Review Article

Distribution, Biology and Management Strategies about a Less Studied Insect Pest (*Trilocha varians*) of *Ficus*: A Review

Muhammad Ramzan[1*], Unsar Naeem-Ullah[2], Muhammad Umair Sial[2], Naeem Iqbal[2] and Shafqat Saeed[2]

[1]State Key Laboratory for Biology of Plant Diseases and Insect Pests, Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100193, China; [2]Institute of Plant Protection, Muhammad Nawaz Shareef University of Agriculture, Multan Punjab Pakistan.

Abstract | *Ficus* spp. (Rosales: Moraceae) are a large group of plants grown for landscape and medicinal purposes in various regions and also known for absorbing various toxic pollutants from the environment. Several insect pests like thrips, whiteflies, mealy bugs and caterpillars attack on these plants. Among them, leaf eating caterpillar, *Trilocha varians* (Lepidoptera: Bombycidae) is serious insect pest for these precious plant species in various countries. The larvae of the pest can cause 80-100% defoliation. The various confirmed host of *T. varians* include *Ficus benjamina, F. religiosa, F. benghalensis, F. caraica, F. infectoria, F. elastica*, *F. nitida, Artocarpus communis, A. heterpphyllus* and *A. kamansi.* Fairly limited studies are documented for its chemical and biological management. For chemical control, deltamethrin was proved more toxic while among biological control agents *Goryphus* sp., *Enicospilus* sp., *Telenomus* sp, *Listrognathus spinifrons, Trichogramma pretiosum*, *T. euproctidis* and *T. dendrolimi* have been documented as potential egg and pupal parasitoids of *T. varians* in many countries of the world. The present paper is an attempt to bring and summarize the basic information on majoraspects like distribution, biological parameters and control strategies of bombycid moth *T. varians.*

Received | January 03, 2021; **Accepted** | July 12, 2021; **Published** | July 31, 2021
***Correspondence** | Muhammad Ramzan, State Key Laboratory for Biology of Plant Diseases and Insect Pests, Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100193, China; **Email:** ramzan.mnsua@gmail.com
Citation | Ramzan, M., U.N. Ullah, M.U. Sial, N. Iqbal and S. Saeed. 2021. Distribution, biology and management strategies about a less studied insect pest (*Trilocha varians*) of *Ficus*: A review. *Pakistan Journal of Agricultural Research,* 34(3): 638-642.
DOI | https://dx.doi.org/10.17582/journal.pjar/2021/34.3.638.642
Keywords | *Enicospilus spp.*, *Ficus spp., Goryphus spp. Leaf eating caterpillar, Trilocha varians, Telenomus* spp.

Introduction

Ficus is a large group of plants species which exceeds more than 800 species of trees, shrubs and vines. Some of them like *F. benjamina*, commonly known as weeping fig are planted to increase aesthetic value in landscape in various states of the world including Pakistan due to their easy adaptability and hardy nature against odd environmental conditions (Arya, 2020). *Ficus* species can grow well in every environmental condition such as at high as well as low temperature. These are mostly native to tropical and sub-tropical regions of the globe. Some of these have well recorded medicinal value such as anti-fungal and anti-tumor characters that used for the treatment of various diseases (Sirisha *et al.*, 2010; Lansky *et al.*, 2008; Mousa *et al.*, 1994) such as ulcers. The plants are also used as bio-indicator for very toxic chemicals or gases such as formaldehyde and CO (Kim *et al.*, 2008) in the environment and can act as purifier of the surroundings.

Ficus plants are attacked by several sucking (thrips, whiteflies and mealy bugs) and chewing insect pests including lepidopteran pests in the world. *Trilocha* (=*Ocinara*) *varians* (Walker, 1855) (Lepidoptera:

Bombycidae) moth is one of the major pest that causes huge (100%) damages to the ornamental *Ficus* species. The severe attack of these insect pests can damage the plants to the tune of complete defoliation (Navasero and Navasero, 2014).

There is need to control this notorious insect pest by using management strategies like chemical and biological. Much less work regarding biology, distribution and management of this notorious pest of precious plants has been presented in literature and an effort to compile published work on above mentioned aspects has been summarized in below paragraphs for ready reference for futuristic workers.

