Scientific Papers. Series B, Horticulture. Vol. LXVI, No. 1, 2022
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

THE BEHAVIOUR OF SOME VINE VARIETIES FOR TABLE GRAPES CREATED AT SCDVV IAȘI TO THE MAIN PATHOGENS AND PESTS ATTACK IN THE CONTEXT OF DIFFERENT CLIMATIC CONDITIONS

Andreea-Denisa GHIUR[1], Liliana ROTARU[1], Doina DAMIAN[2], Gabi ZALDEA[2], Ancuţa NECHITA[2]

[1]"Ion Ionescu de la Brad" Iași University of Life Sciences, 3rd Mihail Sadoveanu Alley, Iasi, Romania
[2]Research and Development Station for Viticulture and Winemaking Iaşi, 48 Mihail Sadoveanu Alley, Iaşi, Romania

Corresponding author email: lirotaru@uaiasi.ro

Abstract

Climate change more evident in recent years has been cause changes in life cycle of pathogens and pests, as well as has been increase aggression attack on vineyards. In this sense, in 2020-2021 period was followed the behavior of some vine varieties for table grapes newly created at SCDVV Iași, 'Mara', 'Paula' and 'Aromat de Iași' to the attack of the main pathogens (Plasmopara viticola, Uncinula necator, Botrytis cinerea) and pests (Lobesia botrana, Calepitrimerus vitis and Colomerus vitis). The observation of intensity and frequency on the leaves and grape attack highlight a different behaviour of the studied varieties. The results of the study confirm that the temperature and rainfall from the vegetation period influenced the pathogens attack and pests occur, attack degree and the economic damage threshold, as well as the quantitative and qualitative level of grape production. Also, varieties resistance in specific climatic conditions of the analyzed period under the application of anticryptogamic treatments was appreciated with notes on the OIV scale from 7-9.

***Key words**: climate change, pathogens, pests, resistance, table grape.*

INTRODUCTION

Climatic factors, especially temperature, light and precipitation, have a decisive role in the vines growth and development. Over time studies on how climate change will affect viticulture in the future shows that it is producing changes in growing phenophases (Urhausem et al., 2011; Biasi et al., 2019), on the wine quality (Cunha et al., 2016) and implicitly on the vineyards profitability (Ashenfelter & Storchmann, 2010; Deschenes & Kolstad, 2011). Estimates of how climatic conditions will evolve suggest an increase of temperatures and a decrease of rainfall in all regions of the world (Santillán et al., 2018), including our country (Rotaru & Colibaba, 2011; Zaldea et al., 2021). It has been shown that changes in temperature and precipitation can directly affect the pathogens development and survival (Calonnec et al., 2004; Tomoiagă, 2006; Carisse, 2016). For example, heat and drought during the growing season can reduce the incidence of pathogens that require high humidity conditions for the onset of infection (Caffarra et al., 2012).

Another important aspect in the vines cultivation is the diseases and pests control by applying phytosanitary treatments that must be carried out according to climatic conditions (Innerebner et al., 2020). Climate change can affect the biology and populations of parasites, and therefore plant protection is expected to evolve in response to increasing and/or decreasing the development of pests or diseases in vineyards (Salinari et al., 2006). Understanding and anticipating the impact of biotic factors on plants is necessary to assess how diseases and pests may affect agriculture in the future, so that adaptations of cultivation technologies in line with plantation requirements can be suggested to minimize crop losses (Duso & Lilo, 1996; Caubel et al., 2014; Altimira et al., 2019).

MATERIALS AND METHODS

The study consisted in evaluating the behavior of newly created vine varieties at SCDVV Iași, 'Aromat de Iași', 'Paula' and 'Mara' (interspecific hybrid with biological resistance)

