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The tomato leaf miner, *Tuta absoluta*

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The tomato leaf miner, *Tuta absoluta*, is an insect indigenous to Peru and is widespread in other South American countries. It migrated from South America to Europe, from where it spread throughout Africa. It was first detected in South Africa in the eastern parts of Mpumalanga in August 2016. It is a notifiable pest, meaning the Department of Agriculture, Forestry and Fisheries (DAFF) must be informed of its presence.

Description

Eggs

The eggs are small (0.36 x 0.22 mm) and cylindrical in shape. Egg colour varies from oyster-white to yellow and they are deposited mainly on the leaves, either as a single egg or in groups of 2-5 (Figure 1). A female moth can lay up to 260 eggs during her lifespan. Eggs usually hatch 4-5 days after being laid.

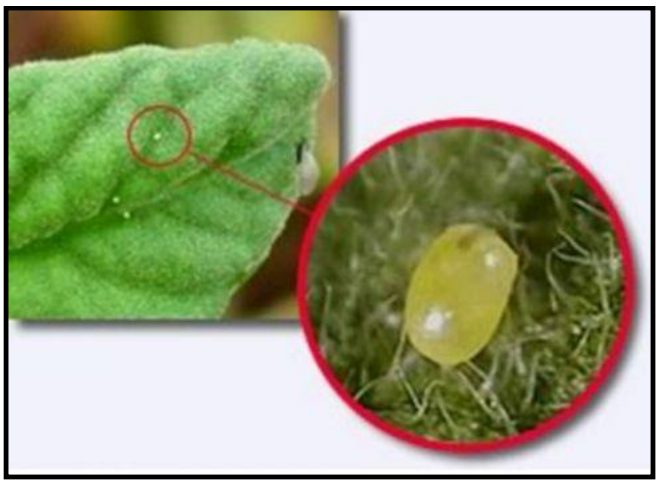

FIGURE 1: The oyster-white, small cylindrical egg of the tomato leaf miner (www.inspection.gc.ca/DAM/DAM-plants-vegetaux/STAGING/images-images/pestrava_tutabs_factsheet_image5_1328554753674_eng.jpg, accessed May 2018)

Larvae

There are usually four development stages (instars). During the first instar, the larvae are white with a distinct dark head but turn to a green and white-pink colour from the second instar onwards. Larvae are 0.9 mm during the first instar, increasing in length to 7.5 mm by the fourth instar. The younger larvae attack the leaves by tunnelling between the epidermis layers. Later instar larvae tend to attack the stems and fruit. When they are mature, they exit the leaves or fruit and search for a place to pupate. By this stage, they are usually fat and pinkish in colour.

Pupae

Pupation can occur in the soil or on the inside or outside surface of the leaf. When pupation occurs on the outside of the leaf or in the soil, a silk cocoon is formed. However, a cocoon will not be formed inside the mined leaf or fruit. They are a green colour in the beginning, turning to dark brown when the adult is bound to emerge (Figure 2). Pupation is usually 10 days but can be slower under cooler conditions.

FIGURE 2: The pupa of the tomato leaf miner (www.agripest.net/gallery/tuta-absoluta/686, accessed May 2018)

Moths

The adult moths are about 10 mm long, with silverish-grey scales (Figure 3). They have long, filiform banded antennae. The female lives for approximately 10-15 days and the male 6-7 days. They are most active during the night and can fly over long distances. The female moth lays about 92% of the eggs during the first two days after she emerges.

FIGURE 3: The adult tomato leaf miner moth (www.idenepal.org/what/tuta.html, accessed May 2018)

The tomato leaf miner can complete its life cycle in about three weeks in summer but it usually takes longer in cooler conditions. The insects can overwinter as eggs or pupae, depending on the environmental conditions and availability of food. In a single year, 10-12 generations can be produced.

Host plants

The tomato leaf miner hosts include species from the Solanacea family. The main host is the tomato but potatoes, eggplant and gooseberries are also potential hosts. Solanaceae weeds such as *Solanum eleagnifolium* (Silverleaf bitter apple), *S. nigrum* (black nightshade), *Datura ferox* (large thorn-apple), and *D. stramoniumi* (common thorn-apple) can also act as hosts.

Damage symptoms

The insect usually reduces the quality and yield of the crop. The primary site of damage is the leaves. The larvae feed on the mesophyll of the leaf, creating tunnels which appear as clear patches that are often filled with frass (excrement) (Figure 4). These patches turn necrotic when the larvae exits to pupate. With high populations, entire leaves and stems can be mined and die off. Young plants can be destroyed. Older plants can be more tolerant although yield losses of 80-100% can occur.

FIGURE 4: The tomato leaf miner mining in the leaf of a tomato creating clear patches (www.africanfarming.com/know-enemy-tuta-absoluta/, accessed May 2018)

Fruit is also attacked as the larvae grows and moves from the leaves to the fruit (Figure 5). Although the insect can enter the fruit at any point, entry at the calyx is more common. Entry points are usually visible due to the frass surrounding the area. These entry points are also sites for secondary infections, leading to fruit rot.

FIGURE 5: Damage to tomato fruits by the tomato leaf miner larvae (www.inspection.gc.ca/DAM/DAM-plants-vegetaux/STAGING/images-images/pestrava_tutabs_factsheet_image6_1328554858609_eng.jpg, accessed May 2018)

Management Strategy

Effective and sustainable control depends on the integration of cultural, chemical and biological control options.

Monitoring

The presence of the insect can be monitored to assist with management. Pheromone traps must be in place at least two weeks before the crop is planted to detect the presence of moths in the area. If traps are not available, containers with soap water can be placed outside close to a light source.

