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Biology and morphometry of tomato pinworm, *Tuta absoluta* (Meyrick) on tomato

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Abstract

An investigation was undertaken in glasshouse and laboratory conditions to study biology and morphometry of tomato pinworm, *Tuta absoluta* (Meyrick) at Post Graduate Institute, MPKV, Rahuri (MS) India. Recorded data of pinworm reveals that eggs were small (0.41×0.24 mm), cylindrical and creamy white in colour. Egg incubation period was about 3 to 7 days. Larvae passes through four different instars. Average larval period of I, II, III and IV instar larvae were 3.15, 2.25, 2.30 and 3.50 days, respectively. Total larval period ranged from 9 to 13 days with an average of 11.2 days. Pupae were dark brown in colour. It was 4.5 mm in length and 1.16 mm in width. Total pupal period was 6 to 11 days. *T. absoluta* has a high reproductive potential, average fecundity was recorded about 165.4 eggs per female. The average longevity of male and female adults were 7.60 and 13.25 days, respectively.

Keywords: Tomato pinworm, *Tuta absoluta*, biology, morphometry

Introduction

Tomato (*Solanum lycopersicum* L.), a member of the family Solanaceae, is one of the most popular and extensively grown vegetables of both tropics of the world [1, 2, 3]. In England, tomato is popularly known as “love of apple” while, in India, it is commonly referred as “poor man’s Orange” [4, 5]. It is an integral part of the daily human diet in many countries. It is consumed as fresh and table tomato and also as an essential raw material for a variety of food recipes and processing industries [6].

Tomato is the host of many insects or non-insect pests and pathogens. Among the different insect pests, tomato pinworm *T. absoluta* becoming one of the major threat to tomato growers in India. In India this pest was initially observed in Pune on tomato plants grown in polyhouse and field during October 2014. Subsequently, the pest was identified from major tomato growing regions of Maharashtra viz., Pune, Ahmednagar, Dhule, Jalgoan, Nasik and Satara [7]. Subsequently pest was recorded from Karnataka [8, 9, 10], Tamil Nadu [11], Andhra Pradesh and Telangana [12], New Delhi [13], Gujarat [10], Madhya Pradesh [14], Punjab [15], Meghalaya [16], Himachal Pradesh [17] and Uttarakhand [18] causing severe damage to tomato in invaded areas in India. In Kerala it was first reported on brinjal in 2015 [19].

Tomato leaf miner *Tuta absoluta* is an oligophagous pest associated with solanaceous crops. *T. absoluta* is one of the most destructive insect pest attacking tomato plant, *S. lycopersicum*. After hatching, newly emerged first instar larvae penetrate the leaf into the mesophyll layer and feed between the lower and upper surfaces of the leaf to form transparent papery patches. As a result of continuous feeding by the larvae, the irregular mines combine together and eventually form galleries. Except, for the roots, the larvae attack all other parts of the tomato plant viz, leaves, flowers, stems, both green and red fruits. Infested fruits shows small hole closer to the stalk. *T. absoluta* infestation may cause 50-100% losses in the tomato crop. It has the capability to cross borders and devastate the crops either in an open field or in the protected greenhouse [20]. Life cycle of insects varies according to associated environment, so life cycle study and physical measurements of *Tuta absoluta* in Indian climatic condition will be useful to prepare management strategies. Hence, efforts were made to describe the biology and external morphology of this newly invaded pest.

Materials and Methods:

The study was conducted at the Department of Agricultural Entomology, MPKV, Rahuri. Duration of all the stages of *T. absoluta* on tomato host was recorded and data were presented as mean ± SD. The life history of the pest was studied on the basis of following points:

Table 1: Observations recorded during biology studies of *T. absoluta*

Egg	Larvae	Pupa	Adult
Colour Shape	Type of larvae	Pupal period	Longevity (Male and Female)
Size (length and breadth)	Period of larval instars	Size (length and breadth)	Fecundity
Incubation period	Size (length and breadth)		

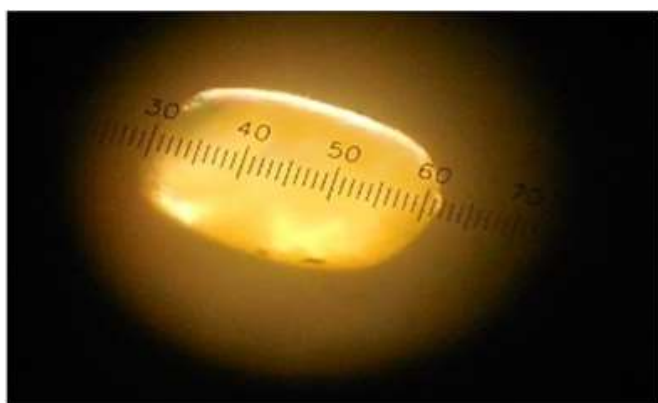
Rearing of laboratory culture for study

The tomato plant has used as laboratory host for rearing of *T. absoluta* culture during biology studies. About 100 seedlings were grown in a glasshouse at PGI, MPKV, Rauri for the rearing of pinworm culture. After sufficient growth of tomato seedlings, the initial culture of *T. absoluta* collected from the field and released on tomato plants in glasshouse. This

glasshouse grown foliage and different stages of *T. absoluta* were used in laboratory for further studies.

