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BUCHAREST

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CONTENT

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HARMFUL VIRUSES OF GRAPEVINE: IMPACT, SPREAD AND BIOTECHNOLOGIES FOR HEALTHY PLANTS REGENERATION

VIRUSURILE DĂUNĂTOARE LA VIȚA-DE-VIE: IMPACT, RĂSPÂNDIRE ȘI BIOTEHNOLOGII DE REGENERARE DE PLANTE SĂNĂTOASE

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Abstract
Grapevine is a horticultural crop with major economic influence worldwide. At the same time, to grapevine is known the largest number of viruses of a cultivated plant. The diseases produced by viruses to grapevine reduce the vigour and longevity of the plants, the production quantity and quality. Therefore, the timely monitoring of the factors that can have a negative effect on plant growth and products quality, primarily the control of the causative agents of grapevine diseases, is of critical importance for grape production. The widespread of viruses, the fact that the viruses can be controlled best using healthy propagating material has led to increased research regarding the virus elimination methods and the application of their results. The paper reviewed the research carried out at NRDIBH Stefanesti on virus-free plants obtaining by meristem culture, thermotherapy, in vitro chemotherapy, electrotherapy.

Key words: Vitis, GFLV, GLRaV-1, GLRaV-3, GFkV, GPGV, control

Rezumat
Vița-de-vie reprezintă o cultură horticolă cu influență economică majoră la nivel mondial. În același timp, la vita-de-vie este cunoscut cel mai mare număr de virusuri al unei plante de cultură. Maladiile produse la vița de-vie de virusuri reduc vigoarea și longevitatea plantelor, cantitatea și calitatea producției. Prin urmare, monitorizarea la timp a factorilor care pot avea un efect negativ asupra creșterii plantelor și calitatea produselor, în primul rând controlul agenților cauzali ai maladiilor viței-de-vie, are o importanță critică pentru producția de struguri. Larga răspândire a virusurilor, faptul că virusurile pot fi controlate cel mai bine prin utilizarea unui material de înmulțire sănătos au condus la intensificarea cercetărilor privind metodele de eliminare a virusurilor și aplicarea rezultatelor acestora. În lucrare au fost trecute în revistă cercetările efectuate la INCDBH Ștefănești privind obținerea de plante libere de virusuri prin cultură de meristem, termoterapie, chimioterapie in vitro, electroterapie.

Cuvinte cheie: Vitis, GFLV, GLRaV-1, GLRaV-3, GFkV, GPGV, control

INTRODUCTION

Grapevine is an agricultural crop with major economic influence worldwide. The viticultural market is considered to be one of the most dynamic and fastest agricultural markets in recent years. Therefore, the timely monitoring of factors that can have a negative effect on plant growth and products quality, primarily the control of the causative agent of grapevine diseases, is of critical importance for grape production.

The genus *Vitis*, with its numerous species, is considered one of the most affected genera by various types of viruses. More than 80 viruses belonging to 17 families and 34 genera have been described so far (Fuchs, 2020), of which 31 are associated with the four main viral disease complexes known as: infectious degeneration (12 Eurasian/European/Mediterranean nepoviruses) and decline (4 American nepoviruses), leafroll (5 viruses), rugose wood (6 viruses) and fleck (4 viruses). In addition, 7 grapevine viroids are known, of which only 2 induce visible symptoms. Vectors include nematodes, mealybugs, soft scale insects, eriophyid mites, cycads (Martelli, 2017).

Diseases produced in grapevines in the presence of viruses reduce the plants vigour and longevity, the production quantity and quality (Martelli and Boudon-Padieu, 2006, Guță and Buciumeanu, 2016).

Continuous research in the grapevine virology field has led to the continuous identification and characterization of new viruses that cause significant damage to grapevines and can spread from one geographic region to another. One such example is *Grapevine Pinot gris virus* (GPGV) which is not included, according to the legislation, in the list of pathogens that must be identified in the viticultural propagation material, but which is increasingly making its presence felt in vineyards in most of the world's grapevine growing countries. Currently, GPGV is considered a major grapevine pathogen in Europe (Cieniewicz et al., 2020).

International publications have reported the presence of viral infections in grapevine varieties originated from Romania (Boscia and Demarinis, 1998; Milkus et al., 2000). Also, the monitoring carried out in the country indicated the presence of viral infections in varieties from the national (Buciumeanu et al., 2009) and international assortment (Pop et al., 1993). Evaluation of phytosanitary status in five vineyards with Romanian grape varieties from The Hills of Vallachia and Oltenia viticultural region revealed the presence of virus infections, with a high level in newly established plantations. This situation can be the consequence of the intensification of circulation of the grapevine propagation material, the sanitary check and the defective traceability of this material (Buciumeanu et al., 2015).

The European Union recommended common rules to the member states regarding the grapevine propagation and selection (EEC recommendation no. 68/193); however, each national legislation recognizes the European recommendations according to the social and environmental conditions of viticulture, so differences can still be found in the way of clonal and sanitary selection achievement in Europe. In our country, Order no. 1267/2005 harmonized with European legislation regulates the quality of viticultural propagation material from the virological point of view. Viruses to be diagnosed and eliminated are: *Grapevine fanleaf virus* and *Arabis mosaic virus* (GFLV+ArMV), *Grapevine leafroll-associated viruses serotypes 1 and 3* (GLRaV-1, GLRaV-3) and *Grapevine fleck virus* (GFkV). Also, Decision no. 164/2015 regarding the approval of the Methodological Norms for the application of the grapevine and wine law in the system of the common organization of the wine market mentions that the initial material is the vegetative propagation material of the grapevine - "it is made up of clones free of virus diseases recognized by the regulations in force, planted on sanitary families".

The identification of viruses and especially of plants infected with viruses becomes important and necessary when the grapevines are used in the programs of propagating material production and creation of new varieties or clones. The circulation of propagating material throughout the world is the main source of spread of viral diseases.

THE IMPACT AND SPREAD OF HARMFUL VIRUSES IN GRAPEVINE

Grapevine fanleaf virus

Several nepoviruses infect grapevines in Europe and the Mediterranean area, causing degenerative diseases whose symptoms are similar or slightly different from those produced by fanleaf, a disease caused by GFLV. The name of this virus comes from the specific malformation of the infected leaves that have wide open petiolar sinus (Fig. 1) and the primary veins abnormally gathered, the leaves having a fan shape.

The GFLV distribution along the green shoots during the active growth period (determined by ELISA) was directly correlated with symptoms of fanleaf disease in St. George variety (Guță and Buciumeanu, 2011a).

GFLV and other several European grapevine nepoviruses have strains that deform the plant, and chromogenic strains (producing yellowing of the leaf), thus classifying the disease symptoms produced by this virus into two groups (Maliogka et al., 2015). These can be found in mixed infections. Tolerant varieties produce good yields, while the sensitive ones are seriously affected, showing a progressive decline, low quantitative and qualitative production, shortening of the production period, low grafting yield, reduced rooting capacity of the propagating material, decreased resistance to adverse climatic factors. Production losses can be as high as 80%, but they dependent on the interaction between genotype, virus strain and environmental factors. Fanleaf is the oldest virus disease known and one of the most important and widespread in grapevines. European literature records over 150 years ago grapevine leaves with typical symptoms that were found in herbaria made before the introduction of American rootstock hybrids. The disease is known all over the world. GFLV is transmitted by *Xiphinema index* nematode (Andret-Link et al., 2004; Martelli and Boudon-Padieu, 2006). ArMV is transmitted by *X. diversicaudatum* nematode, but not by *X. index* (Brown et al., 1995).

Fig. 1. Fanleaf symptoms to Feteasca neagra variety (original) // Simptome de scurtnodare la soiul Fetească neagră (original)

Grapevine leafroll-associated viruses

Leafroll is the most widespread and important viral grapevine disease worldwide. It is associated with a complex of 6 viruses (Fuchs, 2020), from which GLRaV-3 is the most important in this virus complex and the most widespread grapevine pathogenic virus worldwide (Burger et al., 2017). Spreading of leafroll viruses in plantations is by coccidia species (Pop, 2009).

The leafroll is a disease of high economic importance, reducing the yield by 10-70% and reducing the sugar content of the grapes. In the case of some red table varieties, grapes harvested from affected bunches cannot be marketed due to their uneven colouring. The disease reduces the capacity of grafting and rooting of cuttings and reduces the resistance of plants to frost. The disease produces diffuse reddish spots between the main veins of the leaves at the base of the shoot in red varieties (Fig. 2). The spots gradually enlarge and merge, giving to the leaves a uniform red colour, except for some green bands, of few millimetres in wide, located along the main and secondary veins. The leaves curl towards the lower face. In the last stage, necrosis appears at the edge of the blade and in the spaces between veins, and the bands along the veins become pale yellow. In the white varieties, the symptoms are similar to the red ones, but instead of redness, there is a chlorosis of the spaces between veins. The symptoms are very obvious towards the end of the growing season (Pop, 1988; 2009).

Fig. 2. Leafroll symptoms to Feteasca neagra (original) // Simptome de răsucirea frunzei la soiul Fetească neagră (original)

Fleck virus

The disease produced by GFkV (marbrure) is latent in European grapevine species and most American rootstocks. Symptoms are expressed on *Vitis rupestris* and consist of clearing of third and fourth order veins, producing localized translucent spots. The leaves with intense spots are wrinkled, twisted and may curl upward. The virus influences the vigour, the rooting capacity of the rootstocks, the grafting rates. Severe strains induce varying degrees of stunting. There is not known vector for GFkV and the virus is not mechanically transmitted. The disease is ubiquitous, being reported in all grapevine growing countries of the world (Martelli and Boudon-Padieu, 2006).

The studies revealed that the presence of GFkV in different *V. vinifera* genotypes induced a reduced rooting capacity of the cuttings, a small number of shoots and roots as compared to the healthy material. The influence of the virus depends on the infected grapevine genotype (Guţă et al., 2007a).

Grapevine Pinot gris virus

GPGV was first identified in 2012 in Pinot gris variety, in Italy, by next-generation sequencing techniques (Giampetruzzi et al., 2012), although the symptoms of the disease produced by it, known as grapevine leaf mottling and deformation (GLMD) were observed from 2003 (Martelli, 2014). Reports on GPGV revealed a wide spread of the virus in many grapevine growing areas around the world (Fig. 3).

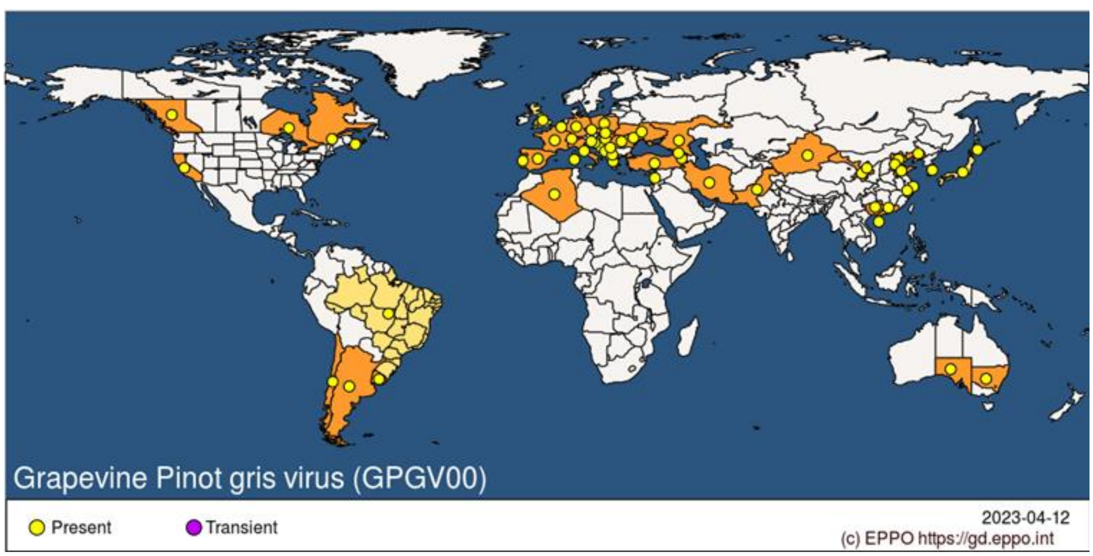

Fig. 3. Distribution of Grapevine Pinot gris virus in the world // Distribuția virusului Pinot gris la vița-de-vie în lume
(https://gd.eppo.int/taxon/GPGV00/distribution)

The first information regarding the presence of GPGV in our country was reported in the viticultural material collected after 2010, during the analysis of some genotypes from germplasm collections in several European countries, including Romania (Bertazzon et al., 2015). EPPO Global Database mentions the presence of GPGV in Romania, but without further details, based on the same information (https://gd.eppo.int/taxon/GPGV00/distribution).

An assessment of GPGV incidence grapevines in Romania was realized in 2019-2020 period, when were analysed 199 samples belonging to newly created varieties/clones, clonal selections, old varieties, traditional fruitful varieties originating from grapevine collections from the country, and rootstocks. Symptoms were observed on the leaves (deformations, chlorosis, mosaic) (Fig. 4), poor development of the hub and shoots with short internodes. Serological tests showed an incidence of GPGV infection of 53.76% (107 ELISA positive samples from 199 analysed). Of these, the largest percent (37.38%) it was recorded by old varieties from germplasm collections. As expected, with a close percentage (32.71%) followed the clones, which reinforces the necessity to use virus-free grapevines in breeding programs. In the study, 12 samples collected from 4 rootstock genotypes were analysed, all of them being ELISA positive for GPGV (Guță and Buciumeanu, 2021).

Molecular characterization and phylogeny of different GPGV isolates indicated the existence of symptomatic and latent variants (Saldarelli et al., 2015; Bertazzon et al., 2017). Since the virus is transmitted by grafting, it spreads primarily through the propagating material (Saldarelli et al., 2015).
Furthermore, GPGV has been detected also in other host plants: *Silene latifolia*, *Chenopodium sp.*, *Asclepias syriaca*, *Rosa sp.*, *Rubus sp.* and *Fraxinus sp*. (Demián et al., 2018). GPGV is transmitted to healthy grapevines by the infested *Colomerus vitis* mite. However, mechanical transmission of GPGV in herbaceous plants has not been found (Malagnini et al., 2016). GPGV was identified in seedlings developed from infected grapevine seeds (Zhang et al., 2022). Currently, GPGV is considered a major grapevine pathogen in Europa (Cieniewicz et al., 2020).

Fig. 4. Symptoms induced by Pinot gris virus to Augusta variety // Simptome produse de virusul Pinot gris la soiul Augusta (original)

The survey carried out in five vineyards with Romanian grapevine varieties in the Hills of Vallachia and Oltenia viticultural region revealed the presence of simple and mixed virus infections in different percentages, without a positive correlation with the presence of symptoms. The percentage of infected plants was higher in newly established plantations (Buciumeanu et al., 2015) (Table 1).

Table 1. Incidence of virus infections in vineyards with Romanian grapevine varieties in the Hills of Vallachia and Oltenia viticultural region (Buciumeanu et al., 2015) // Incidența infecțiilor virale în plantații cu soiuri românești de viță-de-vie în Regiunea viticolă Dealurile Munteniei și Olteniei (Buciumeanu și colab., 2015)

Grapevine genotype/ Year of plantation	Virus-infected samples/ analysed samples (No.)	Virus infection (%)	
		Total	Specification
Feteasca neagra/1986	9/39	23.08	12.82 – GLRaV-1+3; 10.26 – GFkV
Feteasca neagra/1978	6/18	33.33	22.23 – GLRaV-1+3; 5.55 – GFkV; 5.55 – GFkV+ GLRaV-1+3
Feteasca neagra/2010	24/43	55.80	18.60 – GFLV+ArMV; 16.28 – GLRaV-1+3; 9.30 – GFkV; 2.32 – (GFLV+ArMV) + (GLRaV-1+3); 6.98 – (GFLV+ArMV) + GFkV; 2.32 – (GFLV+ArMV) + (GLRaV-1+3) + GFkV
Feteasca neagra/2011	21/50	42.00	26.00 – GFLV+ArMV; 2.00 – GLRaV-1+3 10.00 – GFkV; 2.00 – (GFLV+ArMV) + GFkV; 2.00 – (GLRaV-1+3) + GFkV
Augusta /1993	5/41	12.20	4.88 – GLRaV-1+3; 7.32 – GFkV
Feteasca regala/1989	11/42	26.19	4.76 – GLRaV-1+3; 16.67 – GFkV; 4.76 – GLRaV-1+3 + GFkV
Novac/1994	5/42	11.90	4.76 – GLRaV-1+3; 7.14 – GFkV
TOTAL	81/275	29.45	7.64 – GFLV+ArMV; 8.37 – GLRaV-1+3; 9.82 – GFkV; 1.45 – GLRaV-1+3 + GFkV; 0.36 – GFLV+ArMV + GLRaV-1+3; 1.45 – GFLV+ArMV + GFkV; 0.36 – GFLV+ArMV + GLRaV-1+3 + GFkV

BIOTECHNOLOGIES FOR GRAPEVINE VIRUS ELIMINATION

The first methods of virus-free plant regeneration were meristem/meristematic apex culture with and without thermotherapy

Meristem culture is the oldest method used to eliminate plant viruses (Faccioli and Marani, 1998).

The mechanism of virus elimination through meristematic culture has not been fully elucidated, but various hypotheses are accepted, such as: the absence of plasmodesmata at the level of meristematic cells, the competition between the synthesis of nucleoproteins necessary for cell division and virus replication, or the intervention of inhibitory substances.

Viral replication requires the presence of enzymes normally available in cells close to the meristematic dome. The excision of the meristem causes a trauma that induces a temporary unavailability of these enzymes and, therefore, the viral replication is interrupted and the viral RNA degrades. Thus, if the explant is smaller (0.1-0.3 mm), the chance of obtaining healthy plants is higher. The experimental results confirmed that the elimination of GFLV was possible in a percentage of 54%, and of GLRaV-1 and GLRaV-3 in a percentage of 73-93% (Barba et al., 1992).

Under similar working conditions, Koruza and Jelaska (1993) noted the absence of GLRaV-1 and GLRaV-3 in all plants obtained by meristem culture (0.2-0.4 mm) in 3 clones of the Refošk variety; In the case of GFLV infection, the healthy plants were 60% only.

GFLV was eliminated at a rate of 85% and GLRaV-1 at a rate of 87.5% in Thompson seedless genotype, using a meristem size of 1 mm (Youssef et al., 2009).

Meristem of 0.5 mm led after 6 months of culture to the regeneration of 75% GFLV- free plants and 82.5% GLRaV-1 – free plants of Flame seedless genotype (Fayek et al., 2009).

Grapevine rupestris stem pitting-associated virus (GRSPaV) elimination by meristem of 0.7 mm culture, applied to 6 grapevine genotypes led to unexpected results: only 2 genotypes could regenerate virus-free plants, with very different rates (14.2% to Albarola and 72.7% to Bosco) (Gribaudo et al., 2006).

The research carried out in our country at NRDIBH Stefanesti revealed the possibility of obtaining healthy plants through meristem cultures in a proportion of 60-84.2% for GFLV in complex with GFkV, and 83-95% in the case of leafroll viruses, with the condition that the excised explants should not be larger than 0.2-0.3 mm (Vişoiu and Teodorescu, 2001).

Despite the successes achieved by this method, there are some problems that prevent the use and recommendation of this technique (Altmayer, 1989; Hatjinikolakis and Roubelakis-Angelakis, 1993).

One of the major problems is the difficulty of isolating the meristem as small as possible, followed by the multiple requirements necessary to ensure the viability of the explant and the initiation of regeneration processes: the appearance of adventive buds at the base of the pseudo-petiole of the phylloid formations after 40-45 days of culture, the formation of shoot primordia from the adventive buds after 60 days of culture, the proper multiplication, after approximately 90 days.

A proof of this regard is the experiment carried out by Gribaudo et al. (1997) who obtained a virus elimination percentage of 79.3% for grapevine virus A (GVA), GLRaV-1 and GLRaV-3, pointing out that the rate of elimination of the virus can be influenced by the genotype, the type of the virus and, last but not least, by the difficulty of isolating the meristem.

Thermotherapy and *in vitro* culture are based on decreasing the virus multiplication rate under the influence of high temperature, 35-45°C. Heat-treated plants can produce virus-free tissues, and the lack of vascular elements in the meristem makes difficult to transport viral particles to the meristematic dome. These tissues, if they are collected and grown *in vitro*, can generate new plants identical to mother plant.

Combining tissue culture with thermotherapy led to the virus elimination from different grapevine species (Stellmach, 1980; Barlass et al., 1982; Goussard et al., 1991; Savino et al., 1991; Buciumeanu and Vişoiu, 1996).

In virus elimination experiments by thermotherapy on 4 serotypes associated with leafroll to *V. vinifera*, Black Seedless variety, heat treatment at 38°C for over than 150 days and the use of 3 distal buds for micropropagation led to 100% virus elimination (Stellmach, 1993).

The effect of high temperature (36-38°C), applied for a long period (60-70 days) to infected plant used as donor explants, belonging to *V. vinifera* (Räuschling variety), and *in vitro* cultivation of meristematic apices led to GLRaV-1 total elimination (Staudt and Kassemeyer, 1994).

The results of the research undertaken by Hatzinikolakis and Roubelakis-Angelakis (1993) demonstrated that high percentages of healthy plants can be obtained also through *in vitro* thermotherapy of fragment of a node explants.

In vitro thermotherapy of small explants (apices of 5 mm) led to their necrosis after 8 weeks (Leonhardt et al., 1998). The authors recommended the use of rooted microshoots for virus elimination by *in vitro* thermotherapy. Two months after thermotherapy almost all clones included in the experiment were virus-free.

GVA- elimination of by *in vitro* thermotherapy (57 days at 37°C) was confirmed by RT-PCR in 60% of regenerated plants (Panattoni et al., 2007).

In vitro thermotherapy applied to some rootstock genotypes infected with ArMV, GLRaV-3 and GFLV gave satisfactory results (Křižan, 2008). GFLV elimination in grapevine rootstocks was achieved concomitant by *in vivo* and *in vitro* thermotherapy at 37°C for 45 days. *In vivo* thermotherapy gave better results, although it is more laborious (Křižan, 2009).

Regarding the GPGV elimination have been reported results on the regeneration of virus-free plants by meristem culture with and without thermotherapy. Infected vines belonging to Traminer and Pinot gris genotypes were kept for 2-4 months at 34-38°C before meristem excision. Regenerated plants of Traminer genotype were confirmed virus-free by RT-PCR after an acclimatization period of 3-6 months, during which they did not show characteristic symptoms of the disease. The dependence of the virus elimination method by the genotype was confirmed once again because the plants of Pinot gris did not survive to the heat treatment (Gualandri et al., 2015).

In California, Rieger (2017) reported GPGV elimination by apices micropropagation. The process of virus-free plants obtaining took for 18-24 months before they could be planted, as they were repeatedly analysed for the phytosanitary status safety.

In Romania, Buciumeanu and Vișoiu (2000) reported the elimination of GFLV, GLRaV-3 and GFkV by i*n vitro* culture and/or *in vivo* thermotherapy (Table 2).

Table 2. Elimination of grapevine viruses by thermotherapy and/or *in vitro* culture (Buciumeanu and Vișoiu, 2000) // Eliminarea virusurilor la vița-de-vie prin termoterapie și/sau cultură *in vitro* (Buciumeanu și Vișoiu, 2000)

Thermotherapy (no. of days)	*In vitro* culture (explant)	Virus-free regenerated plants (%)		
		GFLV	GLRaV-3	GFkV
0	Meristem/apex/axillary bud	72/0/0	-/50/16	91/-/-
30	Apex/ axillary bud	60/33	51.7/37.5	-
40	Apex/ axillary bud	100/50	66.5/38.4	84.7/70
60-65	Apex/ axillary bud	100/50	100/100	96/-
80	Apex/ axillary bud	-	-	-/70

A bibliographic study carried out in 1991-2010 period regarding the use of different virus-free plant regeneration methods revealed that thermotherapy was the first and most used method, with a frequency of 56.8% (Panattoni et al., 2013).

Chemotherapy

The deficiencies of the method related to the viability of the explants, the dependence of the virus elimination rate by the genotype and virus, the long time required for the regeneration of new plants and the energy-consuming equipment led to the necessity to develop alternative methods to block viral replication. Thus, the first studies on virus elimination through the use of chemotherapeutics from human medicine and electric current that can cause a degradation of the viral protein at the cellular level appeared.

Among the viricides used to eliminate various types of viruses in horticultural plants, ribavirin was the most frequently used, followed by 5-azacytidine (AZA), acycloguanosine, azidothymidine, 2,4-dioxohexahydro-1,2,5-triazine (DHT), dihydroxy propyladenine (DHPA), oseltamivir, mycophenolic acid (6-(4-hydroxy-6-methoxy-7-methyl-3-oxo-1,3-dihydroisobenzofuran-5-yl)-4-methyl-hex-enoic acid) (MPA), selenazole (2-β-D-ribofuranosylselenasole-4-carboxamide) (SE), 3-deazauridine (DZD), cyanoguanidine, etc.

The use of chemotherapeutics in the *in vitro* culture for the purpose of regenerating virus-free grapevine raised many questions regarding their possible phytotoxic effect on explants grown on the medium. Panattoni et al. (2011) reported 100% explant mortality rate starting from 20 mg/L ribavirin, with oseltamivir registering a mortality rate of 11.1% at 40 mg/L concentration.

Starting from 2006, at NRDIBH Stefanesti were carried out studies on grapevine virus elimination by *in vitro* chemotherapy. The methods were applied for GFLV, GFkV, GVA, GLRaV-1, GLRaV-3, both in simple and mixed infections (Fig. 5).

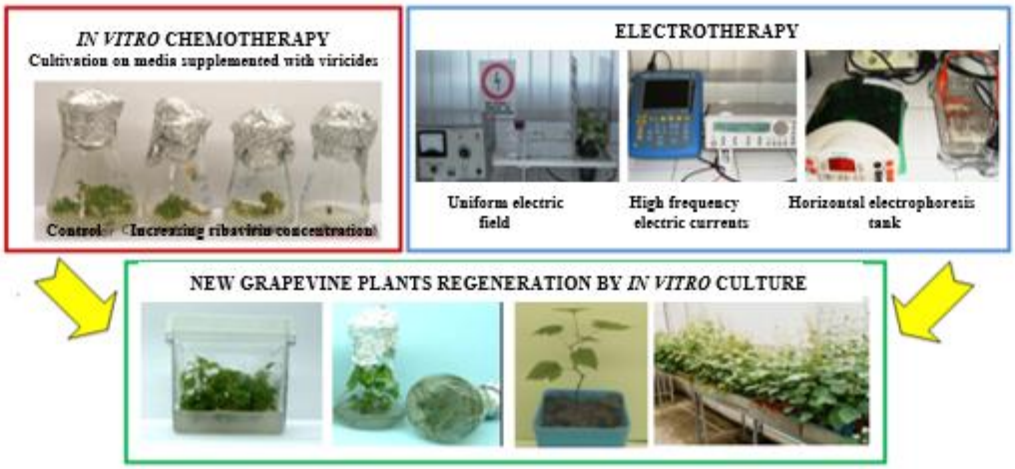

Fig. 5. Alternative methods of grapevine virus elimination developed at NRDIBH Stefanesti // Metode alternative de eliminare a virusurilor la vița-de-vie dezvoltate la INCDBH Ștefănești

In vitro chemotherapy consisted of growing of plant fragments from infected grapevines on medium supplemented with viricides. The chemotherapeutic substances ribavirin and oseltamivir were tested at various concentrations and exposure time, both alone and in combination. Also, in order to expand the list of chemotherapeutics useful for the plant virus elimination, the antiviral substances darunavir and isoprinosine were studied.

The studies shown that ribavirin has a phytotoxic effect expressed by the multiplication rate and mortality of the inoculum more pronounced as compared to oseltamivir (Guţă et al., 2009). At 40 mg/L ribavirin, GFkV-infected Caner genotype behaved by significantly multiplication rate decreasing by 4.3 and 3.03 times, after the first and second subcultures respectively, so that after three treatment subcultures the inocula did not survive. On the other hand, oseltamivir induced the intense proliferation of adventive buds after the first subculture, formations that did not fully evolve in the differentiation and elongation of shoots, and no mortality of the inoculum was recorded at different concentration variant (Guţă, 2010).

The simultaneous use of ribavirin and oseltamivir in order to increase the elimination rate of GFkV from Tamaioasa romaneasca 3-2-2 genotype allowed the initiation of callogenesis processes on all experimental variants, explant mortality being not recorded even after three consecutive treatment subcultures. Visual observations revealed that the differentiation and elongation of shoots, as well as the accumulation of chlorophyll pigments, dependent on the viricides concentration, especially ribavirin, whose phytotoxic effect was more pronounced as compared to oseltamivir. Generally, the multiplication rate decreased as compared to the control in all variants and subcultures. In the first subculture of treatment, the highest concentration of ribavirin caused a higher decrease of multiplication rate (2.2) as compared to the control (3.0), and reducing the viricide concentration by half, completed by the presence of oseltamivir, caused an intense proliferation of adventive buds. Even 40 mg/L ribavirin combined with 40, 80 mg/L oseltamivir caused the multiplication rate decreasing, but does not induce explant mortality after three treatment subcultures (Guţă, 2010). This behaviour is due, on the one hand, to the different phytotoxic effect of the viricides and, on the other hand, to the tolerance to the viricides of the genotypes and their different regenerative potential.

The same treatment with a mixture of viricides applied to Burgund 63 Mn genotype naturally infected with the GFkV and GVA viral complex determined an increase of the multiplication rates after the first subculture, on all viricide concentration variants. In the second subculture, the rates decreased approximately by half for all variants without differences depending on the concentration. This behaviour could be explained by the presence of viricides in the media which produce a stimulation of adventive buds formation, which in the next subculture did not evolve in the favour of shoot differentiation and elongation.

Grapevine virus elimination by *in vitro* chemotherapy showed the dependence of sanitation rate on viral infection, working parameters and even the grapevine genotype (Table 3).

Table 3. Grapevine viruses elimination by *in vitro* chemotherapy (original) // Eliminarea virusurilor la viţa-de-vie prin chimioterapie *in vitro* (original)

Viricide	Concentration (mg /L)	Virus infection	Virus elimination rate(%)	References
Ribavirin	20	GFLV	100	Guţă et al., 2007b
		GFkV GLRaV-1+3	100 78.6	Guţă et al., 2008
		GVA + GLVaV-1	11	Guţă and Buciumeanu, 2010; 2011b
	60	GLRaV-1	26	Guţă et al., 2017a
		GFLV GFkV	33.3 37.5	Guţă and Buciumeanu, 2012a, b
Oseltamivir	30	GLRaV-1+3	71.42	Guţă et al., 2010
	40	GLRaV-1+3 GFkV	62.5 23.3	Guţă and Buciumeanu, 2012a, b
Ribavirin +Oseltamivir	20 Ribavirin +40 Oseltamivir	GFkV	100	Guţă et al., 2014
	40 Ribavirin +40 Oseltamivir	GLRaV-1	13.3	Guţă et al., 2015
	20 Ribavirin +40 Oseltamivir	GFLV	6.8	Guţă et al., 2017b
	60 Ribavirin+ 120 Oseltamivir	GFkV	100	Guţă et al., 2016a
Darunavir	20-120	GFLV; GLRaV-1+3; GFkV	0	Unpublished
Isoprinosine	20-120	GFLV; GLRaV-1+3; GFkV	0	Unpublished

All these results led to the development and patenting of a virus elimination method in grapevines (Patent no. 123133/2010), currently used for the regeneration of virus-free plants belonging to genotypes destined to the grapevine germplasm collection of INCDH Stefanesti.

Regarding the GPGV-elimination by *in vitro* chemotherapy, the unique available reference indicated the use of ribavirin in two concentrations (10 and 20 mg/L) and 3 treatment times (4, 6 and 8 weeks), in two successive stages. Explants cultivated on ribavirin containing media were transferred after the first phase of treatment to regular media for recovery, for 8 weeks, and then treated again with the same ribavirin concentration and exposure time as in the first treatment. After 8 weeks of treatment in the first phase, the efficiency of the method registered a maximum of 66.7% at 10 mg/L ribavirin and a maximum of 86.7% virus elimination at 20 mg/L ribavirin. Applying the same treatment parameters in a new stage led to the complete elimination in two grapevine genotypes out of three treated at both viricide concentrations. The same treatment scheme led to GFKV- elimination in first stage, after 8 weeks of treatment in one of three genotypes treated with both 10 mg/L and 20 mg/L ribavirin. Repeated application of the treatments with 10 mg/L ribavirin determined the GFkV -elimination after only 4 weeks in one genotype, after 6 weeks in all three treated genotypes, next registering rates of 75, 93.3 and 100% after 8 weeks. Increasing the ribavirin concentration to 20 mg/L eliminated virus in all three genotypes after 4 and 6 weeks of treatment, with low decrease in one genotype to 93.3% at 8 weeks (Komínek et al., 2016).

