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Distribution, Host Range, Life Cycle and Management of *Tuta Absoluta* in Tomato

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Abstract

The South American tomato pinworm, *Tuta absoluta* (Lepidoptera-Gelechiidae) is one of the most severe pest on solanaceous plants, especially tomato and causes up to 100 % crop loss. It is an insect of neotropical distribution considered as a major tomato pest in several Latin American countries. Only reliance on insecticides for its management results in resistance development apart from residual effect. Wild relatives of tomato are known for their utilization in insect resistance; therefore, they can be used in resistance breeding and generally the resistance is associated with the presence of different trichome types and densities.

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the important and mostly widely grown versatile vegetable crop of both tropical and sub-tropical region. It belongs to the family Solanaceae and is a native of Peru, equador region. Tomato is a typical day neutral plant and is mainly self-pollinated crop. It ranks second in importance among vegetables after potato. In India, tomato occupies area of 0.81m.ha with a production of 20.57mt with an average productivity of 25.39 t/ha. In Karnataka, tomato is grown in an area of 0.06m.ha with a production of 2.37mt and average productivity of 39.50 t/ha (Anon., 2020). It is universally indicated as protective food and esteemed as an important source of minerals, organic acids and vitamins (A and C).

All tomato species are diploid (2n=24) and their exhibits great difference in morphological characters such as matting system, habitat preference, trichome densities and type, resistant to pest and diseases and other agronomic traits important for breeding.

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Tomato crop is highly challenged by various biotic and abiotic stresses and causes reduction in yield all over the world. This crop is susceptible to many pest-like aphids, whitefly, fruit borer and South American leaf miner.

Tuta absoluta (Lepidoptera: Gelechiidae) is an emerging pest on tomato in different countries causing upto 100% crop loss (Desneux*et al*., 2010; Sridhar *et al*., 2019). Total reliance on insecticides for its management results in resistance development apart from residues and also causes environmental pollution. Wild relatives of tomato are known for their utilization in insect resistance source and generally associated with the presence of different trichome types and densities (Tissier, 2012). Glandular trichomes synthesize and store secondary metabolites. The diversity of trichome type and chemical composition among tomato species respond differently against herbivore attack in conferring resistance (Rakha *et al*., 2017) to *Tuta absoluta*. Current programs for improving tomato plants to obtain pest resistant cultivars by incorporating the alleles for resistance present in wild plants into commercial cultivars through validation of markers linked to *Tuta absoluta* resistance.

Origin and geographical distribution of *Tuta absoluta*

Year	**Invaded regions**
1917	Andes region in Peru
1970	South American regions
2006	Spain
2008-2012	Southern and Northern Europe, Africa, Eastern Mediterranean regions (Israel, Turkey)
2010-2016	Iran & South Asia (India, Bangladesh, Nepal)

Distribution of *Tuta absoluta* in India

In India this pest was initially reported in Pune on tomato plants grown in polyhouse as well as in field conditions during 2014.

Host range of *Tuta absoluta*

Tomato is the main host of *Tuta absoluta.* In tomato plants, the female adults lay eggs on all above ground part of the plant (leaves, shoots and flowers as well on the fruits). Despite the clear preference of this insect on tomato species, it also affects common bean, potato, eggplant and tobacco. It also has been using weeds as an alternative host such as;

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Lycium chilense, Solanum nigrum and Datura stramonium; Datura ferox and *Nicotiana glauca*.

Damage symptoms of *Tuta absoluta*

Leaves:

- The female lays eggs on all the aerial parts of the plants like leaf, stem, flower buds and fruits.
- Larvae is the main damaging stage of *Tuta absoluta*, the emerged larva start feeding on the mesophyll content of the leaves and gives blotch like appearance or white patches on leaf surface with excrements at the end of the mines
- It affects the photosynthetic activity of the plants.
- Later the mines turn brown and become necrotic.

Stems:

- In case of stem we can notice bored entry holes on young stems covered with excreta.

Fruits:

- In case of fruits, we can notice bored pin holes on its surface covered with dark granular excreta.
- The affected fruits become unsuitable for sale and consumption.
- In later stages from the bored holes secondary pathogens may enter and leads to rotting of fruits and affects the fruit quality.

