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RESEARCH ON THE BIOLOGY OF *LOBESIA BOTRANA* (DENIS AND SCHIFF.) IN THE CONTEXT OF THE NEW CLIMATIC CONDITIONS IN MOLDOVA, ROMANIA

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Abstract

This paper reports the results obtained from the analysis of capture data using the TERASEYA FLY device for Lobesia botrana males (Denis and Schiffermüller). The research was carried out in the region of Moldova, within two plantations belonging to two representative wine basins in the country, being the Odobesti Vineyard and the Husi Vineyard. In the study areas, the vineyards (of Vitis vinifera L.) are cultivated mostly with quality wine varieties, predominantly in the Odobesti vineyard we meet the Muscat Ottonel variety, and in the Husi vineyard we meet the Fetească regala variety, which have also been the subject of research our.The main aim of the study was to investigate the dynamics and biology of L. botrana species inside vineyards and to assess the effect of new climate change on pest distribution. Pest prediction and warning models have been developed and tested to monitor the life cycle of L. botrana, integrating both biological and climatic information. The timing of the first appearance of adults and the hatching of the first eggs can be predicted by predictive models based on the temperature requirements of the stages.Unfortunately, the models of prediction based on the calculation of the sum of daily degrees of temperature are empirical and their robustness strongly depends on the environment in which they were validated. The alternative forecasting techniques are currently being developed, such as pest assessment in the study area using these modern digital farming techniques.

Key words: *vine moth, climatic conditions, pheromone atraBot.*

INTRODUCTION

So much has been written and talked about in the vineyard, from Hippocrates and Columela, from Pliny and Horatius to the present day, specialists and writers, doctors and hygienists, scientists and thinkers of all times, revealing the properties of grapes and they brought the wine a well-deserved praise. Poets, writers, painters and sculptors praised grapes and wine. Thus, over the centuries, vines and wine have made their direct contribution to the development of civilization and have contributed directly or indirectly to the progress of mankind, obviously bearing the imprint of the stages of development of human society. The viticulture was one of the main occupations of the Geto-Dacians, most of them alive, occupying the hilly slopes of Moldova, Transylvania and Oltenia, with natural conditions suitable for obtaining quality wines.

Grapes are of great importance from a nutritional, therapeutic, economic and social point of view. Grape production is affected by a number of pathogens and pests, which in the absence of means of control cause significant production losses and quality depreciation. *Phylloxera* sp., first reported in France (1863), destroyed almost all of France's viticulture between 1863 and 1900. The restoration of the new plantations, by using grafted cattle, opened a new stage of modern viticulture. (Tomoioaga et al., 2006)

In order to obtain high yields, both quantitative and qualitative, an important role is played by plant protection, to signal in time the main pathogens and pests and to establish the most effective measures to prevent and control diseases and pests of vineyards.

In order to ensure a good phytosanitary condition of the vineyards, it is necessary to apply integrated control measures by harmoniously combining agrotechnical, physical, mechanical, chemical and biological methods (use of entomophagus, use of biological products, creation of new resistant varieties, etc.). (Tălmaciu et al., 1994)

MATERIALS AND METHODS

Density of moth populations was estimated by visual inspections during vegetation on pheromone traps and laboratory analyzes of collected samples. Thus, the complex of vine moths that characterize the viticultural ecosystem in 2021 was established and inventoried, in the Huși and Odobesti viticultural centers, at the Muscat Ottonel and Fereasca Regala varieties.

During the research, the surveillance of the evolution of the moth generations was made on the basis of the catches registered on the pheromone traps of the atraBOT (Filip, 2003) type through the Teraseya Fly surveillance system (Figure 1), for the capture of the males of the *Lobesia botrana* species. Pheromone traps were produced and procured from the Romanian Institute for Chemistry Raluca-Ripan Cluj-Napoca. The Teraseya Fly capture system together with the pheromone traps were installed at the end of April and the beginning of May, the norm being 2 traps/ha, this Teraseya Fly system is an innovative and bold product designed for monitoring harmful insects in an agricultural crop.

