The Tomato Leafminer / Tomato Borer, *Tuta absoluta*

Recommendations for Sustainable and Effective Resistance Management

IRAC

Insecticide Resistance Action Committee

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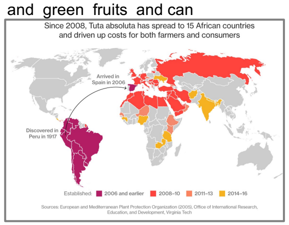
Tuta absoluta, an Aggressive Pest with High Risk of Insecticide Resistance Development

***Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae)** is a pest of great economic importance in a number of countries. Its primary host is tomato, although potato, aubergine, common bean, and various wild solanaceous plants are also suitable hosts. *T. absoluta* is characterized by high reproduction potential. Each female may lay up to 300 eggs and 10-12 generations can be produced each year depending on temperature. In tomato, it attacks all plant parts and crop developmental stages, although the larvae prefer apical buds, tender new leaflets, flowers, and green fruits and can cause up to 100% crop destruction.



This pest is crossing borders and devastating tomato production in protected and open fields. Originally from Latin America, *T. absoluta* has spread throughout Europe, Africa, Middle East and certain Asian countries. Given its aggressive nature and crop destruction potential, it has quickly become a key pest of concern in these new geographies.

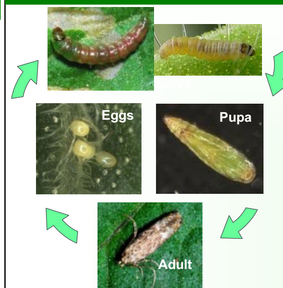
Risk for Insecticide Resistance Development: Pests like *Tuta absoluta*, with high reproduction capacity and short generation cycle, are at higher risk of developing resistance to insecticides. This risk increases significantly when management of the pest relies exclusively on chemical control with a limited number of effective insecticides available. This situation usually leads to increase in the frequency of use and thus, increases selection pressure. In fact, field populations of *T. absoluta* resistant to a range of mode of action groups are already known in L. America and European countries, where it has been a key pest for many years.

Local Evaluation of Insecticidal Efficacy: T. *absoluta* populations in Europe, Middle East, and Africa were most likely imported originally from L. America and thus, may have already expressed high level of resistance to one or multiple mode of action groups. It is therefore essential to first evaluate the efficacy of each insecticide for the control of newly invasive *Tuta absoluta* populations in each geography before specific recommendations are made for their use within IPM (Integrated Pest Management) and IRM (Insecticide Resistance Management) programs.

Damage and Symptoms

Infestation of tomato plants occurs throughout the entire crop cycle. Feeding damage is caused by all larval instars attacking all above ground plant parts. On leaves, the larvae feed on the mesophyll tissue, forming irregular leaf mines which may later become necrotic. Larvae can form extensive galleries in the stems which alter the general development of the plants and prevent flow of nutrients and water. Fruits are also attacked by the larvae, forming galleries which represent open areas for invasion by secondary pathogens, leading to fruit rot. Potential yield loss (quantity & quality) is significant and if the pest is not managed, can reach 100% in tomatoes.

Insect Description and Life Cycle



Modified from Barrientos et al. (1998)

Larval Developmental Time at Different Temperatures	
14° C	76 days
20° C	40 days
27° C	24 days

Tuta absoluta is a lepidopteran insect. The adults are silvery brown, 5-7 mm long. The total life cycle is completed in an average of 24-40 days, with the exception of winter months, when the cycle could be extended to more than 60 days. The minimal temperature for biological activity is 9°C.

Females lay individual small (0.35 mm long) cylindrical creamy yellow eggs. Newly hatched larvae are light yellow or green and only 0.5 mm in length. As they mature, larvae develop a darker green color and a characteristic dark band posterior to the head capsule. Four larval instars develop. Larvae do not enter diapause when food is available. Pupation may take place in the soil, on the leaf surface or within mines. *Tuta absoluta* can overwinter as eggs, pupae or adults depending on environmental conditions.

Key Management Strategy Integration of Control Measures

The basis for effective and sustainable management of *Tuta absoluta* is the integration of cultural, behavioral, biological and chemical control.