Egg stage

For egg stage observation of *T. absoluta* freshly laid eggs were collected from glasshouse culture with the help of fine camel hair brush and needle. Such collected eggs were placed in small Petri plates with black card sheet paper surface. Eggs were examined daily to record days of the incubation period (from egg laid to egg hatching). Also, color and shape of eggs were observed under a microscope and recorded. Morphometric observations such as size (length and breadth) of eggs were recorded with the help of ocular micrometer under a stereo binocular microscope (Fig. 1). Initial observations were recorded in the ocular unit then it converted into millimeter with suitable calculation.



Egg length

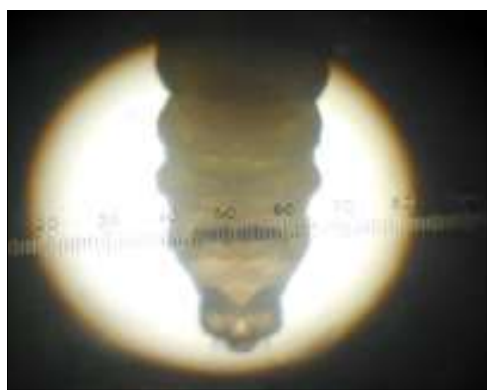


Egg Width

Fig 1: Morphometric observations of egg with the help of ocular micrometer

Larval stage

The duration of the larval period was recorded as the number of days taken from the hatching of egg till the last instar larva pupated. To determine the number of larval instars and the duration of each instar, leaves with eggs laid on the same day were segregated and placed in Petri plates. Each day leaves were carefully dissected and the stage (instar) of larva present inside the leaf mine was determined based on the width of head capsule. The head capsule and body size (length and breadth) of larvae were measured with the help of ocular micrometer under stereo binocular microscope (Fig. 2).

**Fig 2:** Head capsule measurement with the help of ocular micrometer

Pupal stage

When the larvae reached the pupal stage, they were individually placed into separate plastic container with

surface of tissue paper. Pupal period was recorded from the day of formation of pupa till the emergence of adult. Morphometric observations such as size (length and breadth) of pupa were recorded with the help of ocular micrometer under stereo binocular microscope (Figure 3). The emerged adults were sexed according to the methodology proposed by Coelho and Franca [21].

**Fig 3:** Morphometric observations of pupa with the help of ocular micrometer

Adult stage

Emerged adults were combined with two males and one female for mating purpose in compartment prepared with a steel cage and muslin cloth. One tomato seedling was placed inside the compartment to provide egg-laying surface. Also 10% sugar solution was provided as food for adults. An experiment was replicated for 20 times. This experiment was observed daily and adult longevity, fecundity, pre-oviposition period, oviposition period and post-oviposition period were recorded.

Results

Experimental results of biology and morphometry of *Tuta absoluta* is presented in following subheadings.

Egg

The studies regarding the egg-laying pattern indicated that most of the eggs were laid singly on the leaf surface, younger twigs and near the calyx of fruits. Freshly laid eggs were

creamy white and became yellowish at maturity. Eggs were oval in shape and loosely adhered to leaf trichomes. The results presented in table 2 revealed that the incubation period varies from 3 to 7 days with an average of 4.75 ± 1.37 days. The morphometric dimensions of eggs showed that the length of egg varied from 0.31 to 0.46 mm with an average 0.41 ± 0.04 mm and the width of eggs were recorded between 0.15 and 0.30 mm with an average 0.24 ± 0.03 mm (Table 3).

Table 2: Pre-adult biological parameters of *T. absoluta*

Stage*	Range of Development period (days)	Mean±SD
Egg	3.0 - 7.0	4.75 ± 1.37
Larva	9.0 - 13.0	11.2 ± 1.20
Pupa	6.0 - 11.0	8.8 ± 1.40
Total pre-adult period	18.0 - 31.0	24.75 ± 2.83

*N=20

Table 3: Egg length and width, pupal length and width of *T. absoluta*

Parameter	Range	AV. ± SD
Egg length(mm)	0.31 – 0.46	0.41 ± 0.04
Egg width (mm)	0.15 – 0.30	0.24 ± 0.03
Pupal length (mm)	3.49 – 5.34	4.15 ± 0.43
Pupal width (mm)	0.92 – 1.45	1.16 ± 0.14

*N=20

Larvae

The larvae of *T. absoluta* undergoes three moults and four instars. Larval development took place inside the leaf mine. Larval instars differentiated on the basis of head capsule width of larvae. The periods required for each instar was recorded in days and presented in table 4.