(Damian, 2007; Damian et al., 2012), compared to the control variety 'Chasselas doré', to the attack of the main pathogens (*Plasmopara viticola, Uncinula necato*r and *Botrytis cinerea*) and pests (*Lobesia botrana, Colomerus vitis* and *Calepitrimerus vitis*) of vines in the context of different climatic conditions, over two years, 2020 and 2021. The tolerance of the vine variety to the pathogens attack was assessed by analyze the severity of symptoms on leaves and grapes in the case of downy mildew and powdery mildew and the analysis of symptoms on grapes in the case of the gray mold attack, expressed as degree of attack, based on the frequency and intensity, according to the OIV standards. The observations were made during the vegetation period of each year, examining a number of 100 stumps, followed by the collection of plant material and microscopic determinations. The resistance of the studied varieties to biotic stress factors was assessed by assigning marks from 1 (very poor) to 9 (very good) according to the OIV scale and establishing the degree of attack. The monitoring of the appearance and evolution of *Lobesia botrana* pest was performed using atraBOT pheromone traps for capturing males, produced at the "Raluca Ripan" Institute for Research in Chemistry, Cluj-Napoca, Romania. The number of captured males was noted at 3-4 days, and the change of rubber capsules impregnated with synthetic sex pheromones was made after about a month of use. The presence and evolution of the population of eriophyid mites from the *Calepitrimerus vitis* species was followed by repeated surveys to highlight the evolution of pests. The first survey consisted of microscopic examination of winter buds and identification of the number of mites present in the buds. For this observation 100 buds were analyzed for each variety studied, harvested from stumps with different positions on the plot. The second survey was conducted according to the evolution of the attack, at 100 leaves per variety. The presence of the population of *Colomerus vitis* mites was monitored by observations of 100 leaves for each variety and the assessment of the attack characteristic symptoms.

RESULTS AND DISCUSSIONS

The thermal regime of the two years of study, according to the data recorded by the weather station AgroExpert corroborated with the data from the Regional Meteorological Center Moldova Iasi, was different, 2020 warmer, with average monthly temperatures during the vegetation period, higher than the normal values and the year 2021, cooler, with lower temperatures in April, May and September, close to normal in June, August and slightly higher in July. The absolute maximum temperatures were 36.2°C in 2020 and 34.5°C in 2021, they did not exceed the multiannual values. The absolute minimum recorded in the air were within normal limits, so that they did not affect the vines (Table 1).

The pluviometric regime was deficient in 2020, being considered a dry year, the precipitations were unevenly distributed and quantitatively reduced. In 2021, the amounts of precipitation recorded were sufficient, in some places higher than normal, only September was more deficient by only 10.4 mm (Table 2). Under these conditions, the rainfall regime during the active vegetation period (April-September) was 408.8 mm compared to the normal 398.1 mm. Air hygroscopicity values were lower than normal in both years of study.

Table 1. The thermal regime during the vegetation period

Month	Average temperatures, °C					Absolute maximum temperatures, °C					Absolute minimum temperatures, °C				
	Normal	2020	Dif.	2021	Dif.	Normal	2020	Dif.	2021	Dif.	Normal	2020	Dif.	2021	Dif.
IV	10.3	11.3	+1.0	8.1	-2.2	29.8	25.8	-4.0	23.1	-6.7	-4.8	-5.0	-0.2	-1.3	+3.5
V	16.3	14.0	-2.3	15.4	-0.9	34.5	29.0	-5.5	28.1	-6.4	-0.6	3.2	+3.8	3.6	+4.2
VI	19.5	20.9	+1.4	19.7	+0.2	37.0	32.7	-4.3	33.3	-3.7	5.5	6.6	+1.1	9.5	+4.0
VII	21.3	22.7	+1.4	23.4	+2.1	42.3	35.4	-6.9	34.5	-7.8	8.5	10.8	+2.3	13.7	+5.2
VIII	20.6	23.5	+2.9	20.9	+0.3	40.7	36.2	-4.5	33.5	-7.2	6.7	12.8	+6.1	12.1	+5.4
IX	15.6	19.6	+4.0	14.7	-0.9	33.4	34.7	+1.3	27.2	-6.2	1.3	7.4	+6.1	4.2	+2.9