Level of damage

- They can attack at any crop stage under both field and protected condition.
- Incidence of *Tuta absoluta*which cause 50% –100% yield loss

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Leaf damage

Stem damage

Fruit damage

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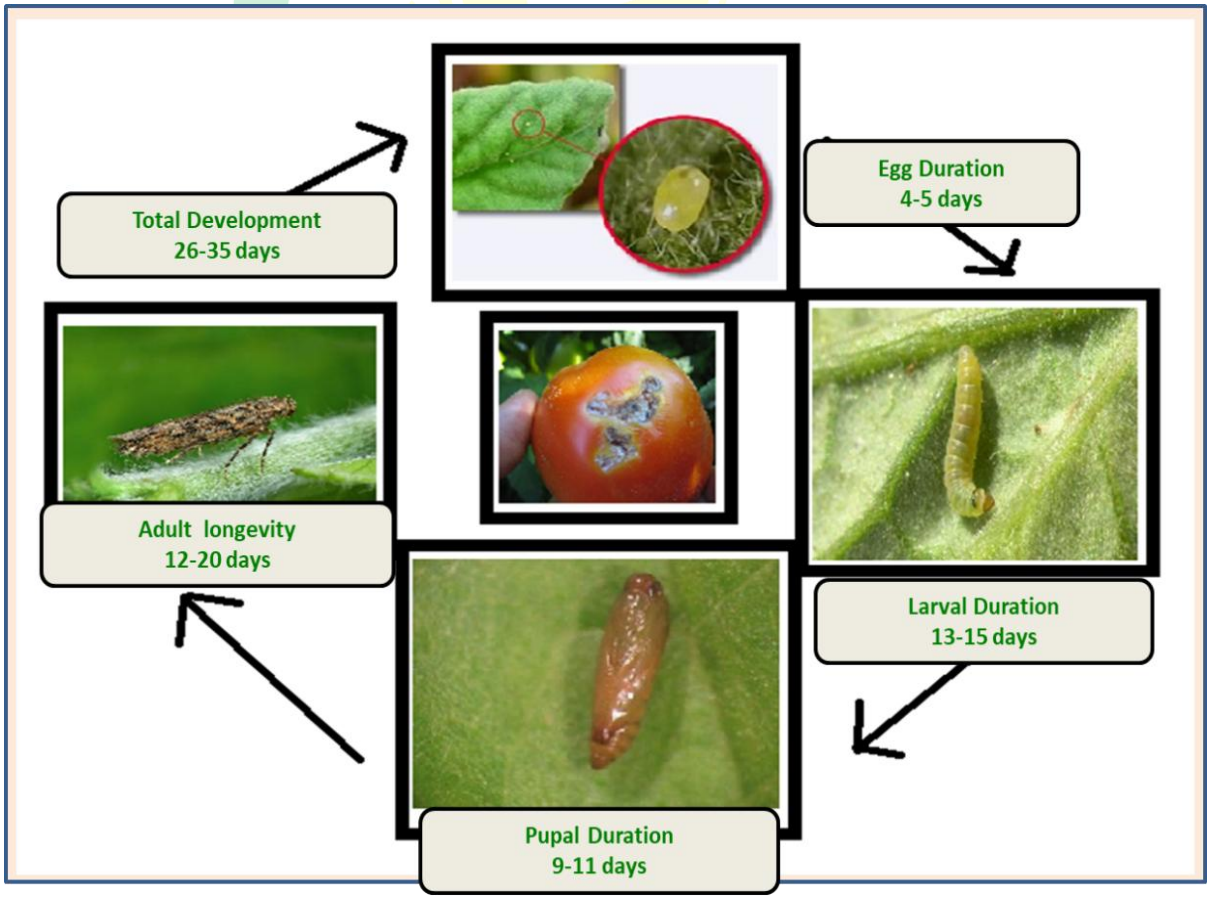
Life cycle of *Tuta absoluta*

The Life cycle of *Tuta absoluta* consist of four biological stages; Egg, larvae, pupae and adult.

