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FIELD MONITORING OF TOMATO LEAF MINER *TUTA ABSOLUTA* (MEYRICK) (LEPIDOPTERA: GELECHIIDAE) BY PHEROMONE TRAPS IN ZONA 1 OF ECUADOR

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Abstract
The tomato leafminer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae), is a economically important pest of processed and fresh tomatoes, both in greenhouses and open field crops. Currently, the pest threatens other cultivated solanaceous plants such as eggplant and potato. In this article we review pheromone control strategies for species-specific and environmentally safe management of the tomato leafminer, *Tuta absoluta* (Lepidoptera: *Gelechiidae*). This insect pest originates from South America and is now considered to be one of the most damaging invasive pests of tomatoes in the Mediterranean Basin countries of Europe and North Africa. In this article we describe strategies used to control *T. absoluta* including pest detection and population monitoring. Monitoring of *Tuta absoluta* was carried out in Imbabura Province in Ecuador. The parameters of using the pheromone traps Delta VI are described.

INTRODUCTION

The tomato leafminer, *Tuta absoluta* (Meyrick) (Lepidoptera: *Gelechiidae*), is an economically important pest of processed and fresh tomatoes, both in greenhouses and open field crops (Desneux *et al.,* 2010). Currently, the pest threatens other cultivated solanaceous plants such as eggplant and potato (Desneux *et al.,* 2010; Unlu L., 2012; Caparros Megido *et al.,* 2013). There are many other reasons for using pheromones; one is that they are elegant (Arn 1990). Three main elements account for the fascination of insect sex pheromones and their feasibility for insect management: 1) they are species-specific, 2) they are active in very small amounts, and 3) the vast majority are not known to be toxic to animals. Pheromones are by definition species-specific, since the discrimination of conspecific and heterospecific pheromone signals is a key element in the evolution of specific mate recognition systems in many insects. Even synthetic, incomplete pheromone blends usually affect only the target, with the possible exception of taxonomically closely related species (Cardé and Haynes 2004).

Sex pheromones have been widely used to monitor, forecast or control populations of moth pests (Prasad *et al.,* 2012). The most widespread and successful applications of sex pheromones concern their use in detection and population monitoring (Witzgall *et al.,* 2010). They are also used to control insect populations, which is achieved by two main techniques: mass annihilation and mating disruption (Witzgall *et al.,* 2010). Sex pheromone management strategies are based on the sexual reproduction of the targeted pest.

MATERIAL AND METODS

The trials were carried out in Zona 1 of Ecuador, in greenhouses at Imbabura province, during February and March of the years 2015 and 2016.

PEST DETECTION AND POPULATION MONITORING

Captures in traps baited with synthetic pheromone lures accurately show whether a specific insect species is present, and when its seasonal flight period starts (Witzgall *et al.,* 2010). Detection of presence or absence is all that is required for early warning of

emergence, for warning of arrival or departure of a pest within a crop, and for survey and quarantine work (Howse, 1998). After pest detection, synthetic sex pheromones are principally used to monitor population levels and trigger applications of chemicals or other control methods (Salas, 2004). The basic components of a monitoring system are the attractant source, the trap design and where to place them (Howse, 1998).

ATRACTANT SOURCE

Currently, different loadings of pheromone are suggested for monitoring *T. absoluta* populations: 0.5 mg in greenhouses for 4–6 weeks of longevity, 0.8 mg in open fields for 4–6 weeks of longevity and 3.0 mg in open fields in hot desert climates for a long lasting lure (Hassan *et al.,* 2010). In our trials, we used the lures PHEROCON® controlled release septa supplied by Trécé Inc., Adair, OK USA.

TRAP POSITION

Three important elements are related to trap placement, they are: trap height, position with respect to vegetation and trap density (Howse, 1998).

