

COMPARATIVE BIOLOGY OF *TRILOCHA VARIANS* (WALKER, 1855) (LEPIDOPTERA: BOMBYCIDAE), A NEW PEST OF *FICUS* PLANT IN PUNJAB, PAKISTAN

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ABSTRACT: An experiment was conducted to determine the comparative biology of *Trilocha varians* on different host plants such as *Ficus benjamina*, *Ficus religiosa*, *Ficus carica* and *Ficus elastica* under laboratory conditions at 26.5°C temperature and 60.5% relative humidity. Results showed that growth and development of *T. varians* completed successfully on *F. benjamina*. It was observed that only *F. benjamina* was the preferable host for *T. varians*. After one day of hatching from eggs, larvae were died on the *F. carica* and *F. elastica* while some larvae were fully developed on *F. religiosa*. The study concluded that *F. benjamina* was the major host plant followed by *F. religiosa*.

Keywords: *T. varians*, *F. benjamina*, *F. religiosa*, *F. carica*, *F. elastica*, Biology.

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INTRODUCTION

Ficus benjamina (Carl Linnaeus) belongs to the Family, Moraceae and is planted alongside the roads as an ornamental plant in Pakistan. It is a perennial plant with 10-20m height. There is great diversity of *ficus* species found in the country. The aesthetic value of a country increases due to ornamental plants especially *F. benjamina*. It is mostly grown in tropical and sub-tropical regions around the globe (Zolotuhin and Witt, 2009), including Pakistan. The plants have some medicinal characteristics, its roots, leaves and twigs are used as the treatment of various diseases (Sirisha *et al.*, 2010; Sing *et al.*, 2011). Plants are used for the management of fungus and many other diseases (Mousa *et al.*, 1994; Lansky *et al.*, 2008). It's also used for the removal of hazardous chemicals and gases such as formaldehyde (Kim *et al.*, 2008).

F. benjamina commonly known as weeping fig is infested with several insect pests such as whitefly and mealy bug (Avery *et al.*, 2011). Among all these pests, leaf eating caterpillar, *Trilocha varians* is major one who attacks on *Ficus spp.* such as *F. benjamina* and *F. microcarpa* (L.). This pest is distributed in various countries such as India (Kedar *et al.*, 2014; Singh and Brar 2016), Philipines (Navasero *et al.*, 2013), Malaysia (Basari *et al.*, 2019), Southeast Asia (Zolotuhin and Witt, 2009) and Pakistan (Ramzan *et al.*, 2019).

T. varians is an economic pest of Moraceae family plants such as figs, jack fruits and many others (Navasero *et al.*, 2013). Larvae of *T. Varians* feed on other species of *Ficus* like *F. benjamina* (Ramzan *et al.*, 2019), *F. infectoria*, *F. religiosa*, *F. benghalensis* and *F. elastica* (Kedar *et al.*, 2014). It is considered an economic pest of *Ficus spp.* and jackfruit (Ruan, 2009). During severe infestation of pest, leaves of plant look

transparent. In 2019, 3rd larval instars are caused 100% plant defoliation and even death of plants. An interest is ignited to generate the comparative biology of *T. varians* on different host plants under laboratory conditions. This is the first study that conducted on this pest in the Pakistan. There is need to check the hosts of this pest in country (Pakistan).

MATERIALS AND METHODS

Study Area: The current study was conducted at MNS-University of Agriculture Multan from 2018-2019. Area was located at Latitude 30.2° N, Longitude 71.4° E and 123-meter-high above sea level. There are great climatic variations in study area. Its climate is arid with very cold winters and hot summers.

Collection of *T. varians*: Different larval instars (1st, 2nd, 3rd and 4th) were collected from plants (*F. benjamina*), planted alongside the University and nearby parks. The collection was carried out through hand picking method and brought to laboratory in plastic jars for further studies.