Geographical distribution

T. varians is distributed in various countries such as Pakistan (Ramzan *et al*., 2019a), Malaysia (Basari *et al*., 2019); China (Wang *et al*., 2015; Chu and Wang, 1993), India (Rajavel and Shanthi, 2007; Singh and Brar, 2017), Vietnam (Zolotuhin and Witt, 2009), Sri Lanka, the Philippines (Navasero and Navasero, 2014), Indonesia, Sulawesi, Hong Kong, Java, Borneo (Gurule, 2013), Thailand (Chuenban *et al*., 2017), Japan (Kishida, 2002).

Hosts of Trilocha varians

This insect belongs to Subfamily Bombycinae of Family Bombycidae in Order Lepidoptera. It is closely related with domesticated silkworm moth, *Bombyx mori*. The larvae of *T. varians* are oligophagous that feed on different closely related moraceous plants (Ramzan *et al*., 2019b) while larvae of *B. mori* are monophagous and only feed on mulberry (*Morus alba*) leaves (Chuenban *et al*., 2017). Several plants species belonging to Family Moraceae and Poaceae have been reported to serve as hosts of *T. varians* (Table 1).

Biology of Trilocha varians

A single female of *T. varians* can lay about 215 ±33.85 eggs in rowson lower surface of the *F. benjamina* leaves. The newly laid eggs were yellow in colour and round flat in shape (Daimon *et al*., 2012). The incubation period was 3-8 days (5.8±0.48). The yellow colour of eggs was changed into black colour before hatching (Kedar *et al*., 2014; Ramzan *et al*., 2019a).

There were five larval instars of *T. varians* (Ramzan *et al*., 2020) and duration of first instar was 2-3 days. The colour of neonate larvae was brown and changed with stage (age). Duration of 2nd, 3rd, 4th and 5th instarsis 3.36±0.16, 3.18±0.13, 4.45±0.17 and 7.09±0.26 days, respectively. The colour of later instar was similar to the colour of branches and difficult to locate. A fleshy and long horn was present on the eighth abdominal segment (Ramzan *et al*., 2019a; Daimon *et al*., 2012) of each larval instar.

Table 1: *Comprehensive summary of host diversity for T. varians.*

Sr. No.	Host Plants		Family	Author
	Scientific name	Common name		
1	*F. benjamina*	Weeping fig	Moraceae	Naeem-Ullah *et al.* (2020); Basari *et al.* (2019); Ramzan *et al.* (2019a, b); Kedar *et al.* (2014), Navasero and Navasero (2014).
2	*F. religiosa*	Pipal	Moraceae	Ramzan *et al.* (2019a, b); Kedar *et al.* (2014); Rajavel and Shanthi (2007)
3	*F. elastic*	Rubber plant	Moraceae	Chu and Wang (1993); Kedar *et al.* (2014)
6	*F. mclelandi*	Popular	Moraceae	Navasero *et al.* (2013)
7	*F. infectoria*	White fig	Moraceae	Kedar *et al.* (2014)
8	*F. caraica*	Common fig	Moraceae	Chu and Wang (1993)
9	*F. benghalensis*	Banyan fig	Moraceae	Kedar *et al.* (2014)
10	*F. septic*	Hauili	Moraceae	Navasero *et al.* (2013)
11	*A. heterpphyllus*	Jackfruit	Moraceae	Navasero *et al.* (2013); Huang *et al.* (2002); Udayagiri (1988); Hutson (1930)
12	*A. communis*	Marang	Moraceae	Navasero *et al.* (2013)
13	*A. kamansi*	Kamansi	Moraceae	Navasero *et al.* (2013)
14	*F. nitida*	Blue fountain bamboo	Poaceae	Navasero *et al.* (2013); Navasero and Navasero (2014)

Pupation was occurred in whitish yellow silken cocoons (Rajavel and Shanthi, 2007) and started from tail to head (Ramzan *et al.* 2019b). The pupal period had reported 5-6 days. The type of pupa was obtect (Ramzan *et al.*, 2019a, b).

Adult male was short lived than females. The longevity of male and female was 5.5 ±0.37 days and 10.3 ± 0.53 days, respectively. Mated female was short lived as compared to unmated female. The abdomen, thorax and head of the insect are dark reddish brown in colour. The forewings and hindwings were pale reddish brown and grayish with reddish brown outer margins (Jia and Jinxin, 1997).

Economic importance and damage pattern of T. varians

Larvae of *T. varians* attack on the new leaves of plants and feed on dorsal side. The white papery patches appeared on dorsal side of plant leaves (Singh and Brar, 2016) which are major symptom of infestation. The early instars (1st-2nd) of *T. varians* can consume only the fresh green twigs of plant (Navasero *et al.*, 2013; Navasero and Navasero, 2014) while later instar (3rd-5th) found most destructive and consume the all types of leaves like soft or rough.

