Management of vegetable crops protection from solanaceous group against pests

(SUMMARY OF Ph.D. THESIS)

PhD student  Băețan Raul

Scientific coordinator  Prof.univ. dr. Ion Oltean
Introduction

In order to obtain productivity and a high quality of the vegetables it is important to establish an inventory of the principal pests to control them. In greenhouses are many pests that destroy different types of vegetables, but also pests that appear only in certain years or certain areas. (CÎNDEA, 1984). In the specialized literature there are many pests of solanaceous crops of which importance differs from one culture to another, being correlated with the system of culture practiced (OLTEAN, 2015; PORCA, 2004).

Description of principal pests of solanaceous crops

Tuta absoluta is a pest of phitosanitary quarantine. In 2006 this pest was accidentally introduced in Spain. (URBANEJA, 2007; ALFARO, 2009; MEGIDO, 2013). In Romania the pest was reported for the first time in 2009, in the western part of the country, Satu Mare area, from where it quickly spread through other vegetable basins. (CEAN, 2009; BĂETAN, 2013a, 2013b).

Originated from North America, the western flower thrips Frankliniella occidentalis (Pergrande) spread in Europe, Hawaii, and New Zealand. In Europe it was reported for the first time in 1983, in Netherlands.

The greenhouse whitefly Trialeurodes Vaporariorum, is one of the most important pest of greenhouses. The adults have elongate and white body covered by a waxy secretion. The antennas are filiform, formed by seven segments. The segments of the antennas are brown. The ocelli are divided in two separated parts.

Tetranychus urticae Koch originates from Eurasia, but it managed to spread worldwide. (RAWORTH, 2002; GRBIĆ, 2011).

 Macrosiphon euphorbiae, the potato aphid originates from North America but it spread to the temperate areas from Europe and Asia, where it produce great damages to solanaceous crops from field cultures and also from greenhouses.

Helicoverpa armigera is spread through the countries from Europe, America, Africa and Australia. In our country the insect is spread everywhere especially in the southern area of the country in Banat, Câmpia Română și Moldova.

Liriomyza trifolii, originates from America and it was introduced in 1977 in the main productive countries of vegetables and ornamental plants from Europe (Netherlands, Denmark, UK, France etc.) becoming one of the most important pests. In our country it was reported for the first time in 1981 at chrysanthemums, gerbera, tomato, bean and cucumber. It can be found in greenhouses where it produces great damages and also in the field cultures. (COSTACHE, 2007).

Meloidogyne incognita, is found in the majority regions of world. In the warm areas it can develop in field and in the temperate and cold areas it can be found only in greenhouses. It attacks over 1500 plant species. In our country this pest is considered
one of the most dangerous pests of vegetable cultures and ornamental plants from
greenhouses.

Orange spiny whitefly *Aleurocanthus spiniferus* Quaintance (1903), originates
from South-East Asia, quickly spreading in tropical and subtropical Asia, then in
Australia, Africa, Pacific Islands. Its presence was reported in Kenya, Tanzania
(NEWSTEAD, 1911), Indonesia (FLETCHER, 1919), Malaysia (GATER, 1924), India
(SINGH, 1931), Cambodia, Thailand (TAKAHASHI, 1942), Japan, Mariana Islands,
Mauritius (MOUTIA, 1955), Philippine (PETERSON, 1955), Micronesia, Sri Lanka
(TAKAHASHI, 1956), Bangladesh (ALAM, 1965), Pakistan (GENTRY, 1965), Hawaii,
Sumatra (WEEMS, 1974) and South Africa (VAN DEN BERG, 1990). The pest was
reported for the first time in Europe in 2008 in Italy (PORCELLI, 2008).

**Methods of integrated control of pests of solanaceous crops**

The greenhouses, the solarium and the field cultures are prone to the attack of
pests and a certain series of pathogens, this fact happening also in the culture cycles
not only in the vegetation period.

Certain factors like excessive humidity from air and soil, inadequate
temperatures, weeds, excessive azoth fertilization or water drops on the leaves can
lead to huge damages, if necessary prevent and control methods are not applied.

The methods of prevent are divided in two categories:

Preventive methods (indirect or prophylactic) which include: phytosanitary
quarantine, agro phytosanitary and the use of resistant hybrids. The main purpose of
these preventive methods is to prevent the multiplication of the pests.