Figure1. Capture system Teraseya Fly

The device is capable of attracting insects, capturing and storing them alive, photographing and recognizing them using advanced image processing software algorithms, and transmitting information to a data server.

Being bold in what it aims at, however, the product must be robust to withstand all conditions in the field, be self-sufficient in energy and provide information in a way that is easy for the user to understand.

The data are recorded and centralized in real time, and the replacement of the capsules impregnated with synthetic pheromone was done at an interval of 4-5 weeks.

The observations regarding the different parameters of the biological cycle of the grape moth were made in natural conditions, the climatic data being recorded in real time by the same Teraseya Fly device.

The placement of the combat experiments in the field was done according to the norms of experimental technique.

The establishment of the treatment warning terms was made on the basis of biological, ecological (Figure 2) and phenological criteria. For this purpose, the following were taken into account: the lower threshold for the development of the grape moth (*Lobesia botrana*) t_0 = 12°C, the flight curve of the adults, the phenology of the host plant, as well as the warning graph prepared on the database ecological and biological.(Mitrea et al., 2000)

Figure 2. Weather station

For each generation of the pest, only one treatment was applied 1-3 days after the registration of the maximum flight curve established with the help of pheromone traps of the type: 'atraBot' produced by the Romanian Institute for Chemistry “Raluca-Ripan” Cluj-Napoca.

The issue of the toxicity of second-generation insecticides to warm-blooded animals had to be

reconsidered and therefore measures were taken to ban, or severely limit, as appropriate, the use of certain types of second-generation insecticides.
The research revealed a third generation of insecticides, designed to eliminate the major deficiencies of those of the previous generation, including endohormones and exohormones of insects.
Exohormones, also known as pheromones, play an important role in the life of insects, causing certain behaviors in finding food, of the opposite sex, as well as in cases of danger. The beginning of pheromone chemistry took place in 1959 and spread very quickly in England, the USA, Italy and Germany, etc. (Ciochia, 1986; Ciochia et al., 1993)
In our country, the study of pheromones began in 1973 at the Cluj-Napoca Institute of Chemistry, in recent years there has been great progress in the application of pheromones in the rationalization of chemical treatments in large production units in several counties. Even the method of direct combat marked a promising beginning in our country (Ghizdavu et al., 1983; Ghizdavu & Bunescu, 1991).

RESULTS AND DISCUSSIONS

Following the analysis of the obtained data, we noticed that the moth, in the two wine centers, has 3 generations annually. The first generation develops in May-June, the second July-August and the third August-May. It winters in the form of a chrysalis (stern) in a cocoon of white silky threads in the bark of the stems or under the leaves. Butterflies appear in the first or second decade of May. The flight is twilight. After 10-11 days of feeding, copulation and spawning take place. Eggs are laid alone or in small groups on flower buds, shoots, leaves. It is noteworthy that the larvae cause great damage to various varieties of vines. (Boguleanu, et al. 1980)
Among the sensitive varieties are: Coarna neagra, Coarna albă, Afuz-Ali, Muscat Ottonel. among the least attacked are: Perla de Csaba, Riesling. The larvae of the first generation bear fruit buds, wrapping the attacked parts in silk threads, in the form of nests. Sometimes they bear fruit inside the shoots. A larva can destroy 60-80 buds. The second and third generation larvae attack the grapes. The grains, attacked during the growing season, turn brown, wrinkle and fall off, and those affected in the ripening phase can be attacked by phytopathogens.
Observations on the number of males captured were performed once a week, and the data were entered tabularly and graphically, in order to compose the flight curve. These highlighted the beginning of the flight, the rescheduling of the third generation with the maximum flight and the cessation of the flight.
In order to have a dynamic record of the adult numerical density, after each weekly centralization, the captured males were removed from the trap device, so that the results could be interpreted both by the cumulative values for the whole period and by the partial values of each observation. The replacement of the capsule with pheromones was done monthly.

