AZADIRACHTIN, A USEFUL ALTERNATIVE FOR CONTROLLING *TUTA ABSOLUTA* (MYERICK)

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ABSTRACT

Tuta absoluta is the main pest affecting tomato plants, which cause a considerable damage with high population dynamic in low coastal area for Albania. Controlling those pests needs huge plant protection products. Using chemical compounds by the farmers does not guaranty a high level of control. The azadirachtin is nowadays one of the most important natural insecticides due to a secondary compound produced by the neem tree (*Azadirachta Indica* A. Juss.; Meliaceae). Using azadirachtin as a highly selective and environmentally-friendly insecticide and integrated it in the control measures of *Tuta absoluta* was an important step of our experiment. It acts as an antifeedant, repellent, insect growth regulator and induces sterility in insects by preventing oviposition and interrupting sperm production in males. 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. The intervention with Neem Azal S/T 0.3% for controlling of *Tuta absoluta* is based on fly dynamic and is useful for light dynamic population. Azadirachtin is used when there are 30 adults in pheromone traps. The treatments are after 14 days is done the assessment of its effectiveness in fruits and leaves. The objective of the experiment was to determinate the proper time of intervention, with Neem Azal based on dynamic population monitored by sexual pheromones.

Keywords: *Tuta absoluta*, azadirachtin, pheromones, effectiveness, antifeedancy.

INTRODUCTION

The tomato plants give high potential yield in our farm conditions, both in open field and in protected area (glasshouses) too. In climatic conditions of Albania, tomato crop is attacked by a various number of insects, which are divided in primary and secondary ones [1]. *Tuta absoluta* is the main pest causes a considerable damage as well as, with high population dynamic in low coastal area of Albania [2]. 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 [2]. 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. Meantime, in our experiment was used azadirachtin besides mass capture technique because, mass capture technique used alone does not guaranty a total effectiveness but it is necessary to be accompanied with other methods [2]. Using azadirachtin as a highly selective and environmentally-friendly insecticide and integrated it in the control measures of *Tuta absoluta* was an important step of our experiment. In accordance with climatic conditions of Albania, *Tuta absoluta* gives four generations starting from March till July [2]. To find the proper time of intervention in experimental field during the year 2014-2016 are used 4 sexual pheromones for monitoring of *Tuta absoluta*. The azadirachtin is nowadays one of the most

important natural insecticide due to a secondary compound produced by the neem tree (*Azadirachta indica* A. Juss.; Meliaceae), which permit a great success in pests control in tropical and temperate zones [4, 15]. The use of azadirachtin in IPM programs is related mainly to a higher contamination by ingestion rather than by contact [6], which presumably makes it less toxic to natural enemies [4, 7]. Azadirachtin, a complex tetranortri-terpenoid limonoid from the neem seeds, is the main component responsible for both antifeedant and toxic effects in insects. Other limonoid and sulphur-containing compound with repellent, antiseptic, contraceptive, antipyretic and antiparasitic properties are found elsewhere in the tree, e.g. leaves, flowers, bark, roots [3]. Its antifeedant mode of action is affected through contact chemoreception (primary antifeedancy) and internal feedback mechanisms (secondary antifeedancy) [10, 14]. Azadirachtin interferes with the growth and molting process of insects. Its ingestion leads to abnormal molts, growth reduction and increased mortalities. Azadirachtin interferes with the synthesis of an "ecdysteroid" hormone, which is responsible for the molting in insects. Indirectly, azadirachtin affects the neurosecretory system in insects by blocking the release of morphogenetic peptide hormones such as prothoracicotropic hormones that control the prothoracic glands and allatostatins, which in turn control the corpora allata (responsible for secreting juvenile hormones) [3]. Molting hormones from prothoracic glands are responsible for controlling the formation of new cuticle, and play a central role in ecdysis. The formation of juvenile stages during each molt is controlled by the juvenile hormone from the corpora allata [13]. Disruption in these events by azadirachtin, leads to various sterility and molting defects. Moreover, cellular uptake of azadirachtin inhibits both cell division as well as protein synthesis thus, causing midgut cell necrosis and flaccid paralysis of muscles [3, 13]. Neem products influence fecundity in female insects in a dose-dependent manner. Azadirachtin prevents oviposition by inhibiting oogenesis and synthesis of ovarian ecdysteroid. In males, azadirachtin acts by interrupting the meiotic process responsible for sperm production [3, 13]. The objective of the study was to determinate the proper time of intervention with Azadirachtin (Neem Azal S/T 0.3%) based on dynamic population monitored by sexual pheromones.

