CONTROLLING *TUTA ABSOLUTA* (MEYRICK, 1917) BASED ON EMAMECTIN BENZOATE USAGE

Ajten Berxolli
Department of Plant Protection
Faculty of Agriculture and Environment, Agricultural University of Tirana
ALBANIA
ajten_b2005@yahoo.com

Shpend Shahini
Department of Plant Protection
Faculty of Agriculture and Environment, Agricultural University of Tirana
ALBANIA
shpend.shahini@gmail.com

ABSTRACT

The experiment was developed in the first culture of the planted tomatoes in the greenhouse during the year 2014-2016. We have used Emamectin Benzoate (AFFIRM 095 SG) to control *Tuta absoluta* besides mass capture. The bio-insecticide Emamectin benzoate is a new macrocyclic lactone insecticide derived from the avermectin family of natural products. These products have been developed for the control of Lepidoptera pests on a variety of vegetable crops worldwide, with a particular efficacy against *Tuta absoluta*. The compound shows translaminar activity, with rapid plant uptake and it is metabolized by photo-oxidation yielding non-toxic levels. This favors its selectivity for biological control agents. The decision scheme of using insecticides for management of *Tuta absoluta* is largely based on adult captures in sexual pheromone traps as adult catches are correlated with larval damages and yield losses. The dosage of AFFIRM was 150 gram per 100 liter water. For each generation are done two treatments as per the above dosage with intervals application 14 days. *Tuta absoluta* is a very harmful insect for tomato plants in Albania climatic condition, so using Emamectin benzoate based on experimental results in our farm is a new alternative to control it. It is very important to alternate Emamectin benzoate with other chemical compound for avoiding the insects` resistance.

Keywords: Emamectin benzoate, *Tuta absoluta*, monitoring, sexual pheromone.

INTRODUCTION

The tomato plant, *Lycopersicum esculentum* belongs to the Solanaceae family. In tropical areas, tomato is produced as a perennial plant, while in Mediterranean countries it grows and cultivates as a one year plant. Tomato is a very important vegetable crop using both for fresh consume and processing. It could be affected from many serious pests; recently the most devastating ones is *Tuta absoluta*. The tomato leaf miner, *Tuta absoluta* (Meyrick, 1917), is a neo-tropical oligophagous moth from the family Gelechiidae (Lepidoptera), originated from South America. In Europe, *Tuta absoluta* has been initially detected in eastern Spain in 2006 [21], then, a few years later, it was found in most of the countries facing the Mediterranean Sea and in several countries of Europe, where it is causing serious damages to open field and greenhouse tomato [5]. Plants can be attacked at any developmental stage, with females ovipositing preferentially on leaves (73%), and to lesser extent on leaf veins and stem margins (21%), sepals (5%) or green fruits (1%), [8]. In Tomato leaves, damages are caused through mine-formation within the mesophyll by feeding larvae, thus affecting the plant's photosynthetic capacity and consequently lowering tomato yield [5].

ISSN 2056-5879

In accordance with climatic conditions of Albania *Tuta absoluta* gives four generations starting from March till July [4]. In the lack of control measure, the percentage of damage caused by this pest on tomato in greenhouses and open-field can achieve very high level [4]. In this context the integration of control measures is crucial to achieve successfully the controlling of this pest [4]. Mass capture technique used alone does not guaranty a total effectiveness but it is necessary to be accompanied with other methods [4]. Integrated Pest Management (IPM) program for controlling *Tuta absoluta* might be applied in different strategies including: mass trapping technique, light traps, insecticides as well as biological insecticide [4].

The impact of *Tuta absoluta* on tomato crops in Europe and North Africa led to the extensive use of insecticides by growers in these regions, especially in the first years after detection of the pest [6, 1]. A large number of insecticides are currently used against *Tuta absoluta* in invaded countries including spinosin, indoxacarb, abamectin, emamectin benzoate and cyromazin. Despite the long list of pesticides registered for the management of the pest, these insecticides are of low to moderate effectiveness due to the cryptic nature of the larvae and the high biotic potential of the insect. In addition, several cases of insecticide resistance have been reported including resistance to organophosphates, pyrethroids, abamectin, cartap, chlorantraniliprole, flubendiamide, permethrin and spinosad [20, 11, 15]. Progress has been made in recent decades in developing reduced risk insecticides that act on specific biochemical sites present in certain insect pest groups. This effort has resulted in the discovery of important molecules that possess novel modes of action and therefore likely to have a minimum non-target effect as well as posing fewer threats to the environment or human health [14].