Electrotherapy as a virus elimination method uses electric current in different forms in order to degrade the viral protein, as a result of temperature increasing at the cellular level. This is not the temperature of the chamber where the tissues are incubated as it happens in traditional thermotherapy. The effect of denaturation is applied to all proteins in the plant tissue, not only to the viral nucleoprotein, and this is a reversible process when the electric current is stopped (Gonzales et al., 2006).

Grapevine cuttings from GFLV-infected plants were subjected to 34 V/cm for 3 hours. Also, the plants were subjected to 1 V/cm and leaf samples were collected after 1, 5, 10, 20, 30, 40, 50, 60 days. The ELISA evaluation showed that the values of the readings obtained from samples of infected mother plants subjected to 1 V/cm decrease with increasing treatment time, only up to 60 days of application of the electric field, after which they stabilized. However, plants regenerated from cuttings subjected to electric current remained positive for GFLV (Burger, 1989).

The effects of electric current were studied in 30 cm long cuttings of grapevine rootstock placed horizontally and crossed by electric current of 30, 60 V, for 3, 6, 9 hours. The rooting rate, the number and the weight of the roots were studied depending of the treatments. At 30 V, all parameters increased with increasing exposure time, while at 60 V they decreased when the time exceeded 3 hours. The treatment with 60 V for 3 hours showed the highest increasing of rooting rate (122%) and number of roots (100%) as compared to the control. These results indicate the possibility of propagation improving of rootstocks with rooting difficulties (Köse, 2007).

Until now, at NRDIBH Stefanesti, studies have been carried out to eliminate the most important grapevine viruses by electrotherapy. For virus elimination, electric current was used in the form of uniform electric field, direct stimulation with high frequency electric currents and electric treatment in horizontal electrophoresis tank.

The electric field applied to grapevine plants belonging to Cabernet Sauvignon genotype, infected with GLRaV-3 led to obtaining high virus elimination rates (57.1-100%), without direct correlations between the exposure period and the treatment efficiency. Three electric field intensities (10, 20, 40 V/cm) and three exposure time (5, 10, 20 min) were applied. At the stimulation variant of 20 V/cm for 20 min, GLRaV-1+3 was completely eliminated, *in vitro* multiplication and rooting rate increasing significantly as compared to other variants (Guță et al., 2008 a, b).

Electrotherapy applied to eliminate GLRaV-1+3 from another grapevine variety, Ranai Magaraci, led to 33.3-66.6% sanitation rates at 10V/cm, 20 min (Guță et al., 2010), which confirmed once again the dependence of virus elimination by treatment parameters and, not the least, on genotype. Uniform electric field electrotherapy was not effective for GFLV-elimination (Guță and Buciumeanu, 2012a, b).

Direct stimulation with alternative electric current of microshoots collected from infected grapevine, followed *by in vitro* culture has been investigated as a technique for virus elimination of both simple and complex infections. Electric current of 1000 and 10000 kHz was applied to the ends of herbaceous grapevine cuttings; after that, the treated axillary buds went through the stages of micropropagation. ELISA performed on regenerated and acclimatized plants showed encouraging results regarding the elimination of filamentous viruses GLRaV-1 and GLRaV-3 (12.5% elimination at 100 kHz and 4.5% at 10000 kHz, respectively, after 10 min of exposure time). The results were not reproducible in the case of GLRaV-1 - elimination from plants with mixed infections. No satisfactory results were obtained regarding the elimination of isodiametric viruses (GFLV, GFkV) in simple or mixed infections (Guță et al., 2011b; Guță and Buciumeanu, 2012a, b).

Another method of electrical stimulation, electrotherapy in a horizontal electrophoresis tank led to the total elimination of GFkV at 100 mA - 20 min by apices culture. GLRaV-1+3 was eliminated at the best rate (33.3%) at 50 mA - 10 min from axillary buds. GFLV was 50% eliminated treating apices with 40 mA - 20 min. GFkV + GVA virus complex was 50% eliminated by apex culture, at 40 mA – 10 min, and of 49.95% by axillary bud culture, at 50 mA - 20 min (Guță et al., 2016, 2019).

CONCLUSIONS

1. The virological analyses of the grapevine aim to obtain a healthy propagation material, free of the viruses mentioned by the Romanian legislation harmonized with the EU legislation: *Grapevine fanleaf virus* and *Arabis mosaic virus*; *Grapevine leafroll-associated viruses serotypes 1 and 3*; *Grapevine fleck virus*.
2. The widespread distribution of *Grapevine Pinot Gris virus*, its transmission by seed and the natural infection of several herbaceous plant species supports the recommendation to include this virus in the breeding programs and the in schemes of high biological value grapevine propagation material production.
3. Visual observations carried out in the field regarding the symptoms developed by the grapevine in the presence of virus infections and laboratory analyses confirmed the existence of viruses and virus complexes, the level of infection being higher in young plantations, as a result of the sanitary check and the inadequate traceability of the material of multiplication.
4. The control of grapevine virus diseases can be achieved using virus-free propagating material. For this purpose, several methods of virus elimination have been applied and developed: intensely regenerative meristem/apex culture with and without thermotherapy, *in vitro* chemotherapy, electrotherapy and their combinations.
5. The studies revealed the dependence of virus elimination rates on the sanitation method, the virus type and the grapevine genotype.

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BEHAVIOR OF MAMAIA AND COLUMNA VARIETIES IN THE CONDITIONS OF MURFATLAR VINEYARD ECOSYSTEM

COMPORTAREA SOIURILOR MAMAIA ȘI COLUMNA ÎN CONDIŢIILE ECOSISTEMULUI VITICOL MURFATLAR

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Abstract
The objective of the present study was to evaluate the influence of climate variability of the last three years, namely 2020-2022, on grape quality and implicitly of obtained wines from two varieties for white and red wines created at the Murfatlar Research Station, Columna and Mamaia. The increase in average annual temperature values by approximately +2.0°C compared to the reference period (years 2000-2019) in the months of February and March, correlated with the lack of precipitation, contributed to the advance the moment of vine budding and flowering, on average by 5-7 days. It was also observed a tendency for early ripening of the grapes (harvesting taking place 5 days earlier for the Columna variety and 7 days for Mamaia variety). The quality of the grapes highlighted by the content of sugars, total acidity and pH, showed significant differences in the three years under study, the sugar concentrations at the time of harvest reaching over 190 g/L, allowing the wines to be classified in the category of quality wines with controlled designation of origin DOC Murfatlar; the best results were obtained in 2022 with values of 208.7 g/L for the Columna variety and 210.8 g/L for Mamaia variety.

Keywords: *new varieties, climate, phenophases, grape quality, wine quality*

Rezumat
Obiectivul acestui studiu a constat in evaluarea influentei variabilităţii climatice din ultimii trei ani, respectiv 2020-2022, asupra calităţii strugurilor şi implicit a vinurilor obţinute din două soiuri de struguri pentru vinuri albe şi roşii create la SCDVV Murfatlar, Columna şi Mamaia. Creşterea valorilor medii anuale ale temperaturilor cu aproximativ +2,0 oC comparativ cu perioada de referință (anii 2000-2019) în lunile februarie și martie, corelata cu lipsa precipitațiilor a contribuit la devansarea momentului declanșării dezmuguritului și înfloritului, în medie cu 5-7 zile. S-a constat deasemenea, o tendinţă de maturare timpurie a strugurilor (recoltarea realizându-se mai devreme cu 5 zile la soiul Columna şi 7 zile la Mamaia). Calitatea strugurilor evidenţiată prin conţinutul în zaharuri, aciditatea totală şi pH, a prezentat diferenţe semnificative în cei trei ani studiaţi, concentraţiile în zaharuri la momentul recoltării fiind de peste 190 g/l permiţând încadrarea vinurilor în categoria vinurilor de calitate cu denumire de origine controlată DOC Murfatlar; cele mai bune rezultate s-au evidenţiat în anul 2022 cu valori de 208,7 g/l la soiul Columna şi 210,8 g/l la Mamaia.

Cuvinte cheie: *soiuri noi, clima, fenofaze, calitate struguri, calitate vinuri*

INTRODUCTION

It is well known that the great wines of the world are produced in regions with a favorable climate for growing grape varieties for quality white and red wines. The Murfatlar viticultural area is of great economic importance in the wine industry, due to its favorable climatic conditions, but also to its tradition in wine grapes cultivation. The natural conditions of this region are particularly suitable for this crop, the entire surface being located in the CII region (cf. Ord. no. 645/2005 MARD). From a climatic point of view, the area benefits from considerable heliothermal resources and low amounts of precipitation. What is worth emphasizing is the uneven distribution of these precipitations, some intervals registering very large deviations from the normal amount, with excess or deficit precipitation, alternating with periods of values above average, followed by periods with pluviometric deficit. The soil consists mainly of calcareous chernozem, rich in calcium carbonate, an important factor of inluence on wine organoleptic qualities.

Grapevine growth and development in the context of current climate changes represents a challenge for winegrowers/oenologists, in order to adapt to these changes through various strategies (optimization of some technological links and viticultural practices), to compensate these imbalances and obtain quality and balanced wines. The consequences that the frequency of climatic accidents and their intensity have on cultivated plants are aspects that can no longer be ignored, especially in case of perennial plants (1). The temperature and humidity regime are among the basic elements that define the viticultural terroir (2), the average air temperature during the growing season being particularly important. Given the current climatic characteristics, it is expected that there will be changes both in terms of the impact on native ecosystems, but also on crops and, implicitly, in the change of viticultural zoning.

Each grape variety has a unique combination of characteristics, which together with applied agrotechnical measures, geographical location and zonal ecological characteristics, as well as winemaking techniques, influences directly the quality of the grapes and of the resulted wine (3). The impact that climate changes of the last decades have on grapevine are highlighted in a series of scientific works in the field. Among the environmental factors with the greatest influence on the phenological development of the vine, temperature is the climatic parameter with the greatest impact. The increase in temperature leads primarily to the initiation and early onset of phenophases (4, 5, 6), a trend observed in many regions of the world; early phenophases onset can lead to early bud exposure to climatic accidents (7), high temperatures can remove certain varieties from the optimal areas for their cultivation (8), this tendency can lead to excessive accumulations of sugars, the decrease of acidity and the loss of aromas.

Climate change also leads to the exposure of vines to drought, either due to reduced amounts of precipitation or through the evapotranspiration process due to increased temperatures. This leads to low crop yield, particularly through reduced berry size (9,10) and reduced bud fertility (11).

The purpose of this paper was to evaluate the climatic conditions during the years 2020-2022, compared to the multiannual average (2000-2019) and their influence on the quality of the grapes and implicitly of the wine.

MATERIAL AND METHOD

Two varieties created at the Murfatlar Research Station were studied, one for white wines, Columna, and one for red and aromatic rosé wines, Mamaia.

The Columna variety was homologated in 1985; it was obtained by sexual hybridization of the Pinot gris and Grasă de Cotnari varieties; it is a variety that stands out for its straight shoot growth, in the form of a curtain, that allows the airing of the stocks and the display of the grapes, facilitating cultivation in ecological system; from a qualitative point of view the must stands out for its relatively high acidity of 5-6 g/L.

The Mamaia variety was approved in 1991; it was obtained by sexual hybridization between the Merlot x (Babească neagră x Muscat Ottonel) varieties; this variety is also suited for cultivation in an ecological system, obtaining quality wines that are easily distinguished by the specific aroma.

The experimental plots were placed on a parcel with N-S exposition, slope of 3-5%, soil of chalky chernozem type with clay texture. The vine is planted on the rootstock *Vitis berlandieri x V. riparia Oppenheim 4 selection*, clone SO_4-4 and trained with semi-high stems of 70 cm and bilateral cordons with cane pruning. The density of the plantation was 4,132 vines/ha, with 2.2 m between rows and 1.1 m between trunks.

The meteorological data presented in this study are part of the climatic database recorded daily using an automatic iMetos 3.3 station of SCDVV Murfatlar, including daily observations of maximum and minimum temperatures, insolation and precipitation.

The data on the development stage of the plants were recorded following observations in the field, noting the budburst on the date when 50% of the existing buds are in the "woolly" stage (cf. Baggiollini); in the case of flowering, the date at which 50% of the inflorescences were opened was considered, and in the case of veraison, the date at which 50% of the berries became pigmented was taken into account.

The must sugar content was determined refractometrically; the total acidity by titrimetry with NaOH solution of 0.1 n concentration; the pH was determined using the WTW inoLab pH 7110 device. Wine physical-chemical composition was evaluated based on the general composition parameters (alcohol concentration, total and volatile acidity, reducing sugar, non-reducing dry extract) which were determined by standardized methods.

The statistical computation was performed using the SPSS Statistics 17.0 program, applying the Duncan test, for DS 5%.

RESULTS AND DISCUSSION

In order to observe the influence of the meteorological parameters during the three years under study (2020-2022) on the production of amaia and Columna varieties, the average monthly temperatures and the amount of precipitation were compared with the average values recorded in the last two decades, correlated with the influence on vegetative phenophases and on the productivity of these varieties from a quantitative and qualitative point of view. The temperature regime, as can be seen in Figure 1, registered a significant increase especially in the months preceding the vegetative season (February and March) compared to the multiannual averages (2000-2019). In February, the average temperatures recorded were approximately 2°C higher, the largest difference of 2.3° being recorded in 2021, and the smallest difference of 1.8 °C in the year 2022. In March the difference in temperature from the average was moderate, with a significant increase of 3.6°C in 2020. These differences in temperature led to the early onset of budding, especially in 2020, and the early start of the vegetation period. Significant temperature differences can be observed also during the ripening period (June and August) during all the years under study, for the month of July the difference being over 3°C, with the biggest difference (3.7°C) in 2020. In August, there were differences between 2.5 and 3.5°C, the smallest difference compared to the multiannual average being recorded in 2021, and the largest in 2022. This phenomenon led to an increased water stress on the plant and a shortening of the ripening period of the grapes.

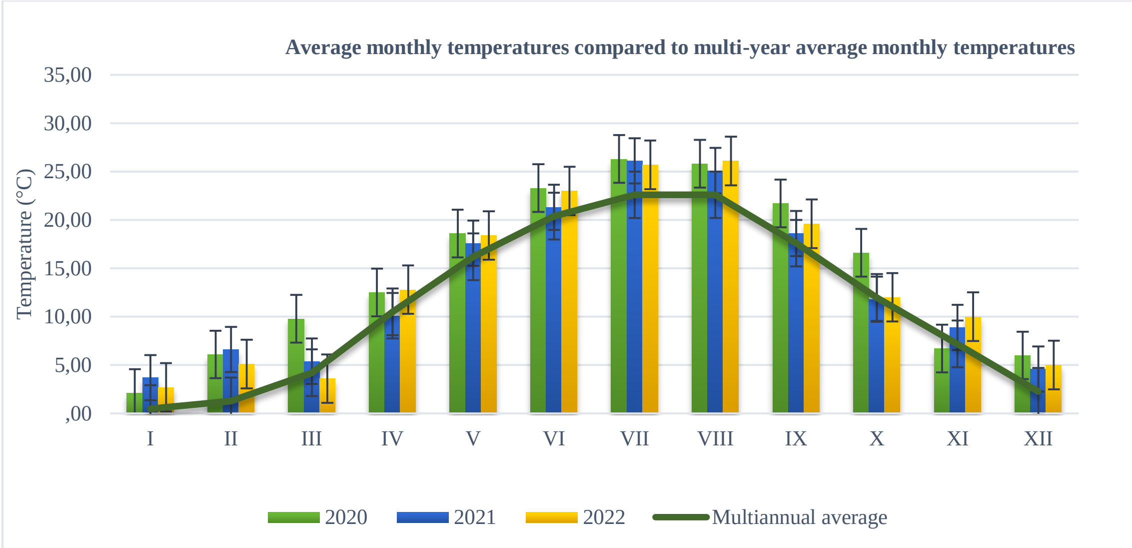

Figure 1. Average monthly temperatures compared to multiannual average monthly temperatures (2000-2019) under the conditions of the Murfatlar wine-growing center // Temperaturile medii lunare comparativ cu temperaturile medii lunare multianuale (2000-2019) în condițiile centrului viticol Murfatlar

Regarding the amount of precipitation, in Figure 2 it can be seen that it presents an uneven distribution, with the highest amounts of precipitation recorded in the months of January (109.0 mm) and June (130.4 mm) 2021, the year characterized by the highest amount of precipitation, with a total of 737.2 mm compared to the multiannual average of 436 mm.

During the three years under study, August was dry, with very low amounts - between 2.2 mm in 2020 and 6.8 mm in 2021, compared to the multiannual average of 31.6 mm.

The year with the biggest precipitation quantity among those studied was 2021, while the lowest amount of precipitation was recorded in 2020 – 333.1 mm.

Although the grapevine has a great capacity to adapt to moisture excess and deficit, these alternate periods of water deficit and excess lead to disruption of the plant's physiological processes, affecting vegetative growth and implicitly the production.

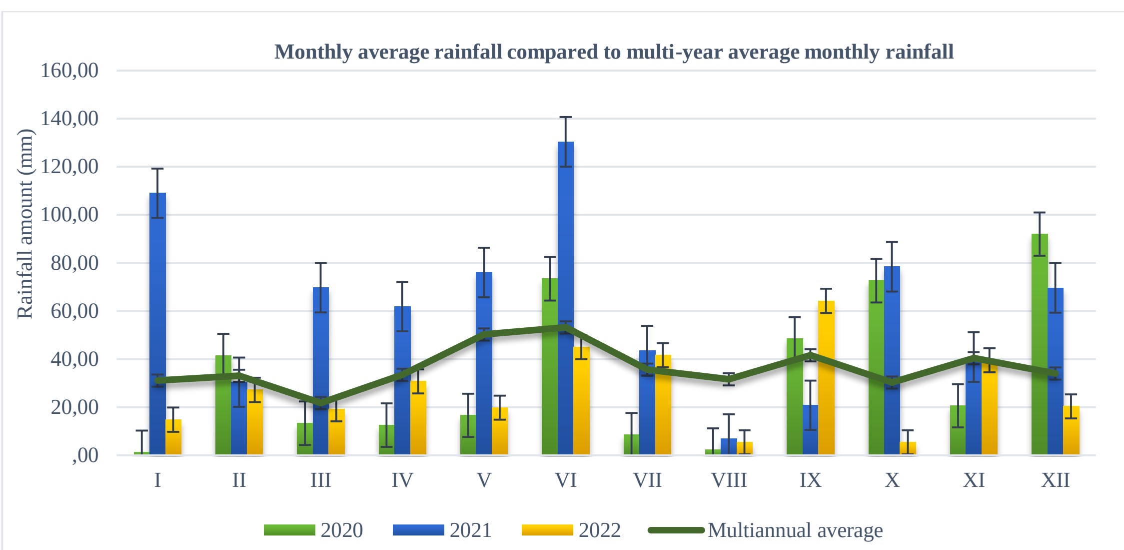

Figure 2. Monthly precipitation compared to multiannual average monthly precipitation (2000-2019) under the conditions of the Murfatlar wine-growing center // Precipitațiile lunare comparativ cu precipitațiile medii lunare multianuale (2000-2019) în condițiile centrului viticol Murfatlar

Grapevine phenology is strongly influenced by temperature. This relationship is so strong that vine phenology can be accurately predicted based on temperature-only dependent models (12). In recent years, observations from different wine regions of the world have shown changes in terms of the development of the grapevine and the ripening time of grapes, a phenomenon also observed in our country and, implicitly, in the Murfatlar vineyard.

Vegetation phenophases were complexly conditioned by the level and cumulative action of climatic factors. All these climate changes influenced the onset and the development of the phenophases of the vine vegetation with influences on the quality of the harvest. The vegetation onset for both varieties (budburst) was reached starting with the second decade of April, with the exception of 2020, for the Columna variety, when budburst occurred on 13. IV. Compared to the reference interval, the start of vegetation for the Columna variety was achieved on average 4 days earlier (on 18. IV compared to 22. IV), flowering and veraison were achieved one day earlier, and full maturity 5 days later. The harvest was carried out on average after 24. IX. For the Mamaia variety the start of vegetation was achieved 3 days later (on average on 23. IV versus 20. IV). Grapes veraison onset was 3 days earlier (on 11 August against 14 August) and full maturity of the grapes was reached during September 2 days earlier than the average period for 2000-2019 (on 15. IX compared to 17. IX). The grapes of the Mamaia variety were harvested 3 days earlier (on 17. IX compared to 20. IX) (Table 1).

Table 1. Vegetative phenophases for the varieties Mamaia and Columna between the years 2020 and 2023 // Fenofazele vegetative pentru soiurile Mamaia și Columna între anii 2020 și 2023

Variety	Year	Budding	Flowering	Veraison	Full Maturity	Harvesting date
Columna	**2020**	13 IV	29 V	10 VIII	16 IX	21 IX
	2021	20 IV	04 VI	20 VIII	27 IX	27 IX
	2022	24 IV	05 VI	09 VIII	19 IX	26 IX
Average 2020-2022		**13 IV -24 IV** **18 IV**	**29 V-05 VI** **01 VI**	**9 VIII -20 VIII** **14 VIII**	**16 IX-27 IX** **21 IX**	**21 IX-27 IX** **24 IX**
Average 2000-2019		**11 IV-04 V** **22 IV**	**21 V-15 VI** **02 VI**	**04 VIII-26 VIII** **15 VIII**	**04 IX-28 IX** **16 IX**	**15 IX- 30 IX** **23 IX**
Mamaia	**2020**	21 IV	04 VI	12 VIII	14 IX	14 IX
	2021	26 IV	03 VI	10 VIII	17 IX	20 IX
	2022	26 IV	03 VI	12 VIII	16 IX	21 IX
Average 2020-2022		**21 IV-26 IV** **23 IV**	**03 VI- 04 VI** **03 VI**	**10 VIII-12 VIII** **11 VIII**	**14 IX-17 IX** **15 IX**	**14 IX-21 IX** **17 IX**
Average 2000-2019		**12 IV-29 IV** **20 IV**	**24 V-10 VI** **02 VI**	**29 VII-30 VIII** **14 VIII**	**10 IX-25 IX** **17 IX**	**15 IX-25 IX** **20 IX**

High temperatures favor malic acid degradation, directly correlated with must acidity, and accelerate the accumulation of sugars by stimulating photosynthetic activity. Production quality in terms of sugar content and total must acidity (table 2) shows different accumulations depending on the potential of the variety and on the climatic conditions specific for each year.

In 2020, the Mamaia variety recorded a higher sugar content, slightly higher than the reference (described by ampelography), while the Columna variety accumulated a sugar content slightly below its potential (196 g/L). In 2021, both varieties were below the optimal sugar accumulation level, with values slightly below their potential. For the 2022 harvest, both varieties show superior values from this point of view, which can be considered the most favorable year among those studied, a fact that was reflected in the favorable climatic conditions of this wine year. From the point of view of total acidity, in the case of the three studied years, the two varieties presented values specific to the variety.

Table 2. Quality of grapes at the time of harvest for the varieties Mamaia and Columna between the years 2020 and 2022 // Calitatea strugurilor la momentul recoltării pentru soiurile Mamaia și Columna între anii 2020 și 2022

Variety	Year	Sugars (g/L)	Total Acidity (g/L H_2SO_4)	pH
Columna	2020	196.0±2.0 (b)	6.4±0.4 (a)	3.36±0.2 (a)
	2021	193.9±1.4 (a)	6.3±0.3 (a)	3.33±0.1 (a)

	2022	208.7±1.7 (a)	5.4±0.2 (b)	3.52±0.1 (a)
Mamaia	2020	206.6±2.1 (b)	4.9±0.2 (b)	3.78±0.1 (a)
	2021	197.0±1.6 (c)	5.3±0.2 (a)	3.49±0.2 (a)
	2022	210.8±2.5 (a)	5.1±0.2 (ab)	3.46±0.2 (a)

Average values, ± standard deviation (n=3), the letters represent the significance of the $p<0.05$ difference between variants. The difference between any two values followed by at least one common letter is insignificant

Wine quality was closely related to the quality of the must, as can be seen in table 3, the results obtained did not present significant differences from a statistical point of view. As for alcohol concentration, the highest values were recorded in 2022, the year in which the best harvests were obtained, both quantitatively and qualitatively. The total acidity has values typical of the two varieties, with lower values in 2022, due to the increased accumulation of sugars, inversely correlated with the metabolism of organic acids. In the case of the three years studied, higher values of volatile acidity are observed for the Mamaia variety, the wine of this variety being susceptible to the early development of this defect, a fact that involves concerns and the subject of future research within SCDVV Murfatlar.

Table 3. Wine quality for the Mamaia and Columna varieties between 2020 and 2022 // Calitatea vinului pentru soiurile Mamaia și Columna între anii 2020 și 2022

Variety	Year	Alcoholic content (%vol)	Total Acidity (g/L)	Volatile Acidity (g/L)	Nonreducing Extract (g/L)	Reducing sugars (g/L)	Density (g/cm^3)
Columna	2020	11.48±0.3 (a)	6.35±0.2 (a)	0.24±0.1 (a)	21.4±1.2 (a)	2.6±0.8 (a)	0.99198±0.0003 (a)
	2021	11.35±0.6 (a)	6.18±0.1 (a)	0.22±0.15 (a)	20.8±1.0 (a)	1.3±0.2 (b)	0.99046±0.0002 (b)
	2022	12.17±0.8 (a)	5.94±0.3 (a)	0.28±0.08 (a)	21.6±1.8 (a)	2.8±0.6 (a)	0.98854±0.0001 (c)
Mamaia	2020	12.03±0.4 (a)	5.65±0.2 (a)	0.56±0.04 (a)	24.1±1.5 (a)	4.0±0.5 (a)	0.99372±0.0002 (a)
	2021	11.52±0.3 (a)	5.83±0.1 (a)	0.54±0.1 (a)	25.0±1.2 (a)	2.6±0.4 (c)	0.99295±0.0001(b)
	2022	12.32±0.2 (a)	5.48±0.3 (a)	0.46±0.07 (a)	23.8±1.6 (a)	3.2±0.6 (ab)	0.99213±0.0002 (c)

Average values, ± standard deviation (n=3), the letters represent the significance of the $p<0.05$ difference between variants. The difference between any two values followed by at least one common letter is insignificant

The data concerning the sensory evaluation of the wines were processed in the form of sensory profiles, presented graphically in Figure 3. Although the analyzed wines present similar aromatic vectors, differences can be observed due to environmental factors specific to each year that influenced the complexity of the aromas. The aromatic characteristics, in the case of both varieties, were best highlighted in the conditions of the year 2022. In case of Columna variety, the predominant olfactory character is floral, of citrus and exotic fruits, and in case of Mamaia variety, floral and fruity.

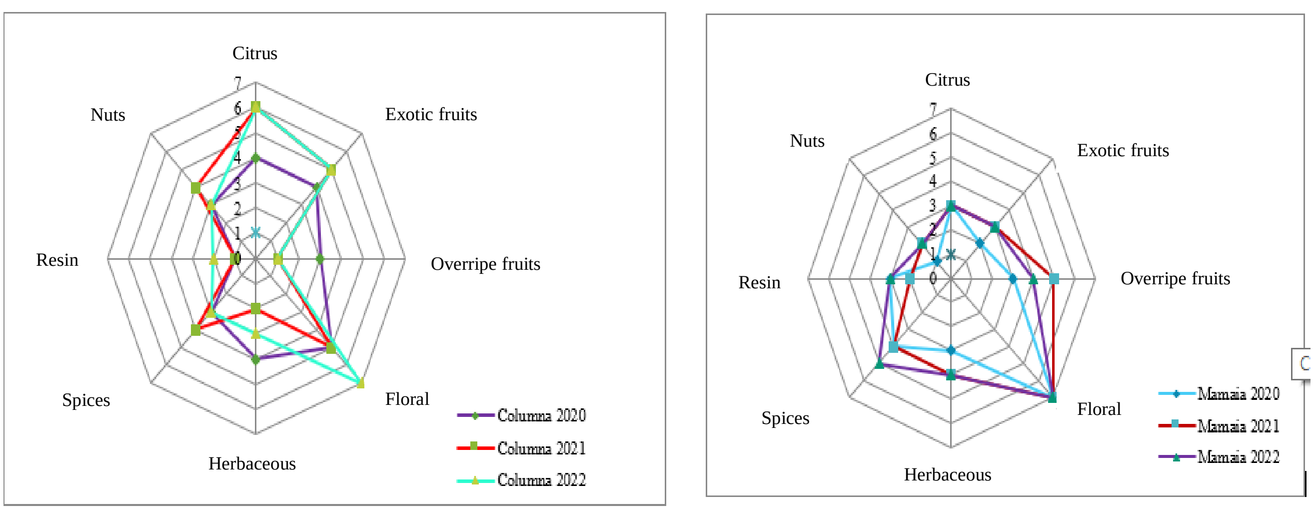

Figure 3. Sensory profile of the wines obtained fromColumna and Mamaia varieties // Profilul senzorial al vinurilor din soiurile Columna și Mamaia

Grape production was significantly influenced by weather conditions, as can be seen from Fig. 4, in 2020 recording the lowest productions for both varieties. The highest productions were achieved in 2022, the difference being 87.1% for the Columna variety and 49.2% for the Mamaia variety compared to 2020.

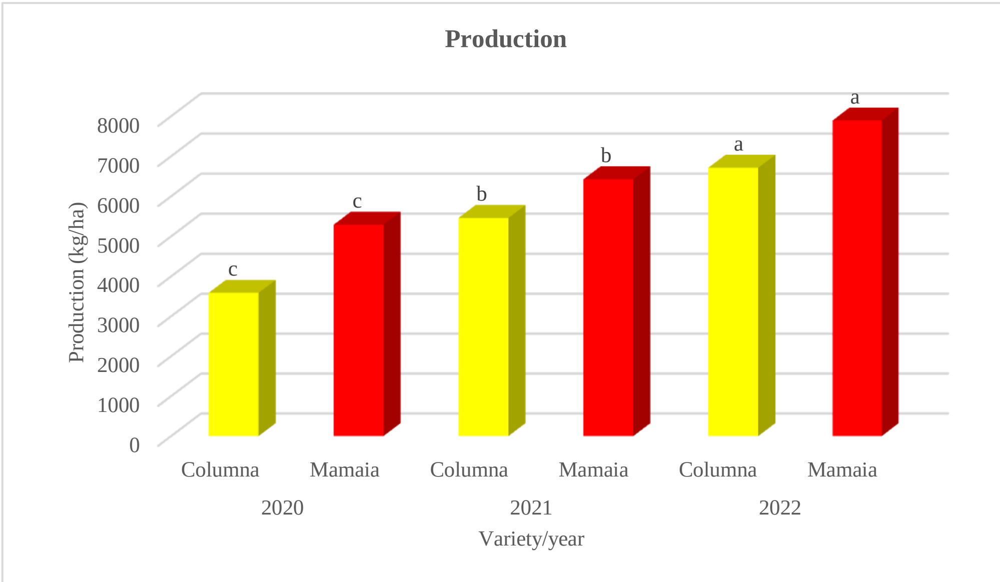

Figure 4. The production obtained for Columna and Mamaia varieties between 2020 and 2022 in the Murfatlar viticultural center // Producția obținută pentru soiurile Columna și Mamaia între anii 2020 și 2022 in centrul viticol Murfatlar

CONCLUSIONS

The increasing trend of air temperature values observed in recent years, especially in the months of February and March, by approximately +2°C, determines the early initiation of budding and the exposure of the buds to bad weather. The increase in temperature values observed during the ripening period, in the months of July and August, of 3-3.5°C determined changes in the metabolism and the processes of growth and development of the vine, influencing the quality and quantity of the obtained wine.

The water regime characterized by the alternation of dry periods with periods of excess rainfall also influenced the production of grapes, causing disruption of the plant's physiological processes and affecting vegetative growth.

The year 2022 met the most favorable conditions for plant development, which can be seen in terms of production, with a difference of 87.1% for the Columna variety and 49.2% for the Mamaia variety compared to 2020, in terms of quality of the must and wine, in 2022 both varieties accumulating over 200 g/L of sugars in the must, but also of the sensory profile.

