

Tuta absoluta; A Devastating Pest of Tomato: A Review

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ABSTRACT

Tomato (*Solanum lycopersicum* L.) is a very important vegetable crop of the world. However, there is a huge loss in tomato production due to pest and disease incidence. Tomato leaf miner is a devastating pest of tomato and other Solanaceous crops in many vegetable crop growing areas around the world and it also attacks non-solanaceous crops. The larva is the most devastating stage of tomato leaf miner. After egg hatching, the larvae feed on tomato fruits, leaves, flower buds, and young shoots and create mines and galleries. Larval feeding may reduce tomato production by 80-100 % in an open field as well as in a plastic house if no control measures are carried out. Chemical control has been found ineffective due to a wide host range and has developed resistance to dozens of pesticides. Hence, Integrated Pest Management (IPM) practices involving mass trapping of the pest using pheromone trap, biological control by a predator, parasitoid, entomopathogenic microbes, including cultural practices should be implemented for the effective control of this pest.

Keywords- Bio-control, Chemical control, Distribution, efficacy, IPM, *Tuta absoluta*

I. INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is the 3rd most important vegetable cultivated in Nepal with a production of 400674 Mt in 21,389 ha and productivity of 18.73 Mt/ha (MoAD, 2016) and has a high potential for income and employment generation to small-holders in Nepal. The production of the crop is hindered by many biotic and abiotic factors.

The major insect pests of tomato are tomato fruit borer (*Helicoverpa armigera*), leaf miner (*Liriomyza trifolii*), and whiteflies (*Bemisia tabaci*) which spreads tomato yellow leaf curl virus. Moreover, the tomato leaf miner (*Tuta absoluta*), has been recently introduced to Nepal in 2016 which can incur a huge loss in tomato production and has become an increasingly important pest with a huge loss in Nepal (Bastola et al., 2021, Joshi et al., 2017). This pest was recorded first time from Kathmandu valley in May 2016 and has been spread to the nearest districts to Kathmandu; Kavrepalanchowk, Dhading, and Nuwakot (Bajracharya et al., 2016).

Tuta absoluta Meyrick (Lepidoptera: Gelechiidae), commonly known as "tomato leaf miner"

and "South American tomato moth" is a devastating pest of great economic importance originating from South America. If appropriate control measures are not taken then losses due to *Tuta* may range up to 80-100 % and may pose a threat to both greenhouse and open-field tomato production (Desneux et al., 2010). The pest has a high reproductive potential and is capable of producing up to 12 generations a year under favorable conditions (21- 30 °C).

Low temperature limits the survival of the pest but it is favored by high temperature (Omonu et al., 2019). The main host plant of *Tuta absoluta* is tomato (*Solanum lycopersicum* L.), however solanaceous crops such as potato (*Solanum tuberosum* L.), eggplant (*S. melongena* L.), pepper, and hot pepper (*Capsicum spp.*), and some wild plants *Solanum nigrum* L. and *Datura stramonium* L. serves as the alternative host of the pest (Bajracharya et al., 2016).

During the entire growing period, the larvae of *Tuta* feed and develop inside tomato leaves, stems, and fruits (Garzia et al., 2012). The larval stage of the moth damages leaves fruits and stems of the crop causing a considerable loss in crop yield (Savino et al., 2012). The mines created by larva forms whitish and irregular spots covered with droppings. The larvae have been found more destructive to the young fruit (MOAD, 2016).

The pest has been found difficult to control as the larva feeds inside the plant body and has developed resistance to the insecticides (Guedes & Picanço, 2012). *T. absoluta*, is very difficult to manage with a single management technique. Integrated pest management needs to be practiced for the proper management of *T. absoluta* (Bajracharya et al., 2016). An Integrated Pest Management (IPM) strategy that employs biochemical, biological, physical, and cultural methods is the only best option.

II. LITERATURE REVIEW

Origin and occurrence of the pest

The pest was originated from South America mainly Peru (Gebremariam, 2015). After its origin in South America, the pest has spread rapidly into Europe, North Africa, and Middle East (Garzia et al., 2012). In South Asia, the pest was first reported in India in 2014 (Shashank et al., 2015), Bangladesh in 2016 (Hossain et al., 2016), and in Nepal, it was reported for the first time

in 2016 in Kathmandu valley by Entomology Division, Nepal Agricultural Research Council and has been spread to the nearest tomato growing areas to the valley (Bajracharya et al., 2016). Earlier pest infestation in 2016 was recorded from Kathmandu, Lalitpur, Bhaktapur, Kavre, and Dhading districts and has been widespread to 33 tomato cultivating districts of Nepal in 2018 (Bajracharya et al., 2018). Tropical and subtropical climatic conditions in the mid-hills and Terai region are also favorable for the development and spreading *T. absoluta* across the country. Wide host range of pathogen, endophytic feeding habits and short life cycle of the pest is attributing factor for its wide-spreading and extensive crop damage.