The bioinsecticide Emamectin benzoate is a new macrocyclic lactone insecticide derived from the avermectin family of natural products. These products have been developed for the control of Lepidoptera pests on a variety of vegetable crops worldwide, with a particular efficacy against *Tuta absoluta* [18]. Mortality rates of 90% were observed, which was similar to the results obtained by *Lopez et al.* [18, 19]. The compound shows translaminar activity [22], with rapid plant uptake and it is metabolized by photo-oxidation yielding non-toxic levels. This favors its selectivity for biological control agents [13]. The effects of Emamectin benzoate result from ingestion and to a certain extent from contact [7]. Emamectin acts on two different points interfering with the neuromuscular process by activating the chlorine channel. The union of the Emamectin to these two objective points is irreversible, allowing the negative charges to accumulate in the muscles, causing a permanent relaxation. This mode of action is unique for the control of Lepidoptera caterpillars. After ingesting a toxic dose the larvae are completely paralyzed, are unable to feed and damage the plant. Soon after, they die. The unique AFFIRM action mode guarantees its effectiveness and makes it an ideal product for anti-resistance strategies. AFFIRM is robust against resistance. After 25 years of use of the avermectins in the world, practically no case of resistance is known [10].

The aim of the experiment is using Emamectin benzoate as a useful alternative for controlling the tomato leaf miner *Tuta absoluta*.

METHODOLOGY

The experiment was performed in low costal area during 2014-2016 years. It takes place in a greenhouse with surface of 2 hectare covered with glasses which is located in Rreth village (ex-greenhouses, NB Sukth). The experiment was developed in the first culture of the planted tomatoes in the greenhouse. Captures in traps baited with synthetic pheromone lures accurately show whether a specific insect species is present, and when its seasonal flight period starts [23]. 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 [12]. After pest detection, synthetic sex pheromones are principally used to monitor population levels and trigger applications of chemicals or other control methods [17]. The basic components of a monitoring system are the attractant source, the trap design and where to place them [12].

In order to monitor the tomato moth *Tuta absoluta* in experimental area, 4 pheromone traps were installed. The experimental scheme was divided into 4 variants with an area of 0.5 hectare. The flies counting and their monitoring into pheromone were performed on regular weekly basis intervals. There are used pheromone lures couplet with Delta traps (0.5 mg E3Z8Z11-14Ac, 0.024 mg E3Z8-14Ac) Product Code PH-937-IRR) [16]. The traps were placed inside the greenhouse, in the center of it with high less than one meter. The intervention for controlling of *Tuta absoluta* is based on fly dynamic [4].

In each plot 10 plants are treated with Emamectin benzoate (AFFIRM 095 SG). The dosage of AFFIRM was 150 gram per 100 liter water. For each generation are done two treatments as per the above dosage with intervals application 14 days. The decision scheme of using insecticides for management of *Tuta absoluta* is largely based on adult captures in sexual pheromone traps [3] as adult catches are correlated with larval damages and yield losses [3, 9]. Time of intervention with Emamectin benzoate (AFFIRM 095 SG) in our experimental is based on economical threshold: 100 males per pheromone trap per day, 2 females per plant, 26 larvae per plant [2], 8% defoliation *(BayerCropScience, Colombia)*.

RESULTS AND DISCUSSION

The tomato plants give high potential yield in our farm conditions, both in open field and in protected area (glasshouses) too [4]. In the experimental field, in tomato plants there are the primary pest and secondary one. The presence of primer pest per each year is upper economical threshold [4]. Controlling those pests needs a lot of plant protection products. In this context, the usage of chemical compounds by the farmers does not guaranty a high level of control [4]. The monitoring technique is a basic element to determine the correct timing for insecticide applications leading to a reduction and to implement mass capture [4]. The plant protection product AFFIRM 095 SG is used in the experiment to know the technical effectiveness besides of mass capture technique. The dosage used was 150 gram per 100 liter water. 100 fruits and leaves are analyzed 7 days after second treatment with Emamectin benzoate (AFFIRM 095 SG) to assess the technical effectively of insecticide used. The calculations are performed based on the following formula (1).