DYNAMICS OF THE FLIGHT OF VINE MOLY IN THE VINEYARD PLANTATION FROM THE ***HUȘI*** *WINE CENTER*

From the analysis of the data presented in Table 1, which represents the evolution of the vine moth in 2021, in the vineyard in Huși, is found as the species *Lobesia botrana* was present in the specific climatic conditions of this year.
Throughout the vegetation period, with the location of the TERASEYA FLY system, daily catch records were made, but the centralization of the data was done every 7 days in order to carry out the treatment warning scheme for each generation.
Following the 28 recordings, three peaks of the flight curve were recorded (Figure 3), data on which the treatment warnings were issued for each generation of the moth.

Table 1. The evolution of the capture of the *Lobesia botrana* Den et Schif moth., in the vine plantation from Huși, the year 2021

Date of observation	Number of males captured	Date of observation	Number of males captured
13.04	**1**	20.07	**76**
20.04	**5**	27.07	**41**
27.04	**11**	3.08	**68**
4.05	**32**	10.08	**89**
11.05	**71**	17.08	**141***
18.05	**125***	24.08	**89**
25.05	**92**	31.08	**42**
1.06	**56**	7.09	**37**
8.06	**14**	14.09	**25**
15.06	**18**	21.09	**13**
22.06	**52**	28.09	**3**
29.06	**195***	5.10	**1**
6.07	**111**	12.10	**0**
13.07	**81**	19.10	**0**

* treatment warning

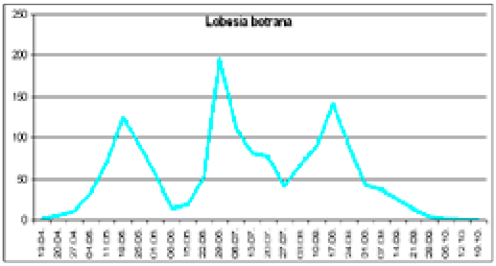

Figure 3. Appearance graph and flight curve of *Lobesia botrana* species in 2021 in Huși wine center

*DYNAMICS OF THE FLIGHT OF VINE MOTH IN THE VINEYARD PLANTATION FROM THE **ODOBEȘTI** WINE CENTER*

Following the data recorded and processed in Table 2, where the evolution of the vine moth in 2021 is represented, in the vineyard from Odobești, it is observed that the species *Lobesia botrana* Den et Schiff. was present in the specific climatic conditions of this year.

Following the location of the experience, respectively the installation of the TERASEYA FLY device, and with its help, adult capture data were recorded daily, and the data was centralized at 7 days in order to carry out the treatment warning scheme for each generation.

Following the 28 recordings, three peaks of the flight curve were recorded (Figure 4), dates on which the treatment warnings were issued for each generation of the moth.

Table 2. Evolution of the capture of the *Lobesia botrana* Den et Schif moth., in the vineyard from the Odobesti wine center, year 2021

Date of observation	Number of males captured	Date of observation	Number of males captured
11.04	**1**	18.07	**74**
18.04	**7**	25.07	**35**
25.04	**10**	1.08	**70**
2.05	**20**	08.08	**98**
9.05	**41**	15.08	**144***
16.05	**96***	22.08	**100**
23.05	**79**	29.08	**53**
29.05	**61**	5.09	**32**
6.06	**22**	12.09	**18**
13.06	**14**	19.09	**11**
20.06	**48**	26.09	**7**
27.06	**102**	3.10	**2**
4.07	**117***	10.10	**0**
11.07	**80**	12.10	**0**

* treatment warning

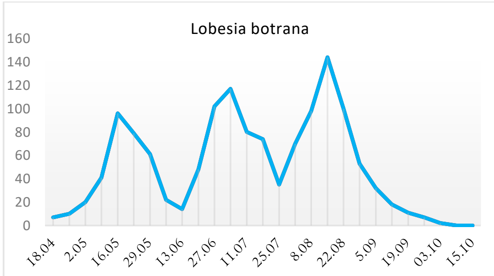

Figure 4. Appearance graph and flight curve of *Lobesia botrana* species in 2021 in Odobesti wine center