Due to climate change, grapevine is increasingly exposed to conditions less favorable to its optimal development, a context that will bring new challenges to the European wine sector. Although this plant has physiological strategies for survival, such as the deep root system or the stomatal control of evapotranspiration, viticulture is strongly dependent on the climate. In order to effectively face these challenges, it is necessary to design innovative strategies, adapt viticultural technological practices, but also minimize the contribution that the wine industry itself has to this phenomenon.

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GOLIA - GRAPEVINE VARIETY WITH INCREASED FROST RESISTANCE

GOLIA - SOI DE VIŢĂ-DE-VIE CU REZISTENŢĂ SPORITĂ LA GER

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Rezumat. *Obţinerea unor noi soiuri valoroase de viţă-de-vie, cu producţie şi calitate superioară, care să posede însuşiri de rezistenţă genetică sporită la boli şi ger este rezultatul lucrărilor de cercetare din domeniul ameliorării. În acest context, la Staţiunea de Cercetare - Dezvoltare pentru Viticultură şi Vinificaţie Iaşi, în urma lucrărilor de hibridare sexuată între soiurile Sauvignon × Şarba, a fost omologat în anul 1999 soiul de viţă-de-vie Golia pentru vinuri albe de calitate. Soiul Golia a fost studiat în perioada 2015 - 2022, comparativ cu Fetească albă, unul dintre soiurile consacrate din sortimentul podgoriei Iaşi. Rezultatele obţinute privind vulnerabilitatea soiurilor la acţiunea temperaturilor scăzute, apreciată prin procentul de ochi viabili, atestă faptul că soiul Golia prezintă o rezistenţă genetică sporită la ger. De asemenea, față de datele înscrise la omologare, s-a remarcat un potențial de producție apropiat de normalul biologic al soiului și o tendință de creștere a acumulărilor de zaharuri din must, acestea fiind condiționate de schimbările climatice din ultimii ani. Astfel, în perioada de referință, valoarea medie a producţiei a fost de 3,57 kg/butuc la soiul Golia, fiind apropiată de cea a soiului martor Fetească albă (3,88 kg/butuc). La maturitatea deplină strugurii au acumulat în medie 217 g/L zaharuri şi 5,65 g/L aciditate (acid tartric). Vinul obţinut se remarcă prin tăria alcoolică (13,10 % vol.) superioară martorului Fetească albă (11,57 % vol.), extractul sec nereducător (19,0 g/L) şi conţinutul ridicat de compuşi fenolici (0,47 g/L).*

Cuvinte cheie: *plasticitate ecologică, rezistența la ger, soiuri noi, struguri pentru vin, Vitis vinifera* L.

Abstract. *Obtaining new valuable grapevine varieties, with superior grape yield and quality, possessing an increased genetic resistance to diseases and frost, is the result of breeding research programs. In this context, at the Research - Development Station for Viticulture and Oenology Iaşi, as a result of the sexual hybridization between the Sauvignon × Şarba varieties, was homologated in 1999 the new variety Golia, intended for quality white wines. The Golia variety was studied in the period 2015 - 2022, compared to Fetească albă, one of the most renowned varieties of the Iaşi vineyard assortment. The results obtained regarding the vulnerability of the varieties to low temperatures, assessed by the percentage of viable buds, attest that Golia variety has an increased genetic resistance to frost. Also, compared to the homologation data, was noted a production potential close to the normal biological yield of the variety and a tendency to increase the accumulation of sugars in the must, under the influence of the climate changes in recent years. Thus, in the study period, the average yield was 3.57 kg/stock for the Golia variety, very close to the control variety Fetească albă (3.88 kg/stock). At full maturity, grapes accumulated an average sugar amount of 217 g/L and a total acidity of 5.65 g/L (as tartaric acid). The obtained wine stands out for its alcoholic strength (13.10% vol.), superior to the Fetească albă variety (11.57 % vol.), a higher non-reducing dry extract (19.0 g/L) and polyphenolic content (0.47 g/L).*

Keywords: *ecological plasticity, frost resistance, new varieties, wine grapes, Vitis vinifera L.*

INTRODUCTION

The main risk factors for the grapevine are represented by the winter frost, assessed by the critical value of the absolute minimum temperature, the drought, due to small amounts of precipitation, combined with absolute maximum temperatures higher than 30°C, as well as other climatic factors of an accidental nature (rain in the winter and hail during the vegetation period). The vineyards from the N-E of the country, located towards the northern limit of the grapevine growing, are more and more affected by the climatic changes that have occurred in the last decades. The change in the environmental conditions causes changes in plant metabolism, in the unfolding of growth and development processes, with positive or negative influences on the quality and vitality of plants (Martin T., 1968).

In order to support the grapevine growers, scientific research in the field of plant breeding has accessed a topic aimed at creating new valuable genotypes, with superior yield and quality, and possessing properties of increased genetic resistance to diseases and frost (Oprea Șt. and Moldovan S.D., 2007; Calistru Gh. *et. al*., 1997). In this direction, at the Research - Development Station for Viticulture and Oenology Iaşi was homologated and patented the grapevine variety for white wines Golia, which stands out for its increased genetic resistance to frost, medium tolerance to drought and gray mold, and good resistance to downy mildew and powdery mildew. The research started in 1979 and was materialized through the homologation in 1999 of the new variety, named Golia, as the result of sexual hybridization between the Sauvignon × Şarba varieties. The genetic material was obtained by grafting on several rootstocks in order to assess the affinity to grafting and production (Calistru Gh. *et al.*, 1999). The variety was patented in 2004, after specific tests carried out by specialists from the State Institute for Testing and Registration of Varieties, who confirmed its biological value, authors: Dănulescu Dumitru, Calistru Gheorghe, Damian Doina and Crăcană Alexandru.

MATERIAL AND METHOD

The Golia variety was studied in the 2015 - 2022 period, compared to Fetească albă variety, one of the renowned varieties in the assortment of the Iasi vineyard. The plantations where the research was carried out are at full production capacity, located on a plot with a slope of 7-8 %, predominantly southern exposition, cambic chernozem soil, with planting distances of 2.2 m between rows and 1.2 m between plants, bilateral cordon system, with a stem height of 0.8 m. The agrotechnical measures, correlated with the level of climatic factors, consisted of dry pruning, spring plowing on the intervals maintained as a “black field”, weed control with manual weeding on the row, and mechanical mowing of long-term grass strips, carrying out treatments for diseases and pests, and specific green works (weeding, tying shoots, pruning). The research focused on observations and determinations regarding the vegetation phenophases, frost resistance, behavior to the attack of pathogenic agents, the evaluation of the quantitative and qualitative production, expressed by the average number of grapes per vine, the average weight of a grape, calculated yield, the sugar and total acidity content of grape must and the main characteristics of the obtained wines (OIV, 2012).

RESULTS AND DISCUSSIONS

The overall analysis of the main climatic elements from the study period (2015-2022), compared to the multiannual average, highlighted the increase in the average annual temperature from 9.8 °C (multiannual value), up to 11.1 °C, with a thermal plus of 1.3 °C; the increase of the thermal balances during the vegetation period and the average temperatures in the months of July, August and September; the reduction in the amount of annual rainfall and during the vegetation period, and the increase in the number of days with temperatures > 30 °C, from 17.3 days to 42.4 days (table 1).

Table 1. Synthesis of the main climatic elements of the years 2015 - 2022 compared to multiannual averages // Sinteza principalelor elemente climatice ale anilor 2015 - 2022 comparativ cu mediile multianuale

Climatic elements analyzed	Multiannual average (1981-2010)	Average 2015 - 2022
Global thermal balance (Σt°g)	3168.4	3384.8
Active thermal balance (Σt°a)	3048.9	3274.9
Useful thermal balance (Σt°u)	1386.0	1604.9
Average temperature in July (°C)	21.0	22.6
Average temperature in August (°C)	20.3	22.5
Average temperature in September (°C)	15.6	17.3
Absolute air minimum temperature (°C)	-27.2/ 28.12.1996	- 21.0/ 01.01.2015
Absolute soil surface minimum temperature (°C)	-35.0/ 26.01.2010	-27.4/01.01.2015
Air average annual temperature (°C)	9.8	11.1
Maximum air temperature (°C)	42.3/20.07.2007	37.3/05.08.2017
Annual rainfalls (mm)	579.6	540.4

Rainfalls during the vegetation period (mm)	398.1	323.3
Insolation during the vegetation period (h)	1448.2	1481.6
Average maximum temperatures in August (°C)	26.9	31.4
Average temperature in Ist and IInd decades of June (°C)	19.1	20.5
Number of days with max. temperatures > 30°C	17.3	42.4
Duration of the bioactive period (days)	169.0	171
Real heliothermal index (IHr)	2.0	2.4
Hydrothermal coefficient (HC)	1.3	1.0
The viticultural bioclimatic index (Ibcv)	7.1	9.4
Oenoclimatic suitability index (IAOe)	4106.1	4681.3
Huglin heliothermal index (IH)	2095.2	2269.7
Night cooling index (CI)	11.2	11.9

Regarding the main synthetic bioclimatic indicators, it was noted: the increase of the real heliothermic index (IHr), from 2.0 to 2.4, ensuring a good maturation of the grapes; the decrease of the hydrothermal coefficient (HC), as a result of the registration of smaller amounts of rainfall during the vegetation period; the increase in the values of the viticultural bioclimatic index (from 7.1 to 9.4), which indicates higher heliothermic resources on the background of lower water resources during the growing season; the increase in the values of the oenoclimatic suitability index (IAOe), from 4106.1 to 4681.3, which confirms that the Copou - Iași viticultural center has favorable conditions for the growing of white grape varieties and medium favorability for the production of red wines. The increase of the Huglin heliothermic index (IH) from 2095.2 to 2269.7 classify the vineyard area, for the reference period, in the "warm temperate" climate category.

The main ampelographic characters

At bud burst the rosette is fuzzy, yellowish-green. The top of the shoot and the first leaves are covered with long, dense, light-green hairs. Young leaves are hairy, light-green. The adult leaf is small (12-14 cm long), orbicular, lobed (3 to 5 lobes), with a light-green limb, hairy along the nervures on the lower side. The lateral sinuses are opened in the U-shape and the petiolar sinus is V-shaped, more or less open. The leaf teeth are small and with convex edges. Insertion of the first inflorescence is at nodes 4-5, being distributed 1-2 per shoot. The flower is hermaphrodite, functionally normal. The grapes are compact, cylindro-conical, multiaxial and branched, small in size (114 g), having a length of 9-14 cm. The berries are small, uniform, round in shape, with a green-yellow colored skin with a persistent pistillar point, elastic and non-adherent to the pulp. The content of the pulp is white-greenish, juicy, sweet-sour, with a specific aroma (figure 1).

Figure 1. Golia variety // Soiul Golia

Agrobiological features

In the conditions of the Iași vineyard, the Golia variety unfold the phenological spectrum in a period of 175 to 180 days of active vegetation, 2-3 days later than the control variety Fetească albă, respectively from the second half of April, when bud burst starts and until the end of October, with the yellowing and falling of the leaves. The flowering takes place in the first decade of June, grape veraison starts in the middle of August and the grape maturity is reach in the IV-V epochs together with the other varieties in the assortment (tables 2 and 3).

Table 2. The phenology of the Golia variety in the Copou-Iaşi viticultural center (2015 - 2022) // Fenologia soiului Golia în centrul viticol Copou-Iaşi (2015 - 2022)

No.	Phenophase	Year								Limits
		2015	2016	2017	2018	2019	2020	2021	2022	
1.	Bud burst	27 IV	13 IV	16 IV	19 IV	25 IV	15 IV	30 IV	26 IV	13 – 30 IV
2.	Flowering	7 VI	9 VI	6 VI	25 V	11 VI	12 VI	22 VI	08 VI	25 V – 22 VI
3.	Grape veraison	12 VIII	14 VIII	16 VIII	29 VII	07 VIII	16 VIII	20 VIII	10 VIII	29 VII – 20 VIII
4.	Grape maturity	16 IX	12 IX	13 IX	17 IX	30 IX	24 IX	07 X	22 IX	12 IX -07 X

Table 3. The phenology of the Fetească albă variety in the Copou-Iaşi viticultural center (2015 - 2022) // Fenologia soiului Fetească albă în centrul viticol Copou-Iași (2015 - 2022)

No.	Phenophase	Year								Limits
		2015	2016	2017	2018	2019	2020	2021	2022	
1.	Bud burst	21 IV	10 IV	12 IV	14 IV	23 IV	13 IV	29 IV	21 IV	10 – 29 IV
2.	Flowering	5 VI	2 VI	2 VI	21 V	7 VI	6 VI	18 VI	4 VI	21 V – 18 VI
3.	Grape veraison	4 VIII	5 VIII	31 VII	21 VII	02 VIII	6 VIII	5 VIII	2 VIII	21 VII – 6 VIII
4.	Grape maturity	14 IX	18 IX	12 IX	25 IX	13 IX	24 IX	27 IX	21 IX	12 IX -27 X

Behavior to climatic stress factors - frost resistance

Specialized literature shows that the frost resistance limit of grapevine is between -15 °C ... -18 °C for buds of table grape varieties, -18 °C ... -21 °C for wine varieties, the annual canes are affected at temperatures of -20 °C ... -21 °C and the perennial wood at -22 °C ... -24 °C (Martin *et al.*, 1972; Oşlobeanu *et al.*, 1991).

In the period 1998-2022, temperatures below the freezing limit of the grapevine were recorded in the years: 2001, 2003, 2006, 2010, 2012, 2014, 2015, 2017 and 2018. Analysis of the absolute minimum temperatures in the winter months showed that the lowest value was recorded on January 26th, 2010, respectively -27.0 °C in the air and -35.0 ^{o}C at the surface of the soil. Also, the average of the lowest absolute minimum temperatures in the air was -18.2 ^{o}C and on the soil surface -23.6 ^{o}C (table 4). These values confirmed that the Copou-Iaşi viticultural center is located in the semi-protected grapevine growing area.

Table 4. Absolute minimum temperatures recorded in the Copou-Iasi viticultural center (1998 -2022) // Temperaturile minime absolute înregistrate în centrul viticol Copou Iaşi (1998 -2022)

Year	in the air			at soil surface		
	month	day	t °C	month	day	t °C
1998	XII	03	-19.0	XII	24	-24,0
1999	XII	24	-13.0	II	20	-19,3
2000	I	25	-15.9	I	26	-22,2
2001	**XII**	**18**	**-20.4**	**XII**	**18**	**-24,5**
2002	XII	26	-19.8	XII	26	-21,0
2003	**I**	**13**	**-21.6**	**I**	**13**	**-30,6**
2004	I	31	-17.0	I	31	-19,0
2005	II	08	-19.4	II	06	-27,6
2006	**I**	**23**	**-25.1**	**I**	**25**	**-29,0**
2007	II	24	-19.6	II	24	-25,0
2008	I	05	-19.5	I	05	-24,2
2009	XII	19	-17.0	XII	21	-29,0
2010	**I**	**26**	**-27.0**	**I**	**26**	**-35,0**
2011	I	05	-14.8	I	25	-20,5
2012	**II**	**12**	**-26.7**	**II**	**08**	**-33,0**
2013	I	09	-14.3	I	29	-20,5

2014	**I**	**31**	**-20.6**	**I**	**31**	**-22,5**
2015	**I**	**01**	**-21.0**	**I**	**01**	**-27,4**
2016	I	04	-17.5	I	03	-18,2
2017	**I**	**20**	**-18.7**	**II**	**11**	**-27,1**
2018	**I**	**24**	**-19.7**	**I**	**24**	**-25,5**
2019	I	8	-12.0	I	8	-22,5
2020	I	7	-8.4	I	9	-7,0
2021	I	19	-16.3	I	19	-22,1
2022	I	25	-11.6	I	21	-13,8
		average	**-18.2**		**average**	**-23.6**

In order to highlight the levels at which temperature drops are possible and to appreciate the degree to which they act destructively on the various grapevine parts, the lowest absolute temperature was analyzed, establishing the number of days with negative temperatures lower or equal to -15 ^{o}C, -20 ^{o}C and -25 ^{o}C, considered as climatic accidents for grapevine, the frequency of the years in which these low temperatures occur, as well as their periodicity. Thus, in the air, the *temperatures considered dangerous for the grapevine* (≤ -15 ^{o}C), at which the fruit buds are affected, were recorded in the analyzed period in 60% of the years in January, in 32% of the years in February and only 16% of the years in December.

Very dangerous temperatures (≤ -20 ^{o}C), which affect buds and annual wood, were recorded in 20% of the years in January, in 4.0% of the years in February and 4.0% of the years in December. The periodicity of temperatures ≤ -20 ^{o}C was 5 years in January, 25 years in February and 25 years in December (table 5).

Table 5. Frequency of negative temperatures recorded in the Copou Iasi viticultural center (1998 – 2022) // Frecvenţa temperaturilor negative înregistrate în centrul viticol Copou Iaşi (1998 – 2022)

Analyzed elements	**Negative temperature groups**					
	≤ - 15°C		**≤ - 20°C**		**≤ - 25°C**	
	air	**soil**	**air**	**soil**	**air**	**soil**
January						
Number of days	28	75	9	25	3	13
Number of years	15	17	5	16	2	5
Frequency of years (%)	60,0	68,0	20,0	64,0	8,0	20,0
Periodicity of the years	1,7	1,5	5,0	1,6	12,5	5,0
February						
Number of days	19	34	6	19	1	14
Number of years	8	14	1	8	1	6
Frequency of years (%)	32,0	56,0	4,0	32,0	4,0	24,0
Periodicity of the years	3,1	1,8	25,0	3,1	25,0	4,2
December						
Number of days	12	46	1	15	-	2
Number of years	4	10	1	6	-	2
Frequency of years (%)	16,0	40,0	4,0	24,0	-	8,0
Periodicity of the years	6,3	2,5	25,0	4,2	-	12,5

Temperatures considered extremely dangerous for the grapevine (≤ -25 ^{o}C), which affect all parts of the plant, were recorded with a frequency of 8% of the years in January and 4% of the years in February. In December, during the analyzed period, no temperatures ≤ - 25 ^{o}C were recorded. The frequency of years with temperatures ≤ -25 °C was 12.5 years in January and 25.0 years in February.
At the soil surface, a much higher frequency of very low temperatures was found compared to those in the air. These temperatures led to significant losses of main buds, damage to the annual and multiannual wood and, implicitly, to the obtaining of grape yields far below the average of thermally normal years. In conclusion, from the analysis of the lowest temperatures recorded in the winter months, it was found that, in all years, the lowest temperatures considered as climatic accident were in January.

The results obtained regarding the vulnerability of the studied varieties to the action of low temperatures, assessed by the percentage of viable buds, attest that Golia variety has an increased genetic resistance to frost, a particularly important aspect for the vineyards of the Moldavian area and for the entire country (table 6).

Table 6. Genetic resistance characteristics // Însuşirile de rezistenţă genetică

Analyzed elements	Golia	Fetească albă
Frost resistance assessed in % viable buds		
✓ average 1985 – 1997	75	68
✓ average 1998 – 2022	83	46
✓ average in years with minimum temperatures > -20°C	53	18
✓ average in the years with min. temperatures between -15°C and -20°C	78	21
Resistance to cryptogamic diseases noted in the OIV scale		
✓ downy mildew	7-8	7-8
✓ powdery mildew	9	9
✓ gray mold	5-7	6-7

In the conditions of an average number of anti-cryptogamic treatments, Golia variety showed a resistance specific to *V. vinifera* L. varieties, respectively, good to downy mildew and powdery mildew, and medium to gray mold.

Regarding the elements that define the fertility of the studied varieties, it was found that, compared to the control variety, the percentage of fertile shoots was higher for Golia variety, 56% during the homologation period and 73% in the 2015-2022 interval (table 7).

In the conditions of an approximately equal bud load attributed by pruning, the average number of inflorescences varied depending on the hereditary specifics of the varieties. The values of the absolute fertility coefficient were supraunitary, the relative coefficient falling between 0.67 (Fetească albă) and 1.08 (Golia).

Table 7. Evolution of the agrobiological and productivity characteristics of the Golia variety compared to the control // Evoluţia însuşirilor agrobiologice şi productive ale soiului Golia comparativ cu martorul

No.	Parameters	Golia		Fetească albă (control)	
		Average 1992-1995 (at homologation)	Average 2015 - 2022	Average 1992- 1995	Average 2015 - 2022
1.	Fertile shoots (%)	56	73	48	71
2.	Absolute fertility coefficient (c.f.a.)	1.36	1.44	1.32	1.31
3.	Relative fertility coefficient (c.f.r.)	0.77	1.08	0.67	0.94
4.	Absolute productivity index (i.p.a.)	162	120	149	123
5.	Relative productivity index (i.p.r.)	95	106	78	90
6.	Yield (kg/vine)	3.51	3,37	2,79	3,88
7.	Average weight of a grape (g)	117	86	113	104
8.	Weight of 100 berries (g)	117	116	167	158
9.	Sugars (g/L)	187	217	183	193
10.	Total acidity (g/L as tartaric acid)	6.36	5.65	4,66	5.06
11.	Alcoholic potential (% vol.)	11.0	12.58	10,8	11.35

The Golia variety showed high values of the absolute and relative productivity indices, close to the control variety. Comparing the results regarding the fruiting capacity, it can be concluded that Golia variety reached its biological potential and presents a good adaptability to the conditions of the studied ecosystem.

The analysis of the technological characteristics of grape production completed the elements of knowledge for the Golia variety. The number of grapes/stock and the yield obtained (kg/stock), confirmed the data on the fertility of Golia variety, compared to the control. In comparison with the initial approval data (at homologation), in the reference period 2015 - 2022, there were changes in the quantitative level of grape yield obtained, as a result of the climate changes recorded in recent years. Thus, the average value of the grape production was 3.57 kg/stock for Golia variety, very close to that of the control variety Fetească albă (3.88 kg/stock).

The quality of the harvest, assessed by the average weight of a grape, the weight of 100 berries, the sugar content and the total acidity of the must, reflects both the specific genetic character of the variety and the influence of climatic factors on these elements. Golia variety is characterized by a higher sugar accumulation potential than the control variety (average values of 217 g/L for the Golia variety, respectively 193 g/L for the Fetească albă), under conditions of an average acidity of 5.65 g/L as tartaric acid.

On the background of global warming, the wines obtained from the Golia variety showed in recent years a higher alcohol concentration, varying between 12.90 and 13.40 % vol., with a balanced total acidity (5.55 - 6.47 g/L acid tartric), completed by a low pH, which confers to the wine a pleasant sensation of freshness (table 8).

Table 8. The main compositional characteristics of wines //
Principalele caracteristici de compoziție ale vinurilor

No.	Analyzed parameters	Golia	Fetească albă (control)
1.	Alcoholic concentration (% vol.)	13.10	11.57
2.	Total acidity (g tartaric acid /L)	5.93	5.42
3.	Volatile acidity (g acetic acid /L)	0.44	0.37
4.	Free SO_2 (mg/L)	28	28
5.	Total SO_2 (mg/L)	87	88
6.	Reducing sugars (g/L)	2.13	1.21
7.	pH	3.31	3.43
8.	Total dry extract (g/L)	21.13	16.63
9.	Non-reducing extract (g/L)	19.00	15.43
10.	Density (g/cm^3)	0.9912	0.9910
11.	Total polyphenols (g EAG/L)	0.47	0.44
12.	Polyphenol index (OD 280 nm)	8.74	7.93
13.	Color intensity (Ic)	0.109	0.10
14.	Color tint (T)	4.95	3.47
15.	d 420%	78.54	71.75
16.	d 520 %	15.92	20.25
17.	d 620 %	5.55	8.00

Sensory, the wines of Golia variety were appreciated as being of high refinement and elegance, standing out for their yellow-green color of medium intensity, bright limpidity, low content of reducing sugars (dry wines), balanced concentrations of phenolic compounds and a special extractive richness and texture. From the olfactory point of view, the wine of the Golia variety is characterized by its fine aromas of green fruit and fresh green pepper, with citrus notes, reminding of those of the genitors (Sauvignon blanc × Şarba). All this are completed by a superior full body and a high persistence of taste, which makes the wine of the Golia variety appreciated as a complex, balanced, ample and generous.

In the Copou-Iaşi viticultural center, the wine of the Fetească albă variety showed lower alcohol concentrations compared to the wine of the Golia variety, rarely exceeding 12.00 % vol., due to a lower biological capacity to accumulate sugar in grapes. The total acidity was balanced (5.17 - 5.85 g/L as tartaric acid), even slightly lower in years with long and warm autumns, completed by a higher pH (3.4-3.5). Compared to the wine of the Golia variety, the wine of Fetească albă presented a lower non-reducing extract, on the background of a lower content of phenolic compounds, which is sensorially translates into a lighter-body perception, lower extractiveness and taste persistence. On the other hand, the yellow-green color, with bright golden hues, the finesse and delicacy of the floral aromas (grapevine flowers, linden), as well as the textural harmony, represent the basic characteristics of the wines obtained from the grapes of the Fetească albă variety.

CONCLUSIONS

The results regarding the vulnerability to low temperatures, assessed by the percentage of viable buds, attest the fact that Golia variety possess an increased genetic resistance to frost, a particularly important aspect for the vineyards located in the areas where this phenomenon occurs with a high frequency.

In comparison with the data obtained at the homologation, during the research period (2015 – 2022), changes were found in the quantitative level of grape production, as a result of the climate changes recorded in recent years.

The quality of the harvest, assessed by the average weight of a grape, the weight of 100 berries, the sugar content and the total acidity of the must, reflects both the specific genetic character of the variety and the influence of the climatic factors. Golia variety was characterized by a higher sugar accumulation potential than the control variety Fetească albă.

Due to global warming, in recent years, the wines obtained from the Golia variety grapes showed higher alcohol concentrations, varying between 12.90 and 13.40 % vol., with a balanced acidity (5.55 - 6.47 g/L tartaric acid), which confers to the wine a pleasant sensation of freshness. Also, the wines of the Golia variety were appreciated for their yellow-green color, bright limpidity, low content of reducing sugars (dry wines) and balanced concentrations of phenolic compounds.

The variety is included in the assortment of vineyards from the region of Moldavian Hills (Dealurile Moldovei), for obtaining quality white wines, being also recommended for plantation in other viticultural areas with climatic conditions similar to those of the Iasi vineyard (Odobeşti, Blaj).

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CONTRIBUTIONS TO THE IMPROVEMENT OF APRICOT AND PEACH ASSORTMENTS AT RSFG CONSTANŢA

CONTRIBUȚII LA ÎMBUNĂTĂȚIREA SORTIMENTULUI DE CAIS ȘI PIERSIC LA SCDP CONSTANȚA

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Abstract
The improvement of apricot and peach the assortments, with new cultivars which are more productive and resistant to frost and specific diseases, with fruit of good quality is one the basic objective of the breeding programs of the two species. The purpose of this paper is to present the apricot cultivar - De Valu and the peach cultivar - Florica, that were obtained by the team of researchers from RSFG Constanța, patented after 2020. The mentioned cultivars have constant yields and valuable fruits, so it's deserved to be extended in Romanian orchards.

Key words: breeding, cultivars, yields, fresh consumption

Rezumat
Îmbunătățirea continuă a sortimentelor de cais și de piersic cu soiuri noi, care să asigure un consum de fructe o perioadă cât mai mare de timp, productive, rezistente la ger și la bolile specifice, constituie obiective de bază în programele de ameliorare a celor două specii, deosebit de apreciate de consumatori. Scopul acestei lucrări este de a prezenta soiul de cais- De Valu și soiul de piersic- Florica, soiuri ce au fost obținute de către colectivul de cercetători de la SCDP Constanța, brevetate după anul 2020 și care datorită producțiilor constante și a calității fructelor merită să fie extinse în livezile din România.

Cuvinte cheie: ameliorare, soiuri, producții de fructe, consum proaspăt

INTRODUCTION

Apricot (*Prunus armeniaca* L.) is a species highly appreciated by consumers, due to its fruits of exceptional quality, very fine and aromatic, which can be consumed both fresh and processed in different forms. According to FAO data, in 2020 the total production of apricots worldwide was 3,719,974 tons, with Asia in first place with a percentage of 65% of the total, followed by Europe with 20%. Africa follows with 12%, North America with 2%, South America with 1% and Australia and New Zealand below 1%, Fig. 1.

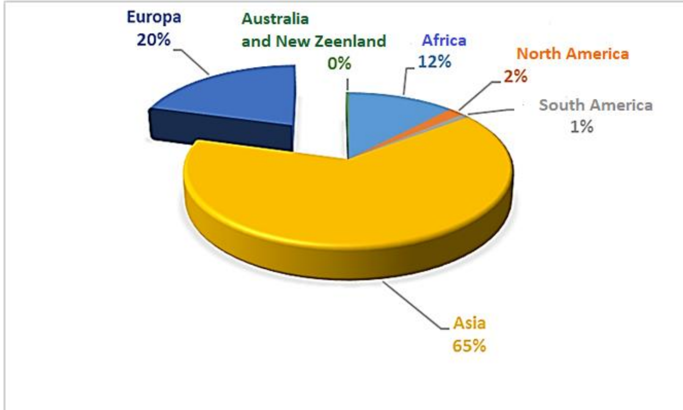

Fig. 1. Apricot yield in 2020 represented by continents // Producția de caise în anul 2020 reprezentată pe continente

In our country, apricots are cultivated in the south-east, south-west and west, where the pedoclimatic conditions are favourable for their growth and fruiting. Since 1977, the apricot breeding program carried out at RSFG Constanta has aimed to broaden the range, to obtain late flowering varieties with qualitative fruits, superior productive characteristics, biological resistance to abiotic and biotic stress factors (Cociu, V., 1991; Cociu, V., p. 1993; Topor, E., 1997, 2006, 2007; Opriţă V. A, 2018, 2020). There were registered 15 varieties of apricot, of which three were patented, de Valu being the last variety of apricot patented in 2020.

Peach (*Prunus persica* (L.) Batsch] is one of the most valuable fruit species, due to the biological characteristics of the trees and the quality of the fruits. Trees bear fruit quickly, and in favorable growing areas, yields are high and constant. The fruits can be eaten fresh or in the form of jam, preserve, compote, juices, etc. Currently, there are a large number of varieties acclimatized or created in our country, which provide fresh fruit from the last decade of June to mid-September. Peach culture is spread over all continents, at the level of the year 2022 large areas holding Asia (72%), Europe (15%), Africa (6%) and South America (4%), figure 2.

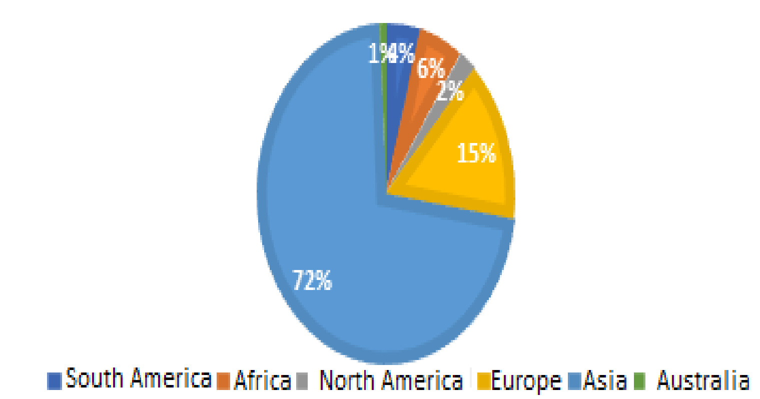

Fig. 2- Peach area by continents, 2020 / Suprafața ocupată cu piersic pe continente, 2020 (sursa FAOSTAT)

FAO data show that the world production of peaches in 2020 was 24,569,744 tons (table 1), with peaches ranking third, after citrus fruits and apples, in the total number of fruits produced worldwide.

