JOURNAL OF OASIS AGRICULTURE AND SUSTAINABLE DEVELOPMENT

www.joasdjournal.org

JOASD

p-ISSN: 2724 – 699X
e-ISSN: 2724-7007

Comparison of the effectiveness of the most used chemicals against *Tuta absoluta* in Tunisia

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Article info

Article history:
Received 23 September 2020
Accepted 29 November 2020

Keywords: *Tuta absoluta*, active ingredients, chemicals tested

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Conflict of Interest : The authors declare no conflict of interest

Abstract

Control failures with several chemicals have prompted research into the resistance status of *Tuta absoluta* and the effectiveness of certain active ingredients against this pest. In this context, a comparison was made of the effectiveness of the most widely used chemicals against *T. absoluta* in Tunisia. The results show that the L1 larval stage of *Tuta absoluta* is very sensitive to all of the chemicals tested. Stage L2 is sensitive to Spinosad, indoxacarb and emactin, while *Bacillus thuringiensis,* martine do not cause 50% mortality. L3 stage mortality fluctuates between 20% and 80% mortality. The L4 stage is more affected by the treatment with *Bacillus thuringiensis* which can go to 100%. Based on these results, chemical treatments should be directed according to the dominant larval stage in the plants.

1. INTRODUCTION

From the 2008-2009 agricultural season, geothermal crops and in particular tomato crops are in danger of a new leafminer; *Tuta absoluta* (Meyrick) which caused significant losses in tomato production (Desneux et al., 2010, 2011; Lebdi et al., 2011; Abbes et al., 2012). Damage is caused by larvae attacking leaves, stems and fruits and losses can reach up to 100% (Chermiti et al., 2009).

Tomato plants can be attacked at any stage of development, from young seedlings to maturity. The damage of *Tuta absoluta* occurs mainly on the leaves, the attack is characterized by the presence of clearly visible discolored areas.

The larvae only devour the parenchyma, leaving the epidermis intact. Subsequently, the attacked leaflets completely necrotize. On stem or peduncle, larval necrosis disrupts the development of the plant. On the other hand, on fruits, tomatoes show necrosis on the calyx and exit holes on the surface. Fruits are susceptible to be attacked from their formation until maturity. A larva can damage several fruits in the same bouquet (Ramel and Oudard, 2008).

Historically, T. absoluta was controlled with organophosphates and pyrethroids which were used during the 1970s and 1980s until newer products introduced in the 1990s (such as abamectin, spinosad, tebufenozide and chlorofenapyr) became available (Lietti et al., 2005). At least 12 classes of insecticides control *T. absoluta* (IRAC, 2009a, b). Control failures with organophosphates and pyrethroids in South America have prompted research into the resistance state of *Tuta absoluta* (Lietti et al, 2005; Siqueira et al, 2000a, b); however, the newer classes of insecticides provide good control of this pest (IRAC, 2009a).

The unstudied use of insecticides can lead to the development of resistance. In Bolivia and Chile, *T. absoluta* was reported to be resistant with organophosphates during the first half of the

1980s. More recently, resistance studies on strains of *T. absoluta* in Argentina revealed the reduction of the efficiency of deltamethrin and abamectin (Lietti et al, 2005). Resistance to cartap, abamectin, permethrin and methamidophos (Siqueira et al, 2000a, b), acephate and deltamethrin (Branco et al, 2001) has been reported.

In Brazil, classes of new insecticides have provided good activity against tomato leafminer (IRAC, 2009a). However, the modes of action must be maintained when implementing resistance management. In practice, alternation, or rotation of compounds with different modes of action, generally provides a sustainable and effective approach to the management of insecticide resistance (IRAC, 2009c).

2. MATERIAL AND METHODS

The aim of this experiment is to evaluate the effectiveness of some of the most widely used chemicals against *Tuta absoluta* in Tunisia. The test was carried out at the El khbayet geothermal site located 84 km from Kebili. Six tri-tunnel greenhouses on the southwest side of the site were monitored by comparing the effectiveness of certain chemicals. These greenhouses are isolated from other newly installed greenhouses and are comparable to traditional greenhouses. The variety of tomato grown in these greenhouses is Romana grown above ground on perlite.The chemicals tested are: Spinosad, Emactine, Martine, Emactine, indoxacarb and Bactospeine *Bacillus thuringiensis*, all products are spray tested (Table 1).

Table 1. Ingredients used Treatment products and active

Greenhouse	product	Active ingredient	Dose 2232 m2	application mode
TT1	Tracer	Spinosad	60 cc	spray
TT2	Proact	Emactine	75 cc	spray
TT3	Baico	Martine Emactine	75cc	spray
TT4	Avaunt	indoxacarbe	30 cc	spray
TT5	B .T	*Bacillus thuringiensis*	150g/10 0L	spray
TT6	without treatment (W.T)			

Three days after treatment, 60 samples per tri-tunnel were taken. The samples are tomato leaves showing galleries with different larval stages of *Tuta absoluta*. Each sample is placed in a plastic bag on which is written all the necessary information, in particular: the date of the sampling, the location, the greenhouse number and the nature of the treatment product.