Rearing and Stock culture: For rearing purposes, 10 plastic jars of 2L were purchased from market, 10 larvae were placed in each jar and reared on different hosts such as *F. benjamina*, *F. religiosa*, *F. carica* and *F. elastica* leaves. Larvae were fed until reached to pupal stage. The containers were covered with fine-mesh muslin cloth for ventilation and aeration. The culture was maintained at seven generations using the same procedure.

Characteristics of *T. varians* recorded under laboratory conditions

Eggs: The egg shape, hatching period, color and measurement.

Larva: Color, size measurement, larval period, body and horn length.

Pupa: Measurement, color variations, period and cocoon.

Adult: Wing length, head and body length, longevity and period, Mating period of male and female.

Biology of *T. varians*: During the current study, 60 larvae were collected randomly from an egg batch and reared individually on different *Ficus* hosts under laboratory conditions at 26.5°C temperature and 60.5% relative humidity, respectively to check the durations of larval and pupal stages. The culture was checked on a daily basis, recorded the data for larval molting, pupation, cocoon formation and adult emergence.

Habit and Behavior

Oviposition and eggs hatching: After emergence of adults, a pair of adults was transferred into cages for oviposition and collection of eggs. After egg laying, eggs were collected carefully with the help of camel brush and a pair of eggs was placed into separate plastic boxes for hatching. The same procedure was repeated until female stopped egg laying. Both male and female mortality was recorded.

Larval feeding and mortality: Feeding, movement, behaviors, food selection, molting behaviors and size measurement of larvae was observed in the study.

Pupation and Cocoon Formation: During the whole study, larval molting and cocoon formation was observed.

Mating: After adult emergence, same day a pair of adults was placed into separate containers for egg laying and mating purpose. The mating period was observed in the study.

RESULTS

Description of each developmental stage on different hosts: There was a complete metamorphosis found in *T. varians*. It passes through 4 different developmental stages that are egg, larva, pupa and adult. The characteristics of each stage on hosts were summarized below:

Eggs: Eggs of *T. varians* were flat and round cake shape. The color of newly laid eggs was light yellow, change into black prior to hatching and laid in 3-6 rows on the wall of the containers. In fields, it was observed that about 3-25 eggs laid in a group on dorsal side of the leaf. The hatchability was 90.22%. The egg width and thickness were described in

Table 1. Measurement (mm) of eggs width and thickness.

Parameters	Mean \pm SD	Range
Width	0.89 \pm 0.05	0.1-1
Thickness	0.52 \pm 0.01	0.4-0.5

Larva: A caudal horn was present on 8th abdominal segment of each larva. The length of caudal horn was varied with instars of the larva. There were two caudal parts of larva, proximal which was brown and black while terminal end was short (0.23-0.32 mm) and retractable. Larvae of the pest were eruciform, with 5 pairs of abdominal prolegs and 3 pairs of thoracic legs. There were 5 larval instars. The dorsal and lateral sides of first instar larvae were whitish and dark green, respectively. The whitish powder was present on the dorsal side of second instar larvae. Color of fifth instar larvae was dull brown. The 1st, 2nd, 3rd, 4th and 5th larval instars have 0.5, 1.0, 1.5, 2.0 and 1.5mm long caudal horn, respectively in Table 4. The head capsule width and length of all instars was given in Table 2. The description of body length was given in Table 3.

Table 2. Head capsule length and width of larval instars

Larval		Head capsule length (mm)		Head capsule width (mm)	
Instar	Total number of larvae	Mean \pm SD	Range	Mean \pm SD	Range
1	40	0.11 \pm 0.03	0.21-0.37	0.18 \pm 0.02	0.25-0.30
2	40	0.28 \pm 0.04	0.36-0.52	0.38 \pm 0.05	0.39-0.60
3	40	0.62 \pm 0.06	0.78-1.11	0.99 \pm 0.06	0.80-1.20
4	40	1.35 \pm 0.41	1.43-1.71	1.66 \pm 0.30	1.60-1.70
5	40	2.59 \pm 0.50	2.01-2.22	2.00 \pm 0.07	2.01-2.10

Table 3. Body length of different instar larva of *T. varians*.