Table 1. Production of peaches and nectarines by continents and in the main growing countries (thousands of tonnes) // Producția de piersici și nectarine pe continente și în principalele țări cultivatoare (mii tone)

The continent/ The country	Production years					% of total 2020	
	2016	2017	2018	2019	2020	Worldwide	Continental
Worldwide total	23 263	24 165	24 307	24 841	24 567	100	-
d.c. Europa	3 930	4 254	4 040	4 245	3 656	14,9	-
North America	881	790	728	643	582	2,5	-
Asia	16 196	16 851	17 250	17 717	18 075	73,5	-
South America	1 013	876	960	906	905	3,8	-
Africa	935	1 100	1 037	1 035	1 047	4,5	-
Australia	80	82	82	86	81	0,5	-
USA	855	764	700	617	560	-	96,2
China	13 585	13 988	14 386	14 770	15 016	-	83,0
Italy	1 427	1 250	1 090	1 224	1 015	-	27,8
France	207	221	184	202	178	-	4,9
Spain	1 421	1 799	1 450	1 545	1 306	-	35,8
Greece	528	640	968	926	890	-	24,4

As in other regions of the world, in Romania, peach cultivation coincides as an area with that of the vine. Currently, in our country, there are approx.1700 ha cultivated with peach. At the level of 2020, in Romania the production of peaches and nectarines was 15,900 tons (https://www.fao.org/faostat/en/#data/QCL). Unfortunately, although the population appreciates the native varieties, on the market there is a massive import of peaches from Mediterranean countries.

Between 1977-2022, the peach breeding program at RDRP Constanța aimed at resistance to diseases and pests, frost, drought, trees habits, fruit quality (size, shape, weight, color, pulp texture, sugar content, acidity, aroma), the productivity, the ornamental character of flowers and leaves (Cociu V., 1981; Ionescu Pr., 1991; Dumitru L.M., 2003, 2007, 2010, 2013; Gavăt C., 2021). During this period, 32 varieties of peach, nectarine, pavia were created, both standard, semi-dwarf and dwarf; four varieties of peach were obtained variety patents.

The purpose of this paper is to present the two varieties, apricot (de Valu), respectively peach (Florica), that was patented after 2020 and which due to the constant production and quality of the fruits deserve to be expanded in Romanian orchards.

MATERIAL AND METHOD

RSFG Constanta is located in the south-eastern area of the country. The climate of the area is semi-arid, with hot and very dry summers and temperate winters. The average annual temperature is 10.7 °C and the annual rainfall is approx. 400 mm, with an uneven distribution during the year. The soil is calcareous chernozem, formed on loess, with a clayey texture (Păltineanu et al., 2015).

The germplasm stock of the two species, apricot and peach, consists of a large number of genotypes, which have been used in breeding work since 1977. Directed hybridization was used as a working method, followed by self-pollination of hybrids and rigorous selection in hybrid offspring regarding resistance to frost, drought, diseases, plant habits, flowering phenology, followed by observations on fruit quality, production, etc. (Cociu V., 1989).

De Valu (synonym Orizont clonă 1) cultivar was obtained at RSFG Constanta and then was tested in competition microculture and enrolled at ISTIS for registration in 2017.

Florica (synonym X sel.V.T) cultivar obtained at RSFG Constanța through individual selection, resulting from self-pollination of the hybrid H 25 11 68; it was studied in 1998 and enrolled at ISTIS for registration in 2019. Peach selection was tested in a competition culture at UASVM Bucharest.

After registration at ISTIS, fruit quality was assessed by fruit size, skin and pulp colour, consistency, succulence, pulp aroma and taste, stone size and easy pulp separation according to UPOV descriptors (https://www.upov.int/test_guidelines/en/list.jsp). Determinations were made regarding fruit content in dry matter (%) and titratable acidity (mg%).

Since 2011, the trees of the patented varieties can be found in the demonstration plots at RSFG Constanța, on rows 9 and 10 the De Valu variety grafted on Constanța 14 and on rows 25 and 26 the Florica variety grafted on Tomis 1.

RESULTS AND DISSCUSIONS

De Valu apricot cultivar

Characteristics of the variety: it is self-fertile, does not require pollinators, and can be planted alone in a plot; it is resistant to the main specific apricot diseases, free from viruses;

The tree is of medium vigour, with an erect posture, it bears fruit predominantly on May bunches. The flower is medium-sized, and white in colour, the stigma is positioned higher in relation to the stamen. Table 2 shows the average yield in the last 5 years (2018-2022). **The fruit** is oblong, slightly elongated, and *large in size* (70 g). The skin is light orange, the covering colour absent or very little on the sunny side. The pulp is orange, very juicy, flavourful, with fine texture and medium firmness. The core is medium-sized, with a sweet kernel, non-stick to the pulp.

Table 2. Average fruit yield in De Valu compared with Goldrich (Control)/ Producția medie de fructe* la soiul De Valu comparativ cu Goldrich (Martor)

Cultivar	Fruit -Average yields									
	2018		2019		2020		2021		2022	
	Kg/tree	t/ha	Kg/tree	t/ha	Kg/tree	t/ha	Kg/tree	t/ha	Kg/tree	t/ha
De Valu	18.0	11.2	21.0	13.1	4.0	2.5	19.0	11.2	17.0	10.6
Goldrich	10.0	6.2	11.0	6.8	3.0	1.8	10.0	6.2	17.0	10.6

*planting density of 625 trees/ha

Fig. 3 și Fig. 4- De Valu

Table 3. Fruit characteristics (multiannual data) // Caracteristici de calitate ai fructelor (date multianuale), Valu lui Traian

Cultivar	Average fruit weight (g)	Soluble solid content (%)	Acidity (mg%)	Fruit destination
De Valu	75 - 90	11.5 – 14.0	0.8 – 1.1	Fresh consumption and proccesing
Goldrich (Mt)	72 - 84	11.5 – 13.6	1.4 – 1.9	Fresh consumption and proccesing

Florica peach cultivar

The characteristics of the cv.: it is self-fertile, does not require pollinators, and is resistant to frost; it is tolerant to the main diseases, requires treatments at the warning; requires fruit thinning and irrigation; the average yields are shown in table 4.

The tree is of medium vigour, with an erect posture, it bears fruit mainly on mixed branches; Medium flowering, abundant every year; The flower is campanulate, on type 5, the shape of the petals is medium oval, and dark pink in colour; The stigma is positioned lower in relation to the stamen.

The fruit is medium-sized, 150-170 g (table 5, fig. 5), round in shape, with the pistil extremity slightly deepened and with the prominence of the middle suture. The background colour of the epidermis is yellow, the covering dark red, and marbled; the thickness is medium and the adhesion to the pulp is weak. The pulp is yellow-orange (fig. 6), with the intensity of anthocyanin pigmentation around the core weak, firm, and very crunchy, with a pleasant taste and intense aroma. The core is non-adherent, and medium in size (7.1 g).


Fig. 5 and Fig. 6-Florica cv.

Fruit ripening period: late, the 3rd decade of August, after the Southland variety, *extends the varietal assembly line with dessert peaches* until the Flacăra cultivar ripens (01.09).

Table 4. Average fruit production* in the Florica cv. compared to the Flacăra cv. (control) /Producția medie la soiul Florica comparativ cu soiul Flacăra (martor)

Cultivar	Average fruit yield									
	2018		2019		2020		2021		2022	
	Kg/tree	t/ha	Kg/tree	t/ha	Kg/tree	t/ha	Kg/tree	t/ha	Kg/tree	t/ha
Florica	25.5	21.2	26.0	21.6	27.2	22.9	27.7	23.0	28.0	23.3
Flacăra	24.8	20.6	25.4	21.2	26.0	21.7	27.2	22.6	27.7	23.0

*planting density of 833 trees/ha

Table 5. Fruit quality characteristics (multiannual data), Valu lui Traian / Parametrii calitativi ai fructelor (valori multianuale)

Cultivar	Average fruit weight (g)	Dry substance (%)	Acidity (mg%)	Fruit destination
Florica	160-180	14.5	0.65	Fresh consumption and proccesing
Flacăra (Mt)	180-200	14.0	0.76	Fresh consumption and proccesing

CONCLUSIONS

1. The pedoclimatic conditions in southeastern Romania are favourable for the growth and fruition of apricot and peach. It is recommended to observe all the agrotechnical links specific to apricot and peach culture (irrigation, thinning, etc.).
2. **The De Valu cv.** has constant yields, it is tolerant to the main diseases and pests. The late bloom offers it the advantage of passing over the late frosts in spring better than other apricot cv. the fruit aspect is pleasant, it has a specific flavour, and a big fruit. It is recommended both for fresh consumption and canning.
3. **The Florica cv.** *has good resistance to handling, transport and temporary storage*. It can be used for fresh consumption as the fruits are very crunchy and aromatic or in the form of compote and preserve.

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CHANGES IN PHENOTYPES OF *PINOT NOIR* AND *CHARDONNAY* VARIETIES DUE TO CLIMATE CHANGE IN THE MINIȘ VINEYARD

MODIFICĂRI ÎN FENOFAZELE SOIURILOR *PINOT NOIR* ȘI *CHARDONNAY* DATORATE SCHIMBĂRLOR CLIMATICE, ÎN PODGORIA MINIȘ

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Abstract
Pinot noir and Chardonnay varieties are relatively well suited to be cultivated in the area delimited for the Miniș PDO and the influences of the oenoclimate, particularly the Active Heat Balance and the Useful Heat Balance, can be modelled with the help of cultivation technology. There is a close link between the cultivation characteristics of the two varieties, which means that in areas where Pinot Noir is suitable for cultivation, the variety for white wines should be Chardonnay, especially for sparkling base wines. The distribution of sugar accumulation values was almost symmetrical during the period studied, the averages being extremely close, which defines a close correlation between the two varieties.

Keywords: Pinot noir, Chardonnay, sugar accumulation correlation, phenophase, climate change

Rezumat
Soiurile Pinot noir și Chardonnay se pretează relativ bine pentru a fi cultivate în arealul delimitat pentru DOP Miniș, iar influențele directe ale enoclimatului, cu precădere bilanțul termic activ și bilanțul termic util, pot fi modelate cu ajutorul tehnologiei de cultură. Există o legătură strânsă între caracteristicile de cultură ale celor două soiuri, ceea ce presupune că este recomandabil ca în zonele unde se pretează cultivarea Pinot noir, să se asigure varianta de soi pentru vinuri albe cu soiul Chardonnay, mai ales pentru vinul bază spumante. Distribuția valorilor acumulărilor de zaharuri a fost aproape simetrică, în perioada studiată, mediile fiind extrem de apropiate, ceea ce definește o corelație strânsă între cele două soiuri.

Cuvinte cheie: Pinot noir, Chardonnay, corelaţie, acumularea zahărului, fenofază, schimbări climatice

INTRODUCTION

Grapevine phenology is a topic of great interest in the context of climate change, and this is evident in the multitude of studies, by grapevine variety, by area, at local, national or continental level. It is difficult to establish the pioneer in this direction, because similar research has been carried out in different wine-growing areas of the country and in most, if not all, wine-growing areas in the world. Observations, experiments and trials have been carried out on grapes for wine, table grapes and raisins.
Mountains are considered the best indicators of climate change. At higher altitudes (Dolomite Alps), the effects of global temperature rise are expected to be more pronounced. Phenological advance is more pronounced in grapevine varieties grown at higher altitudes. Phenophase duration and growing season length are more affected in varieties grown at low altitudes [1]. In a study for the period between 1964 and 2015, Chinese researchers demonstrated that the dominant factor leading to changes in the start and end points of plant phenophase was temperature and that the phenological response to

temperature changes is particularly sensitive, further demonstrating that there is a correlation between phenophase and climate change [4].

Early phenological development, shortened phenophase, poor grape berries development, early maturity with lower yield and lower quality are the consequences of the challenges of climate change [10]. The occurrence of extreme climatic phenomena does not bring changes in all phenological phases, with shoot development and flowering recording significantly more extreme coincidence events than other phenophases. The varieties studied in Switzerland, *Chardonnay* and *Pinot noir*, did not differ in their response to extreme temperatures for the area [13]. In southern England, studies on *Chardonnay* show that the date of the last spring frost advances at a higher rate than grapevine budbreak, indicating an overall decrease in bud frost risk in susceptible phenotypes [8].

On the basis of data obtained in Slovakia during studies carried out between 1985 and 2018, the influence of temperatures: mean-maximum, mean and sum of effective temperatures on the occurrence of phenophases was evaluated. The results of the observations showed an earlier flowering by five to seven days, an earlier start of flowering by 7 to 10 days, an earlier berry softening by 18 days, and harvest dates were advanced on average by 8 to 10 days [2]. The greatest influence was exerted by the average amplitude of air temperatures 10 days before the start of the bleeding phase of the grapevine [9].

Studies comparing phenologically two varieties from a specific area (Douro, Portugal) have also been the subject of predictions for the future and the testing of several phenological models for budbreak, flowering and dormancy [5]. Although phenology is not the only characteristic to consider for grapevine adaptation to climate change, it plays a major role in the current distribution of the variety-vineyard binomial [6].

The results showed that in the conditions of the Giurgiu area, southern Romania, the varieties analysed entered vegetation faster and had a slightly higher percentage of fertile shoots than the average recorded in other growing areas. Fertility coefficients and productivity indices were also high in the studied area. [14] For the bud-break and flowering phenophases, the grapevine varieties analysed in the PDO Ștefănești area showed a similar behaviour with the variation of the identified climatic parameters: average air temperature being the main factor, followed by minimum temperature. [15]

In the area delimited by PDO Odobești, the phenological spectrum of the grapevine, its fertility and productivity, the quantity and quality of grape production were studied and determined for five years, and the data obtained were compared with the *Sauvignon blanc* variety, which is widely cultivated in that area [3]. Murfatlar PDO shows that, in addition to oenoclimatic factors, also the growing system influences the duration of phenological stages [12]. In the area of the PDO Tarnave, the warming of the climate has led to an earlier flowering, with an average of 8 days, correlated with an earlier ripening, with an average of 9-11 days. As regards the start date of the flowering and ripening phenotypes, no clear differences were observed [11].

Knowledge of the HI heliothermal index (Huglin index) was absolutely necessary in the context of climate change and the assessment of the suitability of establishing new plantations with certain wine grape varieties and the favourability of areas with designations of origin [7]. So was the Active and Useful Heat Balance, in addition to a number of other weather and soil parameters [16]. PDO - Protected Designation of Origin belongs to the categories of Geographical Indications in Romania and represents a relatively small area unit compared to the Protected Geographical Indication, which may cover one or more counties [17]. The BBCH scale has been used to define the phenotypes of grapevines [18].

MATERIAL AND METHOD

The experiment was based on observations carried out for three consecutive years, 2020, 2021 and 2022, in *Pinot noir* and *Chardonnay* plantations, in the Miniș PDO, on vine phenophases that are sensitive to environmental factors and their fluctuations: shoot growth, first leaves, flowering, the veraison period and ripening.

The observations were made directly in the field, in identical time intervals, in the locality of Minis in Arad County, in plantations founded in the autumn of 2008, through the reconversion of vineyards with European funds, at 2.2 m between rows and 1 m between grapevines per row, at a density of 4545 grapevines per hectare.

The plantations have been authorized by the National Office of Vineyards and Wine Products [16], as being able to produce grapes for the production of Miniș Protected Designation of Origin (PDO Miniș) wines.

Data from the weather station in the perimeter of the central unit of the Research and Development Station for Viticulture and Winemaking Minis, Ghioroc, Fn, Arad County, were used for correlation with climatic data. The heliothermal index, Huglin for the studied area was: PDO Miniș, HI=2202 [7].

Phenological observations were made at four time intervals in May: shoot growth and leaflet emergence (BBCH10, BBCH13, BBCH15, BBCH19 and BBCH60); two intervals in June for monitoring flowering (BBCH64 and BBCH69); one interval in August for the veraison phenophase (BBCH85), three intervals in August (BBCH85, BBCH86 and BBCH87) and one in September (BBCH89) for monitoring ripening progress (Table 1).

Table 1. The main phenophases of *Pinot noir* and *Chardonnay*, in PDO Miniș (2020, 2021 and 2022) /
Fenofazele principale ale viței-de-vie observate la soiurile *Pinot noir* și *Chardonnay*, în DOP Miniș (2020, 2021 și 2022)

	BBCH10 lăstar (cm)						BBCH 13 lăstar (cm)						BBCH13 frunze degajate pe lăstar (nr)					
Data	4-9 mai						10-12 mai						10-12 mai					
Anul	2020		2021		2022		2020		2021		2022		2020		2021		2022	
Pinot noir	3	4	2	3	5	10	8	10	6	8	10	15	2	3	1	2	3	4
Chardonnay	5	7	4	5	7	15	9	12	8	10	15	20	3	4	2	3	4	5
	BBCH15 lăstar (cm)						BBCH15 frunze degajate pe lăstar (nr)						BBCH19 lăstar (cm)					
Data	17-19 mai						17-19 mai						24-25 mai					
Anul	2020		2021		2022		2020		2021		2022		2020		2021		2022	
Pinot noir	20	23	24	25	20	35	4	5	2	3	5	8	50	52	48	50	45	65
Chardonnay	20	30	28	30	20	40	5	7	3	5	7	9	55	58	58	60	45	70
	BBCH19 frunze degajate pe lăstar (nr)						BBCH60 Înflorit (%)						BBCH 64 lăstar (cm)					
Data	24-25 mai						24-25 mai						2-7 iunie					
Anul	2020		2021		2022		2020		2021		2022		2020		2021		2022	
Pinot noir	5	6	4	5	8	11	0	3	0	0	0	5	50	60	60	70	65	70
Chardonnay	6	8	4	5	8	11	0	0	0	0	0	1	60	70	70	90	70	80
	BBCH64 Înflorit (%)						BBCH69 Înflorit (%)						BBCH85 Ciorchini în pârgă (%)					
Data	2-7 iunie						9-14 iunie						9-aug.					
Anul	2020		2021		2022		2020		2021		2022		2020		2021		2022	
Pinot noir	10	12	12	15	10	15	70	80	80	90	90	100	60	70	80	90	75	80
Chardonnay	50	60	60	65	70	75	80	90	100	100	100	100	80	90	100	100	80	100
	BBCH86 Zaharuri (g/ L)						BBCH87 Zaharuri (g/ L)						BBCH89 Zaharuri la recoltare (g/ L)					
Data	23-24 august						30-aug.						7-13 septembrie					
Anul	2020		2021		2022		2020		2021		2022		2020		2021		2022	
Pinot noir	125	128	139	140	160	165	181	182	179	180	204	206	220	222	218	220	239	240
Chardonnay	130	132	159	160	195	200	190	195	189	190	230	235	235	238	239	240	240	241

RESULTS AND DISCUSSIONS

The sum of active temperatures in the months of observations (May, June, July, August and September) showed an increasing trend during the summer months and a sharp decrease in September, especially in 2021 and 2022 (Figure 1).

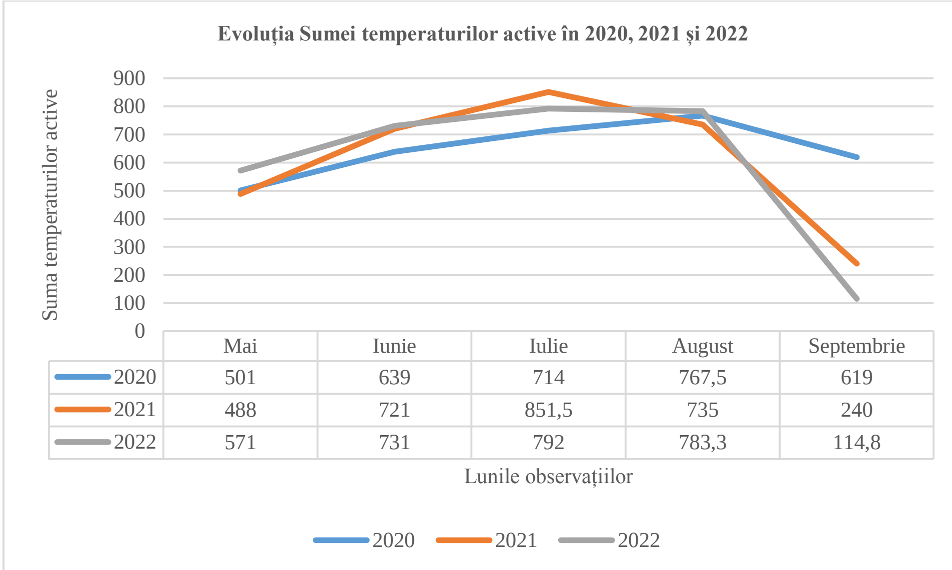

Fig 1. The evolution of the sum of active temperatures for grapevine, in PDO Miniş (2020, 2021 şi 2022) / Evoluția Sumei temperatuilor active pentru vița-de-vie, în DOP Miniş (2020, 2021 şi 2022)

However, it is considered normal when considered in the context of the entire growing season of the vine in the Minis area. The trend in sugar accumulation from the time the grapes enter the veraison until harvest maturity, in accordance with the production requirements and correlated with the provisions of the specification for the Miniş PDO, is parabolic, with a slight inclination to the right, analysed in relation to the variable Sum of active temperatures in May, June, July, August and September (Figure 2).

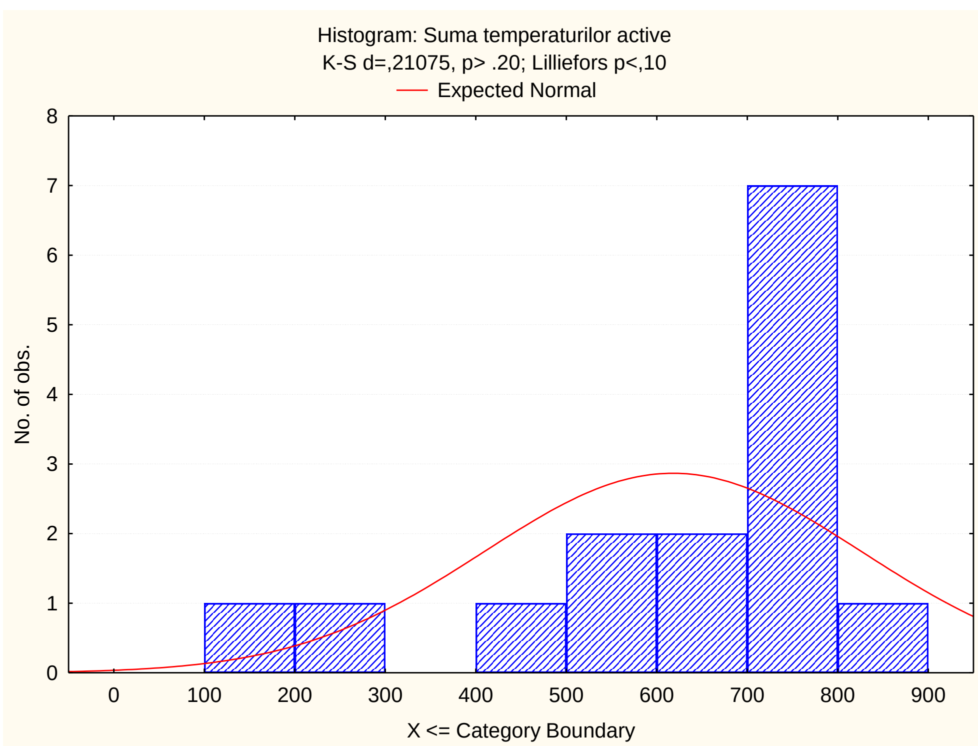

Fig. 2. The unimodal curve of the sum of active temperatures for grapevine, in PDO Miniş / Curba unimodală a sumei temperatuilor active pentru vița-de-vie, în DOP Miniş (2020, 2021 şi 2022)

During the study period, there is a more abrupt drop in active temperatures in September, with the sum of useful temperatures evolving almost identically in 2021 and 2022. In July, useful temperatures peak more sharply in 2021 than in 2020 and 2022. Throughout the period with useful vineyard temperatures, 2021 was steeper than adjacent years (Table 2).

Tabelul nr. 2. The sum of useful temperatures in PDO Miniş (2020, 2021 şi 2022) / Suma temperaturilor utile în DOP Miniş (2020, 2021 şi 2022)

Luna/ Anul	2020	2021	2022
Mai	191,0	178,0	261,0
Iunie	339,0	421,0	431,7
Iulie	404,0	541,5	482,0
August	457,5	425,0	473,3
Septembrie	112,0	242,0	93,0

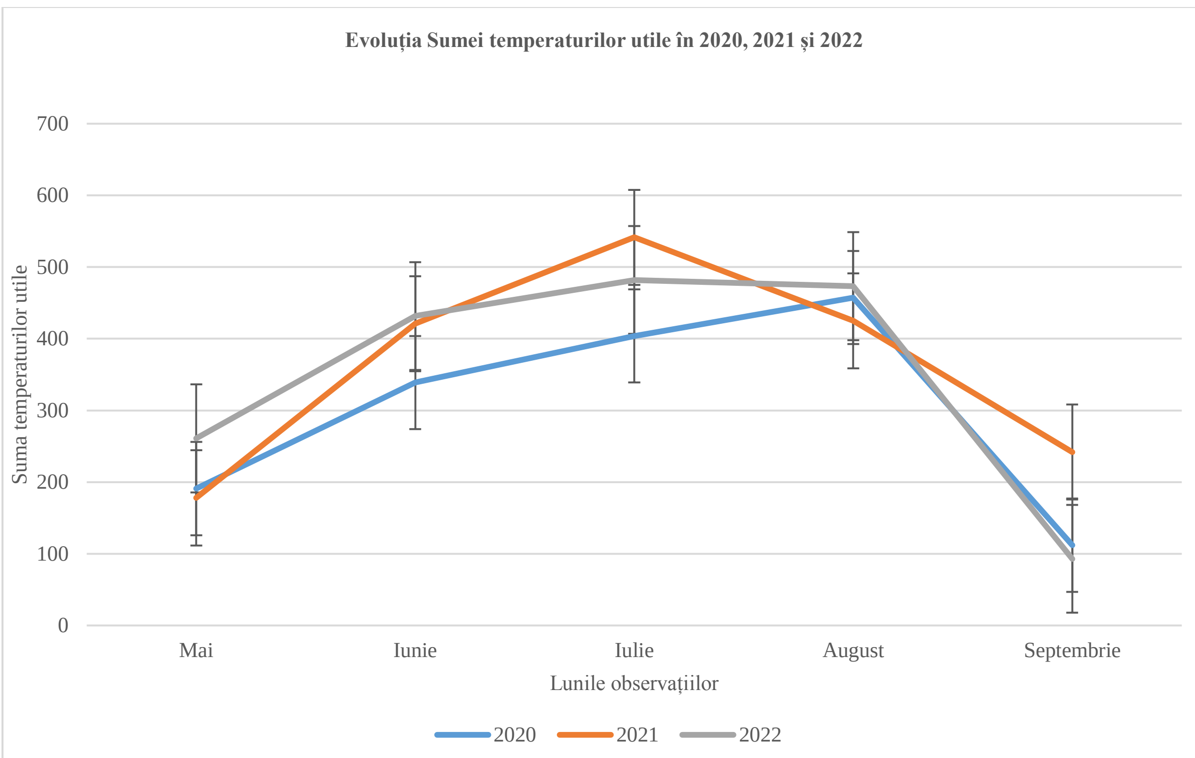

Fig. 3. The evolution of the sum of useful temperatures for grapevine, in PDO Miniş (2020, 2021 şi 2022)/ Evoluția sumei temperatuilor utile pentru vița-de-vie, în DOP Miniş (2020, 2021 şi 2022)

Shoot growth dynamics in the first phenophase of active vegetation are clearly in favour of *Chardonnay* in each of the three years of observations (Figures 4, 5 and 6), although by the time the first leaflets are released (BBCH11), when the shoots are about 10-15 cm, both *Pinot noir* and *Chardonnay* behave almost identically, which means that the swelling of the buds, the bud break and the pink bud were on the same coordinates, confirming the literature, which locates in the cooler areas the areas suitable for growing these varieties in tandem, i.e. where *Chardonnay* is found, *Pinot noir* is also the best expressed.

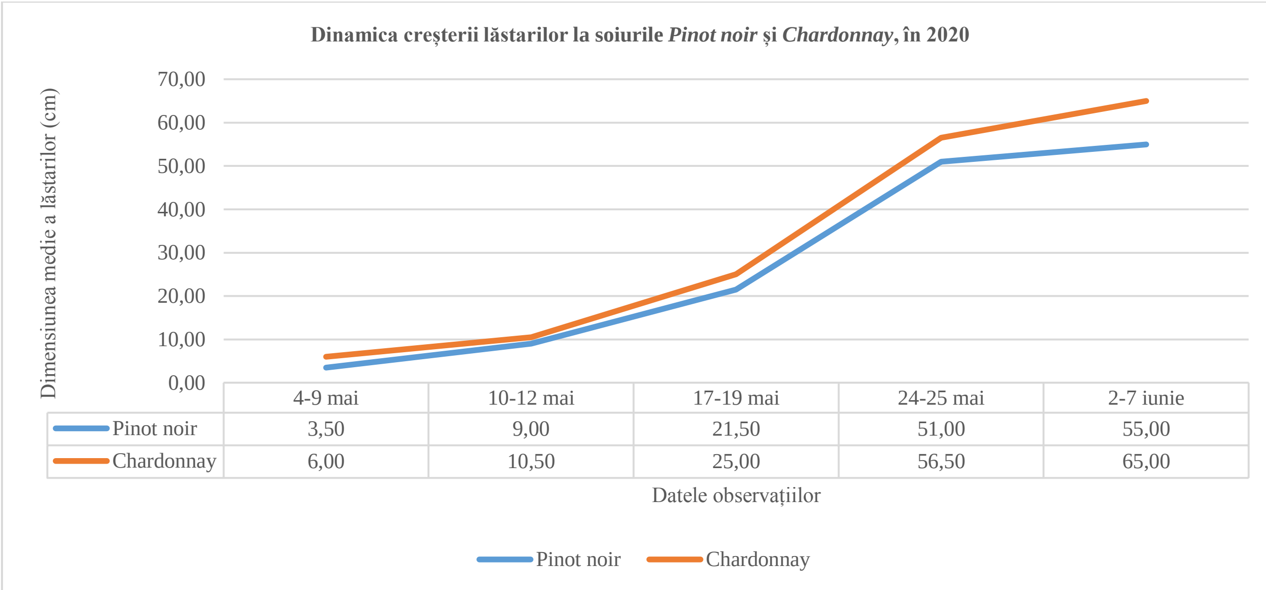

Fig. 4. Dynamics of shoot growth of *Pinot noir* and *Chardonnay* cultivars, in PDO Miniş, in 2020 / Dinamica creșterii lăstarilor la soiurile *Pinot noir* şi *Chardonnay*, în DOP Miniş, în 2020

An increase in shoot length was associated with a greater number of leaves on the shoots and higher amounts of organic substances resulting from photosynthetic processes, which led to the accumulation of sugars in the grapes. Distancing the graph for *Chardonnay* towards the end of May 2021 shows a reaction directly proportional to the useful temperature peak in July 2021, to which the variety responds much more sensitively than *Pinot noir*. Even though throughout the vegetative phenophase the *Chardonnay* variety grew only 2 cm more than *Pinot noir*, from the second half of May 2021 onwards, there were significant differences between the shoots of the two varieties, up to 10 cm in the case of *Chardonnay* (Figure 5).

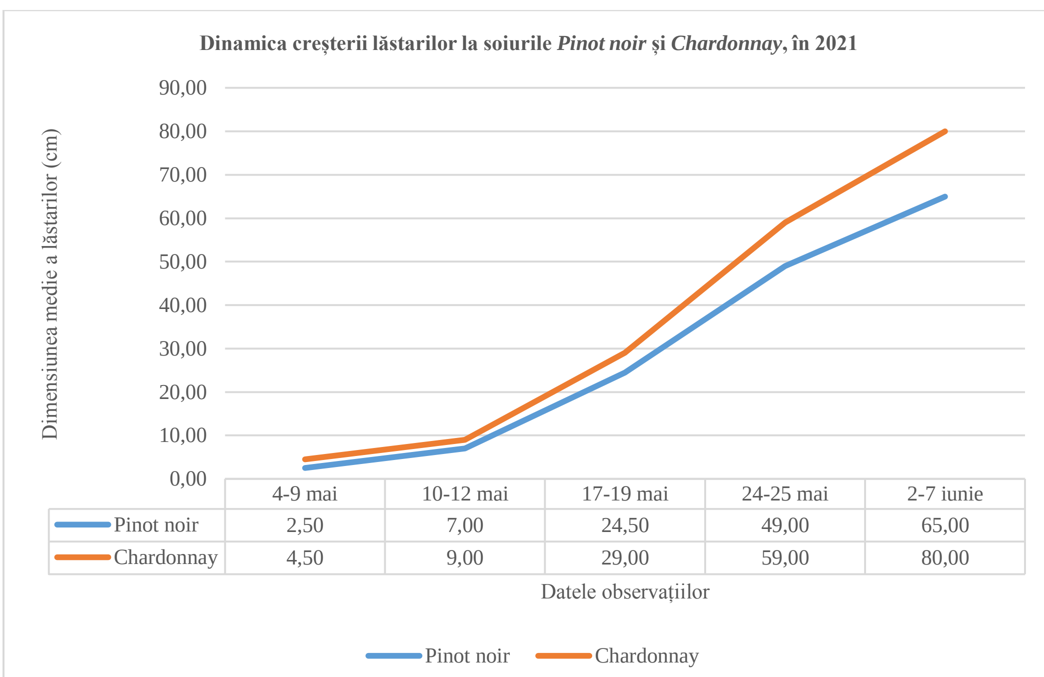

Fig. 5. Dynamics of shoot growth of *Pinot noir* and *Chardonnay* cultivars, in PDO Miniş, in 2021 / Dinamica creșterii lăstarilor la soiurile *Pinot noir* şi *Chardonnay*, în DOP Miniş, în 2021

The 2022 plots show an almost perfect tandem between shoot growth dynamics in both varieties, correlated with cumulative effective temperatures (Figure 6).