First instar larvae

The neonate larvae difficult to locate with necked eyes, because it was very small, creamy white with dark head. Larva enters into the leaf soon after hatching from egg. The development period required for first instar larvae ranged between 2 and 4 days, with an average 3.15 ± 0.75 days. Width of head capsules varied from 0.14 to 0.16 mm, with an average 0.15 ± 0.005 mm.

Second instar larvae

The second instar larvae were distinguished from first instar by considerable change in width of head capsule. Range of head capsule width recorded as 0.21 to 0.26 mm, with an average 0.23 ± 0.014 mm. The data recorded during study revealed that development period of second instar larvae required about 1 to 3 days, with an average 2.25 ± 0.55 days.

Table 4: The duration and width of the head capsule for each instar larva of *T. absoluta*

Larval instar	Range of larval development period (days)	AV. ± SD	Range of head capsule width (mm)	Mean ± SD
First	2.0 – 4.0	3.15 ± 0.75	0.14 – 0.16	0.15 ± 0.005
Second	1.0 – 3.0	2.25 ± 0.55	0.21 – 0.26	0.23 ± 0.014
Third	2.0 – 3.0	2.30 ± 0.47	0.37 – 0.44	0.40 ± 0.018
Fourth	2.0 – 5.0	3.50 ± 0.76	0.52 – 0.62	0.57 ± 0.032
Total	9.0- 13.0	11.2 ± 1.20		

*N=20

Third instar larvae

The third instar larva was greenish in colour and more active compared to first and second instar larvae. Width of head capsule varied from 0.37 to 0.44 mm, with an average 0.40 ± 0.018 mm. The period required for completion of third instar was 2 to 3 days, with an average 2.30 ± 0.47 days.

Fourth instar larvae

The fourth instar larvae was easily identified by the presence of pinkish streak on dorsal surface of its body. The larva was greenish to pink in colour. During this stage, width of head capsule was recorded as 0.52 to 0.62 mm, with an average 0.57 ± 0.032 mm. The period required for completion of last

instar larvae varied from 2 to 5 days, with an average 3.50 ± 0.76 days.

Pupa

Pupa was obctect, light to dark brown in color, formed in folded leaves by winding loose silken cocoon or in leaf mines created by larva. Pupation also takes place in soil. Data presented in table 2 revealed that total pupal period was 6 to 11 days, with an average 8.8 ± 1.40 days. Range of pupal length and width recorded as 3.49 to 5.34 mm and 0.92 to 1.45 mm, with an average 4.15 ± 0.43 and 1.16 ± 0.14 mm, respectively (Table 3).

Table 5: Adult longevity (days) and fecundity (No. of eggs/female) of *T. absoluta* on tomato

Parameter	Gender	Range	Mean±SD
Adult longevity (days)	Male	4.0 – 11.0	7.60 ± 1.85
	Female	9.0 – 17.0	13.25 ± 2.57
Pre-oviposition period (days)	Female	1.0 – 2.0	1.60 ± 0.50
Oviposition period (days)	Female	6.0 – 11.0	8.55 ± 1.67
Post-oviposition period (days)	Female	1.0 – 5.0	3.10 ± 1.07
Fecundity (eggs/female)	Female	131.0 – 191.0	165.4 ± 19.16

Adult

The newly formed adult moths were small, brown or silver with black spots on narrow wings. Antennae were filiform with bicolored segmentation. As per the data recorded (Table 5) the longevity of male moths ranged from 4.0 to 11.0 days, with an average of 7.60 ± 1.85 days, while that of female moth varied from 9 to 17 days, with an average of 13.25 ± 2.57 days indicating that female adult survives for longer period than the male moth. Pre-oviposition, Oviposition and Post-oviposition period varied from 1 to 2 days with an average period of 1.60 ± 0.50 days, 6 to 11 days with an average period of 8.55 ± 1.67 days and 1 to 5 days with an average period of 3.10 ± 1.07 days, respectively. The fecundity of female ranged from 131.0 to 191.0 with an average 165.4 ± 19.16 . Total life cycle of pinworm complete with in 24.5 to 40.0 days.

Discussion

In the present investigation, observations were recorded on developmental period of different stage and morphometric measurements were in accordance with earlier findings reported by [22, 23, and 24]. Except egg length and width reported by [22], it was average length 0.78 ± 0.10 and width 0.14 ± 0.02 . This variation effect might be due to nutritional and environmental factors. The mean head capsule width of all four larval instar were in confirmation with [25]. Pre-oviposition, Oviposition and Post-oviposition period in current findings were in corroboration with the finding of [26].

Conclusion

These results are of great importance to know the behaviour of this invasive pest in Indian climatic conditions, particularly in Western Maharashtra region where considerable tomato cultivating area is present. Which helps to decide management strategies. With reference to current findings, it will be great future line of research to know the changes in life cycle, morphometry and behaviour of this pest in coming future.

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