Larval Instars	Total Number of Larvae (n)	Body length	
		Mean \pm SD	Range
1 st Instar	40	2.05 \pm 0.45	1.20-2.40
2 nd Instar	40	4.01 \pm 0.50	2.00-4.00
3 rd Instar	40	8.60 \pm 1.45	5.50-10.00
4 th Instar	40	14.17 \pm 3.01	10.00-15.00
5 th Instar	40	23.01 \pm 4.99	12.00-27.00

Table 4. Caudal horn length of larval instars.

Larval Instars	Parameters (Length)	
	Mean \pm SD	Range
1 st Instar	0.5 \pm 0.1	0.3-0.4
2 nd Instar	1.0 \pm 0.1	0.5-1.4
3 rd Instar	1.5 \pm 0.1	1.4-2.0
4 th Instar	2.0 \pm 0.1	0.1-2.0
5 th Instar	1.5 \pm 0.0	0.1-1.5

Pupa: Pre-pupal stage was pupated in boat-shaped yellowish white silken cocoons. Pupation process was started from tail and head of the insect. Cocoon filaments was connected the tail with head and form cocoon layers for pupation. The details about cocoon were described in Table 6. These were rolled on their hosts leaf. The color of cocoon was different in both sexes either males or females Table 5. Pupa was obiect.

Table 5. Measurement (mm) of male and female pupa.

Male Pupa			Female Pupa	
Parameters	Width	Length	Width	Length
Mean \pm SD	2.6 \pm 0.1	7.4 \pm 0.6	3.3 \pm 0.1	9.4 \pm 0.3
Range	2-3	6-9	3-4	8-11

Table 6. Measurement (mm) of cocoon width and length.

Cocoon	Mean \pm SD	Range
Width	4.5 \pm 0.4	3-5
Length	10.5 \pm 1.1	9-12

Adult: The colour of head, thorax and abdomen of adult was dark reddish brown. The curved waved lines were present on pale reddish-brown forewings while hind wings were grayish brown. Average length of male and female wingspan was 13.9 \pm 2.6 and 4.8 \pm 0.5 mm,

respectively. Average dimension of adult is also described (Table 8). Forewings of newly emerged adult were fully expanded and tip of abdomen was bent upwards. There were three post developmental periods such as pre-oviposition, oviposition and post-oviposition of adult, given in Table 7. Adults were active at night and female was short flayer while male was fast flayer.

Table 7. Post-developmental periods (Days) of *T. varians* on *F. benjamina*.

Parameters	Mean \pm SD	Range
Pre-oviposition	2.20 \pm 0.5	1-3
Oviposition	2.68 \pm 0.69	1-4
Post-oviposition	1.98 \pm 0.60	2-3

The description of male and female was given in Table 8.

Table 8. Dimensions (mm) of male and female.

Adult Male			Adult Female	
Parameters	Mean \pm SD	Range	Mean \pm SD	Range
Head length	3.5 \pm 0.1	3-4	3.2 \pm 1.2	3-5
Head width	3.7 \pm 0.2	3-5	3.5 \pm 0.3	2-3
Antennal length	5.6 \pm 0.5	6-7	5.4 \pm 0.6	4-5
Body length	8.4 \pm 0.4	7-10	9.7 \pm 0.3	8-10
Hind wing length	7.16 \pm 0.68	5-7	7.8 \pm 0.1	7-9
Hind wing width	4.80 \pm 0.64	3-4	5.5 \pm 0.7	4-6
Fore wing length	8.56 \pm 0.77	5-9	9.9 \pm 0.8	9-12
Fore wing width	18.43 \pm 1.56	15-20	5.7 \pm 0.8	4-6

Development of *T. varians* on different hosts: During the current study, it was observed that only *F. benjamina* was preferable host of *T. varians* while *F. religiosa*, *F. carica* and *F. elastica* were not fed by the pest (*T. varians*). The development and growth of *T. varians* on *figus spp.* during January-June 2019, under laboratory conditions are presented in Table 9, while Table 10 that only reared on *F. benjamina*.