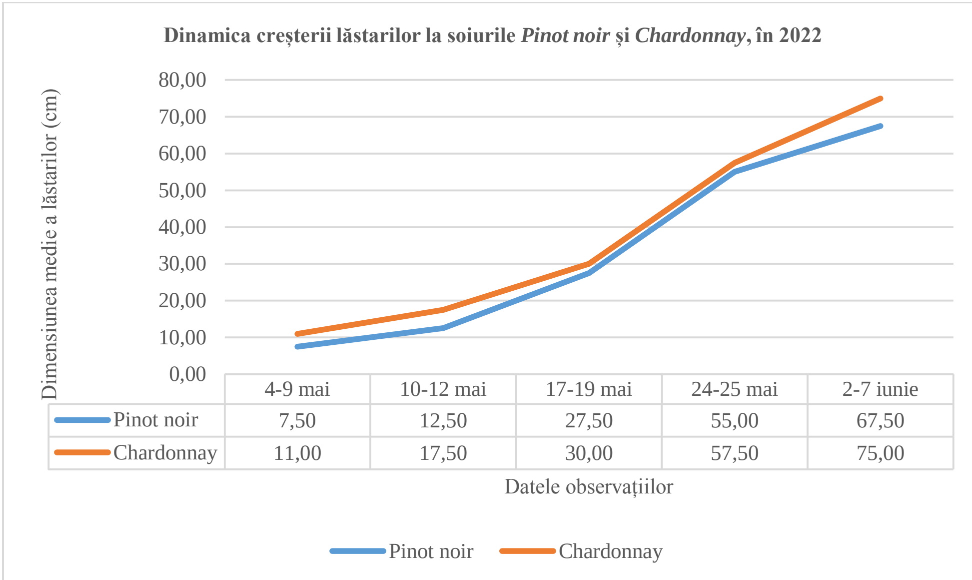

Fig. 6. Dynamics of shoot growth of *Pinot noir* and *Chardonnay* cultivars, in PDO Miniş, in 2022 /
Dinamica creșterii lăstarilor la soiurile *Pinot noir* și *Chardonnay*, în DOP Miniș, în 2022

The year 2020 is atypical compared to 2021 and 2022 in terms of vegetative growth dynamics for each variety (Figures 7 and 8), with the accumulation of useful temperatures leading to a sharp slowdown in Pinot noir. If the percentage of bunches entering the veraison had been significantly higher than for Chardonnay, we could have attributed this stagnation to the physiological processes being directed towards grape ripening and seed maturation.

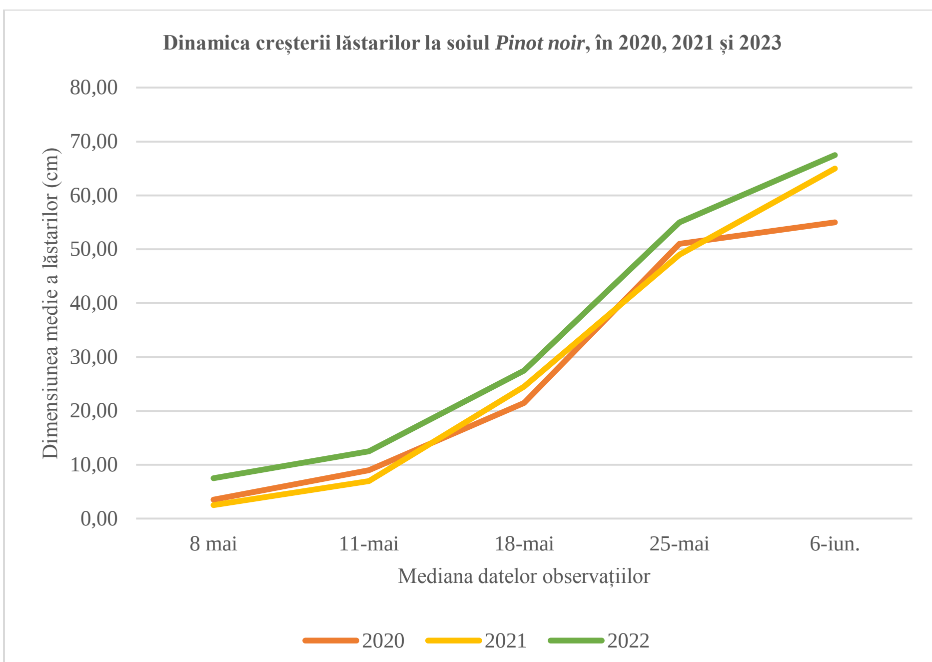

Fig. 7. Dynamics of shoot growth of *Pinot noir* cultivar, in PDO Miniş, in 2020, 2021 and 2022 /
Dinamica creșterii lăstarilor la soiul *Pinot noir*, în DOP Miniș, în 2020, 2021 și 2022

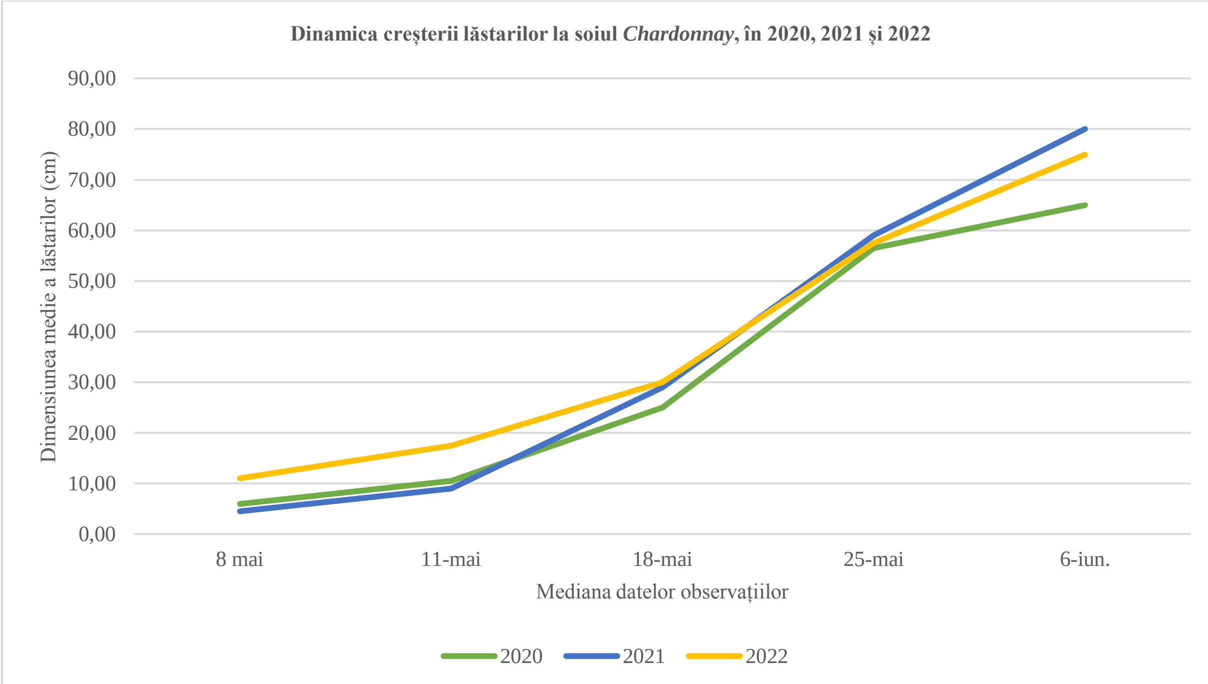

Fig. 8. Dynamics of shoot growth of *Chardonnay* cultivar, in PDO Miniş, in 2020, 2021 and 2022/ /
Dinamica creșterii lăstarilor la soiul *Chardonnay*, în DOP Miniș, în 2020, 2021 și 2022

The *Chardonnay* variety responds much more quickly to the consequences of the useful temperature peak in July 2021, with 100% of the clusters having entered the veraison, compared to *Pinot noir* with only 80%. In years with a normal evolution of useful temperatures during the veraison period, the *Chardonnay* variety is constant in triggering the phenomena preceding grape ripening, whereas *Pinot noir* also reacts to other environmental factors, either biotic or anthropic (Figure 9).

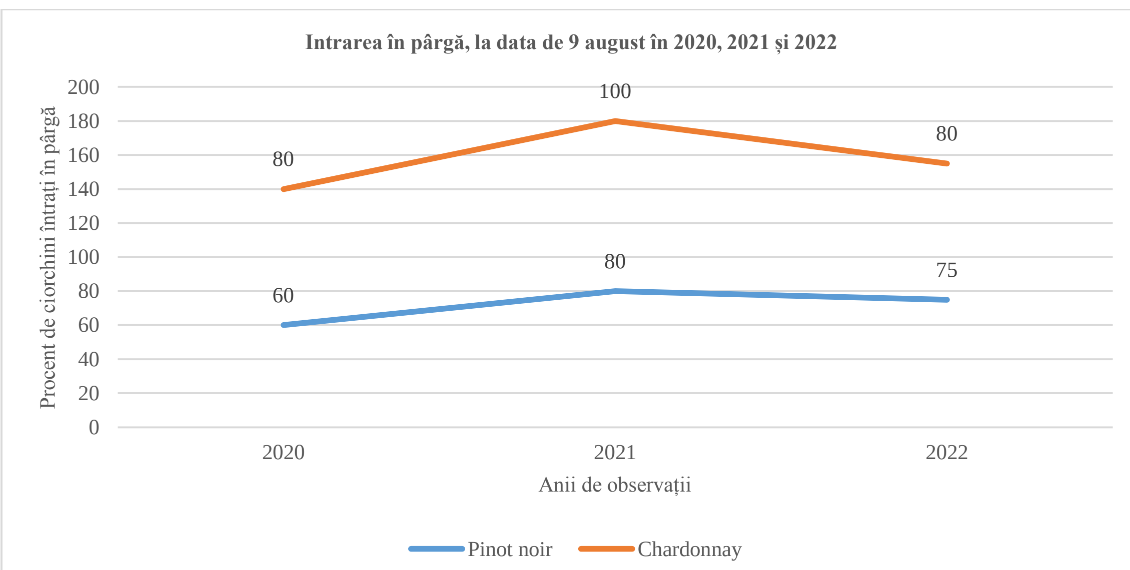

Figura nr. 9. The ripening percentage of the clusters in Pinot Noir and Chardonnay cultivars/
Procentul ciorchinilor intrați în pârgă la soiurile *Pinot noir* și *Chardonnay*, în DOP Miniș, în 2020, 2021 și 2022

Ripening was determined at three different intervals in August and September, but the same in each of the study years. The result, illustrated in Figure 10, reveals an almost parallel trend between the two varieties, as they react effectively identically to environmental factors.

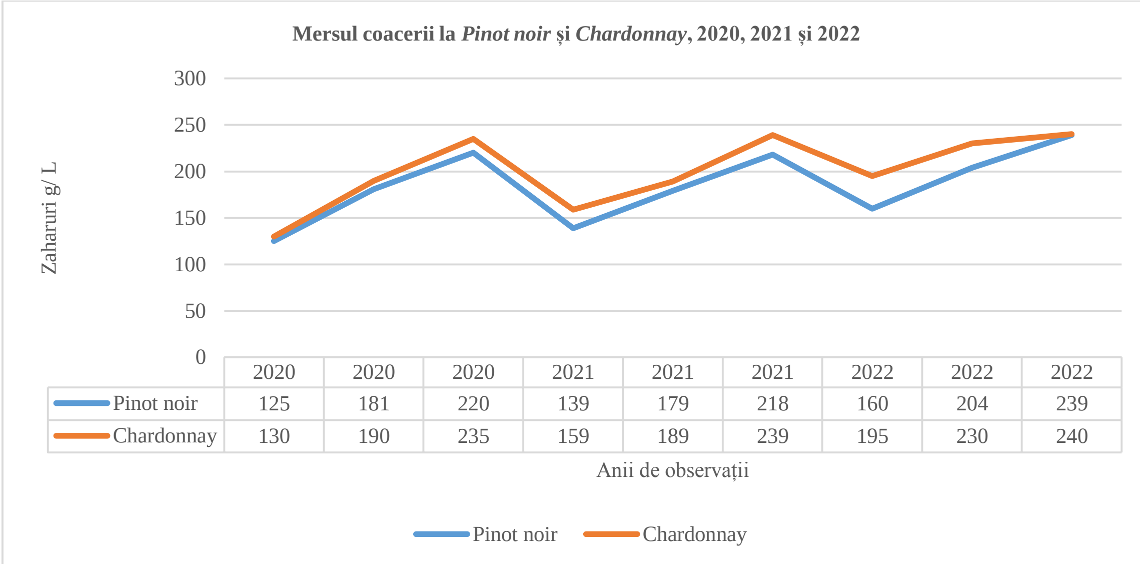

Fig. 10. The ripening progress – sugar accumulation (g/ L) in *Pinot Noir* and *Chardonnay* varieties/
Mersul coacerii – acumularea de zaharuri (g/ L), la soiurile *Pinot noir* și *Chardonnay*, în DOP Miniș, în 2020, 2021 și 2022

Increasing the number of replicates/observations for each variety would have led to a decrease in the variance affecting the mean of each result. The small number of observations, over only three consecutive years, implies the disadvantage that they are subject to errors related to the number of grapevines on which observations were made, the homogeneity of the plots in which the grapevines were studied and the like, including data sensitive to genetic variation (Figure 11).

F-Test Two-Sample for Variances

	Chardonnay	*Pinot noir*
Mean	209,4	195,8
Variance	1121,4	1199,457143
Observations	15	15
df	14	14
F	0,934922941	
P(F<=f) one-tail	0,450795179	
F Critical one-tail	0,402620943	

Fig. 11 Variance analysis of *Pinot noir* and *Chardonnay* cultivar./
Analiza varianței la soiurile *Pinot noir* și *Chardonnay*, în DOP Miniș, în 2020, 2021 și 2022

The distribution of sugar accumulation values is almost symmetrical for the two varieties over the period studied, with the averages being extremely close. There is a strong correlation between the two varieties, with F = 0.935, very close to 1, with a positive trend (Figure 12).

With a confidence level of 50-60%, the experiment would require a much larger number of observations for greater accuracy of the results. The averages of sugar accumulation are very close: 195.8 g/L for *Pinot noir* and 209.4 g/L for *Chardonnay*. Given that 1% alcohol by volume is theoretically obtained by fermenting 17 g of sugars in the presence of yeasts of the genus *Sacharromyces*, *Pinot noir* grapes could produce a wine with 11.58% vol. alc. and *Chardonnay* grapes a wine with 12.31% vol. alc. From both varieties, the possible wines are in line with the specifications for the Miniș PDO, which stipulate a minimum alcoholic strength of 11.5% vol. alc. [17].

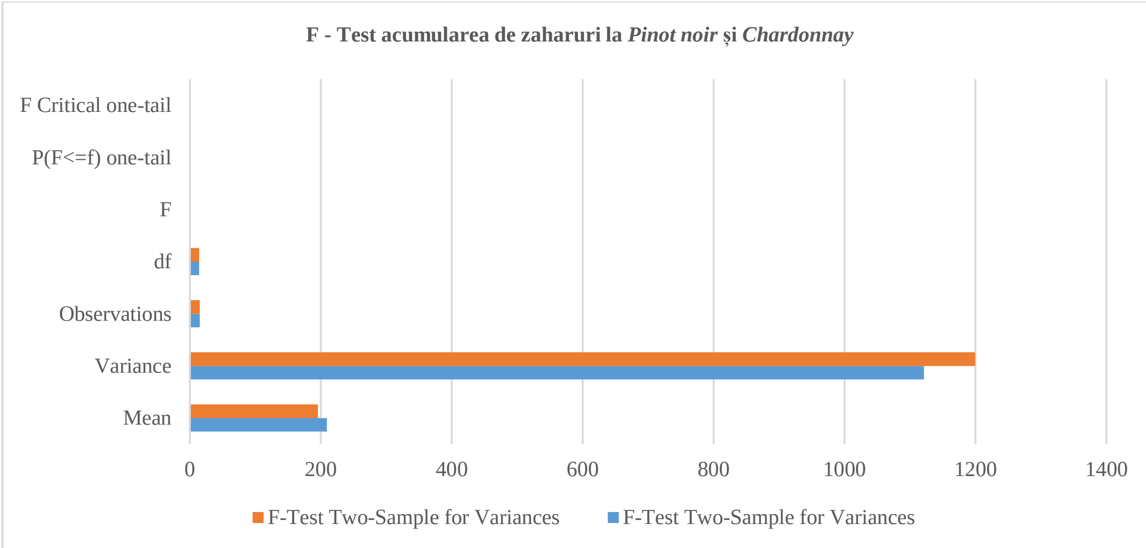

Fig. 12. The F test for sugar accumulation of *Pinnot noir* and *Chardonnay* grapevine /
Testul F, pentru acumularea de zaharuri la soiurile *Pinot noir* și *Chardonnay*, în DOP Miniș, în 2020, 2021 și 2022

The mean standard error shows the value of the discrepancy between the measurements, at the same date, of sugar accumulation in the grapes of the two varieties. Being so far from zero (8.94 for *Pinot noir* and 8.64 for *Chardonnay*), it shows that the discrepancy arises due to the small number of samplings. Kurtosis defines a slight tail to the left (-0.518) in *Pinot noir*, with no outliers to the right (0.353) in *Chardonnay*. This means that we have a univariate normal distribution. Skewness-test shows skewness to the left (negative): (-0.518) for *Pinot noir* and more pronounced (-0.978) for *Chardonnay*. The tabular T-test shows lower values for *Chardonnay* than for *Pinot noir* for the same confidence interval of 95-98% (Figure 13).

Pinot noir		*Chardonnay*	
Mean	195,8	Mean	209,4
Standard Error	8,942248572	Standard Error	8,646386528
Median	204	Median	222
Mode	220	Mode	190
Standard Deviation	34,6331798	Standard Deviation	33,48731103
Sample Variance	1199,457143	Sample Variance	1121,4
Kurtosis	-0,51866804	Kurtosis	0,353075986
Skewness	-0,517971018	Skewness	-0,977616955
Range	112	Range	109
Minimum	128	Minimum	132
Maximum	240	Maximum	241
Sum	2937	Sum	3141
Count	15	Count	15
Largest(1)	240	Largest(1)	241
Smallest(1)	128	Smallest(1)	132
Confidence Level(95,0%)	19,1792157	Confidence Level(95,0%)	18,54465472

Fig. 13. Descriptive statistics of sugars accumulation of Pinot Noir and Chardonnay varieties /
Statistică descriptivă pentru acumularea de zaharuri la soiurile *Pinot noir* și *Chardonnay*

At a critical F of 4.196, with df 15, in the F-table we have the alpha value in the range 2.64 - 2.80. At P-value = 0.283, the null hypothesis is rejected, so there is a link between the variables defining the environmental factors and the results of the observations (Figure 14).

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Pinot noir	15	2937	195,8	1199,457143
Chardonnay	15	3141	209,4	1121,4

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1387,2	1	1387,2	1,195420411	0,28355651	4,195971819
Within Groups	32492	28	1160,428571			
Total	33879,2	29				

Fig.14. One-way ANOVA test for sugar accumulation of Pinot noir and Chardonnay /
Testul ANOVA, cu un singur factor, pentru acumularea de zaharuri la soiurile *Pinot noir* și *Chardonnay*

The recommendation would be to continue the observations, even with extension on varieties created within the research unit, as was done in 2019-2022, in other wine-growing areas in Romania [17].

CONCLUSIONS

Pinot noir and *Chardonnay* varieties are relatively well suited to be cultivated in the area delimited for the Miniș PDO, the former being the most cultivated grape wine variety in this area, according to ONVPV statistics [18].

The direct influences of the enoclimate, especially the active thermal balance and the useful thermal balance, especially in the phenophases of intense shoot growth, entry into veraison and ripening of the grapes, can be shaped by the use of cultivation technology, by green harvesting, shading with white lime film, partial defoliation.

There is a close link between the growing characteristics of the two grape wine varieties, which means that it is advisable in areas where *Pinot noir* is suitable for growing, to provide the variety for white wines with *Chardonnay*, especially for the base wine for sparkling wines.

Further research is needed, in conjunction with environmental factors and especially the response to extreme weather events: late frosts, early frosts, hail, sunburn. More observations will make the results more accurate.

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RESEARCH REGARDING THE GROWTH, DEVELOPMENT AND FRUITING PROCESSES OF SOME ROOTSTOCK- SCION COMBINATIONS IN A HIGH DENSITY APPLE ORCHARD, IN NORTHERN TRANSYLVANIA

CERCETĂRI PRIVIND PROCESELE DE CREŞTERE, DEZVOLTARE ŞI FRUCTIFICARE A UNOR COMBINAŢII SOI-PORTALTOI LA SPECIA MĂR, ÎNTR-O PLANTAŢIE DE MARE DENSITATE, ÎN NORDUL TRANSILVANIEI

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Abstract

Researches have been effectuated in a high density apple orchard (1666 trees/ha) located in Northern Transylvania at FRDS Bistrita, in a highland area called "Bistrita hills" established in the year 2001 with apple varieties resistant to scab (Venturia inaequalis), Florina and Generos, grafted on rootstock M26 conduced as slender spindle training system. The registering and analysing of data focused on two main time periods: early development stage of young orchard in the first 7 years, during 2001-2008 and the full maturity stage during 2019-2021. In the 20 years lifespan of the orchard at both cultivars there have been registered a positive fructification tendency starting with the first years, thus at Florina was 3.56-56.85 to/ha registered and at Generos 5.79-51.07 to/ha. Growth characteristics evaluated by the trunk cross sectional area indicator showed increased values at Florina/ M26 combination at the full development of trees in 2021 (143.36 cm^2) when compared with Generos/M26 variant (126.25 cm^2). Productivity index showed higher values in early stage during 2003-2008 at Florina (0.20-0.93) and at Generos (0.38-0.73) while at maturity during 2019-2021 at Florina ranging 0.15-0.26 and at Generos 0.14-0.26, growth and production beeing more equilibrated. Growth and yield capacity of trees was influenced in the period 2001-2021 beside the fruit growing technology also by the evolution of climatic factors (drought, hail falling, negative temperatures during blossom).

Keywords: high density orchard, rootstock, variety, yield, trunk cross sectional area

Rezumat

Cercetările au fost efectuate într-o plantaţie de măr de mare densitate (1666 pomi/ha) localizată în Nordul Transilvaniei la SCDP Bistrita, într-o zonă colinară denumită "Dealurile Bistriţei", înfiinţată în anul 2001 cu soiuri de măr rezistente la rapăn (Venturia inaequalis), Florina şi Generos, altoite pe portaltoiul M26 având sistem de conducere a pomilor fus subţire. Înregistrarea, analiza datelor s-a focusat asupra a două importante perioade de timp: perioada de tinereţe a plantaţiei în primii 7 ani (2001-2008) şi perioada de maturitate deplină (2019-2021). În cei 20 de ani de viaţă a plantaţiei, la ambele soiuri s-a înregistrat o tendinţă pozitivă de fructificare încă din primii ani, astfel la soiul Florina s-a înregistrat o producţie de 3.56-56.85 to/ha, iar la soiul Generos valorile au arătat 5.79-51.07 to/ha. Caracterisiticile de creştere evaluate prin suprafaţa secţiunii trunchiului au arătat valori mai ridicate la Florina/M26 la dezvoltarea maximă a pomilor (143,36 cm^2), comparativ cu soiul Generos/M26 (126,25 cm^2). Indexul productivităţii a arătat valori mai ridicate în perioada 2003-2008 (Florina 0,20-0,93, Generos 0,38-0,73), iar la maturitate între 2019-2021 la Florina s-au înregistrat valori de 0,15-0,26, respectiv la Generos între 0,14-0,26. Creşterea şi fructificarea pomilor a fost influenţată în perioada 2001-2021 pe lângă tehnologia de cultură şi de evoluţia factorilor climatici (secetă, grindină, temperaturi negative în timpul înfloritului).

Cuvinte cheie: plantatie de mare densitate, portaltoi, soi, producție, secțiunea transversală a trunchiului

INTRODUCTION

The apple (*Malus domestica, Borkh*) takes the second-place in terms of importance in national fruit production after the plum species, and recent data from the last statistical year 2020 showed a slight decrease of the apple areas and yields (52.3 thousand ha) compared to the values recorded in 2015 (55.8 thousand ha). This phenomenon can be due both to the extensive process of reconversion of old fruit plantations and to the clearing of aging orchards, respectively the preparation of land for new orchards (INS, 2021). The total production of apples registered by the INS shows a significant increase from 476.6 thousand tons (2015) to 551.4 thousand tons (2020), this positive trend contributes to an increase in the production of fruit on the consumer's table and can be a cause of the phenomenon of intensification and the increase in the productivity and density of fruit plantations. The reconversion process of the non-performing plantations started in 2015 and continues today, producers are increasingly opting for high-density plantations and production systems. Many fruit plantations were established at the beginning of the 1950`s with densities of 150-250 trees/ha, with a globular canopy and a tall trunk (Cepoiu, 1989, 2005), later after the 1970`s, an intensification phenomenon began and the growth planting densities using less vigorous rootstocks with planting densities of 1,250 trees/ha (Ghena, 2003, Meland, 1996, Stefan, 1993). Due to the lack of high-performance irrigation systems, of water resources in the area or other causes, in the vast majority of current fruit plantations, low-vigor M9 or M26 type rootstocks were not chosen, which require or impose an irrigation system, so the MM106 rootstock still predominates, or other rootstocks from abroad with great vigor that resist even in more difficult eco-pedological conditions in more clayed soils, drier areas with lower amounts of precipitation (Isac, 1998). After the revolution (1989), at the national level in the early 2000`s, more advanced culture systems (thin spindle) began to be known for the apple species, with rootstocks that increased less vigor, higher productivity (M26, M9, M27), but many of these they were still in the testing phase (Gonda, 2003). In Europe, in the large apple-producing countries such as Germany, France, Spain, there are very modern technologies with high-density culture systems, with irrigation and/or fertigation systems having an assortment of varieties and rootstocks resistant to eco-pedological conditions, reaching productions of 40-50 tons/ha. At the beginning of the 2000`s, the main interest was the use of varieties with genetical resistance, especially in apple scab (*Venturia inaequalis*) from abroad, such as `Florina', `Prima', `Priam', `Priscilla', `Wanda', and Romanian cultivar `Generos` to reduce production costs with phytosanitary treatments (Branişte, 1999) and to have apples as healthy as possible with a low content of pesticides. The establishment of these fruit plantations means substantial financial efforts, but these costs are amortized over time if satisfactory production levels are reached. Among the fruit tree rootstocks with vegetative propagation in Romania, the MM106, M9, M26 rootstocks are authorized for propagation, and among them, at the level of the 2000`s, the most optimal candidate for orchards with medium-high density with medium-sub-medium vigor that can withstand more difficult conditions of drought without the application of irrigation systems was the rootstock M26, selected and approved by the East Malling research station in England. The promotion in culture of varieties with genetic resistance to diseases with its many valences constituted a major interest in the fruit-growing of Bistrita-Năsăud county, since the beginning of the 2000`s, thus efforts were undertaken to capitalize on the genetic progress of international and national improvement alike, materializing in a demonstration plot with a high-density planting system in different technological variants. The most valuable characteristic of varieties from a horticultural point of view is productivity and quality, properties that come from the genetics of the species that can be influenced by eco-climatic, biological and technological factors. Productivity is influenced by some genetic peculiarities such as: the vigor of the trees, the differentiation fruit buds, the branching capacity, the behaviour during the fertilization process, the precocity of fruiting, the resistance to stress factors. The aim of this multi-year study (2001-2021) was to investigate the growth, development and fruiting processes of some apple scab-resistant varieties (Florina and Generos) grafted on M26 rootstock in the eco-pedological conditions of Northern Transylvania, in the fruit-growing region of Bistriţa. The aim of this research was to know the productivity of the two relevant apple varieties from the national orchard (Florina and Generos respectively) using the M26 rootstock of medium vigor to explore a very common soil both in Transylvania and in other areas of Romania.

MATERIAL AND METODS

The research was carried out in a high-density apple orchard (1,666 trees/ha) located in the Northern Transylvania at FRDS Bistriţa, in a hilly area called "Bistriţa Hills", established in 2001 with apple cultivars resistant to apple scab (*Venturia inaequalis*), Florina and Generos, grafted on the M26 rootstock with a thin spindle tree management system. The terrain of the research station is located at altitudes between 330-410 m and the studied plot is at an altitude of 345 m. The orchard under study is located on a hill with a 10% slope, with South East exposure. The soil type is typical brown `argilloiluvial`-the term used in the old pedological systematization system at the establishment of the research plot and novadays called eutricambosoil, weak-medium pseudoglayed, loamy, on clays and gravel, medium to low permeability. The experiment was bifactorial, with completely randomized blocks, with three replicates. The biometric, phytometric and production data were analyzed with the statistical program XLSTAT, version 2022. The recording, analysis of the data focused on two important time periods: the youth period of the plantation in the first 7 years (2001-2008) and the period of full maturity (2019-2021).The following phytometric descriptors were analyzed: trunk cross sectional area -TCSA (cm^2), average shoot growth (cm), number of fruits per tree, average fruit weight, fruit yield (kg/tree), fruit total production (to/ha), productivity index (kg/cm^2). The trunk circumference was measured 20 cm above the grafting point, and the phytometric growth descriptors were recorded in synthetic tables, the number, the fruit weight was measured in the orchard and in the laboratory immediately after harvesting the fruits that were ripe for consumption from those 3 replicates.

RESULTS AND DISCUSSIONS

The analysis from national statistical data (INS, 2021) regarding the areas of agricultural land planted and cultivated with apple fruit trees shows a decreasing trend in the last 5 years (Fig.1).

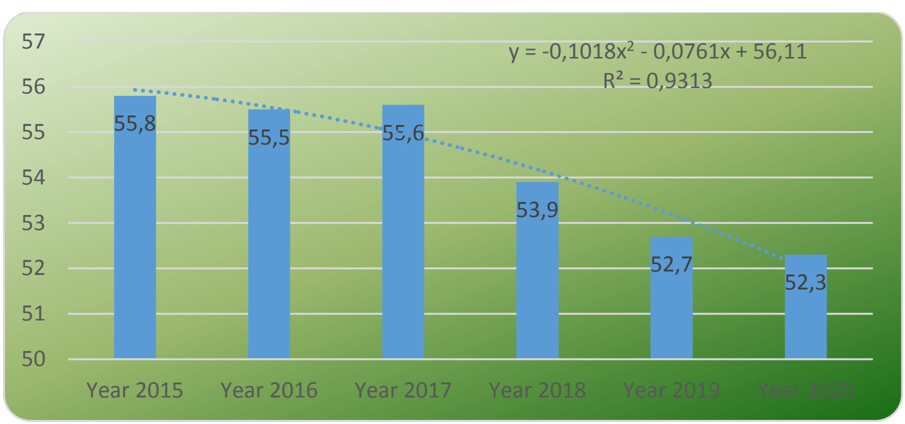

Figure 1 The cultivated area in Romania with apple orchards (thousand ha) // Suprafaţa cultivată în România cu specia măr (mii ha)

The total production of fruits in Romania has increased in the last five years (Fig.2), obtaining relevant fruit productions at national level.

