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Effect of Temperature on the Bahaviour of Epilachna Beetle (*Epilachna dodecastigma* Wied.) among Different Brinjal Varieties

S. Das[1], M. M. Uddin[2] and K. S. Islam[2]

[1]Agrotechnology Discipline, Khulna University, Khulna
[2]Depertment of Entomology, Bangladesh Agricultural University, Mymensingh

Abstract
An experiment was carried out to study the effect of temperature on biology, oviposition and feeding behaviour as well as host preference of Epilachna beetle, *Epilachna dodecastigma* (Wied.) on eight varieties of brinjal, *Solanum melongena* Linn. from November, 2009 to June, 2010 maintaining controlled temperatures of 15ºC, 25ºC and 30ºC using an incubator in the Department of Entomology, BAU, Mymensingh. Temperature has a profound influence on the oviposition and food consumption of Epilachna beetle. In incubator at 15°C, 25°C and 30°C temperature, larval daily average food consumption (mm^2) among eight host plant varieties of *S. melongena* was the highest on Thamba and the lowest on Bijoy, whereas adults daily mean food consumption at three temperature regimes was the highest on Thamba and the lowest on BAU-2 at 15°C and 25°C temperature and at 30°C temperature the lowest recorded on Bijoy. At 25°C temperature, the highest oviposition was recorded on Thamba and the lowest found on Jhumki. Similarly at 15°C and 30°C temperature, the highest oviposition was also observed on Thamba and the lowest on Bijoy. Thus, the varieties namely Thamba, ISD 006 and Kazla appeared to be preferable hosts, whereas Bijoy, BAU-2 and Jhumki seemed to less preferable. The results revealed that temperature had direct effect on the behaviour and 25°C temperature was congenial to both fecundity and food consumption of the Epilachna beetle.

Key words: Behaviour, Brinja variety, Effect, Epilachna beetle, Temperature

Introduction

Epilachna beetle, *Epilachna dodecastigma*, (Coleoptera: Coccinellidae) is one of the major important vegetable pests in South-East Asia and mostly common in Bangladesh. It is widely dispersed in South and East Asia, Australia, America and the East Indies. Distressing attacks by species of Epilachna have been reported from China on potato (Dieke, 1947), from Sumatra on datura (Den Doop, 1919) and from the United States on bean (Dieke, 1947). As said by Dieke (1947), about one sixth of all the illustrated species of the family Coccinellidae belongs to the sub-family Epilachninae and more or less all, to a single genus namely Epilachna. They are suppose to attack especially the leaves and feed on the chlorophillous green portion and thereby preventing the synthesis of carbohydrate by the host plants due to lack of sufficient chlorophyll even though the sunlight is present (Endo *et al.,* 2004). This pest causes serious damage to the crops of major families namely Cucurbitaceae, Leguminosae and Solanaceae of which certain crops are most affected viz. *Solanum melongena* Linn., *Luffa acutangula* Roxb., *Trichosanthes anguina* L., *Momordica cochinchinensis* Spreng., *Eucurbita pepo* Dc. and *Dolichos lablab* L.

Both grubs and adults are injurious to the host plants. Infestation primarily begins in colonial form just after hatching of egg mass (Murata *et al.,* 1994). The adults feed irregularly upon the upper surface of leaves and its grubs feed on the lower surface of leaves by scraping, causing net like appearance of the host plant leaves that turn brown in colour, entirely dry up due to extensive infestation by the growing population and finally defoliate (Pradhan *et al.*, 1990). Vegetative growth and development of the plants are greatly harmed and their economic yield is noticeably declined (Alam, 1969; Rajagopal and Trivedi, 1989). From economic stand point, the Epilachna beetle bears great significance because it can alone damage up to 80% of the host plants (Rajagopal and Trivedi, 1989), while it is responsible for 10-20% yield loss in brinjal (Alam, 1969).

Infestation period of this insect pest varies with temperature, season and region where temperature plays significant role on its molting, metamorphosis, growth and development and oviposition as well as on its food consumption. It is well recognized that the peak attack of this insect pest is generally observed in July to August i.e. during the rainy season and usually there is no movement, activity or infestation by the pest found in winter season when they go to hibernation (Shukla and Upadhyay, 1985). Epilachna beetles feed most actively during morning and evening. The daily fluctuation in the rate of feeding depends mainly on the temperature of the environment which estimates the level of metabolism (Tilavov, 1981). Insect pest prevalence and its degree of infestation vary from season to season, place to place due to the environmental changes especially temperature, and host plant species (Amitava *et al.*, 2002).