AREA OF BIOLOGICAL ACTIVITY OF THE SPECIES LOBESIA BOTRANA DEN ET SCHIF

The general researches of ecology consisted in following the influence of the climatic factors on the development stages of the grape moth (*Lobesia botrana* Den et Schif.), Its development constants were determined in the climatic conditions of the area.These refer to:

- lower biological threshold (t_0) = 12°C
- the threshold of prolificacy (O) = 16.2°C
- lower thermal optimum (O_1) = 26.7°C
- optimal thermal optimum (O_2) = 31.1°C
- upper biological threshold (T) = 35.6°C
- thermal constant of the species (k) = 384°C

Thermal constant (k) and the lower biological threshold (t_0) was established by his method Blunk (1914, 1923) using the relationship:

$$\mathbf{k = X_n (t_n - t_0)}$$ where:

k = thermal constant;
X_n = duration of development (in days);
t_n = development temperature;
t_0 = lower biological threshold;
$t_n - t_0$ = effective temperature.

Following the results obtained regarding the biology of grape moths, it results that the area of biological activity (ZAB), of the *Lobesia botrana* species was differentiated as follows in the two research centers:

From Table 3 it can be observed that in 2021 in the stationary Huși the area of biological activity was between April 13 - September 20, totaling 160 days and a sum of the effective temperature of 1354.4°C

Table 3. Calculation of the area of biological activity (ZAB) of the grape moth (*Lobesia botrana*) in the Huși wine center in 2021

Month	Xn (days)	Precipitations (mm)	Temperat t_n(^{0}C)	Efective temperat. t_n-t_o(^{0}C)	S t_n-t_o	ZAB
January	31	2,3	0,3	-	-	DHP 01.I-12.IV
February	28	1,9	4,8	-	-	
March d1	10	2,8	11,2	-	-	
March d2	10	1,6	9,9	-	-	
March d3	10	3,8	8,1	-	-	
March	31	8,2	9,7	-	-	
April d1	10	10,1	6,7	-	-	
April d2	10	23,8	11,7	-	-	
April d3	10	11,7	12,3	0,3	3	ZAB 13.IV-20.IX
April	30	45,6	10,2	-	**3**	
May d1	10	0	17,9	5,2	52	
May d2	10	4,5	24,1	12,1	121	
May d3	11	7,7	19,3	7,3	80,3	
May	31	12,2	20,4	-	**253,3**	
June d1	10	28,5	25,5	13,5	135	
June d2	10	1,6	25,3	13,3	133	
June d3	10	19,8	21,6	9,6	96	
June	30	49,9	24,1	-	**364**	
July d1	10	11,3	19,8	7,8	78	
July d2	10	8,5	23,2	11,2	112	
July d3	11	67,2	25,1	13,1	144,1	
July	31	87	22,7	-	**334,1**	
August d1	10	67,3	22,6	10,6	106	
August d2	10	7	19,9	7,9	79	
August d3	11	0,1	20	8	88	
August	31	74,3	20,8	-	**273**	
September d1	10	18,5	19,9	7,9	79	
September d2	10	15	14,9	2,9	29	
September d3	10	14	13,9	1,9	19	DHE 21.IX-30.IX
September	30	47,5	16,2	-	**127**	
Octomber d1	10	3	11,3	-	-	DHT 01.X-31.XII
Octomber d2	10	10,4	11,1	-	-	
Octomber d3	11	15	10,3	-	-	
Octomber	31	28,4	10,9	-	-	
November	30	30,2	6,8	-	-	
December	31	11,2	2,9	-	-	
S t_n-t_o in 2021 = 1354,4 ºC						
DT: 01.01.-12.04 + 21.09-30.09 + 01.10.31.12.= 172 days						
ZAB: 13.04 – 20.09 = 160 days						
t0= 12°C						
DHP: 01.01 – 12.04 =102 days						
DHT: 01.10-31.12 = 92 days						

The general ecology research consisted in following the influence of climatic factors on the development stages of the grape moth (*Lobesia botrana* Den et Schif.) its development constants were determined in the climatic conditions of the Odobești wine center area.