$$\text{Attacked fruits and leaves} = \frac{\text{Total fruits and leaves analyze} - \text{Attacked fruits and leaves}}{\text{Total fruits and leaves}} \times 100 \qquad (1)$$

Emamectin benzoate	Data of analyze	Leaves				Fruits			
		Analyzed	*Attacked*	*Not attacked*	*% of uninfected*	*Analyzed*	*Attacted*	*Not attackted*	*% of unifected*
Generation I	20 - Mar	100	13	87	87%	-	-	-	-
Generation II	25 - May	100	11	89	89%	100	10	90	90%
Generation III	15 - Jun	100	9	91	91%	100	8	92	92%
Generation IV	21 - Jul	100	12	88	88%	100	13	86	86%

Table 1. Data of treatment with Emamectin benzoate (AFFIRM 095 SG) 7 days after second treatments during the year 2014

Emamectin benzoate	Data of analyze	Leaves				Fruits			
		Analyzed	*Attacked*	*Not attacked*	*% of uninfected*	*Analyzed*	*Attacted*	*Not attackted*	*% of unifected*
Generation I	20 - Mar	100	14	86	86%	-	-	-	-
Generation II	25 - May	100	12	88	88%	100	15	85	85%
Generation III	15 - Jun	100	10	90	90%	100	11	89	89%
Generation IV	21 - Jul	100	13	87	87%	100	9	91	91%

Table 2. Data of treatment with Emamectin benzoate (AFFIRM 095 SG) 7 days after second treatments during the year 2015

Emamectin benzoate	Data of analyze	Leaves				Fruits			
		Analyzed	*Attacked*	*Not attacked*	*% of uninfected*	*Analyzed*	*Attacted*	*Not attackted*	*% of unifected*
Generation I	20 - Mar	100	16	85	85%	-	-	-	-
Generation II	25 - May	100	13	87	87%	100	15	84	84%
Generation III	15 - Jun	100	11	89	89%	100	9	91	91%
Generation IV	21 - Jul	100	12	86	86%	100	17	83	83%

Table 3. Data of treatment with Emamectin benzoate (AFFIRM 095 SG) 7 days after second treatments during the year 2016

The technical effect of Emamectin benzoate (AFFIRM 095 SG) for the first year following the chemical treatment resulted from 87% to 91% on leaves and from 86% to 92% on fruits (Table I). During the second year the technical effects resulted from 86% to 90% on leaves and from 85% to 91% on fruits (Table 2), while in the third one technical effect resulted from 85% to 89% on leaves and from 83% to 91% on fruits (Table 3).

CONCLUSIONS

The Emamectin benzoate pesticide is a useful alternative for controlling *Tuta absoluta* because such pesticide does not show resistance and has a very high control against *Tuta absoluta*. *Tuta absoluta* is a very harmful insect for tomato plants in Albania climatic condition, so using Emamectin benzoate based on experimental results in our farm is a new alternative to control it. It is very important to alternate Emamectin benzoate with other chemical compound for avoiding the insects` resistance. Also respecting the appropriate time for spraying is very important. Based on the experiment`s results the optimal time to spray is in the early morning or in the evening to avoid high temperatures.

REFERENCES

1. Abbes K., Chermiti B. (2012) Failure of the biological control of Tuta absoluta using the predator Nesidiocoris tenuis in a protected tomato crop: analysis of factors. IOBC/WPRS Bulletin 80:231-236.