Biology of pest

The taxonomic position of tomato leaf miner is given as follows:

Class: Insecta

Order: Lepidoptera

Family: Gelechiidae

Genus: *Tuta*

Species: *Tuta absoluta*

Tuta absoluta, a holometabolous insect with high reproductive potential comprises four development stages in its life cycle of 24 days at 27°C viz. egg, larva, pupa and adult (NAPPO, 2013).

The life cycle begins with egg-laying by an adult moth on the underside of leaves, buds, stems, and calyx of unripe fruits. Freshly laid eggs are oval-shaped, creamy white, and later turns yellow and finally change to black before hatching (Salama et al., 2014).

An adult female can produce up to 260 eggs during her lifetime (Harizanova et al., 2009). Eggs hatch in 4-6 days after egg laying. Larvae soon after hatching, before feeding on the leaf, wander around the surface of the leaf for few minutes (Cuthbertson et al., 2013). The larva feeds voraciously upon tomato leaves, penetrate tomato fruits, burrowing in stalks, and consuming apical buds thus creating conspicuous mines and galleries (USDA-APHIS, 2011). Larvae feed only on mesophyll tissue of leaf leaving behind the epidermis intact (EPPO, 2005). Larval feeding may cause 50-100% yield loss in tomatoes (Desneux et al., 2010). The insect encounters 4 instars larvae, usually for 12-15 days before entering the pupal stage (NAPPO, 2012). The pupal stage lasts for 9-11 days in silken cocoons mostly in soil and also on the leaf surface, within mines (Ballal et al., 2016). Adult moths are small about 5-7 mm in size and are characterized by silvery or greyscales (Bexolli and Shahini, 2017). Adults are most active during the night. The adult female has a lifespan of 10-15 days and the male moth lives for 6-7 days (Desneux et al., 2010).

Economic Importance and Damage

T. absoluta is a devastating pest of both field and greenhouse tomato productions. The damage caused by all larval instars occurs throughout the entire crop growing cycle (Harizanova et al., 2009). The infested plant shows dark color blotch mines on both sides of the

leaf. Larvae bore the apical buds; stems are responsible for leaf folding. The larvae also tunnel in the fruit near the calyx leaving galleries clogged with frass (Bajracharya et al., 2016).

Pest infestation causes considerable loss in yield and fruit quality by direct feeding of the pest as well as the secondary infestation is caused by the pathogen which enters the host plant through the wounds (Kaoud, 2014).



Figure 1: Damage symptom of *Tuta absoluta* (Bajracharya et al., 2016)

[A. Larval infestation on leaf B. Heavily infested tomato field C. Infestation symptom on apical stem D. Larval punctures and exit holes on fruit]

Host plant

It is reported to attack in potato (*Solanum tuberosum* L.), eggplant (*Solanum melongena* L.), pepper (*Capsicum annum* L.), some weeds (*Datura stramonium* L., *Nicotiana glauca* G.), and some other non-solanaceous crop plants like green beans (*Phaseolus vulgaris* L.) or *Malva* spp. Thus, the pest has the widest range of host plants.

Although, *T. absoluta* prefers tomato as its host (EPPO 2005), it also attacks several other solanaceous crops including eggplant (*Solanum melongena* L., also called aubergine), potato (*Solanum tuberosum* L.), tobacco (*Nicotiana tabacum* L.), and African eggplant (*Solanum aethiopicum* L.) (EPPO 2005; Mohamed et al., 2015). *Tuta absoluta* also has been found on a range of wild solanaceous plants (e.g., *Solanum* spp. and *Datura* spp.), which indicates that weed sanitation may be an important tactic for managing pest populations (EPPO 2005; Mohamed et al. 2015).

III. MANAGEMENT METHODS

T. absoluta is a very challenging pest to control. Various control strategies could be applied to control *T. absoluta*. This includes physical control methods, chemical control methods, biological control methods,

cultural methods, and IPMS (Ghoneim, 2014). Mass trapping using pheromone lure, use of an entomopathogenic agent, entomophagous agents, like predators and parasitoids, and bioinsecticide are some of the tactics that are considered the best option for the management of *T. absoluta* (Illakwahhi and Srivastava, 2017).