Table 2. The rainfall regime during the vegetation period

Month	Rainfall (mm)					Days with rainfall >10		Hygroscopicity %				
	Normal	2020	Dif.	2021	Dif.	2020	2021	Normal	2020	Dif.	2021	Dif.
IV	46.6	8.4	-38.2	53.2	+6.6	0	1	68	35	-33	63	-5
V	61.4	102.2	+40.8	68.6	+7.2	4	1	66	64	-2	64	-2
VI	82.5	108.4	+25.9	93.6	+11.1	4	4	70	67	-3	73	+3
VII	83.8	42.0	-41.8	87.6	+3.8	2	4	71	57	-14	66	-5
VIII	62.7	9.2	-53.5	95.4	+32.7	0	3	70	48	-22	67	-3
IX	61.1	29.8	-31.3	10.4	-50.7	1	-	74	53	-21	65	-9
Total	398.1	300.0	-98.1	408.8	+10.7	11	13	70	54	-16	66	-4

The application of phytosanitary treatments to prevent and control diseases and pests on vines was made according to the climatic conditions and the economic damage threshold of each pathogen and pest studied, using contact and systemic products. In 2021, it was necessary to apply two additional treatments compared to 2020, imposed by the heavier rainfall since the entering in ripening and ripening of the grapes (Table 3).

Table 3. Phytosanitary treatments applied in 2020-2021

Phenological stage	Pathogen or pest agent	2020		2021	
		The product used	Dose (kg, L/ ha)	The product used	Dose (kg, L/ ha)
Sprout 3-5 cm	Powdery mildew Mites	Sulfocalcic gravy	20 L	Sulfocalcic gravy	20 L
Sprout 10-25 cm	Downy mildew Powdery mildew Mites	Folpan Kumulus Envidor	1.5 kg 3.0 kg 0.4 L	Dithane Kumulus	2.5 kg 3.0 kg
Before flowering	Downy mildew Powdery mildew Mites	Profiler Topas	2.5 kg 0.25 L	Zorvec Talendo Vertimec	0.2 L 0.2 L 1.0 L
End of flowering	Downy mildew Powdery mildew	Forum Gold Vivando	1.5 kg 0.2 L	Profiler Topas	2.5 kg 0.25 L
Growing grains	Downy mildew Powdery mildew Grey mold	Ridomil Vivando Cantus	2.5 kg 0.2 L 1.2 kg	Ridomil Sercadis -	2.5 kg 0.15 L -
Compaction of bunche	Downy mildew Powdery mildew Grey mold	Dithane Kumulus Cantus	2.0 kg 3.0 kg 1.2 kg	Delan Pro Kumulus Cantus	4.0 L 3.0 kg 1.2 kg
Entering in ripening	Grey mold	-	-	Cantus	1.2 kg
Ripening	Downy mildew	-	-	Bouillie bordelaise	5.0 kg

In 2020, the downy mildew attack on the leaves registered the highest values for ‘Aromat de Iași’ variety, with an intensity of 23.2% and a frequency of 11.0% which generated a degree of attack of 2.2%. In 2021, the most affected was the control variety ‘Chasselas doré’, with an intensity of 12.5%, a frequency of 15.1% and a degree of attack of 1.9%. On grapes, the most affected by the downy mildew was ‘Aromat de Iași’ in both years of study, the attack being visibly higher in 2021, when the degree of attack was 7.5% compared to 2020, when the degree of attack was 2.7%. At the other part, ‘Mara’ was the least affected by the downy mildew attack. On leaves, the symptoms manifested themselves with a degree of attack of 0.03% in 2020 and 0.2% in 2021. On the grapes, the attack symptoms were not present in 2020, and in 2021 the degree of attack had the 0.2% value. During the two years of study, the presence of *Uncinula necator* was reported only in 2020, at ‘Paula’ variety, where it had quite low values, on the leaves the intensity was 3.4%, the frequency 5.3% and the degree of attack 1.8%, and on grape intensity was 7.5%, frequency 7.9% and degree of attack 0.5%.

The most affected by the *Botrytis cinerea* attack was ‘Aromat de Iași’, in which the attack manifested itself with the values of the degree of attack of 0.3% in 2020 and 3.1% in 2021. The least affected variety by grey mold attack was ‘Mara’, which was attacked only in 2020, with a degree of attack of 0.1% (Table 4). Following the evaluation of the degree of resistance to the main pathogens of the vine, the varieties created at SCDVV Iași distinguish itself with a good and very good resistance, having values close to those of the control variety, with notes on the OIV scale between 7- 9.

