OBSERVATIONS ON *CYDIA POMONELLA* (APPLE WORM) DYNAMICS IN THR APPLE ORCHARDS AND WARNING ABOUT CHEMICAL TREATMENTS

OBSERVAŢII ASUPRA DINAMICII SPECIEI *CYDIA POMONELLA* (VIERMELE MERELOR), ÎN PLANTAŢIILE POMICOLE DE MĂR ŞI AVERTIZAREA TRATAMENTELOR CHIMICE DE COMBATERE

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Abstract. *Dynamics of adult the Cydia (Laspeyresia) pomonella flight was followed in the apple orchards owned by SC Service SRL Deleşti-Vaslui. For this purpose, it was used the pheromone traps such as AtraPOM were purchased from the Chemistry Institute in Cluj-Napoca country. The traps were installed in the plantation from the first decade of May to September, with the pheromone being replaced within at 6 weeks. The readings were recorded at 3-5 day intervals, inventing the catches at each reading and captured butterflies were removed from the trap. Depending on the dynamics of the butterfly flight, it was established for each generation: the beginning of the flight; maximum flight; the end of the flight. Finally, according to these data, the time of application of the chemical treatments for each generation was determined and according to the number of catches and the timeliness of their application.*
Keywords*: apple pests, biology, control,* phytosanitary *treatments.*

Rezumat: *Dinamica zborului adulţilor speciei Cydia (Laspeyresia) pomonella a fost urmărită într-o plantaţie pomicolă de măr, aceasta aparţinând societăţii SC Service Deleşti –Vaslui. Pentru aceasta au fost utilizate capcane cu feromoni de tipul AtraPOM achiziţionate de la Institutul de Chimie din Cluj-Napoca. Capcanele au fost instalate în plantaţie din prima decadă a lunii mai până în luna septembrie, feromonul fiind înlocuit la intervalul de 6 săptămâni. Citirile au fost înregistrate la intervale de 3-5 zile inventariindu-se capturile la fiecare citire iar fluturii capturaţi erau înlăturaţi din capcană. În funcţie de dinamica zborului fluturilor s-a stabilit pentru fiecare generaţie: începutul zborului; zborul maxim; sfârşitul zborului. În final, în funcţie de aceste date s-a stabilit momentul aplicării tratamentelor chimice pentru fiecare generaţie iar în funcţie de numărul capturilor şi oportunitatea aplicării acestora.*
Cuvinte cheie: *dăunători ai mărului, biologie, control, tratamente fitosanitare.*

INTRODUCTION

The codling moth is considered to have originated in Southeast Europe, over the last two centuries they have dispersed throughout the world and have reached an almost global distribution, being considered a cosmopolitan insect that

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occurs in almost all countries where apples are grown, becoming one of the most successful species of insect pests in terms of invasiveness (Miletic, 2011).

Cydia pomonella L. (*Lepidoptera: Tortricidae*) is one of the most detrimental and economically important apple pests in Romania, and the moth has the potential to cause complete crop losses in apple orchards frequently being about 25-50% and sometimes even larger, in many parts infestation level of fruits may reach 70-80 %.

The agroecosystems, as a type of highly antropic ecosystem, are subject to a great pressure in front of phytopathogenic agents and pests, which, in the absence of the application of any control measures, can prejudice to a great extent the production in the field of cultivated plants. The large variety of the complex of pests specific to fruit-growing plantations imposes the application of a great number of control treatments during a calendar year.

The codling moth, *Cydia pomonella L*. is one of the most detrimental and economically important apple pests, and the moth has the potential to cause complete crop losses in untreated apple orchards (Cârdei, 2006).

The codling moth is a multivoltine species, and adaptive behavior, such as facultative diapause and multiple generations per breeding season, have allowed the codling moth to adapt to diverse climatic conditions (Diaconu *et al.*, 1977). Although the flight capacity of the codling moth is limited, they can spread over long distances through the transportation of infested fruit and packing material, and this has become the most common method for colonization of new habitats.

The apple is a fruit species with the highest number of control treatments in the world (Blommers, 1994). In Romania, the total number of apple control treatments are around 10 and 15 against all diseases and pests, while the number of control treatment of codling moth ranges from 6 to 8 treatments during one growing season (Cârdei *et al.,* 1997, 2007). Despite ecological concern about the harmful pesticides effects on the environment, control of phytophagous species is mostly based on the use of chemical control (Choinard *et al.,* 2016; Blommers *et al.*, 1994). Biological control incorporates various aproaches called integrated pest management which combines a variety of pest control methods (Mahr *et al*., 2008, Hwan-Seok Choi, 2011).