The later instars are spread on the whole canopy of plant and difficult to locate due to resemblance of larvae colour with plant branches (Ramzan *et al.*, 2019b). After consumed by the larvae of pest, the plants lack their leaves resultantly loosing health and start to die (Chuenban *et al.*, 2017). Some studies depict that larvae consume 80-100% foliage (Ramzan *et al.*, 2019a; Singh and Brar, 2016; Zolotuhin and Witt, 2009) and even cause death of whole plant.

Management strategies

Different control measures have been adopted by farmers and scientists at national and international level to control insect pests like cultural, physical, mechanical, botanical, biological and chemicals etc. Among these, chemical management is widely and excessively used but has some negative impact on environment and causes insecticides resistance to insect pests.By integrating of all possible management strategies from above mentioned, pest species can be controlled in efficient and ecofriendly way and this is now widely accepted tool for controlling harmful insect species throughout the globe. Here are given only two widely used methods for management of the pest under consideration, *i.e.* Biological and Chemical method.

Biological control

Biological agents such as predators and parasitoids are the best method to maintain pest population below economic threshold level in an ecofriendly way. Some studies narrated about eggs, larval and pupal parasitoids of *T. varians*. A couple of workers reported unidentified species of parasitic wasps as natural enemies of this pest (Navasero and Navasero, 2014). Eggs of *T. varians* have been reported to be parasitized by Ichneumonid like *Telenomus* spp., *Trichogramma dendrolimi* and *T. euproctidis* (Udayagiri, 1988) and *T. pretiosum* (Hai-Ying *et al.*, 2006). Whereas, *Enicospilus* spp. (Ichneumonid: Hymenoptera) have been reported as parasitoid of larvae of *T. varians* (Kedar *et al.*, 2014). Some pupal parasitoids have also been documented in the literature for this lepidopteran pest like *Listrognathus spinifrons* and *Goryphus* spp. (Ichneumonid: Hymenoptera) (Kedar *et al.*, 2014). The life histories of natural enemies of *T. varians* have also been studied earlier (Udayagiri, 1988). Egg parasitoids had been proved best control against this pest in the world. The natural enemies of *T. varians* have not been reported from Pakistan till now.

Chemical control

Synthetic insecticides have although exert hazardous effect on environment, ecosystems and non-target species but it is a highly efficient way to control insect pests and have knock-down effect, so widely accepted and used in the world. Same is true for the pest species under consideration and a few studies in this regard have been narrated here. In Malaysia, two insecticides malathion (57% active ingredient) and fipronil (5% active ingredient) were tested against *T. varians* larvae under laboratory conditions, and LT50 and LT95 were evaluated. The study reported that fipronil had lower LT_{50} and LT_{95} than malathion (Basari *et al.*, 2019).

In Pakistan, only one study of toxicity of four insecticides such as chlorantraniliprole, deltamethrin, emamectin benzoate and fipronil was evaluated against third instar larvae of *T. varians*. Among tested insecticides, deltamethrin was reported more toxic followed by emamectin benzoate, chlorantraniliprole and fipronil against 3rd larval instar under laboratory conditions (Naeem-Ullah *et al.*, 2020).

Future prospectus

There is a great need to control this pest by using integrated pest management (IPM) approaches

including botanical, biological (predators, parasitoids and entomopathogenic fungi) and chemical. The biological fauna (parasitoids and predators) should be identified and tested against this pest. Survey to check the pest distribution from areas or countries should also be proposed to identify its complete rangealong with the list of alternative hosts. The genome sequence of *T. varians* is suggested as bioinformaticstool and systematic aspects.

Acknowledgements

Authors are highly thankful to the Institute of Plant Protection, MNS-University of Agriculture Multan, Pakistan for providing necessary facilities.

Novelty Statement

Trilocha variansi, the greenish silk-moth is emerging pest of ornamental plants especially weeping fig (*Ficus benjamina*) in various countries including Pakistan. The current study provides basic informations about it and prove fruitful in managing this pest in Pakistan.

Author's Contribution

Muhammad Ramzan: Conceived the idea and wrote the manuscript.
Unsar Naeem-Ullah: Helped in write up and Technical Input at every step.
Muhammad Umair Sial, Naeem Iqbal and Shafqat Saeed: Critically reviewed the manuscript.