METHODOLOGY

The experiment of 2014-2016 was carried out in low coastal area, at the Sukth`s greenhouses, with surface of 2 hectare covered with glasses. The experiment was developed in the first culture of the planted tomatoes in the greenhouse. 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) [17]. The intervention for controlling of *Tuta absoluta* is based on fly dynamic. Azadiractin is effective on larvae (all insects) and pupae. After ingestion, insects stop feeding; however, death may not occur for several days. Azadirachtin has been recommended for use as a preventive spray and for light infestations (<30 adult catches per week) of *Tuta absoluta* in Spain [6, 16]. Azadirachtin is structurally similar to the insect hormones known as "ecdysones" which are responsible for metamorphosis in insects. The feeding behavior in insects is dependent on the neural inputs received from the chemical sensors of the insects, for example the taste receptors in the mouthparts, tarsi and oral cavity. These sensors integrate a "sensory code" that is delivered to the central nervous system. Manifestation of antifeedancy by azadirachtin occurs through the stimulation of deterrent cells in these chemoreceptors and by blocking the feeding stimulation in insects by firing the "sugar" receptor cells [3, 11]. Neem Azal S/T 0.3% is used when there are 30 adults in

pheromone traps. The treatments are done for first and second generation as well as third and fourth one using the same dosage 0.3%. In each plot 10 plants are treated with Neem Azal S/T 0.3%. The dosage was 300 gram per 100 liter water. For each generation is done one treatment, and after 14 days is done the assessment of effectiveness. Fruits and leaves are analyzed 14 days after the treatments.

RESULTS AND DISCUSSION

Neem Azal S/T 0.3% treatment is based on monitoring of dynamic population of *Tuta absoluta*. The intervention time with Neem Azal S/T 0.3% is useful for light dynamic population. During the first days of intervention the effectiveness of Neem Azal S/T 0.3% is lower because the antifeedancy is not expressed. It is reflected after some days of treatment. The assessment of infected fruits and leaves are calculated based on the following formula (1) [2].

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

The experiment`s results after the treatment of leaves and fruits with Neem Azal S/T 0.3% are as following: During the 1st year (2014) the effectiveness of the treatments for the 1st and 2nd larvae instar of *Tuta absoluta* vary from 71% to 80% on the leaves. While for the fruits vary from 76% to 82% (Table 1). The effectiveness of the treatments for the 3rd and 4th larvae instar of *Tuta absoluta* vary from 61% to 70% on the leaves. While for the fruits vary from 66% to 72% (Table 2). During the 2nd year (2015) the effectiveness of the treatments for the 1st and 2nd larvae instar of *Tuta absoluta* vary from 65% to 74% on the leaves. While for the fruits vary from 77% to 83% (Table 3). The effectiveness of the treatments for the 3rd and 4th larvae instar of *Tuta absoluta* vary from 55% to 64% on the leaves. While for the fruits vary from 71% to 73% (Table 4). During the 3rd year (2016) the effectiveness of the treatments for the 1st and 2nd larvae instar of *Tuta absoluta* vary from 67% to 73% on the leaves. While for the fruits vary from 54% to 74% (Table 6).