Table 4. Manifestation of the attack of the main pathogens of the vine

Variety	Pathogen agent	Leaves						Grapes						OIV score of resistance level	
		2020			2021			2020			2021				
		I%	F%	GA%	I%	F%	GA%	I%	F%	GA%	I%	F%	GA%	2020	2021
Mara	*Plasmopara viticola*	1.35	2.5	0.03	7.9	3.0	0.2	0	0	0	3.7	6.7	0.2	9	9
	Uncinula necator	0	0	0	0	0	0	0	0	0	0	0	0	9	9
	Botrytis cinerea	-	-	-	-	-	-	3.0	5.2	0.1	0	0	0	9	9
Aromat de Iași	*Plasmopara viticola*	23.2	11.0	2.2	3.0	1.7	0.04	16.5	16.4	2.7	7.3	73.7	7.5	8	7/9
	Uncinula necator	0	0	0	0	0	0	0	0	0	0	0	0	9	9
	Botrytis cinerea	-	-	-	-	-	-	4.4	6.8	0.3	5.6	55.6	3.1	9	8
Paula	*Plasmopara viticola*	10.3	9.7	1.0	19.7	7.0	1.3	17.7	12.2	2.1	9.9	28.8	2.8	8	8
	Uncinula necator	3.4	5.3	1.8	0	0	0	7.5	7.9	0.5	0	0	0	8/9	9
	Botrytis cinerea	-	-	-	-	-	-	3.6	5.5	0.2	4.5	11.9	0.5	9	9
Chasselas doré	*Plasmopara viticola*	4.27	5.5	0.2	12.5	15.1	1.9	3.0	4.5	0.1	5.3	7.7	0.4	9	8/9
	Uncinula necator	0	0	0	0	0	0	0	0	0	0	0	0	9	9
	Botrytis cinerea	-	-	-	-	-	-	3.7	3.1	0.1	5.3	4.3	0.2	9	9

In 2020, the first generation flight of *Lobesia botrana* began on April 10, when the sum of the effective temperatures has the value of 27.3ºC. The second generation flight began on June 23, when the sum of the effective temperatures was 434.9ºC. In 2021, the first generation males start flight later compared to the previous year, on May 5, when the sum of the effective temperatures was 49.8ºC. The second generation began its flight on July 2, when the sum of the effective temperatures was 498.3ºC, and the third generation in 2021 began its flight on August 2, when the sum of the effective temperatures was 923.6ºC. From these data it result that an effective temperature of approximately 400ºC is required for a generation. The results presented in Table 5 correspond to the information in the literature according to which the flight of grapevine moths is influenced by high temperatures, which reduce the number of individuals in the crop (Popa, 2012).

By comparing the two years of the study, it is observed that there are significant differences in the moths flight for each generation. In 2020, the first generation flight occured over a period of 39 days, there was a delay in the appearance of adult moths on varieties located on flat ground or those with north-western exposure (‘Paula’ and ‘Mara’). The maximum flight curve for the first generation of moths of 2020 was reached at different times depending on the variety, so for the varieties where the flight started earlier (‘Aromat de Iași’ and ‘Chasselas doré’) the maximum flight curve took place at the end in April and early May, while in the ‘Paula’ and ‘Mara’ varieties it was grown in mid-May (Figure 1). The second generation flight started at the end of June, with a maximum of the flight curve recorded in early July. Comparing the two generations, it is found that during the second flight the number of individuals captured was lower than in the first generation, which confirms the general laws of insect development according to which the population density decreases from the egg stage to adulthood (Ranca, 2001).