For proper management of the pest, it is necessary to have an adequate knowledge about optimum and adverse temperature regimes that greatly influence feeding and oviposition of the pest as well as growth and developmental pattern and prone stage of economic injury to the crops. In Bangladesh there is few works on the effect of temperature on behavioural performance of Epilachna beetle among different hosts. Therefore, the present study has been undertaken to explore the effect of temperature on ovipositional behaviour and food consumption as well as host preference of Epilachna beetle, *E. dodecastigma* (Wied) using eight brinjal varieties.

Materials and Methods

Experiments on the effect of temperature on ovipositional behaviour, food consumption and host preference of Epilachna beetle, *Epilachna dodecastigma* (Wied.) were accomplished using eight different host varieties of *Solanum melongena* in the laboratory of the Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh during November 2009 to June 2010.

Development of host plant seedlings

Quality seeds of eight brinjal varieties were collected from reputed agricultural institutions of Bangladesh namely BARI, BINA and Department of Horticulture, BAU. The seeds were sown on in the field and the young seedlings were sufficiently nourished upto 30 days of their age in Entomology field laboratory, BAU, Mymensingh.

Transplantation and management of host plant

After uprooting, the seedlings were transplanted in previously cultivated and properly managed soil ridges in the field. Each variety was replicated three times, each of which includes 11 rows, where each row contains 10 seedlings maintaining spacing of 70 × 60 cm. The seedlings were carefully maintained up to maturity by providing optimal watering, weeding, earthing up and other agronomic practices as and when necessary.

Mass culture of the test insect

To conduct different experiments a stock culture of huge number of larvae and adult beetles of *Epilachna dodecastigma* was reared in the laboratory. Adults of the beetle were collected from the cultivated brinjal plants of the field at BAU, Mymensingh. Insects were sexed and paired (male and female) and one pair of insects was kept per Petri dish (15 cm diameter). They were allowed to mate each other in the Petri dish. Moistened blotting papers were kept at the bottom of each Petri dish. Fresh and healthy leaves of different brinjal varieties were provided everyday for insects in the Petri dish. After oviposition, adult beetles were uninterrupted for hatching. Immediately after hatching of eggs, the larvae were transferred in several Petri dishes. Ten larvae per Petri dish were reared upto adult emergence. This process was repeated until having enough number of insects for the experiment.

Influence of temperature

.To study the influence of temperature on the food consumption and oviposition of the beetle an experiment was conducted at three distinct temperatures viz. 15 ± 1ºC, 25 ± 1ºC and 30 ± 1ºC on eight host plant varieties of *S. melongena* (BAU-2, Bijoy, Irri begun, ISD-006, Islampuri, Jhumki, Kazla and Thamba) in the laboratory of Entomology Department, BAU using an incubator.

Food consumption

At controlled temperatures of 15 ± 1ºC, 25 ± 1ºC and 30 ± 1ºC in incubator, the leaves of eight preferred varieties of host plant were used as food both for larvae and adult beetle. The insects were released in the Petri dishes with leaves as food and then these Petri dishes were put inside the incubator. The quantity (mm^2) of food consumed by both larvae and adults per day was measured using square millimeter graph paper. Three replications were made for each variety at three different temperatures.

Oviposition

Newly emerged adults were sexed and a pair of insects (male and female) from stock culture was released in each Petri dish containing leaves of a variety as their food. The temperature was controlled as, 15 ± 1ºC, 25 ± 1ºC and 30 ± 1ºC in the incubator. The number of eggs laid on each variety was counted daily. Three replications were made for every variety at each temperature.

Host preference

Host preference of *Epilachna dodecastigma* on eight varieties of brinjal was determined in the laboratory of the Department of Entomology, BAU which was done by measuring the food (leaves) consumption (mm^2) of the beetle at three temperature regimes of 15 ± 1ºC, 25 ± 1ºC and 30 ± 1ºC. The adult beetle was released in each Petri dish containing fresh-tender leaf of a variety of host plant that was replicated three

times and food consumption was estimated regularly and thereby finally revealing their host preference. The preferred variety was determined depending on the amount of leaf area eaten by both larvae and adults. Fresh leaves were provided to the insects in the Petri dishes and waste products and excreta were removed every day.