Trap height and position with respect to vegetation

The height of the trap in the crop influences male capture and is related to the height of the vegetation (Uchôa-Fernandes *et al.,* 1994; Ferrara *et al.,* 2001). The trap height must be adapted according to the growth stage of the plant, knowing that a higher proportion of moths are found in the upper parts of the canopy but never beyond 1 m high (Coelho *et al.,* 1987; Uchôa-Fernandes *et al.,* 1994; Laore, 2010). Traps placed up to 60 cm high captured significantly more males than traps at higher heights, irrespective of the stage of plant growth (before planting, 20 cm high plants, or blooming plants). Therefore, it was suggested to deploy monitoring traps in a field at a height of 20 cm before planting and then move them up to 60 cm high as the plants grow (Ferrara *et al.,* 2001). In our trials we placed the traps 50-60 cm high upper the plant. When the plant grows up, we moved the traps to a higher position.

Trap density

For monitoring *T. absoluta* populations in greenhouses, different trap densities have been proposed and the different sources are not always in agreement. It is usually suggested to use 1 trap.ha^{-1} in greenhouses smaller than 2,500 m^2 and 2–4 traps.ha^{-1} in greenhouses wider than 2,500 m^2 (Bolckmans, 2009; Fredon, 2009; Laore, 2010). Russell IPM advised that a total of 4–5 traps.ha-1 should be deployed, with one trap near the entrance and 1–2 traps in the warmest part of the greenhouse (Al-Zaidi, 2009). Laore (2010) suggested placing traps only in a central position in the greenhouse. In our trials we used under cover: 1 PHEROCON Tuta trap per greenhouse (~1000 m^2). The lures we changed every 6 weeks, sticky bottoms when they got dirty.

LEVEL OF INFESTATION

Several ways have been proposed to evaluate the infestation level of the tomato leafminer in a tomato crop; such as counting eggs, larvae, leaf mines or adult males (with the help of pheromone traps) (Gomide *et al.,* 2001). Since the adult male population caught in pheromone traps should also reflect any increase in the larval population, it seems easier to use this method to evaluate the infestation level. Based on the fact that the number of males caught in pheromone traps is linearly and negatively correlated with tomato production in the crop, a table with indicative values of risk was created (Monserrat Delgado, 2008). Based on the numbers of adult males of *T. absoluta* caught in pheromone traps, the risk of infestation is considered to be low for 1 to 3 captured moths per week, moderate for 4 to 30 captured moths per week and high for more than 30 moths per week (Stol *et al.,* 2009). However, in the Zone 1 of Ecuador, the level of infestation was not established, and it may be different. We present the dynamic flight of codling moth in 2015 and 2016 (during the months inside the frame of the programme) (Figures 1 and 2).

CONCLUSIONS

1. The pheromone lures for *Tuta absoluta* of Trécé Inc. USA, are very effective and selective.
2. It was established that the total life cycle is completed in 33-36 days at Imbabura province, depending upon temperature and other environmental factors.
3. The pheromone traps for *Tuta absoluta* should be used by the growers for detection the pest in Solanaceous crops.
4. The pheromone traps are suitable for observation the appearance and flight dynamic of *Tuta absoluta*.
5. Pheromone traps for *Tuta absoluta* may be used for the environmental friendly control for this pest in the locations with a low population density.
6. Pheromone traps may be used for reducing chemical treatments and receiving ecological and or organic production.

