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Mayukh Sarker

Research Journal of Agricultural Sciences
An International Journal

P- ISSN: 0976-1675
E- ISSN: 2249-4538

Volume: 13
Issue: 01

Res. Jr. of Agril. Sci. (2022) 13: 237–239

CARAS

Res. Jr. of Agril. Sci. (Jan-Feb 2022)
13(1): 237–239

www.rjas.org

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

Full Length Research Article

Host Preference and Nutritional Ecology of Major Defoliator, *Buzura suppressaria* Guenee (Lepidoptera: Geometridae) from Darjeeling Foothills Tea Plantation Areas

Mayukh Sarker*[1]

Received: 03 Oct 2021 | Revised accepted: 22 Jan 2022 | Published online: 15 Feb 2022

ABSTRACT

The major pest of tea, *Buzura suppressaria* (looper caterpillar) mostly defoliates the young and maturing leaves of the full-grown tea bushes of Darjeeling foothills areas. Clonal variety like TV_{26} was preferred as food over TV_1 and TV_{18} variety. Comparison of the host preference between tea leaves and shade trees was evaluated in early instar loopers. The life cycle traits and performance were also assessed of the loopers reared on TV_{26} leaves. The survivorship curves were studied and showing about 26% adult emergence. Values of production index and a maintenance cost were also studied in IV^{th} and V^{th} instar larvae. Chemical analysis of the body mass of Vth instar larva showed that the formation of higher quantity of nitrogen and lipid but a low amount of ash and moisture. So, this study might be helpful in designing the artificial diet for controlling this pest species both conventional and non-conventional methods.

Key words: *Buzura suppressaria,* Tea, Host preference, Shade trees, Tea clone

In Darjeeling foothills, terai and the Dooars there are often outbreaks of *Buzura suppressaria* Guen. (Looper Caterpillar), which mainly defoliates the young and maturing tea leaves. Normally 10% of total crop is lost due to pest but this could rise to 40% in case of devastating attacks by the lepidopteran defoliators [1]. Tea plantations of the said region comprise largely of Tocklai (TRA) released clones. Some of the old and relatively common clones are TV_1, TV_{18}, TV_{26} etc. Host-preference experiments were conducted using these to find out the degree of liking of the *B. suppressaria* early instar caterpillars for the shade trees and particular clone that can support laboratory rearing. Phytophagous insects require adequate concentration of nutritionally important chemical substances, like proteins, amino acids, lipids, carbohydrates in their diet for growth and reproduction. Through all phytophagous insects tend to have similar qualitative nutritional requirements irrespective of feeding habits, their quantitative intake always varies. As such the biotic potential of insects is influenced by the quantitative intake [2-3]. The nutritional ecology of an insect is based on a good understanding of the relationship between insects and plants, so life cycle traits and survival performance are crucial for large-scale multiplication of the pest species at field level. These parameters also give us scope to readily assess the efficacy in supporting mass rearing programmes of the pest species and these data can be suitable in designing the artificial diet for better control of the pest by conventional and non-conventional methods.

* **Mayukh Sarker**
mswbes08@gmail.com

[1] Department of Zoology, APC Roy Government College, Himanchal Vihar, Matigara, Darjeeling - 734 010, West Bengal, India

MATERIALS AND METHODS

Host plant preference study was done between the shade tree (*Indigofera* sp.) and TV_{26} for I^{st} and II^{nd} instar larvae only due to their feeding preference on shade tree. Studies was also done among the tea clones (TV_1, TV_{18}, and TV_{26}) for III^{rd} and V^{th} instar larvae as they prefer tea leaves. Leaf disc of equal diameter of the shade tree and three clonal variety of approximate same maturity were used in Petri dish with moisten toweling. In the center of each Petri dish a single larva ($I^{st}/II^{nd}/III^{rd}/V^{th}$) was released and allowed to feed for 12 hours [4]. After 12 hours leftover leaf discs were oven dried and weighed. Dry weights of food consumed were determined by subtracting the dry weights of leaf discs, after consumption, from the dry weight of an intact leaf disc of equivalence.

Adults were sexed and kept in cloth covered glass chimney (19.5cm × 8.5cm) in 1:1 ratio (n=10). A twig with leaves, two brown paper strips, cotton swabs soaked in diluted honey and paper towel were kept inside the chimney for egg laying. The eggs laid in batches were kept in BOD incubator for emergence in small containers (9.5cm × 5cm) with lid.

The neonates up to II^{nd} instar were reared on shade tree and TV_{26} clone. One set of III^{rd} instar larvae was continued on tea leaves (TV_1, TV_{18} and TV_{26}). Rearing was done under controlled conditions at 28 ± 2°C, 75 ± 5% RH and 12 hours

L:D. Mass cultures were kept in big transparent plastic containers (45 × 20 cm) for studying nutritional indices based on dry mass budget and biochemical components of body.