Figure 2. The total of apple fruit production obtained in Romania (thousands of tons) // Producţia totală de mere în România (mii de tone)

The trunk cross-section area (TCSA) achieved the greatest increase in Florina cultivar grafted on M26 rootstock in the first 4 years of growth and development (43.18 cm^2) and in the period of maximum maturity (in the 17-18 years of the trees' life) there was a growth of only 18.4 cm^2 (Table 1). In case of Generos cultivar, the increase of growth was slower in the first five years of the tree`s life (34.32 cm^2) and in the last years, during the period of maximum maturity, a value of 18.98 cm^2 was recorded, slightly higher than the Florina variety. In the last years of research, a slower growth of the trunk was observed in both varieties, but the growth was continuous in the last years as well (Fig. 3).

Table 1. Trunk growth characteristics of Florina and Generos varieties grafted on M26 rootstock/Dinamica creşterii trunchiului la soiurile Florina şi Generos, altoite pe portaltoiul M26

Trunk cross- sectional area (cm^2)	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Diference TCSA (2008-2003)	Year 2019	Year 2020	Year 2021	Diference TCSA (2021-2019)
Florina/M26/1,666 trees/ha	10.5	14.6	30.49	36.14	46.37	53.68	**43.18**	124.96	131.32	143.36	**18.40**
Generos/M26/1,666 trees/ha	7.6	9.5	23.01	29.14	36.26	41.92	**34.32**	107.27	131.32	126.25	**18.98**

The values for the Florina/M26 cultivar (Table 1) from the initial data of 10.5 cm^2 of TCSA, increased to the level of 143.36 cm^2. The data presented in figure 3 showed an increase from 7.6 cm^2 to the level of 126.25 cm^2 for Generos cultivar.

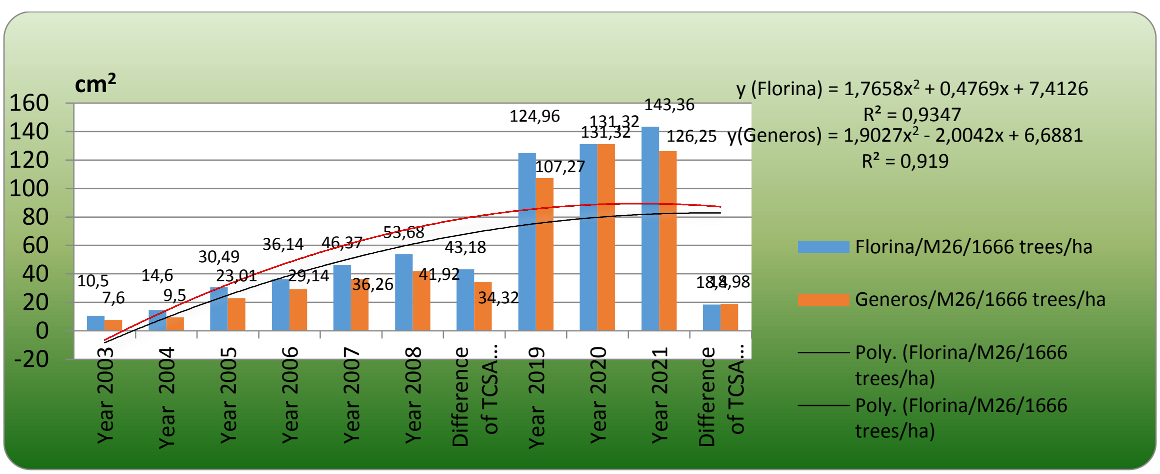

Figure 3. The dynamics of trunk cross sectional area growth -TCSA (cm^2) in Florina and Generos varieties // Dinamica creşterii suprafeței secțiunii trunchiului la soiurile Florina şi Generos

In the first 5 years, the trees developed harmoniously, the crown of the trees was formed according to the standard methodology of forming the shape of a thin spindle crown (Fig. 4).

Figure 4. View from the high density orchard (1,666 trees/ha) in the first years of development // Livadă de mare densitate (1.666 pomi/ha), în primii ani după plantare

The average growth of the shoots in the first 5 years of the tree`s life (2003-2008) was moderate at Florina cultivar with average values of 35.00 cm and 36.73 cm for Generos cultivar (Table 2).

Tabel 2. The shoot growth characteristics of the Florina and Generos cultivars grafted on the M26 rootstock/Dinamica creşterii lăstarilor la soiurile Florina şi Generos, altoite pe portaltoiul M26

Shoot growth (cm)	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Average (2008-2003)	Year 2019	Year 2020	Year 2021	Average (2019-2021)
Florina/M26/1,666 trees/ha	31.3	32.1	46.7	40.3	30.6	29	**35.00**	68.34	43.18	46.51	**52.68**
Generos/M26/1,666 trees/ha	30	34.3	50.6	37.9	35.3	32.3	**36.73**	63.05	44.25	58.88	**55.39**

After 17-18 years after folowing the technological orchard management in the experimental field, the recorded values showed a more pronounced an average growth of 52.68 cm for the Florina cultivar and 55.39 cm for the Generos cultivar. By advancing in age towards the maturity of the trees, the tendency of the growth of the shoots can be observed (Fig. 5).

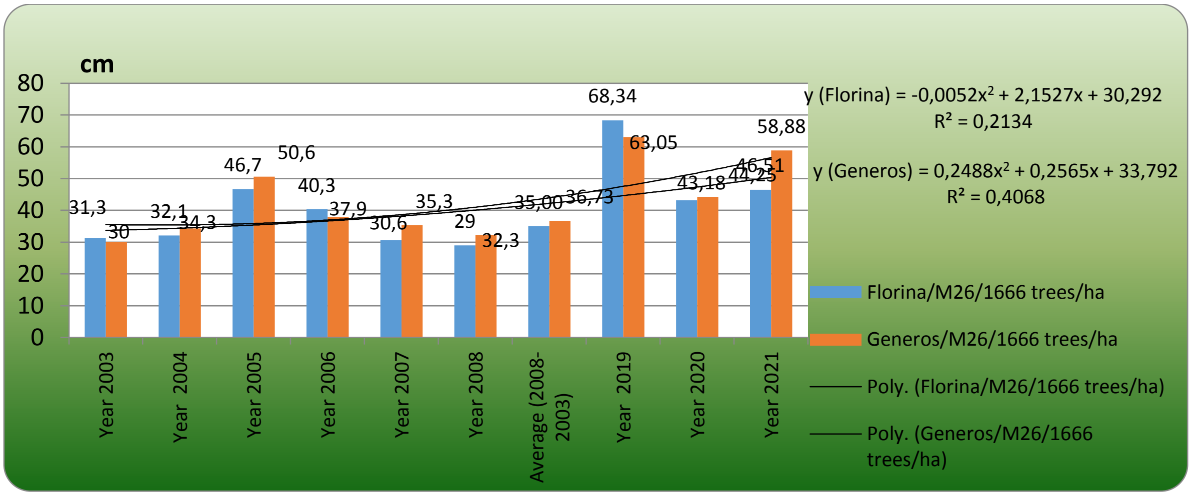

Figure 5. The tendency of the average shoots growth in Florina and Generos varieties // Dinamica creşterii lăstarilor la soiurile Florina şi Generos

The number of fruits per tree in the first years had values between 129 fruits/tree for Florina and 128 fruits/tree for the Generos cultivar (Table 3).

Table 3. The number of fruits per tree (piece) in the Florina and Generos varieties grafted on the M26 rootstock // Numărul de fructe/pom la soiurile Florina și Generos altoite pe portaltoiul M26

No fruits/tree (pieces)	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Average (2008-2003)	Year 2019	Year 2020	Year 2021	Average (2019-2021)
Florina/M26/1,666 trees/ha	29	125	138	170	147	166	**129.17**	118	202	203	**174.33**
Generos/M26/1,666 trees/ha	45	87	147	134	136	219	**128.00**	82	159	154	**131.67**

At the end of the experiment, the trees developed more intensively, the generative fruiting processes intensified and the number of fruits per tree increased, reaching an average number of 174 fruits for the Florina variety and 131 fruits for the Generos cultivar (Fig. 6).

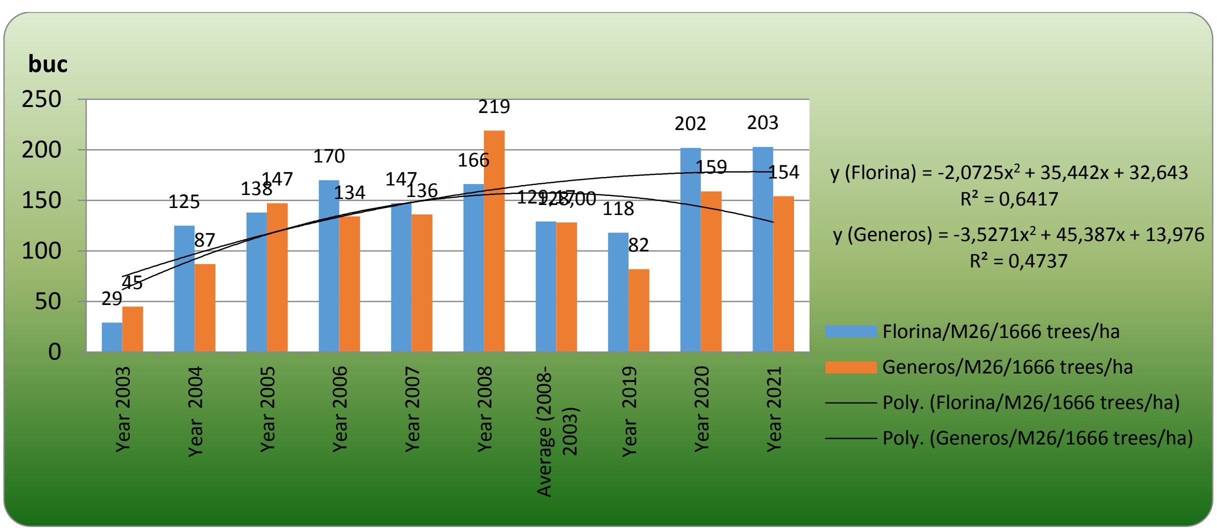

Figure 6. The number of fruits (piece/tree) in the Florina and Generos cultivars // Numărul de fructe (buc./pom) la soiurile Florina și Generos

The average fruit weight was 131.33 g for the Florina cultivar in the first 5 years of life and 119.67 g for Generos, in the last years of full maturity when the trees reached the technological maturity of production, fruit weights of 168.92 g were achieved for Florina and 190.85 g at Generos (Table 4).

Table 4. Fruit weight per tree for Florina and Generos varieties grafted on M26 rootstock // Greutatea fructelor/pom la soiurile Florina şi Generos altoite pe portaltoiul M26

Average weight of fruits (g)	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Average (2008-2003)	Year 2019	Year 2020	Year 2021	Average (2019-2021)
Florina/M26/1,666 trees/ha	72	108	125	170	147	166	**131.33**	167	170	170	**168.92**
Generos/M26/1,666 trees/ha	65	77	87	134	136	219	**119.67**	190	191	192	**190.85**

The evolution of the average fruit weight in the experimental variants from the beginning to the maximum technological maturity is presented in figure 7.

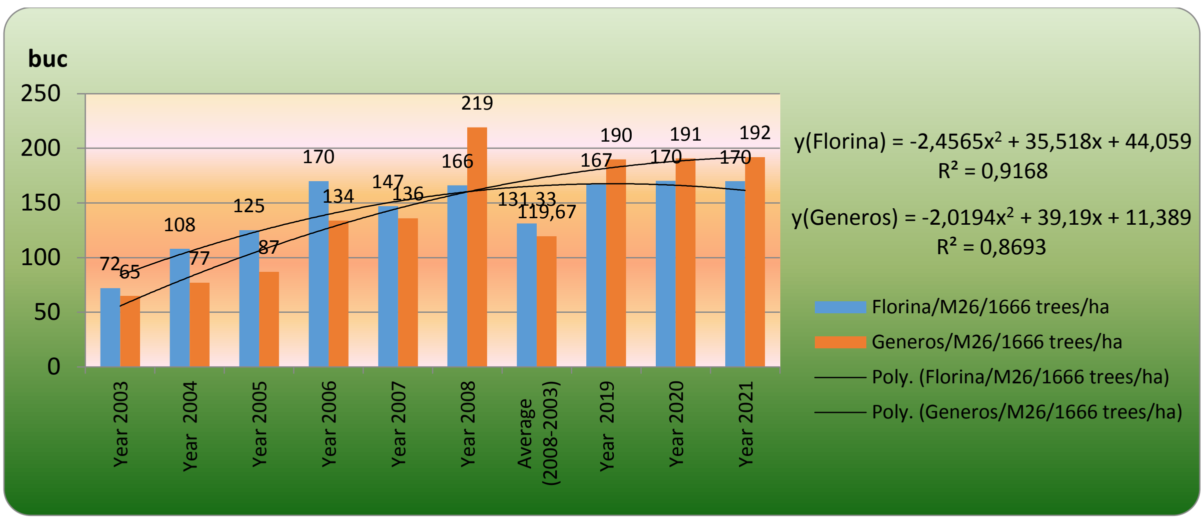

Figure 7. Fruit weight of the Florina and Generos cultivars in 2003-2021 // Greutatea fructelor la soiurile Florina şi Generos în perioada 2003-2021

The average fruit production per tree was 17.4 kg/tree at Florina and 15.32 kg/tree at Generos and in the years 2019-2021 the values of 29.51 kg/tree at Florina and 25.18 kg/tree at the Generos variety were recorded (Table 5).

Table 5. Fruit production kg/tree for Florina and Generos varieties grafted on M26 rootstock // Producția de fructe, kg/pom, la soiurile Florina şi Generos altoite pe portaltoiul M26

Fruit yield (kg/tree)	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Average (2008-2003)	Year 2019	Year 2020	Year 2021	Average (2019-2021)
Florina/M26/1,666 trees/ha	2.14	13.6	17.25	23.46	22.19	24.19	**17.14**	19.59	34.48	34.46	**29.51**
Generos/M26/1,666 trees/ha	2.93	6.7	12.87	19.16	19.58	30.66	**15.32**	15.65	30.28	29.6	**25.18**

The trend of the evolution of fruit production kg/tree is presented in figure 8. We observe a significant increase in fruit production with the advancing age of the trees towards maximum technological maturity.

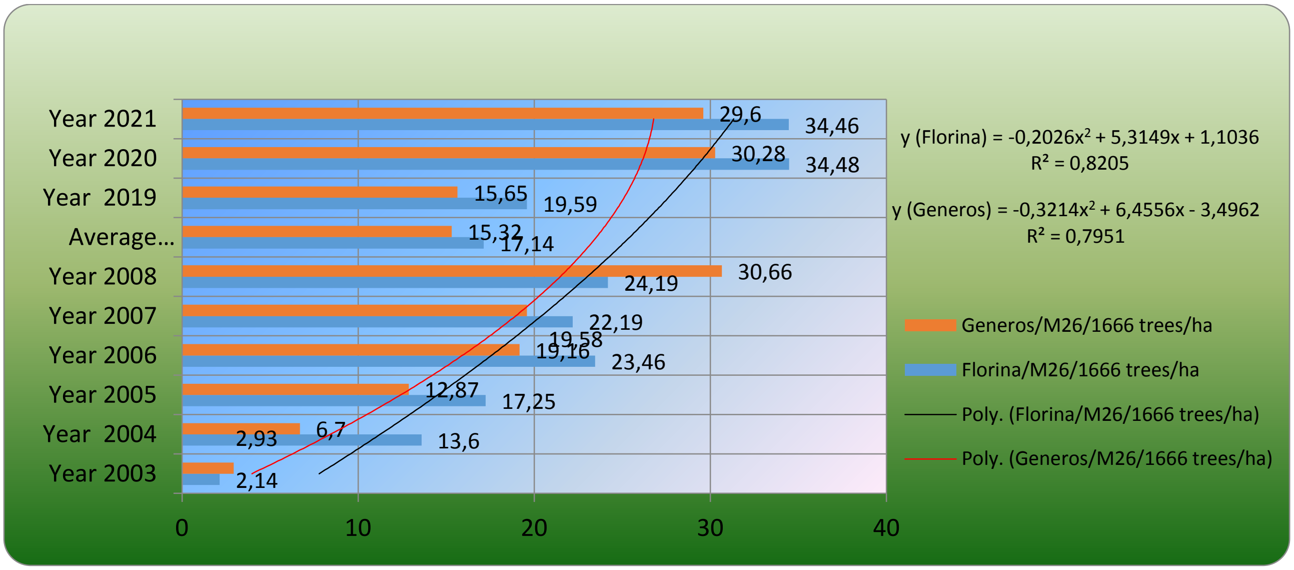

Figure 8. Fruit production trend kg/tree in Florina and Generos varieties // Dinamica creşterii producţiei, kg/pom, la soiurile Florina şi Generos

Fruit production per hectare was 26.62 to/ha in the first 5 years of tree development in Florina and 27.23 to in the Generos cultivar and at the maximum maturity of development it was 49.10 to/ha in the Florina variety and 42.37 to/ha in the cultivar Generos (Table 6).

Table 6. Fruit production to/ha in Florina and Generos varieties grafted on M26 rootstock // Producţia de fructe, t/ha, la soiurile Florina şi Generos altoite pe portaltoiul M26

Fruit Production (to/ha)	Year 2003	Year 2004	Year 2005	Anul 2006	Year 2007	Year 2008	Average (2008-2003)	Year 2019	Year 2020	Year 2021	Average (2019-2021
Florina/M26/1,666 trees/ha	3.56	29.7	19.5	29.7	36.96	40.3	**26.62**	32.67	57.79	56.85	**49.10**
Generos/M26/1,666 trees/ha	5.79	13.5	32.2	28.2	32.62	51.07	**27.23**	26.97	50.88	49.25	**42.37**

We observe a significant increase in fruit production in the last 17-18 years (Fig. 9) since the beginning of the experiment, the trend of continuous growth is described with a 2nd degree equation with a coefficient of determination of 0.75-0.8.

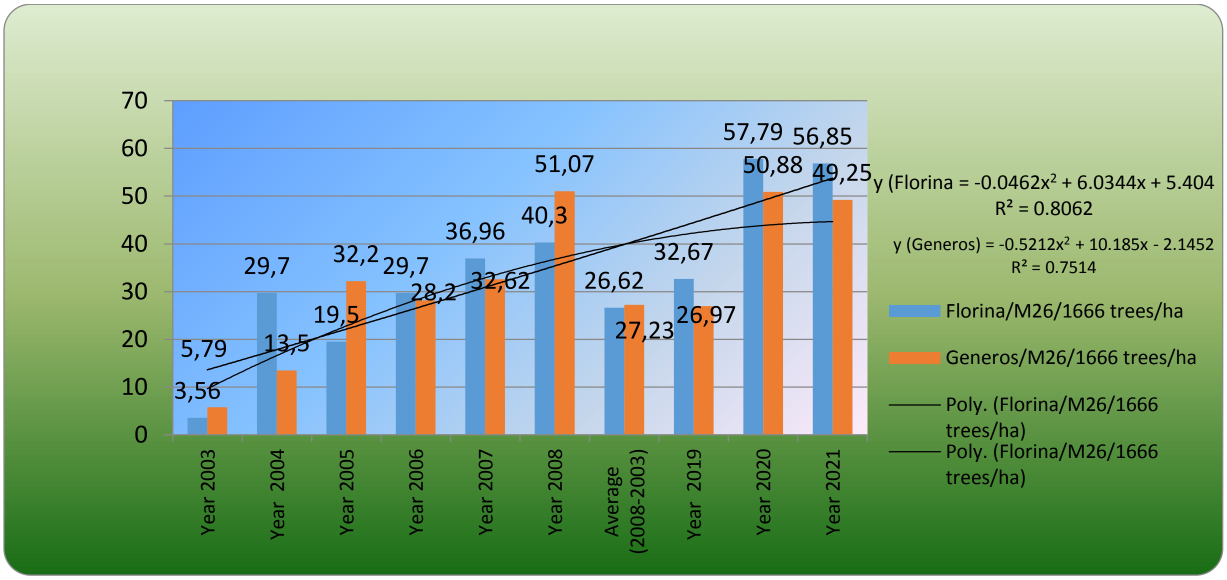

Figure 9. The evolution trend of fruit production to/ha in Florina and Generos varieties // Evoluţia producţiei de fructe, t/ha, la soiurile Florina şi Generos

The productivity index (Fig. 10) recorded higher values in the first 5 years of growth and fruiting, namely 0.55 for the Florina variety and 0.60 for the Generos variety, and in recent years the productivity index capped at lower values of 0.21 for the variety Florin respectively 0.20 for the Generos variety, following the "plateau" phase of the fruit plantation.

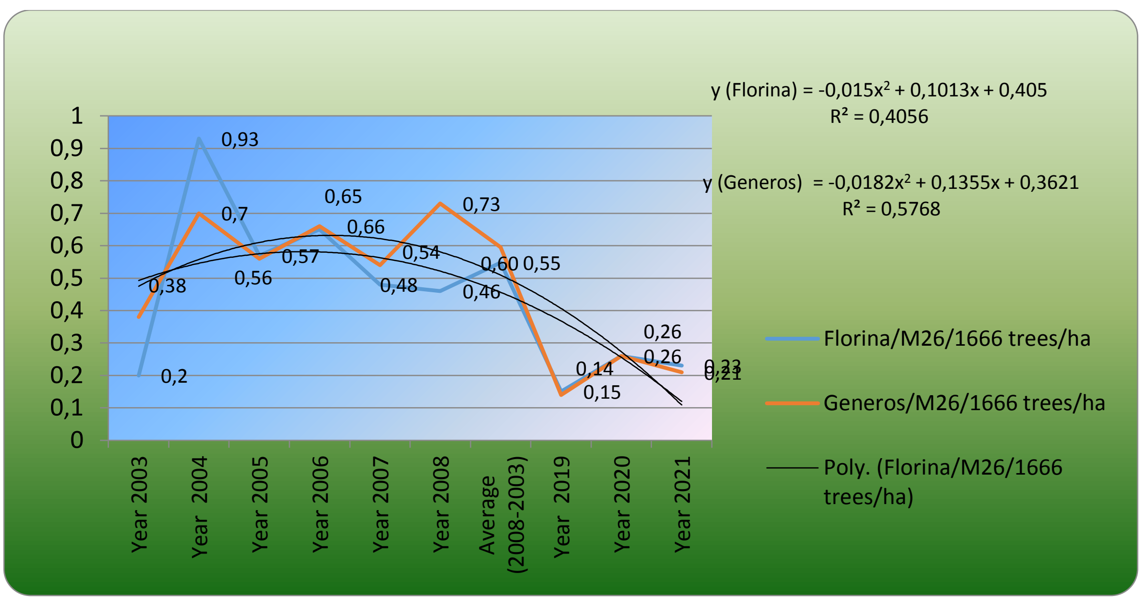

Figure 10. The evolution of the productivity index (kg/cm2) in the Florina and Generos varieties during the experimental period // Evoluţia indexului de productivitate (kg/cm²) la soiurile Florina şi Generos în perioada de studiu

CONCLUSIONS

The reported yield per hectare in the ecopedological conditions from FRDS Bistrita at the maximum maturity of the experimental plantation (17-18 years after planting) was satisfactory, reaching a level of 42-49 to/ha for the Florina and Generos varieties grafted on the M26 rootstock. The fruit production obtained was slightly higher in the Florina / M26 cultivar compared to the Generos / M26 cultivar, but the values were close under the conditions of applying a conventional chemical maintenance technology but with a reduced phytosanitary treatment scheme. The M26 rootstock adapted well to the local eco-pedological conditions, making good use of the typical brown argiloiluvial soil (eutricambosoil) resources, very widespread in Transylvania. Varieties resistant to apple scab (*Venturia inaqualis*) contributed to obtain quality fruits with the possibility of applying technological links in organic fruit growing.

Micu I. (1995) researched the adaptation and fruiting of some apple varieties with genetic resistance to diseases from the Transylvanian plateau and found that the Florina cultivar produced well in the V-XII year after planting and the production obtained was 24.6 tons/ha. In the pedoclimatic conditions of Timişoara, Iordănescu Olimpia (2005) observed the fact that in the eighth year from planting the Florina and Generos varieties grafted on the M26 rootstock in a thin spindle tree management system at a reduced density of 1250 trees/ha can be obtained 14.79 kg/tree for the Florina variety and 12.63 kg/tree for the Generos variety. Similar to the same varieties, Branişte (2005) observed that satisfactory yields can be obtained even in years V-IX from planting of 19.5 kg/tree for Florina and 15.4 kg/tree for Generos cultivars. Our results confirm those reported by the authors of the mentioned studies, at the same biological age, in the young phase of the trees (the first 5-6 years of production) and at maximum maturity, an increase in the level of production by approximately 40% is noted in both varieties.

ACKNOWLEDGEMENTS

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GENETIC RESOURCES USED FOR FRUIT TREES, BERRIES AND STRAWBERRY ROMANIAN BREEDING PROGRAMS

RESURSE GENETICE FOLOSITE ÎN PROGRAMUL ROMÂNESC DE AMELIORARE LA POMI, ARBUȘTI FRUCTIFERI ȘI CĂPȘUN

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Abstract
Fruit genetic resources are an important treasure of traits valuable for breeding and for long-term sustainable fruit production. The research undertaken on ex situ collections for most important fruit species has as results the new registered varieties and launched into fruit production. The pomological characterization (used descriptors, data management, pests and diseases evaluation) allowed accumulating of new knowledge mainly for apple, pear, plum, sweet cherry, strawberry, blueberry and other berries used as genitors in breeding programs, in the last 20 years, at Research Institute for Fruit Growing Pitești, Romania. Growing interest in fruit genetic resources is related to modern breeding for long-term sustainable.

Key words: bank gene, fruit trees, berries, strawberry.

Rezumat
Resursele genetice pomicole reprezintă un tezaur valoros pentru ameliorare și pentru producția durabilă de fructe pe termen lung. Cercetările întreprinse asupra colecțiilor ex situ existente la cele mai importante specii pomicole s-au concretizat în noile soiuri înregistrate și lansate în producție. Caracterizarea pomologică (descriptori folosiți, managementul datelor, evaluarea comportării la principalele boli și dăunători) a permis acumularea de noi cunoștințe, în principal, pentru genotipurile de măr, păr, prun, cireș, căpșun, afin și alți arbuști fructiferi, utilizate ca genitori în programele de ameliorare derulate, în ultimii 20 de ani, la Institutul de Cercetare-Dezvoltare pentru Pomicultură Pitești, România. Interesul tot mai mare pentru resursele genetice pomicole este legat de ameliorarea modernă pentru durabilitate pe termen lung.

Cuvinte cheie: colecții, pomi, arbuști fructiferi, căpșun.

INTRODUCTION

National, regional and local genebank, botanical gardens, arboreta, private companies and NGOs host fruit genetic resources collections (Bramel and Volk, 2019; Flachowsky and Höfer, 2010; Gassmann at al., 2017). A few of the still existing collections were established already in the 1920s, including the UK National Fruit Collection in Brogdale, currently maintained by the University of Reading, and the collection of the N.I. Vavilov Research Institute of Plant Industry in Russia (Loskutov, 1999; Kellerhals et al., 2021). In Germany, the collection of Julius Kűhn - Institut in Dresden-Pillnitz was established around 1930, and the Balsgard collection in Sweden in the late 1940s (Bramel and Volk, 2019). The collection at the Chinese Academy of Agricultural Sciences was established in the 1950s, and, in France, the INRAE collection in 1946 (Roux-Cuvelier et al., 2021).

In Romania, fruit genetic resources are collected and conserved as *ex situ* collections, organized according to biological requirements of species, in different research units, continuation of activity started in 1957, in the same period with organized the Research Institute of Horti-Viticulture. In 1959, the first official catalog of fruit genetic resources with 1,536 genotypes was published (Braniște and Cociu, 2006). This important treasure was the result of the work combined with passion of some

Romanian personalities in horticulture, such as prof. Constantinescu, prof. Ștefănescu, Ph. eng. Botez, Ph. Doc. Cociu, who collected and introduced into the collections everything that was most valuable, at that time, from Romania and abroad.

The pomological collection is a real laboratory, which offers the initial material used in cross combinations, but, in the same time, the possibility for establishing the genetic value of the parental forms, by carrying out hybridological analyzes of segregation of various characters and characteristics from parents (Cociu et al., 1989; Butac M., 2002).

For accessions held by the parties of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) in the Multilateral System, germplasm transfer is performed with a Standard Material Transfer Agreement (SMTA). For germplasm held by non-ITPGRFA parties or not held in the Multilateral System, the exchange could be under the conditions of the Nagoya Protocol or in other specific bilateral agreements (Bramel and Volk, 2019).

The European Cooperative Programme for Plant Genetic Resources (ECPGR) is a collaborative program among most European countries aimed at ensuring the long-term conservation and facilitating the increased utilization of plant genetic resources. The EURISCO catalog provides online passport information on accessions conserved in European plant genetic resources collections. Different working groups on *Malus/Pyrus, Prunus, Vitis* or berries, inside regular meetings, try to improve the management collections. ECPGR decided to establish a European conservation system, focused on existing ex situ collections to create a European Genebank Integrated System (AEGIS) aimed at conserving the genetically unique accessions for Europe and making them available for breeding and research (Kellerhals, 2009).

Presently, the commercial fruit growing is the main factor generating genetic erosion, by restricting of cultivated species and varieties. In addition, the modification of biotic and abiotic factors led to changes in the biological cycle of diseases and pests and, thus, increased the vulnerability of commercial genotypes, and, their defense mechanism became limited and easily defeated. For this reason, the care for fruit genetic resources is manifested by completing, concentrating and restoring the germplasm fund, but also the "intelligent" use of genetic resources, as the main source for food security. Access to a germplasm fund is very important when carrying out breeding programs, the information provided (origin, heritability, pedoclimatic adaptation, phenotypic data, resistances / susceptibilities to biotic and abiotic factors) being essential for the breeder in order to choose the genitors (Militaru et al., 2018).

Collecting and preserving of fruit genetic resources was carried out at Research Institute for Fruit Growing Pitesti, Romania since 1970 with the following objectives: maintaining the heritage of current genetic resources in fruit growing; permanent completion of the germplasm fund with old, traditional and new autochthonous forms, but also with foreign varieties; germplasm extension for some fruit species and berries; inventory, monitoring and evaluation of fruit genetic resources to identify new potential genitor useful for breeding programs.

MATERIALS AND METHODS

Dynamic and sustainable conservation of autochthonous genetic resources involves specific activities, starting with identification and collection of new genotypes, their vegetative propagation (usually, by grafting or cutting), followed by conservation in pomological collections organized *ex situ*, in parallel with evaluation and phenotypic characterization, according to international recognized descriptors (figure 1).

The total fruit genetic resources (fruit species, berries and strawberries) preserved at Research Institute for Fruit Growing (RIFG) Pitești, Romania counts about 2,000 accessions, of which 1,639 of fruit trees, 111 strawberry, 109 currant, 69 blueberry and 95 of other berries (table 1). All accessions are maintained as trees or plants in the field collection.

Woody plant species are grafted on high vigor rootstocks and planted at 4 m between rows and 2-3 m between trees. For berries, the plants are placed at 3 m distance between rows and 50 cm between plants per row. The experimental device is made to illustrate the historical evolution: wild or semi-cultivated species, autochthonous varieties, introduced varieties. Inside each group, the genotypes are planted in order of harvest maturity.

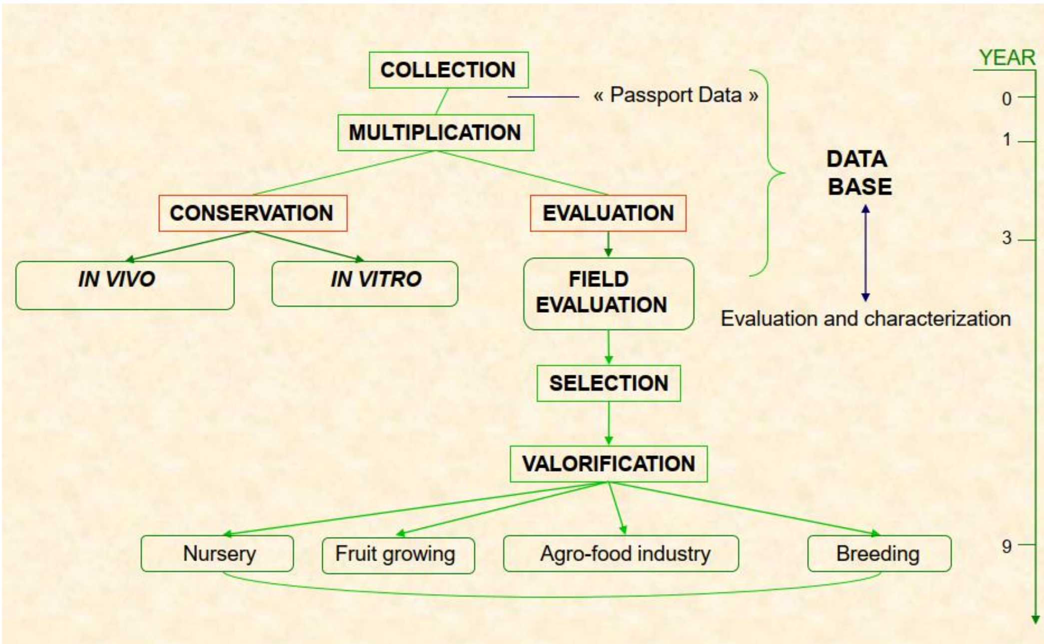

Figure 1. Work methodology // Metodologie de lucru

The periodic reorganization of collections is an absolutely necessary work, which is done at different time periods, depending on biological requests of fruit species. Thus, it is best to refresh the biological material preserved in strawberry, at a maximum interval of 4-5 years, then for some small fruit species (raspberry, currant, gooseberry, and blackberry) at 8-10 years and after a longer period (20-25 years) for other genera and species such as pome, stone and nuts.

