The Tomato Leafminer, *Tuta absoluta*

Recommendations for Sustainable and Effective Resistance Management

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. 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 recently spread to Europe, North Africa and the Middle East. Given its aggressive nature and crop destruction potential, it has quickly become a key pest of concern in these new geographies.

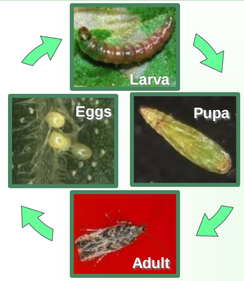
Risk for Insecticide Resistance Development: Pests like *Tuta absoluta*, with high reproduction capacity and short generation cycle, are at higher risk of developing resistance to insecticides. This risk increases significantly when management of the pest relies exclusively on chemical control with a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

Local Evaluation of Insecticidal Efficacy: T. *absoluta* populations in Europe, Middle East and N. Africa were most likely imported from L. America and thus, may already express 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 *Tuta absoluta* 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 and throughout the whole plant. 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. 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 micro 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.

After copulation, females lay individual small (0.35 mm long) cylindrical creamy yellow eggs. Recently 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 an effective and sustainable management of *Tuta absoluta* is the integration of preventive sanitary measures with effective non-chemical and chemical tools.

Key Management Tactics

- Use pest-free transplants
- Prior to transplanting, install yellow sticky traps
- Monitor pest using delta pheromone indicator traps
- Between planting cycles, cultivate the soil and cover with plastic mulch or perform solarisation
- Allow a minimum of 6 weeks from crop destruction to next crop planting
- Seal greenhouse structure with high quality nets (screen size ≤ 9x6 cm^2)
- Inspect the crop regularly to detect the first signs of damage
- For massive trapping, use water + oil traps (20-40 traps/ ha)
- Constantly, remove and destroy attacked plant parts and all plant refuse
- Control weeds to prevent multiplication in alternative host
- Establish populations of effective biological control agents (*e.g. Nesidiocoris tenuis*)
- Use locally established thresholds to trigger insecticide applications
- Select insecticides based on known local effectiveness and selectivity
- Rotate insecticides by mode of action group (MoA), using a window 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, N. Africa, and Middle East: In L. America, high level and widespread resistance is known to exist in field populations of *T. absoluta* mainly to organophosphates (MoA group 1B), synthetic pyrethroids (MoA group 3), and benzoylureas (MoA group 15). However, resistance has also developed to newer classes of insecticides. Because it is likely that resistant populations from L. America may have spread to Europe, N. Africa and the Middle East, 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. Please, refer to IRAC method No. 022 on the IRAC Website (http://www.irac-online.org/teams/methods).

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 and based on established thresholds, and rotation of effective insecticides with different modes of action.

Mode of Action (MoA) Window Approach:

- The basic rule for adequate rotation of insecticides by MoA is to avoid treating consecutive generations of the target pest with insecticides in the same MoA group, by using a scheme of " MoA treatment windows".
- A treatment window is here defined as a period of 30 consecutive days, based on the minimum duration of single generation of *T. absoluta*.
- Multiple applications of the same MoA may be possible within a particular window (follow label for maximum number of applications within a window and per crop cycle).
- After a first MoA window of 30 days is completed and if additional insecticide applications are needed based on established thresholds, a different and effective MoA should be selected for use in the next 30 days (second MoA window). Similarly, a third MoA window should use yet another MoA for the subsequent 30 days etc.
- The proposed scheme seeks to minimize the selection of resistance to any given MoA group by ensuring that the same insecticide MoA group will not be re-applied for at least 60 days after a window closes, a wise measure given the potential of a longer life cycle based on temperature fluctuations throughout the growing season.
- This scheme requires a minimum of three effective insecticide MoA groups but ideally more MoA groups should be included, if locally registered and effective against *T. absoluta*.

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

0-30 days	30-60 days	60-90 days	90-120 days	120-150 days
Insecticide MOA x	Do not apply MoA x		Insecticide MOA x	Do not apply MoA x
Do not apply MoA y	Insecticide MOA y	Do not apply MoA y		Insecticide MOA y
Do not apply MoA z		Insecticide MOA z	Do not apply MoA z	

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

Note: For a comprehensive list of existing insecticides classified by MoA group visit the IRAC website (http://www.irac-online.org/teams/mode-of-action). In 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) **http://www.irac-online.org/irac_spain**

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