Change in instars was noted by detecting the head capsule and exuvium of the larva and the stadial periods were recorded based on 10 samples. Survivorship studies were done under the same conditions starting with 100 eggs.

Fecundity, pupal dry weight, longevity was observed during study of the lifecycle traits. Maintenance cost and production indices for IIIrd and Vth instars were computed using the dry weight nutritional data. Analysis of chemical components of larval body mass reared on clones was done using methods of AOAC [5] for total nitrogen, fat content, ash. Moisture was estimated using standard oven drying method.

RESULTS AND DISCUSSION

Host preference

Acceptance and successful utilization of a host plant by phytophagous insects depend upon the coordinated interaction between the insect and the plant [6]. Most of these insects are specialists and have strong feeding preference that results in various degree of host specificity [7].

Table 1 Host preference for shade tree and TV_{26} clone by Ist and IInd instar larvae of *B. suppressaria*

	Mean* ± SE for Ist instar	Mean*± SE for IInd instar
Shade tree	0.351a±0.008	0.275a±0.09
TV_{26}	0.02b±0.001	0.038b±0.01

*Means followed by same alphabet in column are not significantly different at 5% level

Table 2 Preference for clonal varieties of tea by middle stage (IIIrd) and late stage (Vth) larvae of *B. suppressaria*

Tea clone	Mean* ± SE for IIIrd instar	Mean*± SE for Vth instar
TV_1	0.129a±0.01	0.213a±0.03
TV_{18}	0.136a±0.02	0.271a±0.03
TV_{26}	0.586b±0.05	0.631b±.0.03

*Means followed by same alphabet in column are not significantly different at 5% level

Host preference studies with caterpillars of *B. suppressaria* clearly indicated that they had a marked preference for shade tree (*Indigofera* sp) for Ist and IInd instar stages over the TV_{26} (Table 1). TV_1 and TV_{18} having a higher non-digestible component, mainly cellulose and lignin [8] was less preferred. Most insect ecologists agree, that tough tissue of plants generally act in antiherbivore defense [9-10]. Leaf toughness is also known to be accompanied with a decline in the water content, decline in the nitrogen content, increase in the condensed tannin concentrations and decline in hydrolysable tannin concentrations [11]. It is likely that many of these above factors come to play in selection of the tea clone as choicest host. TV_{26} with higher moisture and less fibre contents, than the other two clones (TV_{18} and TV_1) was therefore a preferred variety for consumption by *B. suppressaria* (Table 2).

Postembryonic development and survivorship

Total lifecycle of *B. suppressaria* was completed in 51-63 days. Eggs laid in clusters were bluish green. The first instar hatched out after 3-4 days of incubation. Development of five larval stages took about 34-38 days. The prepupal stage lasted for 2-4 days and the pupal period was 10-14 days. Male lived for 4-5 days and females 6-7 days (Table 3).

Table 3 Development period (days) of *B. suppressaria* on TV_{26}

Stages	Duration (days) (mean* ± SE)
Eggs	3.100 ± 0.117a
Ist instar	4.900 ± 0.121a
IInd instar	5.890 ± 0.125a
IIIrd instar	6.100 ± 0.112a
IVth instar	6.300 ± 0.157a
Vth instar	8.240 ± 0.124a
Total Larval period	34.170 ± 0.316a
Pre-pupa	3.150 ± 0.190a
Pupa	11.010 ± 0.350a
Adult	6.252 ± 0.268a
Total development period	55.587 ± 0.689a

*Means followed by same letter in rows are not significantly different at 5% level

Survivorship study of *B. suppressaria* showed high mortality in the first larval stage. A greater survival was recorded in subsequent larval stages with only a moderate mortality till pupal stage when reared on tea leaves. Rest of the stages indicated similar percentage of mortality till the pupal stage (Fig 1). Survivorship/ life table is a convenient form of describing mortality schedule of a population. The survivorship curve of *B. suppressaria* on TV_{26} signifying that this clone is successful in supporting growth and development of the species.

Life cycle traits and performance

Reproduction is one of the primary events in the lifecycle of an insect. This involves an integration of several physiological and behavioural events which in turn involve consumption and utilization of food. Several component processes of reproduction such as mating, oogenesis, oviposition, fecundity etc. have a definite relationship with nutrition [12]. Pupal dry weight of female was recorded to be significantly higher than the male dry weight fed on TV_{26} tea leaves. The emergence rate of adult female was also high than male. Heavier pupae of female fed on tea clone may be due to their longer developmental period (Table 4).