The strategies used should be ecologic and should not include the use of certain toxic pesticides. One control method is the use of synthetic sex pheromones that have the purpose to monitor and decrease the pest populations.

Synthetic sex pheromones have provided useful information about the biology, but also about the control of the codling moth. Their use in plant protection has proved, in a short period of time, through multiple researches made on several species of pests, their decisive role in the integrated fight system. The most important function from this point of view is represented by the appreciation offered by the use of pheromones (Charmillot and Bloesch, 1987, Card, 1977,

Neumann, 1992) in the establishment of the moments of application of *phytosanitary* treatments (Cârdei, 2000; Istrate, 2007; Drosu, 2007).

The recent researches regarding the control of the species *Cydia pomonella* L. have emphasized certain changes in the insect's biology and the particular efficiency of some new generation insecticides.

During in the period 2017, in the company SC Loturi Service SRL Deleşti there have been developed experimentations regarding the control of the codling moth within the program of integrated control of pathogens and pests from apple orchards by using plant protection products which were recently introduced in the phytosanitary treatments.

MATERIAL AND METHODS

The researches regarding the biology, control and economic impact of the pest *Cydia. pomonella* L., have been performed in apple plantation, located at the SC "Loturi Servive" SRL with a total surface of 30 ha, cultivated with apple, obtained by purchasing from the private owners also orchards, with the restitution of the land to the former owners of significant areas of state exploited farms in the communist period. Considering the necessity of performing phytosanitary treatments at the optimal moments of control of the complex of pests and phytopathogenic agents specific to the apple, in the orchards belonging to SC "Loturi Servive" SRL, among the rows of trees is arranged a vegetal carpet consisting of a mixture of legumes *Lotus corniculatus, Trifolium repens, Trifolium pretense, Medicago sativa* or a mixture of legumes and graminees (*Lolium perenne, Phleum pratense*).

The varieties of apple used in this intensive planting are: Jonathan, Golden delicious, Starkrimson, Jonagold, Idared, Golden Reinders, Pinova and Elstar.

The evolution of weather conditions was recorded with the help of AgroExpert equipment, placed within the experimental site.

The dynamic of adult flight was monitored with the help of traps with AtraPOM synthesis sex pheromones produced by "Raluca Repan" Institute of Chemistry of Cluj Napoca, and the reading of captures was recorded for 3-5 day intervals in every week during their entire flight period.

The phytosanitary treatments were applied to the warning, according to the evolution of local weather conditions, of the pest biology and of the plant phenology.

RESULTS AND DISCUSSIONS

Climate characterization

Thus, from the thermal point of view, the January-September period recorded monthly average values over the multiannual values, and October lower values, which may characterize the year 2017 as very warm

During the period 2017 there have been recorded many deviations from the normal values of the main climatic factors, although these are very frequent in this area (fig.1).

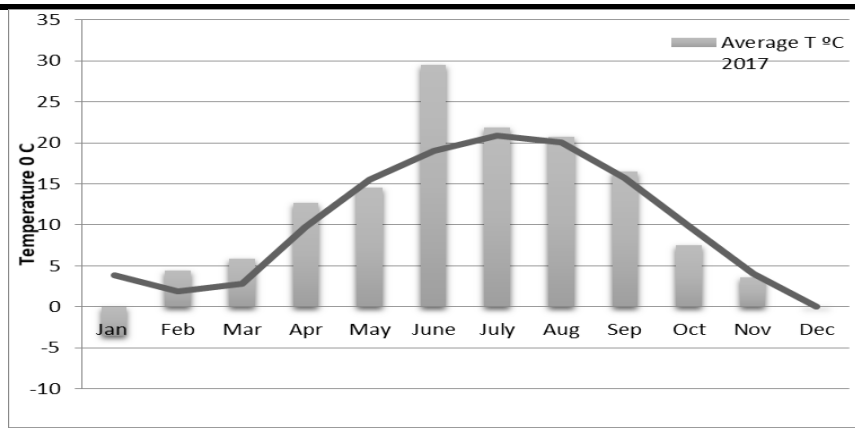

Fig. 1 Temperatures regime of 2017 in Delesti-Vaslui locality

The precipitation regime in January, February, May, June, July and September showed deficits compared to normal total 135.7, which means a droughty year, even though throughout the year the sum of rainfall is above normal (fig.2).