Table 9. Developmental and growth period (days) of *T. varians* on *ficus* spp.

Month	Host	Incubation		Larval		Pupal	
		Mean±SD	Range	Mean±SD	Range	Mean±SD	Range
January	<i>F. benjamina</i>	5.4±1.2	3-9	7.6±0.5	5-8	5.5±1.1	4-7
-February	<i>F. religiosa</i>	5.2±1.1	2-4	1.6±0.2	1-4	1.2±1.0	1-2
	<i>F. carica</i>	5.1±1.1	2-1	1.0±0.0	1-2	-	-
	<i>F. elastica</i>	5.4±1.0	2-1	1.6±0.2	1-2	-	-
February	<i>F. benjamina</i>	5.4±1.2	3-9	7.7±0.3	5-6	5.0±1.6	4-7
-	<i>F. religiosa</i>	5.2±1.3	2-3	1.2±0.4	1-3	1.3±1.0	1-2
March	<i>F. carica</i>	5.1±1.2	2-1	1.1±0.4	1-2	-	-
	<i>F. elastica</i>	5.1±1.3	2-1	1.1±0.1	1-2	-	-
March	<i>F. benjamina</i>	5.4±1.3	3-9	6.6±0.5	5-8	5.2±1.7	5-7
-	<i>F. religiosa</i>	5.1±1.0	2-3	2.6±0.1	2-2	1.4±0.1	0-1
April	<i>F. carica</i>	5.2±1.0	2-2	0.6±0.2	1-2	-	-
	<i>F. elastica</i>	5.1±1.2	2-2	0.3±0.4	1-2	-	-
April	<i>F. benjamina</i>	5.3±1.4	3-9	6.6±0.8	4-7	4.0±1.9	4-8
-	<i>F. religiosa</i>	5.4±1.3	2-6	2.6±0.2	2-4	1.1±1.0	0-1
May	<i>F. carica</i>	5.0±1.1	3-5	2.0±0.1	1-2	-	-
	<i>F. elastica</i>	5.0±1.2	3-4	2.6±0.0	1-3	-	-
May	<i>F. benjamina</i>	5.5±3.2	3-9	8.0±0.1	4-9	5.0±1.1	5-6
-	<i>F. religiosa</i>	5.4±1.2	3-3	1.0±0.2	2-3	-	-
June	<i>F. carica</i>	5.3±2.1	3-4	1.1±0.2	1-3	-	-
	<i>F. elastica</i>	5.4±2.0	3-3	1.3±0.1	1-4	-	-

Table 10. Developmental stages of male and female *T. varians* on *F. benjamina*.

Stage	Mean ± SD	Range (days)
1 st Instar	2.0±1.0	2-3
2 nd Instar	3.2 ± 0.4	1-4
3 rd Instar	3.3 ± 0.4	3-4
4 th Instar	4.5 ± 0.4	4-5
5 th Instar	7.0 ± 0.5	5-8
Total larval period	18.9 ± 2.1	17-21
Total pupal period	11.0 ± 3.0	9-18
Longevity		
Female (days)	11.0 ± 1.0	5-12
Male (days)	6.0 ± 1.1	5-7
Fecundity (no. of eggs/female)	217.1 ± 35.9	160-280
Total life cycle from egg-Adult	30.09±1.1	25-28

Habit and Behavior

Fecundity and adult survival: A single female was laid about 160-280 eggs within 2-4 days of emergence. Life period of mated female was shorter than unmated.

Feeding and Molting: After hatching from eggs larva was wondered for food and on availability of food, settled there and fed. First three instars were fed on the lower side of leaves while remaining on the whole leaf of hosts. The old head capsule was removed posteriorly down on the prothorax and abdomen. The molting process was faster in early instars while slowdown in last instar.

During molting, larvae were in motionless and didn't feed the leaf. Molting was lasted 15-20 min for fifth instar larvae.