Table 4 Reproductive Performance of *B. suppressaria* on TV_{26} (Mean* ± SE)

Tea clone	Pupal Dry wt. (mg)		Adult Emergence		Longevity (days)		Adult Dry wt. (mg)		Fecundity
	Male	Female	Male	Female	Male	Female	Male	Female	
TV_{26}	32.020a ± 0.472	39.030a ± 0.690	26%	47%	5.261a ± 0.301	6.951a ± 0.321	22.531a ± 0.667	29.637a ± 0.697	434.200a ± 20.711

*Means followed by the same letter in columns are not significantly different at 5% level

Maintenance cost and production index

The maintenance costs and production indices of the 4th and 5th instars of *B. suppressaria* calculated based on dry mass budget showed no significant difference. It was marginally higher maintenance cost fed on tea leaves for the Vth instar larva, than IVth instar. A little higher production index in the Vth

instar can be considered as an indicator of better suitability of tea leaves in supporting the final larval instar of *B. suppressaria* (Table 5).

Table 5 Comparison of nutritional indices of *B. suppressaria* (IVth and Vth instars) on TV_{26} (Mean∗ ± SE)

	IVth instar		Vth instar	
	Main.cost	Prod.index	Main.cost	Prod.index
TV_{26}	2.959a ± 0.154	0.267a ± 0.007	3.016a ± 0.050	0.279a ± 0.006

∗Means followed by the same letter in columns are not significantly different at 5% level

Chemical composition of larval body mass

Chemical analysis of nitrogen, lipid, moisture and ash content of the body mass of Vth instar larvae had a reflection of the suitable tea clone on which they were reared. The amount of nitrogen and lipid components accrued in the body mass were higher but the body moisture and ash contents were lower when reared on TV_{26} clone (Table 6).

Table 6 Comparison of biochemical components (% value of dry wt.) and moisture (% fresh wt.) in Vth stage larval body mass of *B. suppressaria* reared on TV_{26}

Nitrogen	5.794
Lipid	18.160
Ash	5.920
Moisture	65.180

CONCLUSION

Judging by the overall performance and lifecycle traits of *B. suppressaria*, on tea leaves for the advanced instars leading to formation of viable pupae and adults. Such attempt may be useful in designing the artificial diet for basic and applied researches on this major lepidopteran defoliator of tea in near future.

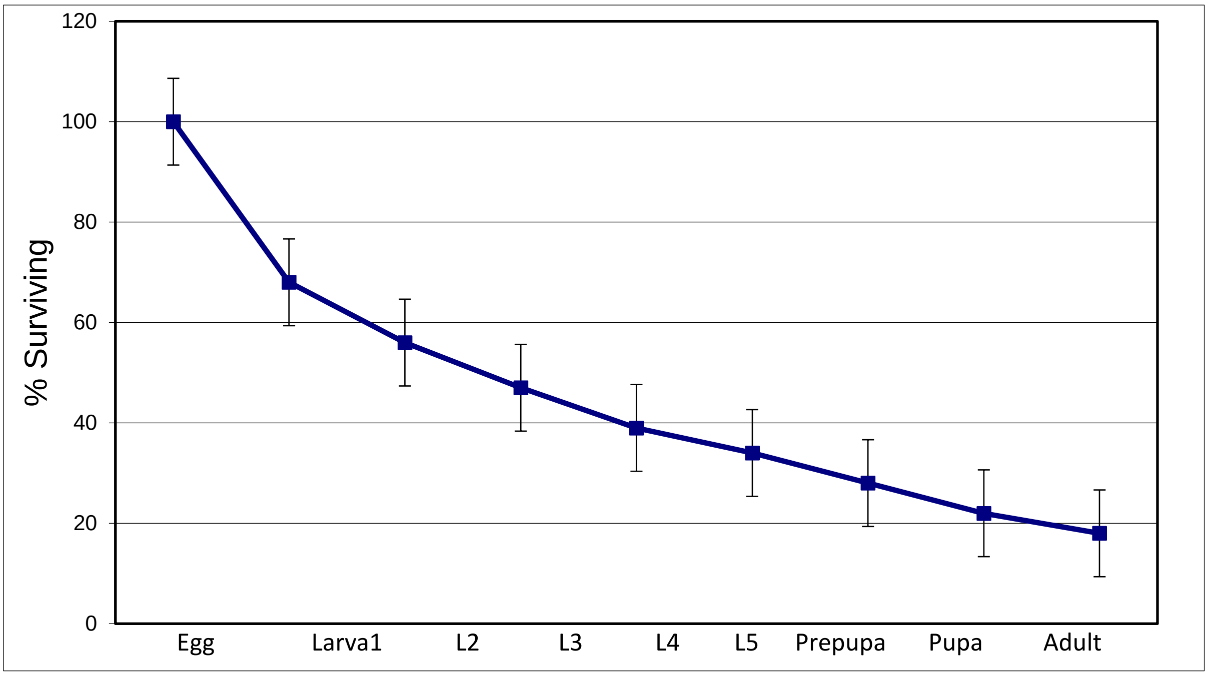

Fig 1 Survivorship curve of *B. suppressaria* on Tea leaves (TV_{26})

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