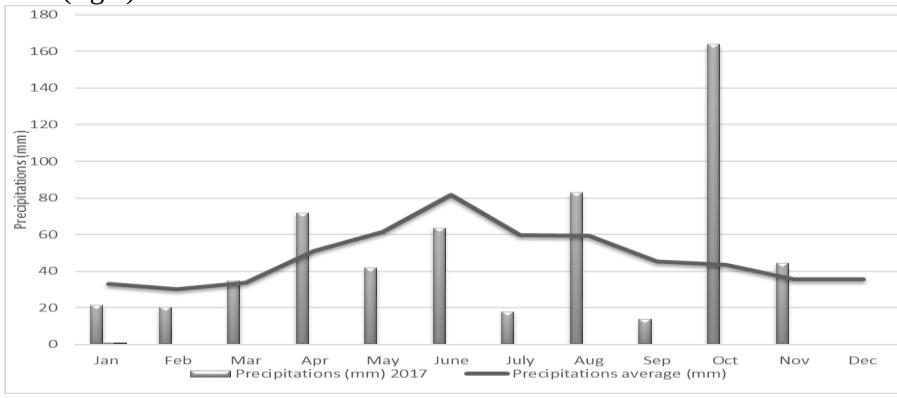

Fig. 2 Precipitation regime of 2017 in Delesti-Vaslui locality

In conclusion, 2017 can be characterized an excessively warm and dry year.

Table 1

Main climatic elements of 2017 in Delesti-Vaslui locality

Month	Average temperature (C^0)		Precipitations (l/m^2)	
	normal	**2017**	**normal**	**2017**
January	3.9	- 3.5	33.1	21.2
February	1.9	4.4	30.3	20.4
March	2.8	5.9	33.7	34.8
April	9.7	12.7	51.1	71.8
May	15.5	14.5	61.6	41.8
June	19.0	29.5	81.7	63.6
July	20.9	21.9	59.7	17.8

August	20.1	20.7	59.2	82.8
September	15.7	16.5	45.2	13.8
October	9.8	7.5	43.5	164.0
November	4.1	3.6	35.7	44.4
December	-	-	35.4	
Total	**10.20**	**9.42**	**570.2**	**576.0**

Characterization of the codling moth biology

It is known the fact that one of the main factors which influences the pest biology is temperature, so that for the development of a complete generation is necessary a sum of real temperature of 630 ^{0}C [$\sum(t_n-t_0)$], where t_n= daily average temperature, and t_0 = biological threshold, which is of 9^{0}C (Săvescu and Rafailă, 1978). From the analysis of the dynamic of adults' flight during of the vegetation period, recorded at Atra POM pheromone traps (fig.3), there resulted two flight curves, well-individualized during a vegetative season (fig.4).

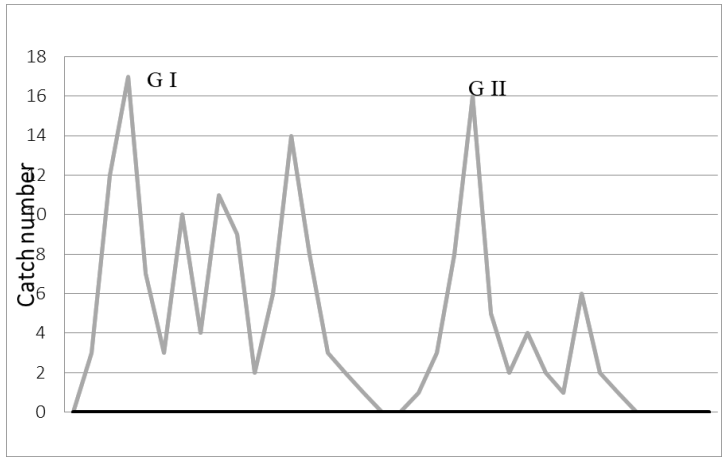

Fig. 4 Dynamic of the apparition of *Cydia pomonella* L. adults, during the 2017, in Delesti-Vaslui locality

Correlated with the sum of real temperature (tab. 3), the beginning of the flight of first generation adults takes place in the first part of May, where there

were accumulated approximately 183,4^{0}C, and at the second generation during July, after an accumulation of approximately 829^{0}C (representing 145 + 645,6^{0}C), sum of real temperature.

In the context of what we have presented, the first generation has two curves of flight and the second generation just one. The exception is represented by very warm years, as it was the case in the year 2017.

Through a complex analysis of climate data and of the flight dynamic of *Cydia pomonella L.* adults, there was confirmed the data from the literature (Diaconu, 1977, 2000) according to which, in the weather conditions of Delesti-Vaslui locality, the biological cycle has a first complete generation and a second incomplete one, with an interesting feature, regarding the alternation along two consecutive years of populations afferent to the three curves of flight during the vegetative season.