Data analysis

Data obtained from different experiments on oviposition, food consumption and host preference of *E. dodecastigma* among eight varieties of brinjal were analyzed using analysis of variance in Completely Randomized Design (CRD). The mean values were ranked by Duncan's New Multiple Range Test (Duncan, 1955).

Results and Discussion

Effect of temperature on oviposition

The eggs of *E. dodecastigma* were spindle shaped, tapering at the micropylar region facing upwards. The female beetles laid eggs in cluster on the dorsal surface of the leaf. The eggs were embedded vertically on the tentacular hairs of the 1eaf. They were closely attached on the lateral side. Soon after laying, the egg was yellow in color with even and glossy surface and afterwards changed into light yellow in color. Females were paired individually on eight different host plant varieties and average number of eggs laid was calculated during the whole period of oviposition at three temperature regimes in the incubator.

The effect of three different temperature viz. 15, 25 and 30ºC on oviposition of the insects among eight brinjal varieties was observed (Figure 1) and the highest egg laying was found at 25ºC followed by 30ºC and the lowest at 15ºC. At 25ºC temperature, the maximum number of egg was laid on the variety Thamba (78.33) followed by ISD 006 (72.33) and minimum egg was laid on the variety Jhumki (44.33). At 30ºC temperature, the lowest number of eggs (39.33) was laid on the variety Bijoy and the highest number of eggs (59.33) was found on the variety of Thamba followed by ISD 006 (56.67) and Kazla (51.33).

At 15ºC temperature in incubator, the lowest number of eggs (24.67) was laid on Bijoy and the highest (49.00) was found on the variety of Thamba followed by ISD 006 and Kazla.

The egg laying performance on eight different brinjal varieties at different controlled temperatures varied significantly and it might be due to variability of insect host preference. Among three temperature 25ºC was found as optimum for the beetles ovipositional behaviour where they laid maximum number of eggs on different varieties of brinjal as per their preference and at 30ºC they laid moderate number of eggs considered as moderately favourable and at 15ºC, laid the lowest number of eggs and regarded as least favourable temperature for oviposition. Amitava *et al.* (2002) found that the egg laying was controlled by the temperature. This result was similar to our present findings.

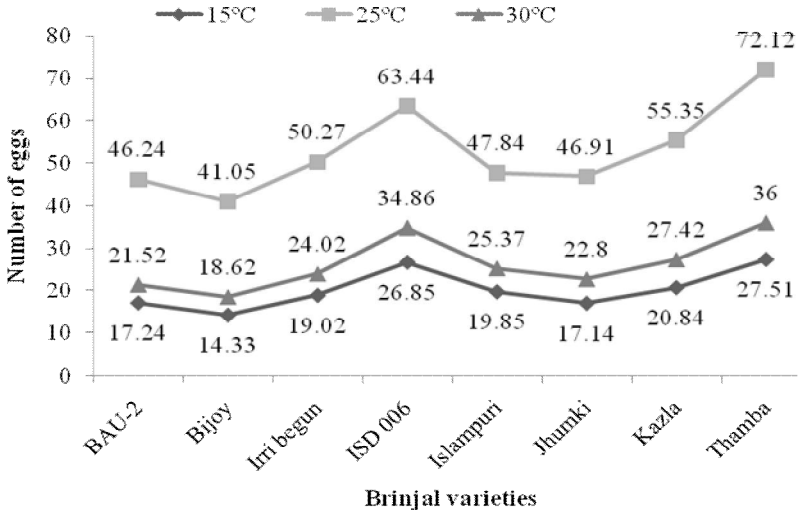

Fig. 1. Oviposition behaviour of *E. dodecastigma on* the leaves of different brinjal varieties at 15, 25 and 30ºC temperature in incubator

Effect of temperature on larval food consumption

In case of larvae, at 15, 25 and 30ºC temperature, the highest quantities of food consumption per day were recorded on Thamba those were 27.51 mm^2, 72.12 mm^2 and 36.00 mm^2, respectively followed by ISD 006 on which food consumptions were 26.85 mm^2, 63.44 mm^2 and 34.86 mm^2, whereas the lowest food consumption per day at 15, 25 and 30ºC recorded on Bijoy which were 14.33 mm2, 41.05 mm^2 and 18.62 mm^2, respectively (Table 1). The findings of the present study was similar to the findings of the Tripathi and Misra (1991) who reported that the duration of the development of *E. dodecastigma* was the longest at 20ºC and the shortest at 40ºC, the optimum temperature for larval development and survival being 25ºC temperature.

