10 (no.) | 6.9±1.91 | 0.493 |
| Total fecundity | 104-308 (no.) | 179.7±56.1 | 14.48 |
| Pre-oviposition | 8-12 | 9.2±1.22 | 0.317 |
| Oviposition | 14-25 | 17.8±3.73 | 0.964 |
| Post oviposition | 2-9 | 4.1±2.37 | 0.64 |
| Male longevity | 21-36 | 26.7±4.47 | 1.155 |
| Female longevity | 25-42 | 31±5.09 | 1.316 |

**Table 3:** Morphometrics parameters of every stages in epilachna beetle.

| | Length(mm) | | | Breadth(mm) | | |
|---|---|---|---|---|---|---|
| **Stages** | **Range** | **Mean ± SD** | **S Error** | **Range** | **Mean ± SD** | **S Error** |
| Egg | 1.19-1.31 | 1.24±0.04 | 0.01 | 0.38-0.49 | 0.44±0.02 | 0 |
| I instar- Immatured | 1.03-1.23 | 1.15±0.05 | 0.01 | 0.37-0.42 | 0.38±0.01 | 0 |
| I instar- matured | 1.23-1.49 | 1.35±0.09 | 0.02 | 0.49-0.58 | 0.53±0.03 | 0 |
| II instar- Immatured | 1.36-2.27 | 1.87±0.25 | 0.06 | 0.58-0.77 | 0.68±0.05 | 0.01 |
| II instar- matured | 2.07-3.18 | 2.61±0.32 | 0.08 | 0.64-1.03 | 0.90±0.12 | 0.03 |
| III instar- Immatured | 3.05-3.56 | 3.33±0.16 | 0.04 | 1.29-1.55 | 1.42±0.08 | 0.02 |
| III instar- matured | 3.63-4.93 | 4.36±0.43 | 0.11 | 2.01-2.40 | 2.19±0.12 | 0.03 |
| IV instar- Immatured | 4.54-6.49 | 5.49±0.73 | 0.18 | 2.07-3.24 | 2.54±0.35 | 0.09 |
| IV instar- matured | 7.13-9.79 | 8.35±0.78 | 0.2 | 2.40-3.89 | 3.22±0.53 | 0.13 |
| Prepupa | 5.25-7.72 | 6.46±0.69 | 0.17 | 3.37-4.15 | 3.75±0.22 | 0.05 |
| Pupa | 5.45-7.78 | 6.34±0.67 | 0.17 | 3.05-3.95 | 3.50±0.29 | 0.07 |
| Male | 4.67-6.42 | 6.01±0.53 | 0.13 | 4.02-4.80 | 4.50±0.23 | 0.06 |
| Female | 5.97-7.29 | 6.79±0.51 | 0.13 | 4.67-6.10 | 5.44±0.55 | 0.14 |

When the adult beetle emerged out from the pupal case, it looks bright yellow in colour which then slowly changed into light brown and then dark brown with dark spots on its elytra (fig1: H&I). The average duration of Pre-oviposition, oviposition and post oviposition for *E. vigintioctopunctata* on brinjal leaves was 8 to12 days (9.2±1.22 days), 14 to 25 days (17.8±3.73 days) and 2 to 9 days (4.1±2.37 days) respectively. The average preoviposition and oviposition period were 5.92 days and 7.69 days respectively [2].

Male longevity varied from 21 to 36 days and female longevity 25 to 42 days (Table 2). Male and female longevity of 57.2 days and 60.8 days on brinjal at 28ºC, 80% RH [26]. The average male longevity of 13.10 and 9.40 days, female longevity of 31.50 and 27.15 days on brinjal and bitter gourd respectively at 29ºC, 60±10% RH were reported [22]. Ghosh and Senapati reported that the average longevity of male beetle was 18.32 days and 23.33 days for female. Ram and Verma recorded that *E. vigintioctopunctata*, a pest hibernated in winter, pre-oviposition period varied from 4-132 days. Male beetle survived for shorter duration (7-185 days) in comparison to female (2-198 days). The whole life cycle was completed in 17-41 days. The pest passed through 7 generations in the laboratory and the duration was found shorter during April-May. Ramzan and Singh studied that pre-oviposition and oviposition periods on *S. melongena* was 8.0 and 12.7 days respectively.

**Acknowledgements**

The authors are thankful to the BIF laboratory, Department of Zoology, MCC for helping us complete this work.

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