Table 1. Fruit genetic resources preserved at RIFG Pitești, Romania // Resurse genetice conservate la ICDP Pitești, România

Species	No. of preserved genotypes	Genetic drift varieties (Source: ISTIS, 2022)
Apple	602	18 (Ardelean, Aromat de vară, Delicios de Voinești, Fălticeni, Florina, Frumos de Voinești, Golden Delicious, Goldspur, Idared, Jonagold, Jonathan, Kaltherer Böhmer, Mutsu, Pionier, Romus 3, Starkrimson, Voinea, Wagener premiat)
Pear	208	18 (Aniversare, Argessis, Aromată de Bistrița, Carpica, Conference, Contesa de Paris, Curé, Favorita lui Clapp, Haydeea, Olivier de Serres, Napoca, Republica, Timpurii de Dâmbovița, Untoasă Bosc, Untoasă de Geoagiu, Untoasă Hardy, Williams, Williams roșu)
Quince	13	0
Plum	440	16 (Alina, Anna Späth, Carpatin, Centenar, d'Agen, Gras ameliorat, Gras românesc, Ialomița, Pescăruș, Piteștean, Renclod Althan, Rivers timpuriu, Stanley, Tuleu gras, Vâlcean, Vinete de Italia)
Sweet cherry	162	9 (Boambe de Cotnari, Germersdorf, Hedelfinger, Izverna, Jubileu, Ponoare, Silva, Stella, Van)
Sour cherry	144	12 (Bucovina, Crișana 2, Ilva, Engleze timpurii, Mocănești 16, Pitic, Schattenmorelle, Timpuriu de Cluj, Timpuriu de Osoi, Timpurii de Pitești, Țarina, Vrâncean)
Walnut	48	5 (Geoagiu 65, Germisara, Jupânești, Novaci, Sibișel 44)
Hazelnut	22	2 (Tonda delle Langhe, Uriașe de Halle)
Strawberry	111	5 (Benton, Gorella, Premial, Red Gauntlet, Senga Sengana)

Currant	109	10 (Mărgăritar, Abanos, Perla neagră, Record,Tinker, Tsema, Houghton Castle, Jonkheer van Tets, Red Lake, Roșu timpuriu)
Blueberry	69	4 (Blueray, Coville, Pemberton, Weymouth)
Gooseberry	14	0
Raspberry	22	5 (Cayuga, Citria, Malling Exploit, Ruvi, The Latham)
Blackberry	21	2 (Darrow, Thornfree)
Seabuckthorn	5	1 (Șerpeni)
Honeysuckle	10	0
Chokeberry	2	1 (Nero)
Elderberry	3	2 (Ina, Nora)
Cornel	12	0
Rosehip	6	1 (Can)
Total	**2,023**	**111**

In order to harmonize the data, the germplasm evaluation and characterization was done according to some descriptors, recognized at international level. For each genotype, the fruit use, the plant use, status of sample and virus disease status are noted. In addition, a set of specific descriptors are used for each species, especial the fruit characteristics (size, shape, color) and susceptibility to some specific diseases and pests with major economic impact (table 2).

Table 2. Descriptors used for germplasm characterization and evaluation // Descriptori folosiți pentru caracterizarea și evaluarea germoplasmei

Apple	season of flowering, colour of flower button, harvest maturity, fruit size, fruit shape, over colour, ground colour, susceptibility to *Venturia inaequalis*
Pear	season of flowering, colour of flower button, harvest maturity, fruit size, fruit shape, over colour, ground colour, resistance to *Erwinia amylowora,* resistance to *Psylla* sp.
Plum	season of flowering, harvest maturity, fruit size, fruit shape, over colour, adhesion of the kernel to the pulp, susceptibility to *Monilia laxa, Monilia fructigena*, PPV
Sweet and sour cherry	harvest maturity, over colour, juice colour, fruit cracking, susceptibility to *Monilia laxa, Monilia fructigena, Blumeriella jaapii*
Walnut	growth habit, tree vigour, dichogamy, season of flowering, tipul înfloritului, harvest maturity, nut size, nut shape, shell colour, shell thickness, ease of removal of kernel halves, kernel flavour, susceptibility to *Xanthomonas juglandis, Gnomonia juglandis, Cydia* sp.
Hazelnut	growth habit, tree vigour, flowering precocity, shape of nut apex, size of nut basal scar in relation to nut size, double (twin) kernels, first male bloom date, first female bloom date, dichogamy, nut maturity date, nut falling, susceptibility to *Xanthomonas corylina, Phyllactinia corylea, Balaninus nucum*
Strawberry	growth habit, vigour of the plant, fruit size, fruit shape primary fruits, external fruit colour, flesh colour, fruit firmness, susceptibility to *Botrytis cinerea, Phytophtora fragariae*
Currant	plant vigor, plant growth habit, number of basal shoots, number of flowers, fruit size, fruit shape, beginning of flowering, beginning of fruit ripening
Blueberry	growth habit, size of corolla tube, fruit size, intensity of bloom, skin color, sweetness, acidity, time of beginning of vegetative growth, time of beginning of flowering, time of beginning of fruit ripening
Gooseberry	plant vigor, plant density, number of basel shoots, shoot princkes, fruit size, fruit shape, fruit color, time of bud burst, time of beginning of flowering, time of fruit ripening
Raspberry	plant habit, for varieties which fruit on previous season's cane in summer: length and color of dormant cane, fruiting lateral: attitude and length, spines presence, spines density, fruit shape in lateral view, fruit size of single drupe, fruit color, glossiness, firmness, adherence to plug, main bearing type, length of fruiting period on previous year's cane
Blackberry	growth habit, number of new canes, length of dormant cane, spines, number of spines, leaf type, color of petal, length of fruiting lateral, fruit size, ratio length/width, fruit color, time of beginning of flowering, time of fruit ripening

RESULTS AND DISCUSSION

Apple collection has 1.2 ha and it was organized in the spring of 2010, by transferring, for safety reasons, of preserved biological material from Research Station for Fruit Growing Voinești, Dâmbovița. It includes a number of 602 genotypes grafted on the MM106 rootstock, with 2 trees/genotype planted at 4 m between rows and 2.5 m between trees per row. From 602 genotypes, 7 are *Malus* species, 82 local varieties and 513 foreign varieties. The characterization and evaluation of genotypes is based on the ECPGR (European Cooperative Program for Plant Genetic Resources) descriptors, updated and completed by Marc Lateur et al., in 2022.

In the last 20 years, the main donors used in apple cross combinations have been:

- for fruit quality and attractiveness: 'Gala' clones ('Mitchgla', 'Venus Fengal', 'Decarli Fendeca'), 'Golden Orange', 'Red Jonaprince', 'Falstaff', 'Auriu de Bistrița';
- for late ripening and good storage: 'Goldrush', 'Enterprise', 'Generos';
- sources for scab resistance: 'Crimson Crisp', 'Goldrush', 'Enterprise', 'Topaz', 'Red Topaz', 'Rubinola', 'Luna', 'Galiwa';
- for powdery mildew resistance: 'Ariwa';
- for earliness: 'Dalinbel', 'Romus 3'.

Pear collection, established in 2 years (2009 and 2010), includes 208 accessions, of which 13 species, 68 autochthones varieties and 127 foreign varieties. Each accession is represented by 2 trees grafted on *Pyrus communis* rootstocks, planted at 3.5 m between rows and 2 m between trees per row, with linear distribution. Characterization and evaluation of conserved genotypes is based on ECPGR descriptors (Lateur et al., 2022).

As a result of data collected out of evaluation of tree's and fruit' characteristics, genotypes common used in breeding activity, in the last 18 years, were:

- 'Monica' for nice appearance;
- 'Angelys', 'Williams', 'Max Red Barlett', 'Abate Fetel', 'Packham's Triumph', 'Rocha' for fruit quality and appearance;
- 'Euras', 'Orizont', 'Isadora' for good storage capacity and resistance to fire blight (*Erwinia amylowora)*;
- 'Tse Li', 'Isadora' for tolerance to *Psylla* sp.;
- 'Packham's Triumph', 'Xenia', for high productivity;
- 'Paradise', for red skin;
- 'Cu miezul rosu' (local variety), for red flesh.

Plum collection, reorganized in 2018 and 2019, has 440 genotypes, with 2 trees of each genotype, grafted on the 'Myrobolan' rootstock, planted at a distance of 4 x 3 m. As structure, the collection has 5 species of *Prunus*, 170 autochthonous varieties and 265 foreign varieties.

The characterization and evaluation of genotypes is based on the ECPGR (European Cooperative Program for Plant Genetic Resources) descriptors.

In the last years, the main genitors used in plum cross combinations have been:

- for fruit quality and attractiveness: 'Romanța', Toptaste', 'Andreea', 'Boranka', 'Timocanka', 'Milenium';
- for productivity: 'Stanley', 'Čačanska lepotiča', 'Romanța', 'Jojo', 'Haganta';
- for self-fertility: 'Stanley', 'Čačanska lepotiča', 'Romanța', 'Jojo';
- for Plum pox virus resistance/tolerance: 'Jojo', 'Haganta', 'Hanita', 'Andreea';
- for earliness: 'Tita', 'Piteștean', 'Carpatin', 'Topfirst'.

Sweet cherry collection was planted in spring 2013, having 162 accessions (one species, 35 autochthonous varieties and 126 foreign varieties). Each accession is represented by two trees grafted on 'Mahaleb' rootstock, planted at 5 x 4 m.

In the last years, for different objectives we used in cross combinations the following genitors:

- for fruit quality: 'Van', Techlovan', 'Kordia', 'Regina', 'Rubin', 'Tentant', 'Vanda';
- for productivity: 'Van', 'Skeena';
- for self-fertility: 'Stella', 'Skeena', 'New Star', 'Lapins';
- for fruit cracking resistance: 'Kordia', 'Regina', 'Lapins', 'Adriana';
- for earliness: 'Bigarreau Burlat', 'Merchant', 'Bellise', 'Spectral';
- for lateness: 'Kordia', 'Regina', 'Skeena', 'Areko', 'Sylvia'.

Sour cherry collection, planted on 2010, has 0.8 ha and contained 144 accessions (one species, 50 autochthonous varieties and 93 foreign varieties), with three trees per genotype, grafted on 'Mahaleb' rootstock and planted at 4 x 3 m.

In the sour cherry germplasm fund there are very valuable genotypes, some of them being used in controlled hybridizations, such as:

- for fruit quality and red colour: 'Rival', Sumadinka', 'Erdy Nogy', 'Stelar', 'Schatenmorelle', 'Vaskova', 'Vatinska';
- for productivity: 'Erdy Nogy', 'Sumadinka';
- for self-fertility: 'Nana', 'Schattenmorelle';
- for earliness: Țarina', 'Timpurii de Pitești', 'Mari timpurii', 'Dropia'

Strawberry and berries collection. According to the breeding objectives, in the last 15 years, the main donors used in berry cross combinations have been:

- strawberry: 'Mira' and 'Benton' for disease resistance, 'Mira' and 'Garda' for fruit quality, 'Albion' and 'San Andreas' for day neutral cultivars;
- blueberry: 'Simultan' and 'Bluecrop' for adaptability to local conditions of soil and climate, 'Simultan' and 'Delicia' for fruit quality, 'Duke' and 'Berkeley' for wide ripening season;
- currant: 'Abanos' for productivity and processing, 'Poli 51' for fruit quality and chemical content;
- raspberry: 'Opal' for frost resistance, 'Triple Crown' and 'Chester' for fruit quality;
- blackberry: 'Darrow' for frost resistance, 'Polka' and 'Benefis' for fruit quality and 'Opal' for wide ripening season (Table 3).

Table 3. Objectives and genitors for berry breeding programs //
Obiective și genitori pentru programele de ameliorarea ale arbuștilor fructiferi

Strawberry	Genitor	Blueberry	Genitor	Currant	Genitor	Raspberry	Genitor
Disease resistance (anthracnose, red stele)	Benton Idea Mira	**Adaptability to local conditions of soil and climate**	Simultan Azur Augusta Safir Bluecrop Blueray	**Productivity**	Tsema Kantata 50 Abanos Geo Deea	**Frost resistance**	Opal Star Gustar Ruvi Citria
Fruit quality (size, shape, firmness, colour)	Queen Elisa Mira Clery Garda Tecla Asia	**Fruit quality (size, appearance)**	Bluecrop Spartan Simultan Delicia Augusta	**Fruit quality and chemical content**	Tsema Kantata 50 Poli 51 Deea Perla Neagră	**Fruit quality (size, color, firmness)**	Latham Polka Polana Benefis
Early season **Late season** **Day neutral**	Premial Alba Clery Argentera Mira Albion San Andreas	**Wide ripening season**	Simultan Duke Bluecrop Blueray Berkeley	**Processing**	Perla Neagră Poli 51 Abanos	**Wide ripening season**	Heritage Citria Opal Ruvi

Walnut collection, planted on April 2019, with planting distance 8 x 6 m, grafted trees on *Juglans regia*, has 48 genotypes, of which 33 are autochthonous.

Hazelnut collection, organized on 2020 and completed in 2021, has 22 genotypes planted at 4 m between rows and 3 m between plants.

CONCLUSIONS

The fruit genetic resources collected at RIFG Pitesti contributes to the sustainable preservation of biodiversity of different fruit growing species and to ensure the availability of this biological material for distinct user purposes (breeding, research, agro-food industry).

Traditional fruit breeding and evaluation of fruit genetic resources was based on phenotypic characterization. For future, the request is to combine both, phenotyping and genotyping characterization, as common practice. However, field evaluation regarding pests and diseases resistance or susceptibility is important for breeding and for replanting traditional varieties. The information on the fruit quality of genetic resources are useful for breeding or specific processing and consumption purposes.

The selection from wild flora still offers the possibility of identification and utilization of valuable genotypes adapted to different soil conditions and climate changes.

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CARBOHYDRATE RESERVES IN SOME GRAPEVINE CULTIVARS FROM SCDVV BLAJ

REZERVA DE CARBOHIDRAȚI A UNOR SOIURI DE VIȚĂ-DE-VIE CULTIVATE LA SCDVV BLAJ

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Abstract

Carbohydrate reserves are crucial for the growth cycle of grapevine because they provide the carbon source that supports the start of vegetation. There is scientific evidence that shows that the carbohydrate amount from the reserves stored over winter influences the new root and bud development, the shoot growth and the development of the inflorescences in the following season. The present study assesses the overwintering carbohydrate reserve status of several grapevine varieties cultivated at SCDVV Blaj. The studied cultivars were: Italian Riesling, Fetească regală, Fetească neagră, Fetească albă, Neuburger, Traminer roz and Sauvignon blanc, all located at Crăciunelu de jos grapevine plantation. The soluble sugars content, the starch content and the amount of total carbohydrates were determined using the classic anthrone reagent method. All of the samples were assessed as possessing a sufficient carbohydrate reserve for the first phenophases of this year's (2023) vegetation period, most of them being classified as very well-matured, having a total carbohydrate content higher than 16 g % DW.

Keywords: grapevine, soluble sugars, starch, total carbohydrates, reserve

Rezumat

Rezerva de carbohidrați îndeplinește un rol crucial în ciclul de creștere a viței-de-vie fiind principala sursă de carbon necesară pornirii în vegetație. Mai multe rapoarte științifice evidențiază faptul că această rezervă de carbohidrați înmagazinată susține creșterea noilor rădăcini, dezmuguritul, creșterea lăstarilor și dezvoltarea inflorescențelor în sezonul următor. Prezentul studiu evaluează starea rezervei de carbohidrați din perioada de repaus vegetativ a mai multor soiuri de viță-de-vie cultivate la SCDVV Blaj. Soiurile studiate au fost: Riesling italian, Fetească regală, Fetească neagră, Fetească albă, Neuburger, Traminer roz și Sauvignon blanc, toate situate în plantația viticolă Crăciunelu de jos. Conținutul de zaharuri solubile, conținutul de amidon și cantitatea de carbohidrați totali au fost determinate prin metoda reactivului anthronă. Toate probele au fost evaluate ca având o rezervă suficientă de carbohidrați pentru primele fenofaze de vegetație ale acesui an (2023), cele mai multe dintre ele fiind clasificate ca foarte bine maturate, având un conținut total de carbohidrați mai mare de 16 g% DW.

Cuvinte cheie: viță-de-vie, zaharuri, amidon, carbohidrați, rezervă

INTRODUCTION:

Vineyards from Transylvania's viticultural zone often face a lot of challenges related to climatic conditions. Cold winters with low temperatures are quite common, and this can have a negative impact on the grapevine's health, destroying the buds and the vascular tissues, in extreme cases, leading to the complete loss of the grapevines. Another challenge of this area is the late spring frosts which can destroy the young shoots leading to the loss of the grape harvest (Țâra *et al.*, 1992; Răcoare *et al.*, 2022). The cold resistance of the winter buds is conditioned by the maturation degree of the canes, which is determined by the total content of carbohydrates (Noronha *et al.*, 2018; Călugar *et al.*, 2019; Popova, 2021). Also, in grapevines, the carbohydrate reserves act as a buffering mechanism that allows the functioning of cellular processes, growth and stimulation of defense mechanisms when metabolic demands exceed energy intake. They help perennial plants to resist biotic and abiotic stress factors including the attack of diseases and pests (Noronha *et al.*, 2018). Therefore, through an adequate management, the stress of the grapevine can be minimized by ensuring the optimal accumulation and storage of carbohydrates in buds and woody tissues (Țâra *et al*., 1999; Iliescu *et al*., 2012).

Carbohydrates are produced by leaves and stored as starch and soluble sugars (mostly glucose, fructose and sucrose) in the perennial organs (Bennet *et al*., 2005; Pellegrino *et al*., 2014; Călugăr *et al*., 2022). Starch is stored as granules within the xylem and phloem ray cell. Areas of high starch concentrations can be seen after staining with iodine at the whole-tissue level (Călugăr *et al.,* 2022). In the wood, starch concentrations are higher than those of sugars during the growing season, but some of the starch is converted to sugars prior to the dormancy period in order to help the grapevine protection from cold damage during winter (Noronha *et al*., 2018; Călugăr *et al*., 2019; Popova, 2021). At all phases of development, starch is the primary storage carbohydrate in the roots. Fine root development that occurs in early spring is most likely provided by carbohydrates stored in the permanent roots (Zapata *et al*., 2004; Pellegrino *et al.*, 2014;). In order to assist the early shoot growth, localized carbohydrate reserves and possibly sugars diffused from the bleeding sap are utilized. As the phloem function of the canes and older wood restarts in the weeks following bud break, reserves from more distant sections of the vine are progressively used (Zapata *et al*., 2004; Pellegrino *et al.*, 2014;). The transport of reserve carbohydrates to the shoot reaches a maximum amount at the stage of 8-10 leaves and then it declines as the canopy photosynthesis becomes sufficient (to meet the carbohydrate demand) (Bennett, 2002). After that, the newly assimilated carbon starts to be exported back to the perennial organs of the grapevine (a week or two before flowering). The reserve replenishment may occur at the same time as the fruit ripening if yields are adequate or if the photosynthesis rates are high enough to produce an excess of carbohydrates for preservation. However, if the productions are to high or if circumstances like water stress or high temperatures decrease photosynthesis, the reserve replenishment may be delayed until after harvest. Along with heavy crop loads, renewed mobilization of carbohydrates may occur in the earlier part of the ripening phenophase to help berry ripening (Zapata *et al.*, 2004; Pellegrino *et al.*, 2014;).

The dynamics of the carbohydrate reserve in the perennial organs of grapevines are mainly determined by the growth and maintenance requirements at particular developmental stages. This balance between carbon supply and demand is influenced by manageable factors such as yield, canopy size, and water supply, and by limiting climatic factors such as temperature or seasonal duration that affect photosynthesis and thus the net capacity of carbon assimilation (Holzapfel *et al.,* 2010).

Shoots maturation is a physiological process of reserve substances accumulation, which is highlighted in autumn by the change of the bark color and marks the transition from the active period of vegetation to the dormancy period (Alexandrescu *et al.,* 1994). The maturation process of the shoots starts in mid-August, with the slowing down of growth, from the base of the shoots and gradually advances towards their top. Along the length of the shoot, there is a maturation lag in the sense that the internodes at the base accumulate a greater amount of carbohydrates than those oriented toward the tip of the shoot. The maturation process ends when the leaves fall, therefore at the end of the vegetation period, the tops of the shoots remain unmatured, often being affected by the early frosts in autumn (Țârdea and Dejeu, 1995). Canes maturation shows inconstancy and variations from one year to another and from one cultivar to another, due to environmental factors and polygenic heredity (Oprea and Moldovan, 2007).

Overall, the assessment of the wood maturation degree of grapevines, at the end of the vegetation period is an important indicator that shows if the morphological, physiological anatomical and structural processes proceeded normally. The degree of cane maturation influences the differentiation of fruit buds, the rooting of cuttings and the formation of callus when grafting the grapevine (Iliescu *et al*., 2010).

This study aims the dosage of carbohydrates (the most reliable laboratory indicator for assessing the degree of wood maturation) from several grapevine cultivars in order to anticipate the course of this year's vegetation period at SCDVV Blaj.

MATERIALS AND METHODS

The study was carried out during dormancy in the winter of 2022-2023. The following grapevine (wine) cultivars: Fetească albă, Fetească regală, Fetească neagră, Italian Riesling, Neuburger, Traminer and Sauvignon blanc, located in the Experimental Base - Crăciunelu de Jos of the Blaj Viticulture and Vinification Research Station (Table 1) were investigated. The determined parameters included canes water content and diameter, grape yield in the fall of 2022, and the carbohydrate content of canes (sugars, starch and total carbohydrate content).

Table 1. Data regarding the identification and characterization of the samples // Date de identificare și caracterizare a probelor

Crt no.	Sample Code	Cultivar	Experimental plot	Establishment year	Training sistem	Soil type	Soil management	Planting distance [m]	GPS coordinates
1	**FA_R**	Fetească albă	Crăciunel reconversion	2007	Demi-high Guyot system with periodic replacement arms	Coluvisol with lotony sand texture	Grass strips	2.0 x 1.2	46.178252 23.818766
2	**FR_R**	Fetească regală	Crăciunel reconversion	2012		Coluvisol with lotony sand texture		2.0 x 1.2	46.180496 23.511440
3	**FN_PM**	Fetească neagră	Crăciunel, mother plantation	2010		Alluvial soil with a sandy texture		2.0 x 1	46.174396 23.850859
4	**RI_PM**	Riesling italian	Crăciunel, mother plantation	2010		Alluvial soil with a sandy texture		2.0 x 1	46.173977 23.849361
5	**RI_R**	Riesling italian	Crăciunel reconversion	2012		Coluvisol with lotony sand texture		2.0 x 1.2	46.180745 23.856663
6	**NB_R**	Neuburger	Crăciunel reconversion	2012		Coluvisol with lotony sand texture		2.0 x 1.2	46.181368 23.857553
7	**TR_PM**	Traminer roz	Crăciunel, mother plantation	2007		Alluvial soil with a sandy texture		2. 0 x 1	46.173307 23.848492
8	**SG_PM**	Sauvignon blanc	Crăciunel, mother plantation	2014		Alluvial soil with a sandy texture		2.0 x 1	46.173307 23.848492

The water content of canes was determined using the oven drying method at a temperature of 105 ˚C until constant mass. The diameter of the canes was measured with the caliper - 24 measurements were made for each sample. The yield per vine were calculated according to the productions per hectare (reported in accounting) for the year 2022, taking into account the density of vines for each cultivar.

For the determination of the carbohydrate content, samples of annual canes (5) of each cultivar, were collected (in three repetitions) on the 19th of January 2023. The canes were then cut into pieces of approximately 20 cm and dried in an oven (ESAC sterilizer, ELECTRONIC APRIL SRL, Cluj-Napoca, Romania) at 55˚C, for approximately 72 hours (until constant mass). Then the samples were ground, sieved (sizes of max 0.7 mm), packed and labeled accordingly, and stored at room temperature until analysis. The maturation degree of the samples was appreciated by the determination of the carbohydrate content using the colorimetric method adapted from DuBois M., *et al*., (1956). The method principle consists in the extraction of sugars with ethyl alcohol and the extraction of starch with perchloric acid, under determined conditions and the measurement of the color intensity after treating the extracts with the anthrone reagent. The measurement of the color intensity was done spectrophotometrically using a UV/VIS Spectrophotometer (ScanDrop2, Analytik Jena, Konrad, Germany) at 620nm wavelength. The total carbohydrate (TCH) content of the samples sums up the sugar and starch content, expressed as glucose (in grams) and expressed as a percentage of dry weight (d.w).

The results obtained were evaluated as follows:

- TCH < 12 g% d.w = very poorly matured
- TCH between 12 - 14 g% d.w = poorly matured
- TCH between 14 - 16 g% d.w = matured
- TCH between 16 - 18 g% d.w = well matured
- TCH > 18 g% d.w = very matured

Samples were analyzed in triplicate. The obtained data were statistically analyzed with the program Minitab 17 using the One-Way ANOVA method as well as the PCA method. Tukey test with a 95% confidence interval was used for the statistical interpretation of the results. PEARSON correlation was also used to check correlations between variables.

RESULTS AND DISCUSSION

The analyzed samples recorded a normal level of humidity for the period in which the samples were collected, oscillating around 40%. The lowest moisture level 37.7% was observed in the sample of Italian Riesling from the "mother plantation" and the highest moisture level 43.73% was observed in Traminer. From a statistical point of view, the water content of the canes shows significant differences (Table 2). The canes diameter ranged between 6.82 mm in the sample of Italian Riesling from the "mother plantation" and 8.21 mm in the Traminer sample, the differences between cultivars were not statistically significant (Table 2). The grapes yield, for the studied cultivars, in 2022, ranged between 2.3 and 3.9 kg/vine (Table 2). The Neuburger cultivar recorded the highest yield (3.9 kg/vine), exceeding the normal levels. For the other studied cultivars, the productions obtained in 2022 were within the normal limits.

Table 2. Results regarding canes water content and diameter and grape yield obtained in 2022 // Rezultate privind umiditatea si diametrul coardelor și a producției obținute în anul 2022

Crt.no.	Sample code	Humidity [%]	Diameter [mm]	Yield [kg/vine]
1	FA_R	$41.42±0.11^{bc}$	$7.55±0.34^{a}$	2.3
2	FR_R	$39.72±0.11^{d}$	$7.97±0.62^{a}$	3.1
3	FN_PM	$41.97±0.39^{b}$	$6.88±0.54^{a}$	2.4
4	RI_PM	$37.7±0.28^{e}$	$6.82±0.37^{a}$	2.9
5	RI_R	$41.20±0.42^{bc}$	$6.88±0.41^{a}$	3.1
6	NB_R	$40.50±0.14^{cd}$	$7.45±0.55^{a}$	3.9
7	TR_PM	$43.73±0.11^{a}$	$8.21±0.30^{a}$	2.3
8	SG_PM	$41.35±0.14^{bc}$	$7.30±0.06^{a}$	2.9

*results are presented as means ± standard deviation
**different letters represent statistically significant differences (p<0.05%)

The total carbohydrate content varied between 12.63 g% d.w in the Neuburger cultivar and 17.94 g% d.w in the Fetească albă cultivar (Table 3). From a statistical point of view, the cultivars Fetească albă, Sauvignon and Neuburger show significant differences in terms of total carbohydrate content, and the cultivars Fetească regală, Fetească neagră, Italian Riesling and Traminer do not show significant differences, having a similar content of total carbohydrates.

Table 3. Results regarding the carbohydrate content // Rezultate privind conținutul de carbohidrați

Crt.no.	Sample code	Sugar content [g% d.w]	Starch content [g% d.w]	Total carbohydrate content [g% d.w]	Interpretation
1	**FA_R**	10.97±0.76[a]	6.97±0.35[bc]	17.94±0.41[a]	well matured canes
2	**FR_R**	8.19±0.98[b]	8.48±0.25[a]	16.67±01.21[ab]	well matured canes
3	**FN_PM**	9.53±0.78[ab]	7.34±0.11[b]	16.87±0.68[ab]	well matured canes
4	**RI_PM**	10.20±0.97[ab]	6.31±0.24[c]	16.51±0.74[ab]	well matured canes
5	**RI_R**	10.89±0.18[a]	5.24±0.12[d]	16.13±0.30[ab]	well matured canes
6	**NB_R**	9.24±0.95[ab]	3.39±0.27[e]	12.63±0.68[c]	poorly matured canes
7	**TR_PM**	8.79±1.19[ab]	6.88±0.37[bc]	15.67±0.82[ab]	matured canes
8	**SG_PM**	8.96±0.71[ab]	6.31±0.43[c]	15.27±1.13[b]	matured canes

*results are presented as means ± standard deviation
**different letters represent statistically significant differences (p<0.05%)

The location of the cultivars within the Crăciunelu de Jos plantation does not influence the total carbohydrate content, in the sense that there were no statistically significant differences between the samples collected from the "mother plantation" and/or "reconversion" (Table 3).

Regarding the sugar content, significantly higher values were observed in the samples of Feteasca albă and Italian Riesling from the "reconversion" experimental plot, significantly lower values being recorded by the Feteasca regală cultivar. The Italian Riesling samples from the "mother plantation", Neuburger, Fetească neagră, Traminer and Sauvignon recorded a statistically similar sugar content ranging between 8.79 and 10.20 g% d.w (Figure 1 and Table 3).

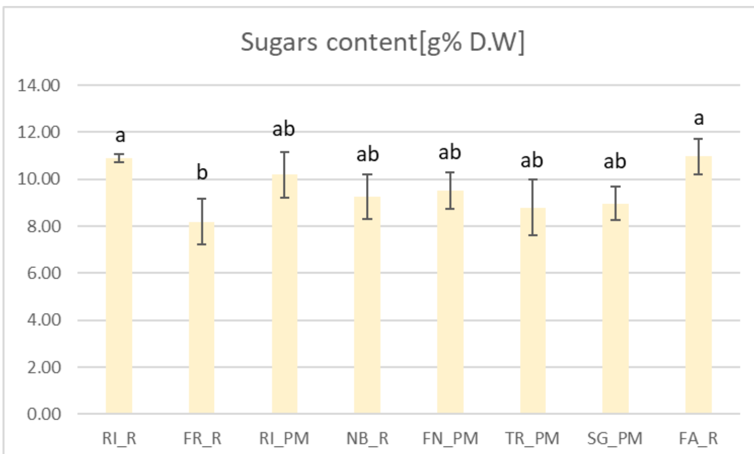

Figure 1. Graphical representation of the sugar content // Reprezentare grafică a conținutului de zaharuri

The starch content ranged between 3.39 and 8.48 g% d.w, lower values than those recorded for the sugar content (Figure 2 and Table 3). The differences are significant between most of the analyzed samples, the highest starch content being recorded by the Fetească regală cultivar, followed by Fetească neagră, Fetească albă and Traminer. A lower starch content was observed in the Sauvignon and Italian Riesling cultivars, the lowest value being recorded in the Neuburger cultivar.