Curative methods (direct or therapeutic) which include: physical methods,
mechanical methods, biotechnical methods, biological and chemical methods. The main
purpose of these curative methods is the monitoring and control of the pests, to
diminish the eventual damages. By using these methods there are not excluded or
diminished the importance of the preventive methods, but the both methods will be
integrated (OLTEAN, 2004).

The phytosanitary quarantine methods are divided in two categories: intern and
external.

Certain hybrids are resulted by genetic engineering method or amelioration and
they have increased resistance towards certain pests.

The use of pheromone is an efficient method in monitoring and combat of the
pests.

The use of bio products is an alternative for chemical control method of pests
from greenhouses and open field (OLTEAN, 2004).

The natural predators and parasitoids are used to combat phytophagous insects.
The objectives of the research

The vegetable cultures are a rich complex of pests which sometimes can destroy the crops if are not established good strategies of control. Because the vegetables are usually consummated fresh, it requires applying a concept of integrated control by using preventive methods but also curative methods. Obviously, a great importance should be attached to diminishing the residues from the insecticides.

Therefore the purpose of this thesis is to establish certain methods of monitoring pest species, but also the verification of biological efficiency of different alternative combat methods.

The study of this thesis aims the assembly of pests from greenhouses but also from field, which attack solanaceous crops, in order to maintain the population under the economical damages limit.

The main objectives of thesis include:

➢ The monitoring of species Tuta absoluta Meyrick
➢ The study of external morphology aspects of all development stages of Tuta absoluta Meyrick species
➢ The study of biological cycle of Tuta absoluta Meyrick species
➢ The study of Tuta absoluta Meyrick adults feeding
➢ Methods of combat of Tuta absoluta Meyrick species
  • Testing the efficiency of attractant pheromone
  • Testing the efficiency of food sources
  • Testing the efficiency of chemical control
➢ The monitoring and control of other species in greenhouses
  • Frankliniella occidentalis Pergande
  • Trialeurodes vaporariorum Westwood
  • Tetranychus urticae Koch
  • Macrosiphon euforbiae Thomas
  • Helicoverpa armigera Hübner
  • Liriomyza trifolii Burgess
➢ The study of spreading of Aleurocanthus spiniferus Quaintance species in South Italy.

The particularities of natural environment where the experiments took place.

The environmental or ecological factors have a complex and continuous action over the populations of the species and over all organisms from biogenesis. The ecological factors influence the number of insect populations because of their organic or inorganic nature and the consequences of their actions in time and space. Because of these factors in nature are produced imbalances which lead to acceleration or delay of development of certain organisms, to reduction or multiplication of species populations and even to the structural change or the dynamic modification of the ecosystems.
One of the most important inorganic factors which influence the geographical distribution, development and activity of insects are the climatic factors.

The studies were made in greenhouses but also in fields, in the western part of the country, in Arad and Hunedoara counties.

The infested materials for the studies made in Bari (Italy) originated from Molfetta greenhouses, a city near to Bari.

**Material and work methods**

In order to achieve the objectives suggested in the research period, we used methods enshrined in specific entomology domain, adapted to practical conditions from experimental years.

The main pest monitored in period of time 2013-2015 it was Tuta absoluta. To monitoring its area of spreading, observations have been done in several greenhouses and field crops from the western part of Romania, Arad County (Curtici and Arad) and Hunedoara county.

In order to study the external morphology aspects we used Tuta absoluta adults breed under laboratory conditions, where we studied the biological cycle of species.

The biological cycle of Tuta absoluta species has been studied under laboratory conditions on tomato plants, at a medium temperature of 23°C and RH 70%, under natural photoperiod, at University of Bari, Italy. The tomato hybrid was Ox heart, being placed repetition of each 5 plants in 3 baskets from IKEA. The initial biological material was collected from a greenhouse near to Bari.

When studying the prolificacy of Tuta absoluta species and removing leaves from isolator, we noticed scars on them; therefore we suspected that the scars are produced by the adult from the isolator. For this, every time we introduced another leaf, we checked its integrity. By repeating every time the same symptomatology of attack on leaves we proceed to record the behavior of adult.

To test the efficiency of sex pheromone the experiment was realized in greenhouses from Arad and the field near to city. The variants of pheromone tested came from “Raluca Ripan” Institute for Research in Chemistry from Cluj Napoca, a variant of pheromone for the greenhouses and a variant of pheromone for field.