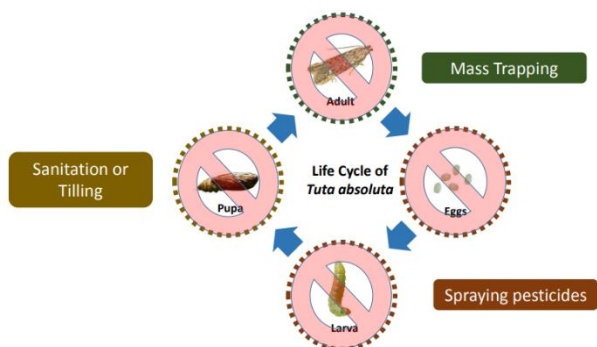


Figure 2: Best practice for *Tuta* management (Sah et al., 2017)

Cultural management

The cultural method includes crop rotation, intercropping, trap cropping and various other practices in which the environmental conditions are altered to reduce the pest attack. Infested plant parts should be removed and destroyed to reduce the pest infestation. *Tuta absoluta* prefers Tomato but there are many alternative hosts of the pest Mohamed et al. 2015). So, crop rotation may prevent pest incidence (Adhikari et al., 2019). Intercropping tomato with coriander (*Coriandrum sativum* L.) and gallant soldier (*Galinsoga parviflora* L.) can enhance the natural enemies and shows a positive effect on reducing pest density. Pupae of *T. absoluta* remain in the soil after harvest so; soil solarization has been advised to kill the pupae (Balzan & Moonen, 2012).

Physical management

Tuta absoluta can be easily managed under greenhouse conditions by a screening of vents in the roof and sides of greenhouses. The use of double entry doors can reduce the migration of pests into the greenhouse (Retta and Berhe, 2015). The adult pest can be monitored and trapped by using different traps.

Pheromone traps are used to detect the presence and abundance of the pest which subsequently helps to determine the correct timing for the application of control measures (Chemical) which leads to the rational use of pesticides (Bexolli and Shahini, 2017).

Braham et al. (2013) during a study conducted in Tunisia reported greater efficacy of mass trapping over chemical control. In this technique, special attention is given to the color of the trap to attract more insects towards it.

Biological management

The biological control method involves the use of entomophagous insects (predators and parasitoids) for

controlling the pest. The biological control method is potentially a very beneficial tactic to be developed (Savino et al., 2012) and is an eco-friendly, effective, sustainable and economical way of managing the pest (Illakwahhi and Srivastava, 2017).

The enemies of *T. absoluta* are commercially available and can be used effectively in controlling the pest. The predatory bugs such as *Macrolophus pygmaeus* and *Nesidio coristenuis* are large consumers of eggs of the pest and have been identified as the most promising natural enemies of *T. absoluta* in Europe (Retta and Berhe, 2015).

Parasitoids have been found parasitizing the larvae of *T. absoluta* and can be used to control pest population in both greenhouses and open field tomato farms. *Trichogramma acheae*, an egg parasitoid has been identified as a potential biological control agent and is currently being released in commercial tomato greenhouses (Caparros Megido et al., 2013).

Bacillus thuringiensis, an entomopathogenic bacterium is an eco-friendly measure that has been effectively used in controlling tomato plant pests as a very effective bio-insecticide (Gözel & Kasap, 2015).

Chemical management

Management of *Tuta absoluta* is not possible only by the use of botanical and bio-pesticides so, for the effectiveness in pest control chemical-based pesticides should be used in an alternative manner with bio and botanical pesticides at a recommended dose. Chemical pesticides have been found effective in controlling *T. absoluta* infestation. *Tuta absoluta* is a potentially very damaging pest and is difficult to control as it feeds inside the plant leaf and fruit and can develop resistance to several insecticides (Siqueira et al., 2000).

Bastola et al. (2021) during study reported Chlorantraniliprole to be the most effective insecticide against *T. absoluta* followed by spinosad and emamectin benzoate. Braham and Hajji (2012) from a study conducted in Tunisia reported the effectiveness of three insecticides viz. indoxacarb, triflumuron, and diafenthiuron against *T. absoluta*. The study conducted by Bastola et al. (2021) reported the higher use of emamectin benzoate due to its better crop protection. An experiment conducted by Bajracharya et al. (2017) at commercial Farmer's field in Poly house conditions reported the effectiveness of Chlorantraniliprole. A laboratory experiment conducted by Deleva and Harizanova, (2014) reported 90-100 % larval mortality with the application of insecticides like azadirachtin, emamectin benzoate, spinosad, metaflumizone and chlorantraniliprole.

IV. CONCLUSION

Tomato leaf miner, *Tuta absoluta*, is an emerging pest in tomatoes and hinders crop production leading to 80-100% yield loss. The larva is the most damaging stage of the pest and damages the plant

producing large galleries in their leaves, stem, immature and mature fruits. Intensive chemical treatment leads to the development of resistance, hampering the ecological and biological world. Therefore, alternative methods should be considered. The excessive use of chemicals develops resistance and hampers the ecological and biological world. Hence, the use of an alternative method of pest management should be promoted. It is critical to combine all the control measures viz. cultural, biological, use of botanicals, chemical for the effective control of the pest.

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