In the laboratory, samples are stored in a cool medium to be analyzed as quickly as possible. The analysis is done under a binocular magnifying glass to identify the larval stages present and to determine their state (dead or alive). Thus we can determine the mortality rate of the larvae according to the treatment, and know the most sensitive stages for each product.

3. RESULTS AND DISCUSSION

Observation of the histogram (Figure 1) which represents the effect of chemical treatments on larval mortality shows that the L1 larval stage of *Tuta absoluta* is sensitive (100% mortality) to all chemicals tested. Stage L2 is sensitive to Spinosad, indoxacarb and emactin, while *Bacillus thuringiensis*, martine do not cause 50% mortality. L3 stage mortality fluctuates between 20% and 80% mortality. The L4 stage is more affected by the treatment with *Bacillus thuringiensis* which can go to 100%.

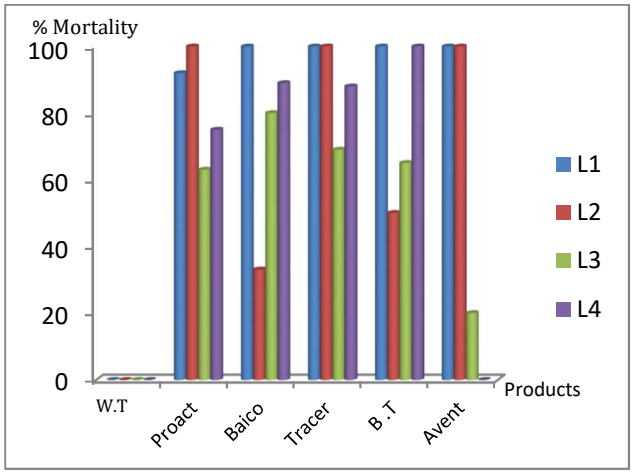

Figure 1. The effect of treatment products on *T. absoluta* larval mortality

Based on these results, chemical treatments should be directed according to the dominant larval stage in the plants. Indeed, the two larval stages, L1 and L2 of *Tuta absoluta* generally appear to be the most sensitive to the chemical tested. Thus, treatments should target these stages, to ensure their effectiveness.

Interventions based on indoxacarb alone or Bt + indoxacarb, carried out against Heliothisarmigera, and treatment with spiromesif against Aculopslycopersici did not affect the population of *N. tenuis* (Abbes et al 2012). This confirms the work of Alomar et al. (2002) and Arno et al. (2006). Indoxacarb or Bacillus-based products are classified as not very harmful against *N. tenuis*.

Indeed, several natural enemies are able to limit the populations of *T. absoluta*, but the most important and the most used are limited to predatory bugs of eggs and larvae in particular: *Nesidiocoris tenuis* and *Macrolophus caliginosus* (Torres et al., 2002) and parasitoids of eggs of the genus *Trichogramma spp*. (Villas Boas & Franca, 1996; Torres et al. 2002). Given the risks of large-scale use of chemicals that are not very specific to the environment and auxiliary fauna, researchers have focused in recent years towards a rationalization of chemical control and the development of biological protection. The latter corresponds, mainly, to microbiological control by the use of antagonistic biological agents such as predatory entomophagous beneficial insects such as *Nesidiocoris tenuis* and other predators.

4. CONCLUSION

Cultivation in heated greenhouses in southern Tunisia is a very important axis of agricultural development. Thanks to a great geothermal potential in the governorates of Kebili, Gabes and Tozeur, this sector has experienced great development since its start in 1986. Despite its importance, this sector is subject to several technical and phytosanitary constraints. Among the problems affecting tomato crops in greenhouses heated by geothermal water, the introduced insect *Tuta absoluta*. Indeed, the control failures have prompted research into the resistance state of *Tuta absoluta* and the effectiveness of several active ingredients against this pest. In this context, our study of the effect of chemical treatments on larval mortality shows that the L1 larval stage of *Tuta absoluta* is sensitive to all the chemicals tested. Stage L2 is sensitive to Spinosad, indoxacarb and emactin, while *Bacillus thuringiensis*, martine and it do not cause 50% mortality. L3 stage mortality fluctuates between 20% and 80% mortality. The L4 stage is more affected by the treatment with *Bacillus thuringiensis* which can go to 100%. Based on these results, chemical treatments should be directed according to the dominant larval stage in the plants. Indeed, the two larval stages, L1 and L2 of *Tuta absoluta* generally appear to be the most sensitive to the chemical tested.

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