Because the insecticides market there is a large variety of products we tested several of them in order to observe their efficiency. In the greenhouses from Arad and Curtici, in 2013 and 2015 we used a large variety of products for chemical control. The products tested were: Coragen 0.02%, Affirm 0.25% and Karate zeon 0.05%. The efficiency of the treatments was evaluated by comparison the frequency of the attack on the leaves and fruits from the experimental variants with the untreated plant.

In greenhouses there is a large complex of pests and in order to combat them it is recommended to apply different strategies of protection. In the period of doctoral internship we followed the efficiency of some conventional and unconventional...

In 2014 during a year of internship in Italy, we monitored Aleurocanthus spiniferus, being a new species in Europe. The monitoring was made in the south of Italy.

Results and discussions

The first report of the presence of Tuta absoluta was made in the greenhouse from Curtici, Arad county, in March 2013. The attacked plants were only in one sector of the greenhouse and the proportion of the infested plants was approximately 2%.

In 2015, since the first sowing it have been placed sex pheromone traps for Tuta absoluta pest. In the complex of greenhouses S.C. Agro Codlea from Arad, where are 6 ha of tomatoes and 0.7 ha of eggplants, we applied different methods to combat the species. The monitoring and the caption of the adults are made with pheromone traps, there are applied biological treatments in the first place, and when the population increases there are applied chemical treatments. This strategy reduced the frequency of attack under 3% in 2015.

In phytoprotection actions to establish the most efficient strategies of combat it is necessary to identify correctly the species. The determination of them is made considering the aspects of external morphology of development stages but also by the symptomatology of the attack.

Whereas this species is less known among the greengrocers and specialized personal, we described it and presented illustrative materials for different stages of development.

The adult, a microlepidoptera, has a grey body, and the wings are yellow with dark veins through them. The female has two dark spots on the ventral part of each abdominal segment, and this feature is absent to male. Among the population there are different individuals that have a darker abdomen.

The antennas are filiform, compound by 78 segments. The segments are alternatively colored, yellow and black. The eyes are big, rounds and facetted.

The mouth part is a large proboscis and the mandibles are big, being separated. Usually the proboscis measures 2.5 coiled and 1.4 mm length; uncoiled it measures 4x diameter of the eye. The proboscis is divided in three parts: proximal, medial and distal. The proximal part is measurable, the medial part is visible but the distal part is not visible. This is showed in the cuticular processes and measures 2 μm. The top of proboscis measures 30-35 μm, divided in two lobes.

The egg is oval, yellowish deposited on the inside part of the leaf. The medium length is 0.34 mm and 0.22mm height. On the surface of it there are hexagonal figures and the eggs are deposited in small groups.
Larvae are a true caterpillar and they have four instars. The first instars larvae measures 1.58mm and the head measures 0.43mm. The head has on the dorsal part numerous sets and the prothorax is the longest segment. The tegument is pleated. The second instars larvae measures 2.51 mm and the head measures 0.48mm. The elements of thorax are more visible. 

The third instars larvae measures 3.94mm and the head measures 0.62mm. The mouth parts are well developed. At this stage the most developed is the mezothorax.

The fourth instars larvae measures 6.68mm and the head measures 1.08 mm. The head is yellow-brown, with a transversal line interrupted in the median part, black colored, and the rest of segments have a yellow-greenish to soft pink.

The thoracic legs have a conic shape with bristles and a well-developed crochet. The larvae can be observed by its epidermal semi transparency.

Pupae measure 3.64mm and brown colored. The wings and the proboscis are stretched to the abdomen, leaving uncovered the last three abdominal segments. After examining the biological cycle of Tuta absoluta Meyrick under laboratory conditions at 23°C, RH 70%, under natural photoperiod (fig. 6.49.), we discovered:

- The longevity of the adults lasts 14 days
  - From which: the preoviposition lasts 3 days
  - the Oviposition lasts 9 days
  - the postoviposition lasts 2 days
- The average number of deposited eggs by a female is 139 eggs
- The incubation period lasts 4 days
- The development of larvae is echeloned in 18 days
- The pupation lasts 7 days

**The results of attractant pheromone efficiency**

The catches from the traps with tested pheromone on the experimental period counted 261 adults, and the commercial pheromone captured 249 adults, which means the tested product had a higher rate of attraction with 5%.