Table 5. Biology of *Lobesia botrana* grape moth at SCDVV Iași

Year	Generation	Start fligh	Tm-12°C	Top flight	End of the flight	Male caches average
2020	G1	10 April	27.3	20 April	18 May	59.25
	G2	23 June	434.9	6 June	31 July	35.5
	G3	-	-	-	-	-
2021	G1	5 May	49.8	17 May	9 June	26.0
	G2	2 July	498.3	23 June	2 August	24.5
	G3	2 August	923.6	31 August	22 September	54.5

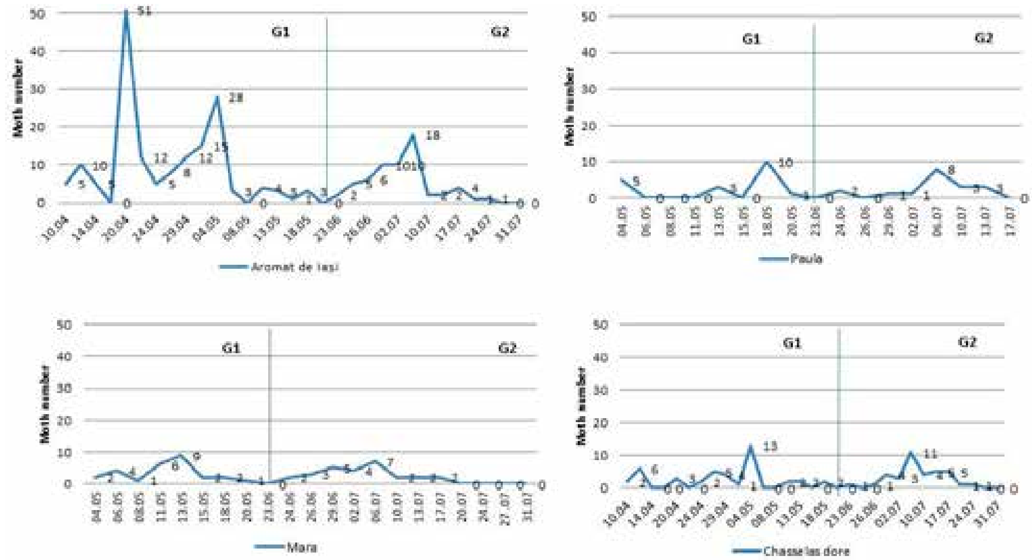

Figure 1. *Lobesia botrana* flight curves in varieties studied in 2020

In 2021, the first generation flight began in early May and occurs over 36 days. The maximum flight curve was recorded in mid-May for all varieties studied (Figure 2). The second generation of european grapevine moth began its flight in early July, and as in the previous year, there was a decrease in the number of individuals caught during the second flight. Due to the favorable climatic conditions, high temperatures and high biological reserves of previous years, in 2021 the flight of the third generation of moths occur, which intersected with the second generation, the adults continuing their flight from August to mid-September for 51 days. Due to the emergence of the third generation, in 2021 there were a higher number of moths in culture, resulting a stronger attack of grey mold on all varieties studied compared to the previous year.