Cultural control

Inspect the crop on a regular basis for any damage. As soon as an infected plants is noticed, it needs to be removed and destroyed. This includes all affected areas of the plant. All the containers used for cultivation must be inspected and cleaned to remove possible eggs, larvae or pupae. Weeds belonging to the Solanacea family must be controlled as they can serve as alternative hosts for the multiplication of the insect. Plant only pest-free seedlings. Crop rotation with crops not affected by the tomato leaf miner must be implemented to reduce the population.

Biological control

The tomato leaf miner can be controlled biologically through disease, predators and parasitoids. In South Africa, the fungus *Beauvaria bassiana* and the bacteria *Bacillus thuringiensis* are commercially available as Eco BB and Delfin. Some of the predators and parasitiods are already in South Africa and may therefore attack the insect.

Chemical control

Due to its high reproduction potential and short life cycle, *T. absoluta* has the capacity to build up resistance very quickly to insecticides. The risk increases significantly if chemical control is the primary management option. In Latin America, resistance exists to organophosphates, (IRAC Mode of action (MoA) group 1B), pyrethroids (MoA 3) and benzoylureas (MoA 15). The Insecticide Resistance Action Committee (IRAC) proposes that a "MOA window approach" be followed regarding the rotation of insecticides with different MoA's. A treatment window consists of 30 consecutive days due to the duration of one *T. absoluta* generation cycle. If a second application is needed after a first MoA window of 30 days, an insecticide with a different MoA must be selected (Figure 7).

The same principle applies for a third MoA window. According to this approach, selection for resistance would be minimized by ensuring that insecticides with the same MoA are not sprayed within 60 days. It is advisable that insecticides with more than three different MoA be included. This will however depend on insecticides registered for the control of the insect as well as the application restrictions. The label of each insecticide should therefore be scrutinized and the instructions followed (Figure 6).

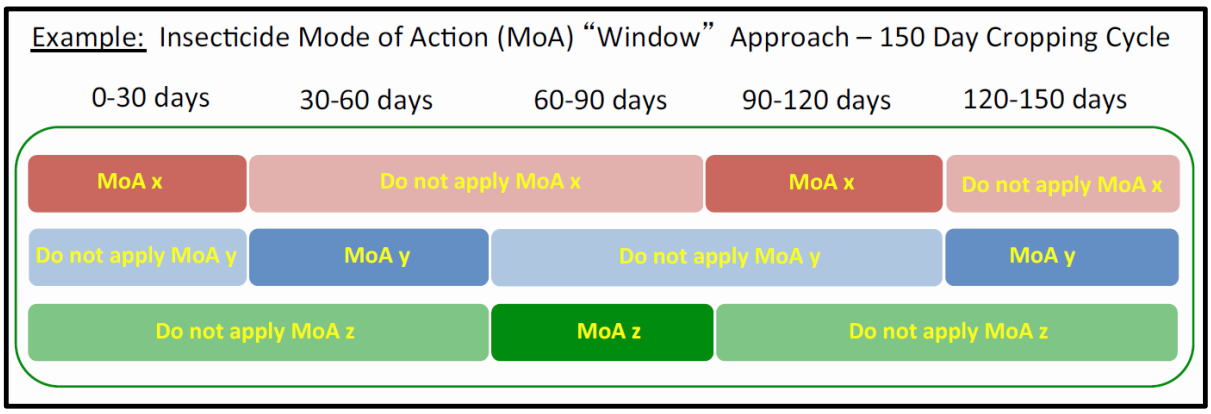

FIGURE 6: The window approach to the rotation of insecticides with different Modes of Action according to IRAC

The registered insecticides with their MoA for the control of *T. absoluta* in South Africa are shown in Table 1.

TABLE 1 Registered insecticides for the control of *Tuta absoluta*, tomato leaf miner

Active ingredient	Trade name	Registration number	Crops	Mode of Action
Chlorantraniliprole	Coragen	L8529P	Eggplant, potatoes, tomatoes	28
	Prevathon	L8622	Potatoes, tomatoes	
Chlorantraniliprole/ lambda-cyhalothrin	Ampligo	L8685	Eggplant, peppers, potatoes, tomatoes	28/3
Flubendiamide	Belt	L8860	Potatoes, tomatoes	28
Emamectin benzoate	Promec 20 WE	L9729	Tomatoes	6
	Vitrex 50 WD	L9525	Tomatoes	
	Warlock	L9872	Tomatoes	
Emamectin benzoate/ Lufenuron	Denim Fit	L9978	Eggplant, peppers, potatoes, tomatoes	6/15
Indoxacarb	Steward 150 EC	L8435	Eggplant, potatoes, tomatoes	22A
Spinetoram	Delegate 250 WG	L8392	Potatoes, tomatoes	5A
Spinosad	Entrust Naturalyte 800 WP	L7389	Cabbage, cucurbits, lettuce, potatoes, tomatoes, spinach	
	Eco Insect Control	L7232	Cabbage, cucurbits, lettuce, potatoes, tomatoes, spinach	
	Tracer 120 SC	L7234	Cabbage, cucurbits, lettuce, potatoes, tomatoes, spinach	
	Tracer 480 SC	L6557	Cabbage, cucurbits, lettuce, potatoes, tomatoes, spinach	
Bacillius thuringeinsis	Delfin WG	L9761	Eggplant, peppers, potatoes, tomatoes	11
Beauvaria bassiana	Eco BB	L8469	Tomatoes	
T. absoluta pheromone/ cypermethrin	RB Hook Tuta	On permit		
T. absoluta pheromone	RB Splat Tuta	On permit		
	RB Tuta Lure	On permit		

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