The catches from the traps with tested pheromone on the experimental period counted 22 adults, an equal number with the catches realized by the commercial pheromone. In open field the population of this species is very reduced.

**The results of chemical control efficiency**

Being a very dangerous pest, Tuta absoluta requires a rigorous control. From the moment when the sex pheromone traps were full of adults we applied chemical treatments.

The most efficient product against the pest was Coragen, which reduces the frequency of attack by 94.4%, in the greenhouses from Arad, and at Curtici the efficiency was 100%. The second product was Affirm reduced the frequency of attack
by 83.3% at Arad, respectively 85.7% at Curtici. The most reduced rate of efficiency had the insecticide Karate Zeon, 72%.

**Conclusions**

When recording the adults from isolators with infrared they feed on tomato leaves.

When feeding on leaves appear some scars in line or circular, measuring 0.5mm length and 0.4-2mm height, and sometimes they even perforate the leaf.

In greenhouses the varieties of pests that attack the solanaceous crops are: *Frankliniella occidentalis; Trialeurodes vaporariorum; Tuta absoluta; Macrosiphon euphorbiae; Helicoverpa armigera; Tetranychus urticae.*

In greenhouses there can be produced ecological vegetables by applying unconventional control methods: the use of natural predators (*Amblyseius swirsky, Amblyseius californicus, Orius insidiosus și Orius laevigatus*), the use of sticky traps and sex pheromone traps.

The use of natural predators can be done when seedling with a norm of: 100 individuals/m for *Amblyseius swirsky* and *Amblyseius californicus*, respectively one individual/ m², for *Orius insidiosus* and *Orius laevigatus*.

When using mites predators is recommended supplementing their food with pollen, 200mg/ha.

To combat *Macrosiphon euphorbiae*, it can be used chemical treatments with Teppeki, product that is selective for the natural predators.

Whereas *Aleurocanthus spiniferus* Quaintance, was reported in many other European countries it is mandatory to have a rigorous control of vegetal material from imports in order to prevent its entrance in our country.

**Recommendations**

Whereas in greenhouses there is a large variety of pests is mandatory a continuous monitoring of them.

In order to obtain residues free vegetables it is recommended the use of biological, biotechnical and mechanical combat methods.

In the unconventional system of plant protection, to control Tuta absoluta species it is recommended the use of water traps or Delta traps; for *Trialeurodes vaporariorum* it is recommended yellow traps; for *Frankliniella occidentalis* it is recommended blue traps and for *Helicoverpa armigera* it is recommended pheromone traps.

It is recommended to perform improvement research of functional parameters for sex pheromones used for solanaceous crops pests.

The training of the personal in plant protection domain regarding the risk and the recognition of invasive pests.
The originality and innovative contributions of thesis

It is affirmed for the first time in specialized literature that Tuta absoluta adults feed on tomato leaves, the phenomenon being demonstrated by describing the symptomatology and recording in real time the phenomenon.

It is affirmed for the first time that Tuta absoluta can develop on turnip leaves.

It was studied the external morphology of Tuta absoluta, by describing the instars of larvae, and a real proof are the microscopic pictures.

It was tested for the first time the possibility if using food sources with sweet juices to detect and monitoring Tuta absoluta species.

In the doctoral internship there were checked for the first time in our country 2 types of attractant pheromones for Tuta absoluta, pheromones that have a higher functionality than the commercial pheromone.

In order to train specialists in identification and monitoring of invasive pests, the PhD student performed internship in Italy, a country where Aleurocanthus spiniferus Quaintance species is met and its damages are considerable.

Selective bibliography


3. BĂEȚAN R., I. OLTEAN, P. VĂRĂDIE, FLORIAN TEODORA, 2013a, Researches concerning the spreading of Tuta absoluta species into greenhouses from west of Romania, Bulletin UASMV serie Agriculture 70(1):110-112.


5. COSTACHE M., ROMAN T. și COSTACHE C., 2007, Bolile și dăunătorii culturilor de legume, Editura Agris, București


15. OLTEAN ION, RAUL BĂETAN, TEODORA FLORIAN, 2015, Specii de dăunători invazive în ecosistemele agrohorticole, *Revista "Protectia Plantelor" Cluj-Napoca, Vol. XXV, nr. 95, pag.23-48*