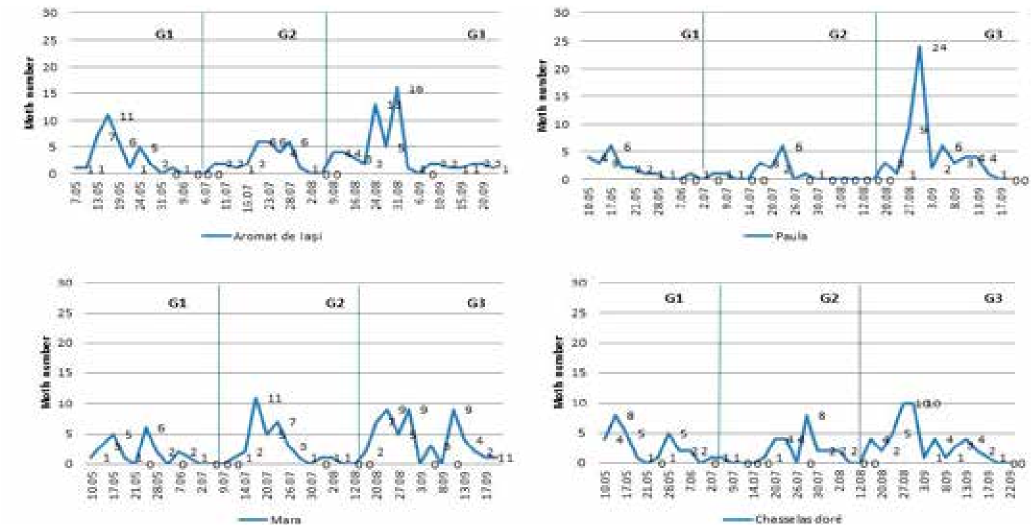

Figure 2. *Lobesia botrana* flight curves in varieties studied in 2021

The largest number of moths was caught in 'Aromat de Iași', a variety sensitive to pest attack, in both years of study, followed by 'Paula' and 'Mara', in which the number of individuals was close to the control. With the exception of 'Aromat de Iași', for all the varieties analized, the number of individuals captured was higher in 2021, compared to 2020, due to the appearance of the third generation (Figure 3).

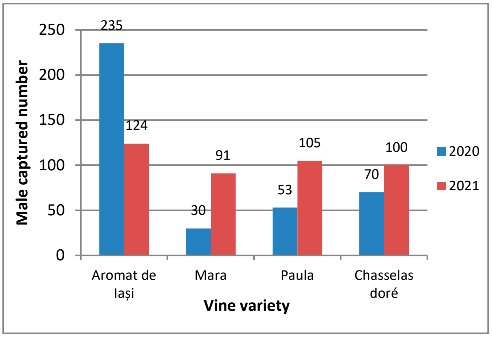

Figure 3. Cumulative male trap catches of *Lobesia botrana* during 2020-2021 at SCDVV Iași

The biological reserve of mites remained below the economic damage threshold in both years of study, for all varieties analyzed. For *Calepitrimerus vitis* species, on the first survey, the most affected variety was 'Chasselas doré', in its buds were 129 individuals in 2020, and 178 individuals in 2021. At the opposite pole is the 'Mara' variety, in the buds of which no pests of the species *Calepitrimerus vitis* have been found in any of the years studied. In the 'Paula' variety, 34 individuals were found in 2020 and 113 in 2021, and in 'Aromat de Iași', following the first survey, 28 individuals were identified in the first year and 49 mites in the second year (Table 6).

The second survey of leaf symptoms caused by vine rust mite of grapevine shows that the most affected was the 'Chasselas doré' variety, which in 2020 had 24% of leaves with symptoms of attack, and in 2021, 21% leaves with attack symptoms. The least affected variety was 'Mara', in which the attack in 2020 had a percentage of 9% attacked leaves, and in 2021 there were 10% attacked leaves. The 'Paula' and 'Aromat de Iași' varieties obtained relatively low values at the leaf attack of the pest, between 12 and 20%.

Grape erineum mite (*Colomerus vitis*) in 2020 manifested itself with greater intensity in the 'Aromat de Iași' variety, where it had a value of 22% symptoms on the leaves. The lowest value was recorded by the 'Mara' variety, with leaf attack symptoms of only 9%, and 'Paula' and 'Chasselas doré' varieties had a value of 19%. In 2021, the most affected variety of mite attack from the *Colomerus vitis* was 'Chasselas doré', with a percentage of 25%, followed by 'Aromat de Iași', which obtained the value of 24%, 'Paula' with 21% and the least affected by the gall mites attack was 'Mara' , with 11%. symptoms. By comparing the two years, the eriophyes mites attack was stronger in 2021 compared to the previous year, and symptoms of the attack were also identified on the inflorescences.

The results regarding the production capacity of the studied varieties showed that in the climatic conditions of 2020 and 2021 and the proper application of the cultivation technology, they reached the biological potential specific to the mass varieties. Among the varieties analyzed, the most productive was 'Paula', with 6.40 kg / hub, respectively 6.85 kg/hub, and from the point of view of marketed production, the resistant 'Mara' variety stood out (Table 7).