Azadirachtin (Neem Azal T/S 0.3%)	Date of analyze	Leaves				Fruits			
		Analyzed	Attacked	Not attacked	% of uninfected	Analyzed	Attacked	Not attacked	% of uninfected
Generation I	20 - Mar	100	25	75	75%	-	-	-	-
Generation II	25 - May	100	21	79	79%	100	24	76	76%
Generation III	15 - Jun	100	29	71	71%	100	18	82	82%
Generation IV	21 - Jul	100	20	80	80%	100	22	78	78%

Table 1. Data of treatment with Neem Azal T/S 0.3% during the year 2014 (14 days after treatments of larvae in 1st and 2nd instar)

Azadirachtin (Neem Azal S/T 0.3%)	Date of analyze	Leaves				Fruits			
		Analyzed	Attacked	Not attacked	% of uninfected	Analyzed	Attacked	Not attacked	% of uninfected
Generation I	20 - Mar	100	35	65	65%	-	-	-	-
Generation II	25 - May	100	31	69	69%	100	34	66	66%
Generation III	15 - Jun	100	39	61	61%	100	28	72	72%
Generation IV	21 - Jul	100	30	70	70%	100	32	68	68%

Table 2. Data of treatment with Neem Azal T/S 0.3% during the year 2014 (14 days after treatments of larvae in 3rd and 4th instar)

Azadirachtin (Neem Azal S/T 0.3%)	Date of analyze	Leaves				Fruits			
		Analyzed	Attacked	Not attacked	% of uninfected	Analyzed	Attacked	Not attacked	% of uninfected
Generation I	20 - Mar	100	26	74	74%	-	-	-	-
Generation II	25 - May	100	31	69	69%	100	19	81	81%
Generation III	15 - Jun	100	34	66	66%	100	23	77	77%
Generation IV	21 - Jul	100	35	65	65%	100	17	83	83%

Table 3. Data of treatment with Neem Azal T/S 0.3% during the year 2015 (14 days after treatments of larvae in 1st and 2nd instar)

Azadirachtin (Neem Azal S/T 0.3%)	Date of analyze	Leaves				Fruits			
		Analyzed	Attacked	Not attacked	% of uninfected	Analyzed	Attacked	Not attacked	% of uninfected
Generation I	20 - Mar	100	36	64	64%	-	-	-	-
Generation II	25 - May	100	41	59	59%	100	29	71	71%
Generation III	15 - Jun	100	44	56	56%	100	33	67	67%
Generation IV	21 - Jul	100	45	55	55%	100	27	73	73%

Table 4. Data of treatment with Neem Azal T/S 0.3% during the year 2015 (14 days after treatments of larvae in 3rd and 4th instar)

Azadirachtin (Neem Azal S/T 0.3%)	Date of analyze	Leaves				Fruits			
		Analyzed	Attacked	Not attacked	% of uninfected	Analyzed	Attacked	Not attacked	% of uninfected
Generation I	20 - Mar	100	28	72	72%	-	-	-	-
Generation II	25 - May	100	30	70	70%	100	36	64	64%
Generation III	15 - Jun	100	33	67	67%	100	16	84	84%
Generation IV	21 - Jul	100	27	73	73%	100	32	68	68%

Table 5. Data of treatment with Neem Azal T/S 0.3% during the year 2016 (14 days after treatments of larvae in 1st and 2nd instar

Azadirachtin (Neem Azal S/T 0.3%)	Date of analyze	Leaves				Fruits			
		Analyzed	Attacked	Not attacked	% of uninfected	Analyzed	Attacked	Not attacked	% of uninfected
Generation I	20 - Mar	100	38	62	62%	-	-	-	-
Generation II	25 - May	100	40	60	60%	100	46	54	54%
Generation III	15 - Jun	100	43	57	57%	100	26	74	74%
Generation IV	21 - Jul	100	37	63	63%	100	42	58	58%

Table 6. Data of treatment with Neem Azal T/S 0.3% during the year 2016 (14 days after treatments of larvae in 3rd and 4th instar)

CONCLUSIONS

The usage of azadirachtin is a useful alternative in context of integration control measures for reduction of dynamic population of *Tuta absoluta* on tomato plant. Azadirachtin is much more effective to be used for controlling the larva 1st and 2nd instars. The treatment against for 3rd and 4th instars azadirachtin is less effective. During the first days of the treatment the effectiveness is low, and after that start to be increased, and achieve the maximum 14 days after treatments.