The establishment of optimum moments for the application of insecticides in order to control the codling moth is very important for obtaining productions of safe, reliable and high-quality fruits.

Therefore, according to current methods for the control of the codling moth (Săvescu, 1978), the first treatment is applied at 4-8 days from the date of laying the first eggs which takes place 3-6 days after the highest point of the curve of adult appearance at the traps with synthesis sex pheromones. The second treatment is applied at an interval of 8-12 days after the first treatment, according to the evolution of the local weather conditions and to the control period of the insecticides used.

In 2017, the appearance of butterflies was reported beginning at the beginning of May, at Σ (tn-t0) = 183.4°C. Flight and mating flight lasted about 15 days. Females begin to lay eggs in mid-May, the first eggs being deposited on branches, leaves and fruits. After a 10-11 day incubation period, the larvae begin to appear.

The first larvae were reported to Σ (tn-t0) = 285.5°C. At full development, the larvae leave the fruit through a lateral gallery and retreat to the cracks of the bark, where it builds a cocoon of silk yarns inside of which it turns into a stern. The first knuckles were reported at Σ (tn-t0) = 829°C. The first occurrences of second-generation butterflies were reported on Σ (tn-t0) = 891.7°C. The butterflies of this generation fly, feed and mating, and females deposites their eggs only on green fruits.

The incubation lasts 8-10 days, the second generation larvae being recorded starting on 05.08. The development of second-generation larvae lasts for 15 to 20 days, so at the end of August the larvae retreat for hibernation. The larvae of the second generation enter the hyemal diapause, in a fusiform cocoon, weaving at the exit of the fruit, preferring the bark at the base of the trunk or various shelters from the surface of the soil.

Taking into consideration the special evolution of the pest's biology in the ecosystem conditions of the current observations, with 2 curves of flight of the

adults which are well-defined in time it was necessary to apply 4 control treatments, two for each curve of the flight. Therefore, the first treatment was applied 4-5 days after the highest point of the adult flight at the first curve from G.1 and at 3-4 days from the highest point of the flight for the second curve from G1 and the curve afferent cu G.2.

The drought conditions during the first part of the vegetation period had a negative impact on the yields obtained, being lower than the biological potential of the apple plantation.

Regarding the dynamics of apple-specific pests reported in the company SC Loturi Service SRL Deleşti is presented as follows (tab. 2):

- San Jose scale (*Quadraspidiotus perniciosus*) attacked in 3 stages the first generation (G1) of the pest manifested the attack from 15.04 to 30.04, the second generation (G2) occurred at 10.07 and ended on 15.07, and the third generation pest attack was sampled from early August (03.08) to 16.09.
- Green apple aphid (*Aphis pomi*) is an extremely important and very common pest in apple tree plantations where it presents up to 8-12 generation per year. In 2017 he attacked between 5 May and 12 August.
- Red mite (*Panonichus ulmi*) throughout the development cycle presented 4 generations, the attack from 20 April to 28 August.
- The codling moth (*Cydia pommonella*) is perhaps the most important pest attacking apple fruit, and in the 2017 research period it attacked from May 11 to September 13.
- The apple leaf mining moth (*Phyllonorycter blancardella*) has a number of 3 generations per year, so in 2017 it attacked between May 15th and September 15th.

Table 2

The period of attack of apple-specific pests signaled at SC Loturi Service SRL Deleşti

crt. no	Pest		Attack period
	Scientific name	The popular name	
1.	Quadraspidiotus perniciosus	San Jose scale	15.04-30.04; 10.07-15.07; 03.08-16.09.
2.	Aphis pomi	Green apple aphid	5.05- 12.08
3.	Panonichus ulmi	Red mite	20.04 – 28.08
4.	Cydia pommonella	Codling moth	11.05- 01.06; 15.07-13.08.
5.	Phyllonorycter blancardella	Apple leaf mining moth	15.05 -28.06; 10.06 – 15.09

Different control methods are introduced for the control of the pest. The use of chemicals is very famous among the farmers but it may deteriorate the nutritional quality of the product. Against these pests were carried out a total of five chemical treatments, as follows:

- treatment no. 1 (T1) - against the San Jose scale, and the common red mite during 15-25.04
- treatment no. 2 (T2) - carried out during the period 15-20.05 against: apple worm (G1), green apple aphid and apple leaf mining moth.

- treatment no. 3 (T3) - performed against the common red mite, San Jose scale and the apple worm.
- treatment no. 4 (T4) - was performed against the San Jose scale, the common red mite, the green apple aphid, the apple worm, and apple leaf mining moth.
- treatment no. 5 (T5) - looked at the same pests as T4.