Key Management Tactics

- Use pest-free transplants.
- Prior to transplanting, install yellow sticky traps in greenhouses.
- Monitor pest using delta pheromone indicator traps.
- Disrupt mating using industry approved/recommended pheromone dispensers.
- Between planting cycles, cultivate the soil and cover with plastic mulch or perform solarisation in greenhouses.
- Allow a minimum of 6 weeks from crop destruction to next crop planting.
- Seal greenhouse structure with high quality nets suitable for *T. absoluta.*
- For massive trapping in greenhouses, use water + oil traps (20-40 traps/ ha).
- Inspect the crop regularly to detect the first signs of damage.
- Constantly, remove and destroy attacked plant parts.
- Control weeds to prevent multiplication in alternative host (solanaceous spp.)
- Establish populations of effective biological control agents (*e.g.Nesidiocoris).*
- Use locally established thresholds to trigger insecticide applications.
- Select insecticides based on known local effectiveness and selectivity.
- Rotate insecticides by MoA group using a "windows" approach.
- Use only insecticides registered for control of *T. absoluta* .
- Always follow the directions for use on the label of each product.

Insecticide Resistance Management

Resistance status in L. America vs. Europe, Africa, and Middle East: In L. America and Europe high level and widespread resistance exists in greenhouse and field populations of *T. absoluta* to many different commonly used mode of action chemistries including newer classes of insecticides. Because it is likely that resistant populations Africa, the Middle East, and Asian countries it is urgent that regional technical experts understand the susceptibility profile of *T. absoluta* field populations to the available insecticides so that local recommendations can be made.

Evaluation of Insecticide Susceptibility: IRAC has a standard "leaf-dip" larval bioassay method to assess susceptibility of field populations to insecticides. See IRAC Method No. 022 on the IRAC Website.

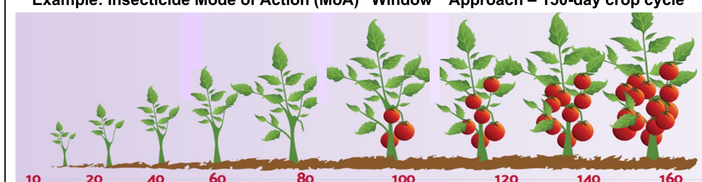
Insecticide Resistance Management (IRM):

The recommendations for sustaining the effectiveness of available insecticides is centred on integration of as many pest management tools as possible, use of insecticides only when needed based on established thresholds, and rotation of effective insecticides with different modes of action.

Mode of Action Window Approach:

- Avoid treating consecutive generations of the target pest with insecticides in the same MoA group, by using a MoA "window" rotation approach.
- A treatment window is defined as a period of approximately 30 consecutive days, generally based on the duration of a single generation of *T. absoluta*.
- Multiple applications of the same MoA or different MoA's may be possible within a particular window only if their residual activity does not extend beyond the approximate 30-day period.
- After a first MoA window of 30 days is completed and if additional insecticide applications are needed based on established thresholds, different and effective MoA's should be selected for use in the next 30 days (second MoA window). In window 3, the best resistance management practice would be to rotate to a MoA which is different from those used in windows 1 and 2 if an effective insecticide MoA is available
- This scheme is designed to delay resistance and is likely to be most effective when three or more insecticide MoA groups are rotated. If fewer (2-3) effective MoAs are available, rotating MoAs using the proposed window approach is still the best practice.

Example: Insecticide Mode of Action (MoA) "Window" Approach – 150-day crop cycle



MoA 1	MoA 2+4 MoA 5	MoA 3 MoA 3	MoA 4 MoA 2	MoA 3+5

Sequence of Mode of Action (MoA) Windows throughout the season

- Within a "window" more than one application of the same MoA or different MoA's can be applied but these MoA's are not re-applied for approximately 30 days. The greenhouse Tuta control example above shows a combination of solo and mixed MoA products applied within a window and their appropriate rotation between windows.
- Following the "window" rotation scheme, use as many effective MoA groups as locally registered/available and always follow product labels for specific directions of use.

Designed & produced by the IRAC Lepidoptera Working Group. Also refer to IRAC Spain brochure "Prevención de resistencias en *Tuta absoluta* (April 2009) www.irac-online.org/irac_spain

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