Table 1. Larval feeding (mm^2) of *E. dodecastigma* on the leaves of different brinjal varieties at three different temperatures in incubator

Brinjal varieties	**Larval feeding (mm^2)/day at controlled temperature in incubator**		
	15ºC	25ºC	30ºC
BAU-2	17.24 bc	46.24 de	21.52 bc
Bijoy	14.33 c	41.05 e	18.62 c
Irri begun	19.02 bc	50.27 cd	24.02 bc
ISD 006	26.85 a	63.44 b	34.86 a
Islampuri	19.85 bc	47.84 de	25.37 bc
Jhumki	17.14 bc	46.91 de	22.80 bc
Kazla	20.84 b	55.35 c	27.42 b
Thamba	27.51 a	72.12 a	36.00 a
Mean	20.35	52.90	26.33
±SE	1.65	3.63	2.19
LSD value	5.68	7.00	7.04
Level of significance	0.01	0.01	0.01
CV (%)	15.93	7.56	15.27

Means followed by common letter (s) are not significantly different.

Effect of temperature on adult food consumption

In respect of adults, the highest daily food consumption at 15, 25 and 30ºC temperature was observed on Thamba which were 90.42 mm^2, 175.7 mm^2 and 112.50 mm^2 followed by ISD 006 on which food consumptions were 75.96 mm^2, 157.00 mm^2 and 102.50 mm^2, respectively whereas the lowest food consumption per day at 15 and 25ºC temperature recorded on BAU-2 were 45.67 mm^2 and 103.5 mm^2 and at 30ºC the lowest eating per day recorded on Bijoy that was 70.37 mm^2, respectively. The food consumption differed significantly among brinjal varieties (Table 2). It was noticed that 25ºC temperature was congenial to food consumption both for larvae and adults whereas 15 and 30ºC temperature were not as favorable as 25ºC temperature but insects were able to survive through food consumption. The results of the present research might be similar with some other literature. Shukla and Upadhay (1985) observed that temperature and relative humidity had the most profound effect on the digestion of food but light had no significant effect on *E. dodecastigma*. The optimum conditions for digestion by *E. dodecastigma* were 25 -30ºC, 50 - 60% RH and natural light as compared with continuous darkness. Tilavov (1981) suggested that the daily fluctuation in the rate of feeding depends mainly on the temperature of the environment, which determines the level of metabolism.

Table 2. Adult feeding (mm^2) of *E. dodecastigma* on the leaves of different brinjal varieties at three different temperatures in incubator

Brinjal varieties	Adult feeding (mm^2)/day at controlled temperature in incubator		
	15ºC	25ºC	30ºC
BAU-2	45.67 f	103.5 e	74.81 d
Bijoy	49.86 e	105.9 de	70.37 d
Irri begun	55.43 d	119.7 cd	79.86 cd
ISD 006	75.96 b	157.0 b	102.5 b
Islampuri	53.54 d	118.7 cde	79.29 cd
Jhumki	55.39 d	117.5 cde	79.30 cd
Kazla	66.44 c	131.9 c	87.42 c
Thamba	90.42 a	175.7 a	112.5 a
Mean	61.58	128.75	85.75
±SE	2.95	8.94	5.13
LSD value	2.13	14.49	8.90
Level of significance	0.01	0.01	0.01
CV (%)	1.97	6.43	5.92

Means followed by common letter (s) are not significantly different.

Effect of temperature on host preference

Host Preference of *E. dodecastigma* was assessed by the amount of food consumed by each larva and adult per day on different host plant varieties of *S. melongena* at three temperature regimes of 15, 25 and 30ºC. Based on daily mean food consumption it was found that both larvae and adults consumed the highest amount of leaves from the variety Thamba at three temperature regimes. In case of larvae the lowest food consumption per day at 15, 25 and 30ºC was recorded on Bijoy, whereas the adult daily food consumption at 15 and 25ºC temperature was the lowest on BAU-2 and at 30ºC, the lowest was recorded on Bijoy. Therefore, it was evident that the beetle mostly preferred Thamba followed by ISD 006 whereas Bijoy and BAU-2 were the least preferred hosts and remaining other brinjal varieties were moderately preferred by the beetle at three different temperature regimes. Richards and Filewood (1990) stated that host preference of *E. vigintioctopunctata* was influenced by odour, taste and age of plant and by thickness of leaves, proportion of crude fibers, parenchymatous tissue, and water content. They also stated that temperature has some effect on the host preference of this species of Epilachna beetle.

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