2. Bajonero J., Cordoba N., Cantor F., Rodriguez D., Cure J.R. (2008) Biologı a y ciclo reproductivo de Apanteles gelechiidivoris (Hymenoptera: Braconidae), parasitoide de Tuta absoluta (Lepidoptera: Gelechiidae). Agron. Colomb. 26:417–426.
3. Benvenga S.R., Fernandes O.A., Gravena S. 2007 Decision making for integrated pest management of the South American Tomato pinworm based on sexual pheromone traps. Hortic. Bras. 25:164–169.
4. Berxolli A., Shahini Sh. (2018) Indoxacarb as alternative for controlling *Tuta absoluta* (Meyrick) (Lepidoptera: Gelichiidae). European Journal of Physical and Agricultural Sciences 6(1):8-14.
5. Desneux, N., Wajnberg, E., Wyckhuys, K.A.G., Burgio, G., Arpaia, S., Narváez-Vasquez C.A., González-Cabrera J., Catalán Ruescas D., Tabone E., Frandon J., Pizzol, J., Poncet C., Cabello T., Urbaneja, A. (2010) Biological invasion of European tomato crops by Tuta absoluta: ecology, geographic expansion and prospects for biological control. Journal of Pest Science 83(3):197-215.
6. Desnenux N., Luna M.G., Guillemaud T., Urbaneja A. (2011) The invasive South American tomato pinworm, Tuta absoluta, continues to spread in Afro-Eurasia and beyond: the new threat to tomato world production. Journal of Pest Science, 84(4):403-408.
7. Dybas R.A., Babu J.R., (1998) 4”-deoxy-4”methylamino-4”-epiavermectin B1 hydrocloride (MK-243): a novel avermectin insecticide for crop protection. Brighton Crop Prot Conf Pests Dis 1:57-64.
8. Estay P. (2000) Polilla del Tomate Tuta absoluta (Meyrick) Polilla del Tomate Tuta absoluta (Meyrick).
[WWW document] URL http://alerce.inia.cl/docs/Informativos/Informativo 09.pdf. Accessed 2 Feb 2010.
9. Faccioli G. (1993) Relationship between males caught with low pheromone doses and larval infestation of Argyrotaenia pulchellana. Entomol Exp Appl 68:165–170.
10. AF Folleto AFFIRM (2010) Available from World Wide Web:
https://www.syngenta.es/file/5816/download?token=45IdXudY
11. Haddi K., Berger M., Bielza P., Cifuentes D., Field L.M., Gorman K., Rapisarda C., Williamson MS., Bass C. (2012) Identification of mutations associated with pyrethroid resistance in the voltage-gated sodium channel of the tomato leaf miner (Tuta absoluta). Insect Biochemistry and Molecular Biology, 42(7):506-513.
12. Howse P. (1998) Pheromones and behaviour. In: Howse P., Stevens I. & Jones O., eds. Insect pheromones and their use in pest management. London, UK: Chapman & Hall, 1-130.
13. Ishaaya I., Kontsedalov S., Horowitz A.R. (2002) Emamectin, a novel insecticide for controlling field crop pests. Pest Manag Sci 58: 1091-1095.
14. Ishaaya I., Kontsedalov S., Horowitz A.R. (2005) Biorational insecticides: Mechanism and cross-resistance. Archives of Insect Biochemistry 58:192-199.
15. Roditakis E., Vasakis E., Grispou M., Stavrakaki M., Nauen R., Gravouil M., Bassi A., (2015) First report of Tuta absoluta resistance to diamide insecticides. Journal of Pest Science, 88(1):9-16. http://link.springer.com/article/10.1007%2Fs10340-015-0643-5
16. Russell IPM Integrated Pest Management, Technical Data Sheet. Available from World Wide Web: http://www.happydays123.com/uploads/files/TutamonitoringTDS.
17. Salas J. (2004) Capture of Tuta absoluta (Lepidoptera: Gelichiidae) in traps baited with its sex pheromone. Rev. Colomb. Entomol. 30(1):75-78.
18. Schallman M.D., Valentino D., Nallin M. and Kamlan L. (1986) Avermectin ß 0-Methyltransferase activity in ‘Streptomyces avermitilis’ mutants that produce

ISSN 2056-5879

increased amounts of the avermectnis. Antimicrobial Agents and Chemtherapy, April, pp. 620-624.

19. Schallman, M.D., Valentino D., Streicher S. and Ruby C. (1987) 'Streptomyces avermitilis' mutants defective in methylation of avermectins. Antimicrobial Agents and Chemtherapy, Mai, pp: 744-747.
20. Siqueira H.Â.A., Guedes R.N.C., Picanço M.C. (2000) Insecticide resistance in populations of Tuta absoluta (Lepidoptera: Gelechiidae). Agricultural and Forest Entomology, 2(2):147-153.
21. Urbaneja A., Vercher R., Navarro V., Garcıá Marí F., Porcuna J.L. (2007): La polilla del tomate, Tuta absoluta. Phytoma Espaňa 194: 16-23.
22. Willis G.H., McDowell L.L. (1989) Pesticide persistence on foliage. Rev Environ Cont Tox 100:23-73.
23. Witzgall P., Kirsch P. and Cork A. (2010) Sex pheromones and their impact on pest management. J. Chem. Ecol. 36(1):80-100.