REFERENCES

1. Berxolli A., Shahini Sh. (2017) Population dynamic of tomato leaf miner *Tuta absoluta* (Myerick) (Lepidoptera: Gelichiidae). Albanian Journal Agriculture Science (Special edition), 85-89.
2. Berxolli A., Shahini Sh. (2017) Friendly using methods for controlling of *Tuta absoluta* (Meyrick) (Lepidoptera: Geliichidae). JMEST, 4(9):8171-8175.
3. Flavia A.C., Silva D.A., Martinez S. (2004) Effect of neem seed oil aqueous solutions on survival and development of the predator *Cycloneda sanguinea* (L.) (Coleoptera: Coccinellidae). Neotropical Entomology 33:1-9.
4. Mordue (Luntts) A.J., Simmonds M.S., Ley S.V., W.M.Blaney, Mordue W., Nasiruddin M. (1998) Actions of azadirachtin, a plant allelochemical, against insects," Pestic. Sci. 54:277-284.
5. Mordue (Luntz) A.J., Nisbet Alasdair J. (2000) Azadirachtin from the neem tree *Azadirachta indica*: its action against insects. An. Soc. Entomol. Bras, 29:4.
6. Mordue (Luntz) A.J., Nisbet Alasdair J., Nasiruddin M., Walker E. (1996) Differential thresholds of azadirachtin for feeding deterrence and toxicity in locusts and an aphid. Entomol. Experi. Applicata 80:69-72.
7. Nisbet A.J. (2000) Azadirachtin from the neem tree *Azadirachta indica*: its action against insects. Anais Soc. Entomol. Bras, 29:615–632. doi: 10.1590/S0301-80592000000400001
8. Deleva E.A., Harizanova V.B. (2014) "Efficacy evaluationof insecticides on onlarvae of the tomato borer *Tuta absoluta*, Meyrick (Lepidoptera: Gelichiidae) under laboratory conditions. JISP: Agriculture and Food, 2:1314-8591.
9. Edrees A.E.E. (2014) Effect of neem seeds ethanolic extracts on mortality of tomato leaf-miner *Tuta absoluta* (Lepidoptera: Gelechiidae). Thesis of Master, Sudan University of Science and Technology, 1-71.

10. Schmutterer H. (1990) Properties and potential of natural pesticides from the neem tree, *Azadirachta indica*. Annual Review of Entomology 35:271-297.
11. Schmutter H., Angew Z. (1985) Which insect pests can be controlled by application of neem seed kernel extracts under field conditions? Entomology 100:468-475.
12. Chaudhary S., Kanwar R.K., Sehgal A., Cahill D.M., Barrow C.J., Sehgal R., Kanwar J.R. (2017) Progress on Azadirachta indica based biopesticides in replacing synthetic toxic pesticides. Front Plant Sci. 8:610.
13. Martinez S., van Emden H.F. (2001) Growth disruption, abnormalities and mortality of *Spodoptera littoralis* (Boisduval) (Lepidoptera: Noctuidae) caused by Azadirachtin. Neotropical Entomology 30:113-125.
14. Plant Health Service-Murcia (2008) Control of the tomato moth *(Tuta absoluta)*. Ministry of Agriculture and Water. Servicio de Sanidad Vegetal-Murcia, "Control de la polilla de tomate *(Tuta absoluta*)," Consejeria de Agricultura y Agua.
15. De Oliveira Sh.O.D., Barbosa W.F., Malqui K.S.V., Guedes R.N.C. (2012) Mating behavior of the predator of the *Podisus nigrispinus* (Heteroptera: Pentatomidae) under exposure to neem. CHILEAN JAR, 72(4):523-527.
16. Linton Y.M., Nisbet A.J., Mourde A.J. (1997) The effects of azadirachtin on the testes of the desert locust, Schistocerca gregaria (Forskal). Journal Insect Physiol, 43:1070-1084. 10.1016/S0022-1910(97)00060-7
17. Russell IPM Integrated Pest Management, Technical Data Sheet. Available from World Wide Web: http://www.happydays123.com/uploads/files/TutamonitoringTDS.pdf.