Pupation: Cocoon spun on the dorsal surface of leaf within one day. During heavy winds, cocoon fall down and pupae spent their developmental period on the ground. Under laboratory, pupation occurred on the wall of containers or at muslins cloth.

Mating: Mating was occurred at night right after adult emergence and continued for 15-18 hours.

DISCUSSION

Comparative biology of leaf eating caterpillar, *T. varians* was carried out in MNS-University of Agriculture, Multan. In the current study, four different host plants were used to check the growth and development of *T. varians*. It was observed that only *F. benjamina* was preferable host for *T. varians* while all other three hosts such as *F. religiosa*, *F. carica* and *F. elastica* didn't proved to be fruitful. The larvae of pest were died on *F. carica* and *F. elastica* after one day of hatching from eggs while some larvae completed their development on *F. religiosa*. The leaves of hosts such as *F. carica* and *F. elastica* were hard and tough, which not suitable for neonate larvae. Neonate larvae didn't feed on the tough leaves. The tough leaves were the main reason of pest death. During severe infestation, *T. varians* was

caused 90-100% defoliation. The same results had been observed (Sing and Brar, 2016).

Heavy infestation was observed in January-May. After mating copulation, a cluster of 160-280 eggs in 2-6 layers was laid by single female. It was observed, that unfertilized eggs also laid by female in some situations (Navasero and Navasero, 2014). Incubation period of eggs was 3-5 days. Eggs were laid on the dorsal side of leaves in filed while on the wall of containers under laboratory conditions. The colour of eggs was similar with the findings of other researchers (Daimon *et al.*, 2012). The hatching time of eggs were observed at morning (9:30-11:30 am) and same at night time.

There were 5 larval instars. After hatching from eggs, larvae didn't feed on egg shell. The similar findings had been observed by earlier studies (Chuenban *et al.*, 2017). A caudal horn was present on each larva. The length of caudal horn was larger in early instar and reduced in late instar larvae. The observations about caudal horn were described by other researchers (Ramzan *et al.*, 2019; Daimon *et al.*, 2012; Rajavel and Shanthi, 2007). Caudal horn was present on the 8th abdominal segment of larvae and divided into terminal and proximal parts. Our results were similar to the observations of many researchers (Chuenban *et al.*, 2017). It was observed that 1st, 2nd and 3rd instar larvae were fed on the dorsal side of the leaves while 4th and 5th instars on the whole leaves. Last two instars were active feeder and consumed the whole leaf or some time remaining the midrib or veins. White and papery patches were the main symptoms of heavy infestation of pest. The plants died during severe attacks of pest (Ramzan *et al.*, 2019).

Pupa was obtect and pupation happened in boat shaped cocoon. The results of present study were similar with the observation of Rajavel and Shanthi (2007) and Daimon *et al* (2012). Pupation was stated from head to tail of the insect. The average width and length of cocoon was 4.5 ± 0.4 and 10.5 ± 1.1 , respectively. Chuenban *et al* (2017) was reported the similar results.

Unmated female was long lived as compared to male. Longevity was due to many factors such as resorption of eggs as food. Most of the eggs were laid during first egg-lying night. The similar observations had been reported by workers (Navasero and Navasero, 2014). It was observed, a female was mated once in the whole life. Seven generations had been reported by Jia and Jinxin (1997) that after egg-lying, female was died (Udayagiri, 2006). Mating period was lasted many hours. Navasero and Navasero (2017) was reported that mating process continued for 20 hours or longer. Our findings were agreed with the conclusion of earlier works (Navasero and Navasero, 2017). During the study, it was observed that no proboscis presents in adults. Adult don't feed on the honey dew or any other food due to absence of proboscis.

Conclusion: *T. varians* is pest of several *Ficus* spp. especially *F. benjamina* and an emerging in Pakistan. Further studies related to biology on different host plants, morphology and management strategies are required to control this notorious pest in the country (Pakistan).

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