1) **Egg stage**: Female lay the eggs individually on the underside of the leaves, stem and sepals. The eggs are elliptical and their colour ranges from oyster white to bright yellow. Egg duration is 4-5 days. Asingle female can lay upto 260 eggs in its life cycle.
2) **Larval stage**: There are four stages of larvae. The first instar larvae are whitish in colour, later becomes light green or light red in colour based on the food ingested. Larval duration is 13-15 days. Larva is the main damaging stage.
3) **Pupal stage**: Pupae are 5 mm long and are light green in colour at first, later turn to dark brown near adult emergence. Pupal duration is 9-11 days. It undergo pupation in the soil or on leaf surface.
4) **Adult stage**: The emerged adults were brown in color with black spots with black spots on its narrow wings with filiform antenae. Adult longevity period is 12-20 days. Adults are noctural in nature hide between leaves during day time.



Life cycle of *Tuta absoluta*

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Management of *Tuta absoluta*

- Use of healthy transplants
- Collection and destruction of infested plant parts
- Crop rotation with non-solanaceous vegetables
- Use of Sex pheromone traps
- Spray NSKE @ 4%
- Spray insecticides like spinosad @ 0.3 %
- Use of resistant varieties

Mechanisms of Insect Resistance

There are four mechanisms of insect resistance.

1) **Non preference:** The host varieties those are unattractive or unsuitable for colonization, oviposition or both by the insects.
2) **Antibiosis:** The adverse effect of host plant on the development and reproduction of insect pests which feed on resistant plant.
3) **Tolerance:** The ability of a variety to produce greater yield than susceptible variety at the same level of insect attack.
4) **Avoidance or Escape:** To escape of variety from insect attack either due to earliness or due to its cultivation in season where insect population is low.

Basis of Insect Resistance in Plant Breeding

Insect resistance is mainly governed by the following features of host plant;

- **Morphological Factors-**
  - Hairiness
  - Colour of plant
  - Solid stem toughness of the tissues
  - High tillers
  - Long pedicels
- **Physiological Factors-**
  - Some physiological factors such as osmotic concentration of cell sap and leaf exudates are associated with insect resistance.
  - Some species of solanum gummy exudates from hairs on the leaves. Aphids and Colorado beetles get trapped in such exudates and are unable to feed and reproduce.
  - Osmotic concentration of sap & exudates – cotton resist to Jassids

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- **Biochemical features of host plant-**

  Certain biochemical substances act as feeding stimuli for insect pests. Lack or low concentration of such substances in host plant will lead to non-preference type of resistance.

Identification of source of resistance

- Cultivated varieties
- Germplasm collections:can range from collections of wild species to elite, domesticated breeding lines that have undergone extensive human selection.
- Wild species:are wild plant species that are genetically related to cultivated crops. Untended by humans, they continue to evolve in the wild
- Mutations:sometimes, insect resistance is obtained through induced mutations. Insect resistance has been obtained in many crops by this method.
- Microorganism:Now microorganisms are being used as source of resistance to insect pests.
- In USA, Monsanto Company has transferred a gene from *Bacillus thuringiensis* (Bt) into the system of cotton plant through genetic engineering.

Breeding approaches

1. Screening techniques
2. Development of resistant hybrids against***Tuta absoluta***along with good horticultural traits
3. Identification and mapping of resistance genes
4. Marker assisted selection for resistance genes
5. Gene pyramiding
6. Biotechnological approaches

Problems in breeding for *Tuta absoluta* resistance

- It is a long term process.
- Sometimes, breeding for resistance to one pest leads to the susceptibility to another pest.
- Chances of linkage between desirable & undesirable genes.
- It is the expensive and difficult method.
- In some cases resistant variety has lower yield and poor quality.

Conclusion

The devastating invasion of *Tuta absoluta* represents a significant biosecurity threat that affects majority of livelihoods dependent on agriculture. The adoption of genetically resistant plant materials is one of the main strategies for pest management in sustainable tomato crops, in which the use of pesticides should be reduced or mitigated due to their adverse effects on

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environment and human health. A large number of biochemical and morphological characteristics have been related to tomato resistance to several key and secondary pests. The introgression of genes from wild species has shown to be the main strategy for tomato breeding programmes.

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