Conflict of interest
The authors have declared no conflict of interest.

References

Arya, P.V., 2020. Recent diversity and potential biological control studies on major ornamental *Ficus* sp. defoliating moth bombycid *Trilocha* (= *Ocinara*) *varians* (walker) (Lepidoptera: Bombycidae). J. Exp. Zool. India, 23(1): 215-217.

Basari, N., N.S. Mustafa, N.E.N. Yusrihan, C.W. Yean and Z. Ibrahim. 2019. The effect of temperature on the development of *Trilocha varians* (Lepidoptera: Bombycidae) and control of the *Ficus* Plant Pest. Trop. Life Sci. Res., 30: 23.

Chu, H.F. and L.Y. Wang. 1993. Saturniidae of China. Bull. Zool. Sci. Press, Beijing. 10: 211–238.

Chuenban, S., S. Bumroongsook and S. Tigvattananont. 2017. Observation on Trilochavarians (Lepidoptera: Bombycidae). *Int. J. Agric. Tech.*, 13(7.3): 2189-2195.

Daimon, T., M. Yago, Y.F. Hsu, T. Fujii, Y. Nakajima, R. Kokusho and T. Shimada. 2012. Molecular phylogeny, laboratory rearing, and karyotype of the bombycid moth, *Trilocha varians*. J. Insect Sci., 12: 49. https://doi.org/10.1673/031.012.4901

Daimon, T., T. Fujii, M. Yago, Y.F. Hsu, Nakajima, T. Fujii, S. Katsuma, Y. Ishikawa and T. Shimada. 2012. Female sex pheromone and male behavioral responses of the bombycid moth *Trilocha varians*: comparison with those of the domesticated silkmoth *Bombyx mori*. Nat. Wise Aften, 99: 207-215. https://doi.org/10.1007/s00114-012-0887-3

Gurule, S.A. and S.M. Nikam. 2013b. The moths (Lepidoptera: Heterocera) of northern Maharashtra: A preliminary checklist. J. Threat. Taxa., 5(12): 4693–4713. https://doi.org/10.11609/JoTT.o2555.4693-713

Gurule, S.A., 2013a. Taxonomic study of moths (Lepidoptera: Heterocera) from north Maharashtra (India). Ph.D. thesis, University of Pune, India.

Hai-Ying, O., R. Lin, L. Mei, C. Yi-Jing, H. Yu-Rong and T. Ming-Yi. 2006. Parasitizing capacity of several trichogrammatid species on *Ocinara varians*. Chinese Bull. Entomol., 43: 669-672.

Huang, G.D., X.D. Yu, Y.Z. Xie, F.H. Wu and H.Y. Liu. 2002. Bionomics of *Ocinara varians* and its control. *Entomol. Knowledge Kunchong Zhishi*, 39(2): 123-126.

Hutson J.C. 1930. Half-Yearly Report of the Entomological Division, Department of Agriculture, Ceylon. January to June, 1930. 2 pp. Retrieved on February 28, 2013 from http://www.cabdirect.org/abstracts/19300501423.html.

Jia, L. and L. Jinxin. 1997. Studies on the bionomics of *Ocinara varians* Walker. Entomol. J. East Chinn., 40: 31-34.

Kedar, S.C., K.M. Kumaranag and R.K. Saini. 2014. First report of *Trilocha* (=*Ocinara*)

varians and its natural enemies on *Ficus* spp. from Haryana, India. J. Ent. Zool. Stud., 2(4): 268-270.

Kim, K.J., M.J. Kil, J.S. Song, E.H. Yoo, K. Son and S.J. Kays. 2008. Efficiency of volatile formaldehyde removal by indoor plants: contribution of aerial plant parts versus the root zone. J. Am. Soc. Hortic. Sci., 133: 521–526. https://doi.org/10.21273/JASHS.133.4.521

Kishida, Y., 2002. *Trilocha varians* (Walker) (Bombycidae) from Ishigaki Island, the Ryukyus. Japan Heterocerist's J., 219: 370.