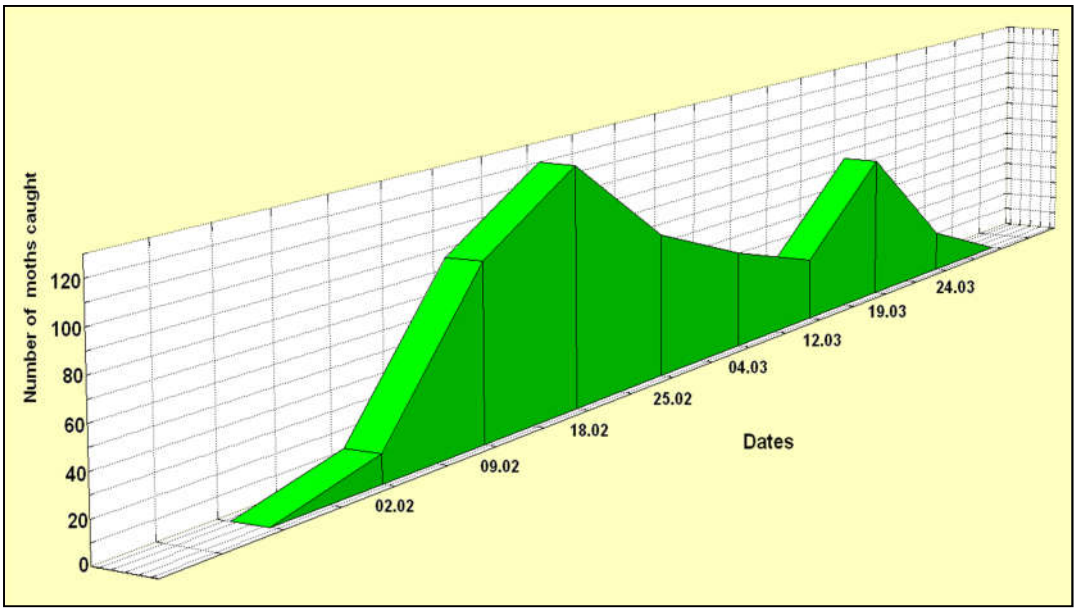

Fig.1. Flight dynamic of Tuta absoluta in Imbabura province in 2015

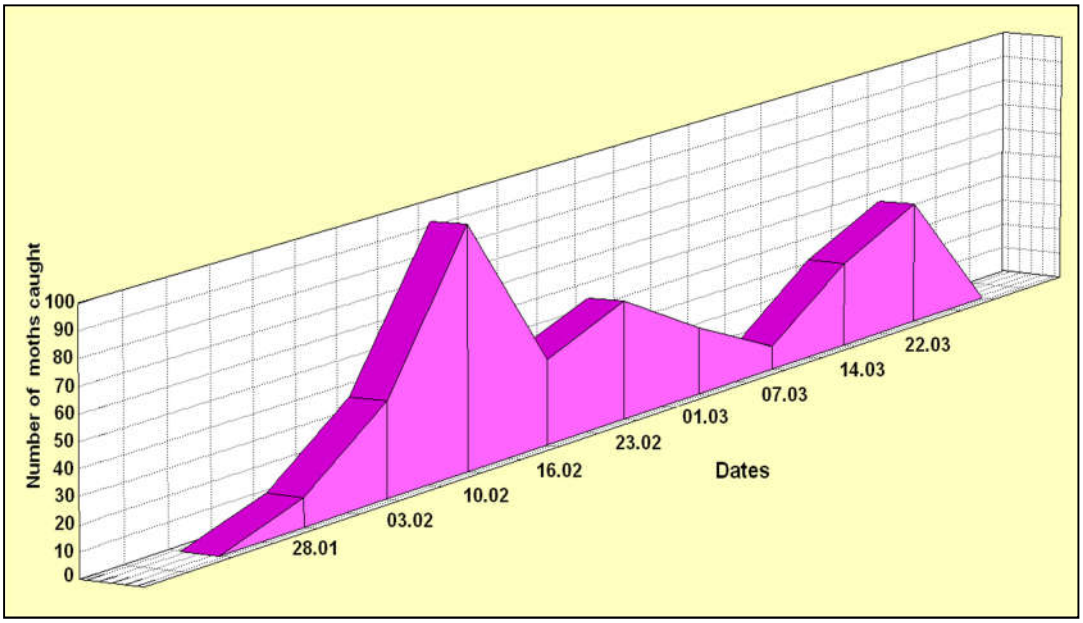

Fig.2. Flight dynamic of Tuta absoluta in Imbabura province in 2016

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