Following the results obtained regarding the biology of the grape moth, it results that the area of biological activity (ZAB), of the *Lobesia botrana* species was thus differentiated in the two research centers.

From Table 4 it can be observed that in 2021 the area of biological activity was between April 13 and September 20, totaling 160 days and a sum of the effective temperature of 1383.7°C.

Table 4. Calculation of the area of biological activity (ZAB) of the grape moth (*Lobesia botrana*) in the Odobești wine center in 2021

Month	Xn (days)	Precipitations (mm)	Temperatt$_n$(^{0}C)	Efective temperat. t_n-t_o(^{0}C)	S t_n-t_o	ZAB
January	31	47	0,6	-	-	DHP 01.I-11.IV
February	28	4,4	1,6	-	-	
March d1	10	3,6	9,2	-	-	
March d2	10	41,8	6,6	-	-	
March d3	10	1,4	12,2	-	-	
March	31	46.8	9,3	-	-	
April d1	10	4,8	7,4	-	-	
April d2	10	28	9,0	-	-	
April d3	10	8,2	10,2	-	-	ZAB 12.IV-03.X
April	30	41	9,9	-	-	
May d1	10	0,8	15,7	3,7	37	
May d2	10	6,8	16,9	4,9	49	
May d3	11	15,2	19,8	7,8	85,8	
May	31	22,8	17,5	-	**171,8**	
June d1	10	20,6	18,1	6,1	61	
June d2	10	98,4	18,5	6,5	65	
June d3	10	15,6	24,3	12,3	123	
June	30	134,6	20,3	-	**249**	
July d1	10	19,6	23,4	11,4	114	
July d2	10	15,0	25,3	13,3	133	
July d3	11	5,4	26,7	14,7	161,7	
July	31	40,0	24,3	-	**408,7**	
August d1	10	4,4	24,9	12,9	129	
August d2	10	10,8	22,9	10,9	109	
August d3	11	29,8	23,2	11,2	123,2	
August	31	45	22,9	10,9	361,2	
September d1	10	0	17,1	5,1	51	
September d2	10	5,6	19,2	7,2	72	
September d3	10	0,6	13,6	1,6	16	
September	30	6,2	16,7	4,7	**139**	
Octomber d1	10	0,6	17,4	5,4	54	DHT 04.X-31.XII
Octomber d2	10	8	15,4	-	-	
Octomber d3	11	0,6	17,5	-	**54**	
Octomber	31	9,2	16,8	-	-	
November	30	12	12,9	-	-	
December	31	81,6	5,1	-	-	
S t_n-t_o in 2021 = 1383,7 ºC						
DT: 01.01.- 10.04 + 04.10-31.12= 189 days						
ZAB: 11.04 – 3.10 = 156 days						
t_0= 12°C						
DHP: 01.01 – 10.04 =100 days						
DHT: 04.10-31.12= 89 days						

On October 10, the average air temperature dropped further, which led to the continuation of the rest of the crisalids and their entry into the autumn-winter diapause. This break lasted 100 days from October 10 to December 31. The spring- winter diapause covered the period from January 1 to April 10, totaling 100 days.

The climatic conditions in 2021 were favorable in terms of the biology of the *Lobesia botrana* species, a situation in which the pest recorded 3 generations / year.

For a long time, pest control has been done by mechanical and chemical means. The long and intensive use of insecticides has revealed a number of negative aspects. In addition to ecosystem pollution, a major drawback is the lack of selectivity of chemicals, which leads to biocenotic imbalances, in some cases dramatic.

CONCLUSIONS

Among the vine pests, grape moth remains the main pest in Moldovan vineyards.

The grape moths, but especially *Lobesia botrana* is the species that has shown its presence and has been considered a key pest, which is why it has been monitored using AtraBot pheromone traps.

Between April and September, the population of *Lobesia botrana* exceeded the PED of 100 catches / trap / week for all 3 generations in the two stations, Huși and Odobești.

Currently, the evolution of the pest in the two stationary was marked by three peaks of its evolution, taking into account the evolution of climatic conditions recorded in the Huși and Odobesti stationary.

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