Table 6. Eriophydes mites attack in 2020-2021

Variety	Total buds/ leaves analized	*Calepitrimerus vitis*						*Colomerus vitis*	
		No. mites/ sample		No. mites/bud		Leaves with attack symptoms (%)		Leaves with attack symptoms (%)	
		2020	2021	2020	2021	2020	2021	2020	2021
Aromat de Iași	100	28	49	0	0	16	18	22	24
Paula	100	34	113	0	1	12	20	19	21
Mara	100	0	0	0	0	9	10	9	11
Chasselas doré	100	129	178	1	2	24	21	19	25

Table 7. The production components of the varieties studied

Variety	The average weight of a grape, g		Effective production, kg/stump		Calculated production, t/ha		Marketed production, %	
	2020	2021	2020	2021	2020	2021	2020	2021
Aromat de Iași	200	170	5.40	5.78	20.41	21.85	62	60
Paula	310	298	6.40	6.85	24.19	25.89	79	80
Mara	175	256	4.30	6.14	16.25	23.27	94	95
Chasselas doré	135	154	3.24	4.31	12.27	16.32	89	95

CONCLUSSIONS

From the analysis of the climatic data recorded in 2020-2021 it can be seen the 2020 year was drier, the rainfall regime recorded during the vegetation period was deficient, with unevenly distributed rainfall, while the 2021 year was a normal meteorological one. This has resulted in the cryptogamic occur diseases whose development is dependent on humidity with higher intensity, frequency and degree of attack in 2021, compared to the previous year.

Among the analyzed varieties, 'Mara' was distinguished by its resistance to the pathogens attack, at the opposite pole being the 'Aromat de Iași' variety, which was the most affected by the attack of vine diseases.

Another consequence of the temperature differences between the two years was the need to apply two phytosanitary treatments to control grey mold and downy mildew in 2021, compared to 2020, which were stronger due to the conditions optimal development during the growing season.

Regarding the grapevine pests, the treatments applied in culture for protection against mites from *Calepitrimerus vitis* and *Colomerus vitis* species have proved their effectiveness, the number of populations being below the economic damage threshold both in 2020 and in 2021.

There are differences in the development of *Lobesia botrana* populations from one year to another and from one variety to another, depending on the recorded temperatures and the altitude or location of the plantation. Thus, for the varieties with north-western exposure ('Mara', 'Paula') there was a delay in the beginning of the flight for each generation compared to the control variety. The delay in the start of the flight can also be associated with temperature differences, so in the year with higher temperatures the flight started much earlier compared to 2021, when the rainfall was more frequent and the temperatures lower.

The most receptive variety to the *Lobesia botrana* attack was 'Aromat de Iași', and at the opposite pole, the least affected by the pest attack was the 'Mara' variety.

Under the conditions of application of anticryptogamic treatments to the studied varieties, grape productions were specific to their biological potential, the differences from one year to another being insignificant, which shows that they have acquired genetic stability and have the adaptability to the conditions of the viticultural ecosystem where they were created.

ACKNOWLEDGMENTS

This research work was developed under the Sectorial Plan the ADER 2022, PS 7.1.4.

REFERENCES

Altimira, F., De La Barra, N., Rebufel, P. (2019). Potential biological control of the pupal stage of the European grapevine moth Lobesia botrana by the entomopathogenic fungus Beauveria pseudobassiana in the winter season in Chile. *BMC Res Notes* 12, 548. https://doi.org/10.1186/s13104-019-4584-6

Ashenfelter, O., Storchmann, K. (2010). Using Hedonic Models of Solar Radiation and Weather to Assess the Economic Effect of Climate Change: The Case of Mosel Valley Vineyards, *Review of Economics and Statistics*, 92(2). 333-349.

Biasi, R., Brunori, E., Ferrara, C., Salvati, L. (2019). Assessing Impacts of Climate Change on Phenology and Quality Traits of *Vitis vinifera* L.: The Contribution of Local Knowledge. *Plants*. 8(5):121. https://doi.org/10.3390/plants805012

Caffarra, A., Rinaldi, M., Eccel, E., Rossi, V., Pertot, I. (2012). Modelling the impact of climate change on the interaction between grapevine and its pests and pathogens: European grapevine moth and powdery mildew. *Agriculture, Ecosystems & Environment,* 148, 89–101. doi:10.1016/j.agee.2011.11.017

Calonnec, A., Cartolaro, P., Poupot, C., Dubourdieu, D., Darriet, P. (2004). Effects of *Uncinula necator* on the yield and quality of grapes (*Vitis vinifera*) and wine. *Plant Pathol*. 53, 434–445.