Graph on the dynamics of harmful stages and the moment of application of chemical treatments (fig.5)

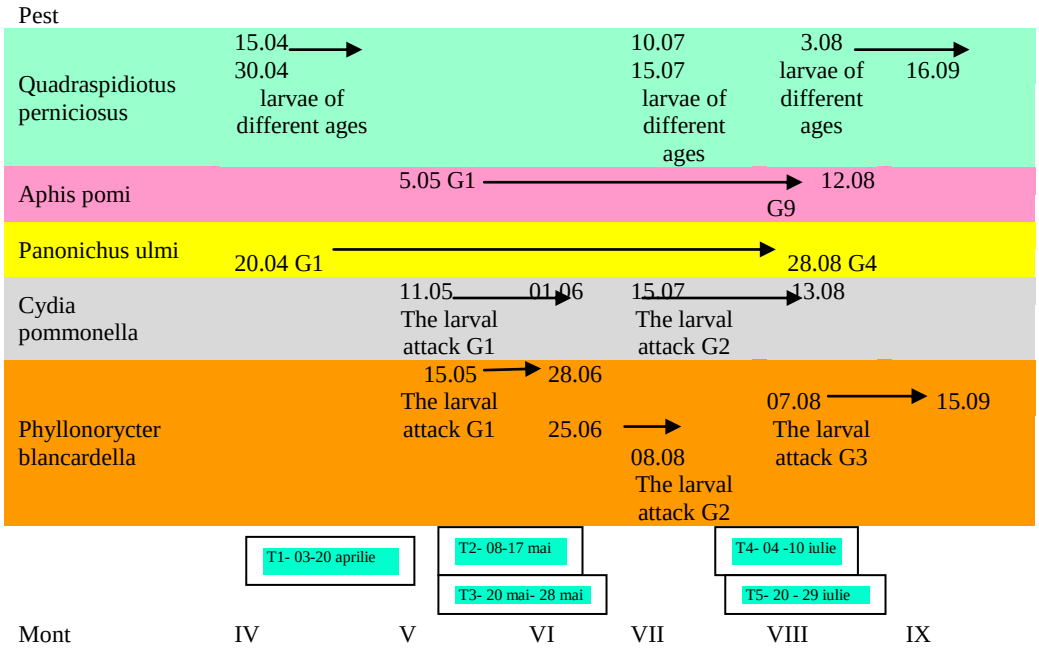

Fig. 5 Moment of attack and applied treatments

The selection of the insecticides used in the treatments of control of the codling moth has been correlated with the evolution of the entire complex of apple pests.

For each generation the first treatment was applied with Calypso 480 SC 0.02%, and Coragen 0.0075%. Calypso is a last-generation systemic product, with long-term action (over 15 days) and with a very good ovicidal effect beside the larvicidal and the adulticidal one. The oivicidal effect is maximal if the treatment is made at the beginning of the laying of eggs. Coragen proved to be very efficient having a method of action which is different from that of the other insecticides, being efficient and on long-term (14-21 days).

At the following treatments there have also been used new products with very good effect on the codling moth, such as: Proteus and Novadim 40EC.

Proteus insecticide contains thiacloprid and deltamethrin, both components being activated at contact and ingestion on the pest and Novadim 40EC, is an insect-acaricide with systemic action, contact and ingestion. The active substance, dimethoate 400 g/L, is rapidly absorbed by the plant and translocated inside it. The action consists in interrupting the nerve impulses to the insect's nervous system.

CONCLUSIONS

- the weather conditions during the period of development of the researches were favorable for the evolution and attack of the species *Cydia pomonella* L., multiple deviations from normal values being recorded;

- in the weather conditions of in the company SC Loturi Service SRL Deleşti, the biological cycle of the species *Cydia pomonella* L. has presented two generations/ year;

- the phytosanitary treatments applied for the control of the codling moth have also been correlated with the evolution of the other pests of the apple;

- during the vegetative season there were applied 5 treatments with insecticides;

- even if the weather conditions were very favorable for the pest evolution the optimal moments, the plans of application of the treatments and products used for the control of this pest had a very good efficiency.

In conclusion year 2017 was characterized as a favorable year for the attack of pathogens and pests. For fruit growers very important in the control of diseases and pests is the alternative use of contact and systemic products, applying treatments before and after flowering, the warning and consulting laboratories forecasting and warning of the Plant Protection Inspectorates, the forecasting and warning being the main pivots of the integrated control, the alarm signal regarding the presence of a phytosanitary danger in the area.

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