Lansky, E.P., M.P. Helena, D.P. Alison and A. Robert. 2008. *Ficus* spp. (fig): Ethnobotany and potential as anticancer and anti-inflammatory agents, J. Ethnopharmacol., 119: 195-213. https://doi.org/10.1016/j.jep.2008.06.025

Mousa, O., P. Vuorela, I. Kiviranta, S.A. Wahab, R. Hiltunen and H. Vuorela. 1994. Bioactivity of certain Egyptian *Ficus* species. J. Ethnopharmacol., 41: 71-76. https://doi.org/10.1016/0378-8741(94)90060-4

Naeem-Ullah, U., M. Ramzan, S. Saeed, N. Iqbal, Z.M. Sarwar, M. Ali, S. Saba, A.D. Abid, K.A. Khan and H.A. Ghramh. 2020. Toxicity of four different insecticides against *Trilocha varians* (Bombycidae: Lepidoptera). J. King Saud Univ. Sci., 32: 1853–1855. https://doi.org/10.1016/j.jksus.2020.01.032

Navasero, M.M. and M.V. Navasero. 2014. Biology of *Trilocha varians* (Walker) (Lepidoptera: Bombycidae) on *Ficus benjamina* L. in the Philippines. Phili. Entomol., 28(1): 43-56.

Navasero, M.V., M.M. Navasero, M. Ceres and S.M.F. Calumpag. 2013. Occurrence of the Moraceae-feeding bombycid, *Trilocha varians* (Walker) (Bombycidae, Lepidoptera) as pest of jackfruit and some ornamental species of *Ficus* in the Philippines. J. Int. Soc. Southeast Asian Agric. Sci., 19(2): 41-48.

Rajavel, D.S. and M. Shanthi. 2007. Note on the first occurrence of *Trilocha* (=*Ocinara*) *varians* walker (Bombycidae: Lepidoptera) as a pest of pipal tree (*Ficus religiosa*) in Madurai, Tamil Nadu. Indian For., 133: 1706-1708.

Ramzan, M., U. Naeem-Ullah, M. Ali and H. Riaz. 2020. Biological and morphological parameters of *Trilocha varians* (Lepidoptera: Bombycidae) in Pakistan. Punjab Univ. J. Zool., 35(2): 255-259. https://doi.org/10.17582/journal.pujz/2020.35.2.255.259

Ramzan, M., U. Naeem-Ullah, M. Javaid, M. Nadeem, N. Iqbal and S. Saeed. 2019b. Comparative biology of *Trilocha varians* (walker, 1855) (Lepidoptera: Bombycidae), a new pest of *Ficus* plant in Punjab, Pakistan. Pak. J. Sci., 71(4): 220-225.

Ramzan, M., U. Naeem-Ullah, N. Iqbal, Z. Rasheed, S. Saba, H. Ghaffar and S. Saeed. 2019a. Effect of temperature on the life cycle of *Trilocha varians* (Lepidoptera: Bombycidae) in Pakistan. Pure Appl. Biol., 9(1): 436-442. https://doi.org/10.19045/bspab.2020.90047

Singh, A. and J.S. Brar. 2016. First record of *Trilocha varians* (Family: Bombycidae) a pest of *Ficus benjamina* (L.) and its biology in Talwandi Sabo, Dist. Bathia, Punjab. Int. J. Sci. Nat., 7(4): 711-713.

Singh, A., J.S. Brar and P. Sarari. 2017. Habitat Preference of Butterflies and Moths (Insecta: Lepidoptera) in Talwandi Sabo, Punjab. Bull. Environ. Pharmacol. Life Sci., 6(12): 67-71.

Sirisha, N., M. Sreenivasulu, K. Sangeeta and C.M. Chetty. 2010. Antioxidant properties of *Ficus* species. A review. J. Pharm. Tech. Res., 2: 2174-2182.

Udayagiri, S., 1988. Life history and new records of natural enemies of *Trilocha varians* (Walker) (Lepidoptera: Bombycidae). Ann. Entomol., 6: 1-6.

Walker, F., 1855. s.n. In: List of the specimens of lepidopterous insects in the collection of the British Museum. Printed by order of the Trustees, London., 583–775.

Wang, X., M. Wang, V.V. Zolotuhin, T. Hirowatari, S. Wu and G.H. Huang. 2015. The fauna of the family Bombycidae sensulato (Insecta, Lepidoptera, Bombycoidea) from Mainland China, Taiwan and Hainan Islands. Zootaxa, 3989(1): 1–138. https://doi.org/10.11646/zootaxa.3067.1.1

Zolotuhin, V.V. and T.J. Witt. 2009. The bombycidae of Vietnam (Lepidoptera). Entomofauna Suppl., 16: 231-272.