Carisse, O. (2016). Development of grape downy mildew (Plasmopara viticola) under northern viticulture conditions: influence of fall disease incidence. *European Journal of Plant Pathology* 144, 773–783.

Caubel, J., Launay, M., Garcia de Cortazar-Atauri, I., Ripoche, D., Huard, F., Buis, S., Brisson, N. (2014). A new integrate approach to asess the impacts of climate change on grapevine fungal diseases: the coupled mila-stics model, S*pécial Laccave, J. Int. Sci. Vigne Vin*, 45 – 54.

Cunha, M., & Richter, C. (2016). The impact of climate change on the winegrape vineyards of the Portuguese Douro region. *Climatic Change*, 138(1-2), 239–251. doi:10.1007/s10584-016-1719-9

Damian, Doina., Calistru, Gh., Nechita, Ancuța, Savin, C. (2012). Mara, new variety of vine for table grapes, with increased genetic resistance, created at SCDVV Iași, *Lucrări Ştiinţifice, 55*(1), *Seria Horticultură,* Editura Ion Ionescu de la Brad, Iași, 315-320.

Damian, Doina, Calistru, Gh., Vasile, Ancuța (2007). Principalele însușiri agrobiologice și tehnologice ale soiurilor de viță de vie create la SCDVV Iași,*Stațiunea de Cercetare-Dezvoltare pentru Viticultură și Vinificație IAȘI, 50 de ani de cercetare ştiinţifică în sprijinul viticulturii și vinificației din nord-estul României, 1957-2007,* Editura Pim, Iași,179-193.

Deschenes, O., Kolstad, C. (2011). Economic impacts of climate change on California agriculture. *Clim Chang* 109:365–386.

Duso, C., de Lillo, E., (1996). Grape. In: Lindquist EE, Sabelis MW, Bruin J (eds), Eriophyoid Mites-Their Biology, Natural Enemies and Control. *Elsevier*, Amsterdam, 571–582

Innerebner, G., Roschatt, C., Schmid, A. (2020). Efficacy of fungicide treatments on grapevines using a fixed spraying system, *Crop Protection, 138,* https://doi.org/10.1016/j.cropro.2020.105324.

Popa, O. E. (2012). Researches on wine moths flight captured on pheromone traps, *Scrientific Papers, Series B, Horticulture, Vol. LVI,* 481-484

Ranca, A. (2001). Studii preliminare în modelarea dezvoltării moliei strugurilor la Murfatlar. *Analele Institutului de Cercetări pentru Viticultură și Vinificație Valea Călugărească,* XVI, București, RO.

Rotaru, Liliana, Colibaba, Cintia (2011). The influence of climatic changes on the behaviour of some grape varieties for white wines in Moldavian vineyards, *Lucrări ştiinţifice 54(1), seria Agronomie,* 174-179

Salinari, F., Giosuè, S., Tubiello, F. N., Rettori, A., Rossi, V., Spanna, F., Rosenzweig, C., Gullino, M. L. (2006). Downy mildew (Plasmopara viticola) epidemics on grapevine under climate change. *Glob. Change Biol.* 12, 1299–1307

Santillán, D., Iglesias, A., La Jeunesse, I., Garrote, L., Sotes, V. (2018). Vineyards in transition: A global assessment of the adaptation needs of grape producing regions under climate change. *Science of The Total Environment.* doi:10.1016/j.scitotenv. 2018.12.079

Tomoiagă, L. (2006). *Bolile și dăunătorii viței-de-vie. Prevenire și combatere.* Cluj-Napoca, RO: Mediamira.

Urhausem, S., Brienen, S., Kapala, A., Simmer, C. (2011). Climatic conditions and their impact on viticulture in the Upper Mosel region, *Climatic Change*, 109(3): 304-373

Zaldea, Gabi, Nechita, Ancuta, Damian, Doina, Ghiur, Andreea-Denisa, Cotea, V. V., (2021). Climate changes in recent decades, the evolution of the drought phenomenon and their influence on vineyards in north-eastern Romania, *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 49(4), 12448. https://doi.org/10.15835/nbha49412448