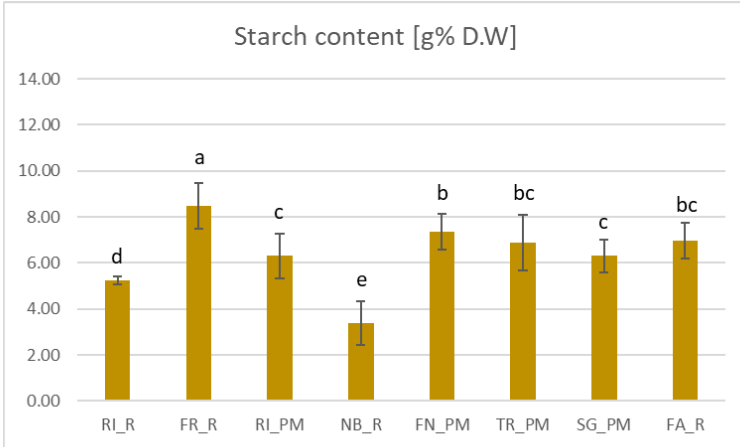

Figure 2. Graphical representation of the starch content // Reprezentare grafică a conținutului de amidon

The correlation between the total carbohydrate content and the yield (per vine) obtained in the year 2022 demonstrated a very strong negative relationship (r=-0.713). In this sense, it can be observed that the Neuburger cultivar, which had the highest yield per vine among the analyzed samples (Table 2), recorded the lowest content of total carbohydrates (Table 3). In the same way, the cultivar Fetească albă, which had the lowest yields, recorded the highest content of total carbohydrates. A weak negative correlation was observed between sugar content and yield, and a strong correlation was observed between starch content and yield.

The PCA analysis of the samples shows that they are differentiated into separate groupings by the 2 studied variables (sugars and starch content). Thus, the Italian Riesling varieties (both the one from the "reconversion" and the one from the "mother plantation") and Fetească albă stand out as having a high sugar content, at the opposite pole are the Sauvignon, Traminer and Fetească regală varieties. With respect to the starch content, the Fetească regală and Fetească neagră cultivars are noted as having a high starch content and the Neuburger variety as having a low starch content (Figure 3).

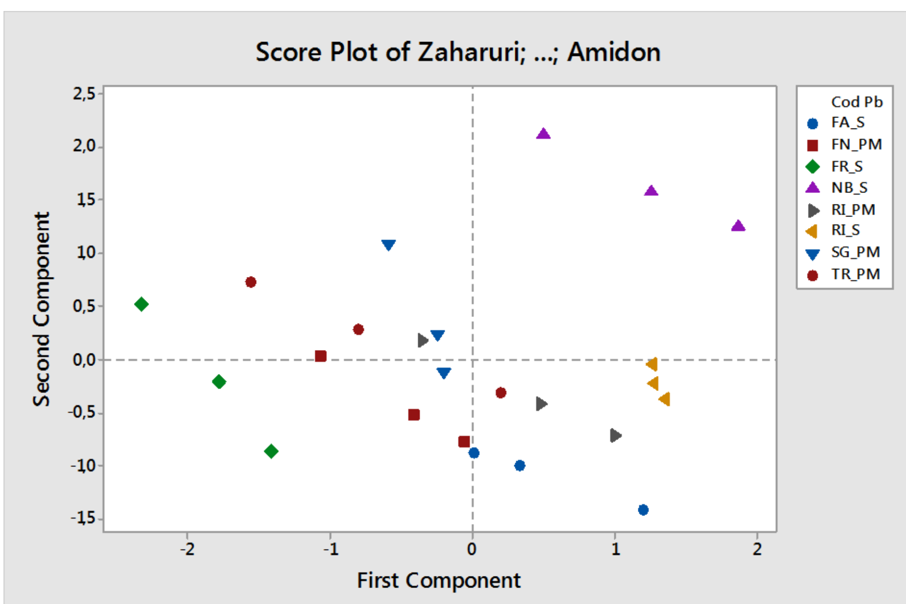

Figure 3. Score plot chart of the PCA analysis regarding the sugar and starch content // Graficul de tip score plot al analizei PCA a conținutului de zahăr și amidon

The results of the present study are consistent with the existing data in the specialized literature. The shoot or cane is considered mature if at the end of the vegetation period, the starch content is greater than 10 g% d.w., or the total carbohydrates are greater than 12 g% d.w. (IRIMIA, 2012). Holzapfel *et al.*, (2010) consider that the shoot is fully matured (reaches a maximum degree of lignification), if at leaf fall it has a total carbohydrate content of 19 g% dry matter. Iliescu *et al.*, (2011) report, for the years 2008 and 2009, in the Fetească regală, Sauvignon, Italian Riesling and Traminer cultivars a total carbohydrate content between 13.47 and 17.60 g% d.w as well as slightly higher values for the year 2010 (14.10 and 17.80 g% d.w), the Traminer cultivar recording the highest values in each of the 3 years. Comșa *et al.*, (2013) report a carbohydrate content ranging between 18 and 20 g% d.w for Fetească regală, Italian Riesling and Sauvignon cultivars. Cimpoi *et al.*, (2020) also report a total carbohydrate content of 15.64 g% (summing the content of soluble sugars 11.38 g %, and the content of starch 4.26 g%), followed by the "Aromat de Iași" cultivar with a total carbohydrates content of 14.97 g%, of which 9.56 g% representing the content of soluble sugars and 5.41 g% the content of starch. Călugăr *et al.*, (2022) report for the dormancy period of 2019-2020, a total carbohydrate content between 12 and 18 g% d.w. and a starch content between 3 and 5 g% d.w.

CONCLUSIONS

1. At harvest time, the canes had a water content of approximately 40% and a diameter of approximately 7 mm. None of the samples reached the maximum lignification threshold, but most of the samples exceeded the threshold of 14 g% d.w. total carbohydrates, which means that they are mature enough to expect a normal vegetation period for 2023. Most samples recorded a total carbohydrate content between 16 and 18 g% d.w. being appreciated as well matured.
2. The Fetească albă cultivar was appreciated as well matured, registering a total carbohydrate content of 17.94 g% d.w., and the least matured was the Neuburger cultivar 12.63 g% d.w, being appreciated as poorly matured.
3. The Fetească albă cultivar recorded the highest sugar content of canes (10.97 g% d.w.) while the Fetească regală cultivar recorded the lowest sugar content (8.19 g% d.w.).
4. The starch content recorded lower values than those recorded for the sugar content, ranging between 3.39 g% d.w. in the Neuburger cultivar and 8.48 g% d.w. for the Fetească regală cultivar.
5. The samples from the Fetească cultivar (albă, regală and neagră) and Italian Riesling (from the "reconversion" and the "mother plantation") recorded a total carbohydrate content between 16 and 18 g% d.w. being thus categorized as well matured.
6. A very strong negative correlation was revealed between production and total carbohydrate content, while cultivar location within the plantation had no influence on the carbohydrate content.
7. The results obtained are consistent with the specialized literature, Iliescu *et al.*, (2011), Comșa *et al.*, (2013), Cimpoi *et al.*, (2020) and Călugăr *et al.*, (2022) reporting similar results.

Based on the results of this study, in the 2023 season, at SCDVV Blaj in the Crăciunelu de Jos vineyard, can be expected a normal vegetation period which can provide a good harvest yield, with the Neuburger cultivar requiring special attention.

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THE STUDY OF THE BICAN ROZ 6 MF CLONE IN THE CLIMATE CONDITIONS OF THE MURFATLAR VINEYARD

STUDIUL CLONEI BICAN ROZ 6 MF ÎN CONDIȚIILE CLIMATICE ALE PODGORIEI MURFATLAR

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Abstract
At Murfatlar Research Station, in the period 2018 – 2022, a study was carried out on 5 clonal elites of the 'Bican roz' variety, selected from existing trunks in the ampelographic collection of the research station. In all 5 years of studies and observations, the clonal elite 80/10/6 was superior to the other elites, this being approved under the name Bican roz 6 Mf in 2022, following testing at ISTIS (State Institute for Testing and Registration Varieties). During the research period, average annual temperatures were 2-3°C higher in comparison with the multiannual average, while precipitation values were situated below the multiannual average (406 mm, average during the study period, compared to 522.6 mm, the multiannual average). For all 5 clonal elites, the agrobiological properties, as well as the technological and agroeconomic characteristics, were compared to those of the original variety. Bican roz 6 Mf is a table grape clone with high growth vigor and 79% fertility. It is a productive clone, with an average grape weight of 714 g, compared to 403 g, the average grape weight for the original variety and with yields of 10.76 kg/trunk, respectively 24 t/ha and commercial production of 75 – 80%.

Key words: table grapes, clonal elites, grapevine, productivity, quality.

Rezumat
La SCDVV Murfatlar, în perioada 2018 – 2022, a fost realizat un studiu pe 5 elite clonale ale soiului 'Bican roz', selectate din butuci existenti în colecția ampelografică a stațiunii. În toți cei 5 ani de studii și observații, elita clonală 80/10/6 a fost superioară celorlalte elite, aceasta fiind omologată sub denumirea de Bican roz 6 Mf în anul 2022, în urma testării la ISTIS (Institutul de Stat pentru Testarea si Inregistrarea Soiurilor). În perioada de cercetare au fost înregistrate temperaturi medii anuale cu 2 – 3°C mai ridicate comparativ cu media multianuală și precipitații sub valoarea medie multianuală (406 mm, media în perioada studiului comparativ cu 522,6 mm, media multianuală). Pentru toate cele 5 elite clonale au fost urmărite însușirile agrobiologice, precum și caracteristicile tehnologice și agroeconomice, comparativ cu cele ale soiului inițial. Bican roz 6 Mf este o clonă pentru struguri de masă, cu vigoare de creștere mare și fertilitate de 79%. Este o clonă productivă, având greutatea medie a unui strugure de 714 g, comparativ cu 403 g, greutatea medie a strugurelui pentru soiul inițial, și cu producții de 10,76 kg/butuc, respectiv 24 t/ha și producția marfă de 75 – 80%.

Cuvinte cheie: struguri de masă, elite clonale, viță de vie, rezistență, calitate.

INTRODUCTION

Grapevine is a light and heat loving plant [11,15] of great socio-economic importance, that uses the energy resources offered by the environment rationally and efficiently, but at the same time conditions the dynamics of its growth and development is in agreement on how they comply with its vegetation requirements [6,7,13].

The climate changes that are currently happening condition the creation of plant genotypes that will be able to develop and ensure increased productivity in the new pedoclimatic conditions and at the same time will contribute to mitigating desertification processes [1].

The expansion of the grapevine plantations or the introduction of new varieties in a certain area requires the assessment of the ecological favorability of the area allocated for this purpose [4].

The grape breeding achievements obtained thus far, by clonal selection from populations of older varieties, natural mutants and newly created varieties with superior traits, have ensured increased grape production, of superior and relatively constant quality from one year to another [3].

The ecoclimate of the Murfatlar vineyard is characterized by a relatively short period of vegetation, during which a large amount of global radiation and a large heliothermal reserve accumulate, creating favorable conditions for the growth and development of the grapevine.

In ampelographic collections, in addition to the conservation of genetic resources, the aim is to carry out detailed research in order to describe the existing genotypes and the perspective elites that have appeared within the population, which by their characteristics lend themselves to testing in order to obtain valuable clones, these being tested and approved by ISTIS, in order to multiply and establish plantations.

MATERIAL AND METHOD

The team of researchers from Murfatlar Research Station carried out a study during the period 2018-2022 on 5 clonal elites of the 'Bican roz' cultivar, selected from existing trunks in the ampelographic collection of the research station. In this study, the botanical characters and agrobiological properties were established, and the technological and agroeconomic characterization was also carried out.

The choice of clonal elites was made in two stages:

a) in the first stage, field observations were made regarding the vigor, the phytosanitary condition, some morphological components and the production capacity;
b) in the second stage, at the selected clonal elites, determinations were made regarding the quality and quantity of the grapes, the size of the bunches, the number of berries per bunch, but also the quantity of must obtained.

As a result of the observations made, five elite trunks were marked, from which the top elite will be chosen that corresponds to all the criteria chosen by the breeder: consistent production and quality, as well as good resistance to diseases and pests.

RESULTS AND DISCUSSION

During the study period, research was carried out for the creation of varieties and the identification of clonal elites superior to the original 'Bican roz', a cultivar for table grapes, which, along with good quality and productivity, possesses properties of resistance to biotic and abiotic environmental factors, and which requires a minimum of phytosanitary treatments, helping to reduce the pollution of the viticultural ecosystem as well as the final products.

The climate of the Murfatlar vineyard is continental, with hot summers and moderate winters, creating the most favorable natural conditions for the cultivation of grapevine.

Climatic indices express the interaction of several elements of the climate (temperature, precipitation, relative air humidity, real insolation, etc.) and are used to characterize the viticultural potential at the macroclimatic level [10].

In table 1, a series of climatic elements are analyzed, as well as a series of climatic indices that are used worldwide, such as: Huglin heliothermic index [9] and cool night index [16].

Table 1. Climatic indicators for the Murfatlar Wine Center // Indicatori climatici ai Centrului Viticol Murfatlar

Analyzed climatic elements	Multiannual average	2018	2019	2020	2021	2022
Global thermal balance, Σt ° g, ° C	**5203.5**	5,379.6	5534.4	4999.6	4396.8	5053.3
Active thermal balance, Σt ° g, ° C	**4689.8**	4,815.5	5061.8	4500.5	3693.3	4573.8
Useful thermal balance, Σt ° g, ° C	**2538.7**	2,427.2	2811.8	2270.5	1850.1	2228.8
Absolute minimum air temperature,°C	-15.6	-12.8	-10.5	-13.9	-13.1	-10.6
Average annual temperature °C	12.3	14.6	14.8	14.9	13.8	13.9
Maximum air temperature, °C	37.8	37.4	39	33.9	39.5	36.0
Σ annual precipitation, mm	559.7	696.2	311.4	267.9	661	383.7
Σ active period precipitation, mm	367.6	364.3	180.4	161.7	339.3	206.7
Σ real active period insolation, (h)	1708.4	1453.9	1329.7	1574.6	1300.6	1401
No. of days with max. temperatures > 30°C	51	78	98	57	44	64
Active period, days	192	202	206	213	213	198
Real heliothermic index (IHr)	4.5	3,4	4.5	5.7	3	4.5
Hydrothermic coefficient (CH)	0.9	0.8	0.4	0.4	0.9	0.6
Bioclimatic index (Ibcv)	12.8	8.7	22.6	20.3	6.4	12.3
Oenoclimatic aptitude index (IAOe)	5492.7	5125.0	5847.5	5457.0	4700.3	5250.7
Huglin heliothermic index (IH)	3130.1	3280.0	4583.7	4584.0	2856.3	3976.9
Cool night index (IF)	12.8	14.1	14.4	14.5	10.4	12.9

Analyzing the data from table 1 we can see an increase in thermal balances: global, active and useful, in comparison to the multiannual average. The sum of real insolation during the growing season (1401 hours), is lower than the multiannual average (1708.4 hours); the sum of the annual precipitation (383.7 mm) is lower compared to the multiannual average (559.7 mm); the sum of the precipitation during the growing season (206.7 mm, is significantly smaller (367.6 mm), whereas the cool night index (12.8) has slightly increased (12.9 in 2022).

Due to climate changes, the number of days with maximum temperatures > 30°C increased (64 days) compared to the multiannual average (51 days) and the Huglin heliothermic index (IH) increased (3976.9) compared to the multiannual average which is 3130, 1.

Grapevine fertility represents the ability of the plant to form fruiting organs every year as the initial basis for the grape harvest and can be appreciated under two aspects: potential and actual fertility. In the climatic conditions of the last year of observations on the elites taken in the study, the fertility values recorded for each elite were close to normal or even higher, compared to the initial variety (Table 2).

Table 2. Observations and determinations on the fertility of clonal elites // Observații și determinări privind fertilitatea elitelor clonale

Variety	Clonal elites	Total Buds/ trunk	Dead buds/ trunk	Total shoots /trunk	Fertile shoots	Sterile shoots	Inflorescence primordia /trunk	Fertility %
'BICAN ROZ'	80/2/7	27	6	21	16	5	18	85
	79/5/3	26	7	19	12	7	18	90
	79/2/5	29	9	21	14	7	17	83
	80/5/2	27	8	19	14	5	17	87
	80/10/6	32	5	27	22	5	25	94
	Average	**28**	**7**	**21**	**16**	**6**	**19**	**88**
'Bican roz' initial variety		25	10	15	8	7	12	53

Pruning the vine is one of the most important works applied during the rest period, by which a large part of the wood grown on the trunk (80–85%) is removed annually [5].

The total amount of annual and multi-annual wood that is removed during the fruiting cut depends on the planned production, the load of fruit on the trunk and the vigor of growth on each elite in the previous year. In this case, the elite that has the higher amounts of annual and multiannual wood in comparison with the initial variety, is the clonal elite 80/10/6 (Table 3).

Table 3. The amount of annual and multiannual wood removed after pruning (average during the study period) // Cantitatea de lemn anual și multianual eliminat la tăiere (media în perioada studiului)

Variety	Clonal elites	Annual wood amount g/trunk	Multiannual wood amount g/trunk	Total amount of wood g/trunk
'BICAN ROZ'	80/2/7	652	453	1105
	79/5/3	650	471	1121
	79/2/5	666	494	1160
	80/5/2	699	436	1135
	80/10/6	799	515	1314
	Average	**693**	**474**	**1167**
'Bican roz' initial variety		548	275	823

During the 5 years of observations, the clonal elite 80/10/6 was remarked, which after being tested by ISTIS was approved as Bican roz 6 Mf in 2022 (Figure 2).

Figure 1. 'Bican roz' initial variety // 'Bican roz' soi inițial

Figure 2. Bican roz 6 Mf // Bican roz 6 Mf

The ampelographic main features of this clone, as compared to the Bican roz initial variety (Figure 1), are:

- ❖ The budburst is medium, the rosette is green with rare trichomes. The clonal elite has good fertility (79%) and great vigor. The young shoot is green in colour, with very rare trichomes, the positions is semi-erect and the tendrils are very long. The color of the adaxial side of the young leaf is green with anthocyanin areas, with soft hairs between the main ribs, which are dense on the abaxial side. The shoot has a green and red color of the dorsal part of the internode, the red on the ventral part.
- ❖ The adult leaf has a slightly shorther petiole than the median rib, pentagonal limb of medium size, green with red, medium embossed on the superior side, soft dense hairs between main ribs on lower side. The upper lateral sinuses are deep, with five slightly overlapping lobes, the teeth are medium

size, the tooth length/width ratio is medium; rectilinear shape, the petiolar sinus presents semi-open lobes.

- ❖ The flower has fully developed stamens and gynoecium. The bunch has a cylindrical-conical shape, long, yellow color, very large, peduncle long, compactness and ripening are medium.
- ❖ The berry is troncovoid, large, pink, with a fairly easy pedicel detachament. The berry is also characterized by high epidermal thickness, semi-crunchy pulp, moderately firm skin, absent or very weak anthocyanin pigmentation, with a different taste and fully formed seeds.

The development of vegetation phenophases is specific to the ecoclimate of the Murfatlar vineyard. The active vegetation period begins with the budburst and ends in autumn when the leaves fall. Bican roz 6 Mf buds in the second half of April, blooms in early June, starts the verasion in the second half of August and ripening in the second decade of September, having a vegetation period of 199 days, compared to the initial variety that has 206 days (Table 4).

Table 4. Phenological data of Bican roz 6 Mf clone, compared to the initial variety // Date fenologice ale clonei Bican roz 6 Mf, comparativ cu soiul inițial

Variety	Year	Calendaristic dates						No. of days vegetation period
		Budburst	Flowering	Veraison	Full maturity	Harvest	Leaf fall	Budburst – Leaf fall
Bican roz 80/10/6	2018	19.04	05.06	14.08	11.09	17.09	30.10	202
	2019	26.04	04.06	08.08	20.09	24.09	26.10	201
	2020	27.04	12.06	12.08	10.09	14.09	11.11	201
	2021	24.04	08.06	17.08	17.09	23.09	04.11	195
	2022	22.04	06.06	10.08	12.09	18.09	10.11	196
Average Bican roz 6 Mf		**19-17.04**	**04-12.06**	**08-17.08**	**10-20.09**	**14-24.09**	**30-11.11**	**199**
'Bican roz' initial variety		28.04	15.06	20.08	25.09	28.09	12.11	206

In order to appreciate the quality of the production and to recognize table varieties, a series of grape characters specific to each variety are used [8,12].

According to table 5, the values of the absolute and relative fertility coefficients, as well as the values of the absolute and relative productivity indices are higher compared to those of the initial variety. For table grapes, the winter bud is affected by temperatures of -18 ±3 ^{o} C, depending on the biological particularities of the varieties. The clone Bican roz 6 Mf has a weak resistance to frost (-18°C), like the initial variety [2].

Table 5. Agrobiological characterization of the Bican roz 6 Mf clone, compared to the initial variety // Caracterizarea agrobiologică a clonei Bican roz 6 Mf, comparativ cu soiul inițial

Clones	Year	Fertility, fertile shoots %	Absolute fertility coefficient	Relative fertility coefficient	Absolute production index	Relative production index	Growth vigour	Cold resistance, %viable buds
Bican roz 80/10/6	2018	75	1,2	0.8	680	453	big	78
	2019	86	1.4	0.9	1173	838	big	73
	2020	68	1.3	0.9	996	689	big	72
	2021	76	1.0	0.4	794	325	big	70
	2022	90	1.1	0.5	642	295	big	84
Average Bican roz 6 Mf		**79**	**1,2**	**0.7**	**857**	**520**	**big**	**75**
'Bican roz' initial variety		56	1.1	0.6	443	242	big	60

The Bican roz 6 Mf is superior to the initial variety in terms of the quality and quantity of the grapes, in that the start of verasion is faster, the thickness of the epidermal is medium and the grape is large and long, compared to the initial variety, where the epidermal is thin and the grape is medium (Table 6).

Table 6. Technological characterization of the clone Bican roz 6 Mf, compared to the initial variety // Caracterizarea tehnologică a clonei Bican roz 6 Mf, comparativ cu soiul inițial

Clones	Year	Average bunch weight, g	Weight of 100 berries, g	Average berry weight, g	Must sugar content, g/l	Must total acidity g/l H_2SO_4	Grape production kg/trunk	Grape production t/ha
Bican roz 80/10/6	2018	567	264	2.64	162.0	7.0	10.44	24
	2019	838	260	2.60	185.0	3,4	11.6	24
	2020	766	170	1.70	197.0	2.6	12.76	24
	2021	794	172	1.72	159.8	5.9	9.72	24
	2022	605	269	2.59	166.2	5.1	9.28	24
Average Bican roz 6 Mf		**714**	**225**	**2.25**	**174.0**	**4.8**	**10.76**	**24**
'Bican roz' initial variety		403	165	1.65	148.0	5.8	7.96	19

The grape is par excellence a noble fruit, which possesses a history and a culture. The elegance of its shape and appearance (visual and tactile sensory) together with the organoleptic properties (gustatory sensory) and the high energy value make it a prestigious and generous product, particularly appreciated by the consumer [14].

The beries of the clone Bican roz 6 Mf have a greater weight than those of the initial variety (Figure 3).

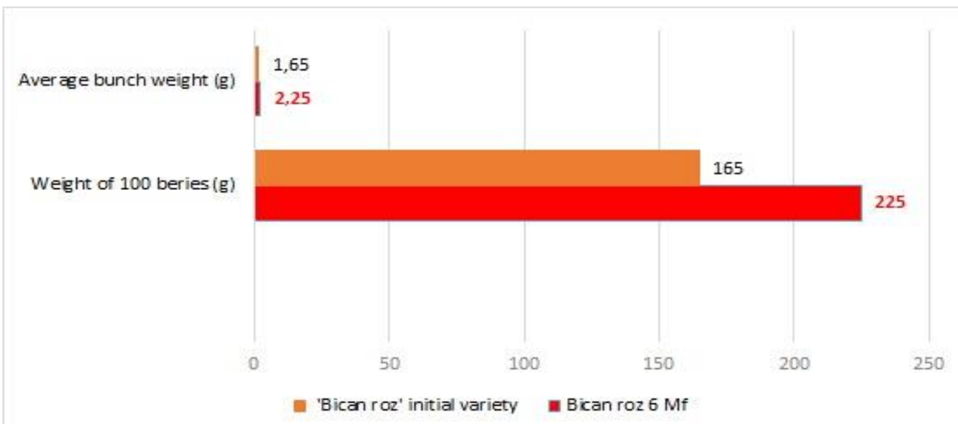

Figure 3. Average berry weights of the Bican roz 6 Mf clone, compared to the initial variety //
Figura nr. 3. Greutăți medii bob și strugure, ale clonei Bican roz 6 Mf, comparativ cu soiul inițial

Regarding the sugar content, the Bican roz 6 Mf clone differed significantly from the initial variety, having an average of 174 g/L compared to 148 g/L, the value of the initial variety (Figure 4).

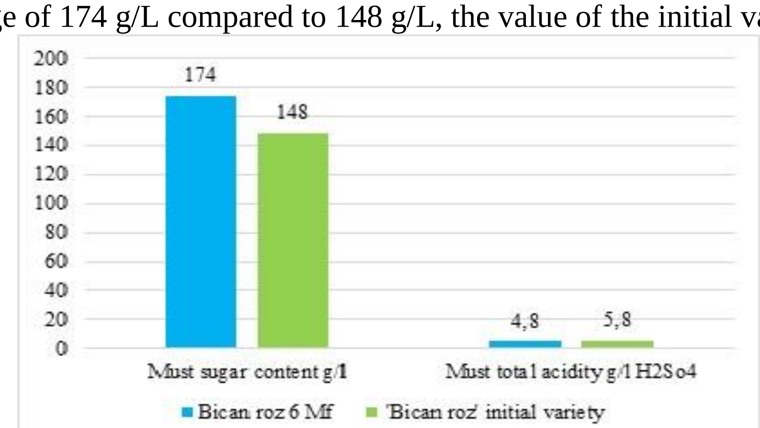

Figure 4. Total acidity and sugar content of the Bican roz 6 Mf clone compared to the initial variety //
Figura nr. 4. Aciditatea totală și concentrația în zaharuri a clonei Bican roz 6 Mf, comparativ cu soiul inițial

Grape yield raported as kg/trunk and t/ha is clearly higher for the clone (Figure 5).

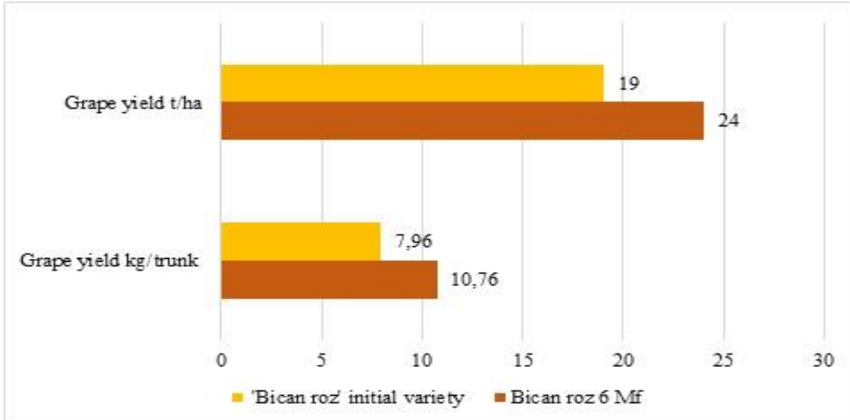

Figure 5. Average grape yields kg/trunk and t/ha of the Bican roz 6 Mf clone, compared to the initial variety // Figura nr. 5. Producții medii de struguri kg/butuc și t/ha ale clonei Bican roz 6 Mf, comparativ cu soiul inițial

The technological indices for the Bican roz 6 Mf clone are clearly higher, compared to the initial variety, the productive potential of the clone is highlighted and leads to the improvement of the assortment of varieties for table grapes in the Dobrogea area (Table 7).

Table 7. Bican roz 6 Mf clone technological indices compared to the initial variety // Indicii tehnologici ai clonei Bican roz 6 Mf, comparativ cu soiul inițial

Clones	Year	Berry index	Bunch structure index	Berry composition index	Yield index	No. berries/ bunch	Peduncule length (cm)
Bican roz 80/10/6	2018	31	5.1	6.6	4.6	50	3.5
	2019	38	5.4	6,7	5.2	56	2.8
	2020	35	5,6	6,7	4.0	44	3.3
	2021	22	5.8	6,7	4.1	52	3.04
	2022	29	5.1	6.8	2.1	33	2.86
Average Bican roz 6 Mf		**31**	**5.4**	**6,7**	**4.5**	**47**	**3.1**
'Bican roz' initial variety		28	5.4	6,7	4.3	35	3.03

The ripening is medium, the bunch has a cylindrical-conical shape, is long, with a pink color and of a very large size, the peduncle is long, with medium compactness and ripening. The berry is troncovoid, large, pink, with a fairly easy pedicel detachament. The berry is also characterized by high epidermal thickness, semi-crunchy pulp, moderately firm skin, absent or very weak anthocyanin pigmentation, with a different taste and fully formed seeds, it is recommended for consumption in fresh state (table 8).

Table 8. Technological characteristics regarding commercial value, suitability for transport and storage // Caracteristici tehnologice privind valoarea comercială, pretabilitatea la transport și păstrare

Clonal selection	Bunch size	Berry size and uniformity	Compactness	Shape and color	Pruine layer thickness	Skin adherence and elasticity	Pulp consistency	Presence of seeds	Taste	Aroma
Bican roz 6 Mf	Very Large	Large and uniform	Compact	Ovoid, Pink	Medium	Moderately Firm	Crisp	Fully Formed	Different taste	Unflavoured

CONCLUSIONS

The team of researchers from SCDVV Murfatlar during the period 2018-2022 carried out a study on 5 clonal elites of the 'Bican roz' variety, selected from existing trunks in the ampelographic collection of the research station. In this study, the ampelographic characters and agrobiological properties were established, and the technological and agroeconomic characterization was also carried out.

During the 5 years of observations, the clonal elite 80/10/6 was remarked, which after being tested by ISTIS was approved as Bican roz 6 Mf in 2022.

The clonal elite has good fertility (79%) and great vigor. Concerning the active vegetation period Bican roz 6 Mf buds in the second half of April, blooms in early June, starsts the version in the second half of August and ripening in the second decade of September, having a vegetation period of 199 days, compared to the initial variety that has 206 days.

The grapes and berries of the clone Bican roz 6 Mf have a greater weight than those of the initial variety, and the grape yield raported as kg/trunk and t/ha is clearly higher for the clone.

The technological indices for the Bican roz 6 Mf clone are clearly higher, compared to the initial variety, the productive potential of the clone is highlighted and leads to the improvement of the assortment of varieties for table grapes in the Dobrogea area. It is recommended for fresh consumption.

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AGROBIOLOGICAL, TECHNOLOGICAL AND OENOLOGICAL POTENTIAL OF SOME HYBRID ELITE WITH BIOLOGICAL RESISTANCE OBTAINED AT RDSVO ODOBEŞTI

POTENȚIALUL AGROBIOLOGIC, TEHNOLOGIC ȘI OENOLOGIC AL UNOR ELITE HIBRIDE CU REZISTENŢĂ BIOLOGICĂ OBŢINUTE LA SCDVV ODOBEŞTI

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Abstract
In the context of current climate changes, the exploitation of viticultural biodiversity and the practice of a sustainable, environmentally friendly viticulture, with the reduction of the quantities of pesticides applied through phytosanitary treatments, requires the obtaining and promotion of vine varieties with complex biological resistance, with high potential of adaptation to the ecopedoclimatic conditions of each wine growing area, and valuable technological characteristics. Responding to this desire in the period 2020-2022, at RDSVO Odobeşti were studied in order to evaluate the agrobiological, technological and oenological potential of two hybrid elites with biological resistance: hybrid elite 2-5 (Galbenă de Odobeşti x Lydia) and hybrid elite 10-18 (Italian Riesling x Siebel 6720). This paper presents the agrobiological and technological potential of the two hybrid elites in the climatic conditions of the 2020, 2021 and 2022 wine years. The results obtained from this study showed that the two hybrid elites (E.H. 2-5 and E.H. 10-18) have a high agrobiological, technological and oenological potential, shows high biological resistance to the main diseases of the vine, and can be proposed for testing and approval at ISTIS, in order to improve the national assortment and practice a sustainable viticulture.
***Keywords*: biological resistance, vine variety, agrobiological and technological value**

Rezumat
În contextul schimbărilor climatice actuale, valorificarea biodiversității viticole și practicarea unei viticulturi durabile, prietenoase cu mediul, cu reducerea cantităţilor de pesticide aplicate prin tratamentele fitosanitare, impune obţinerea şi promovarea soiurilor de viţă-de-vie cu rezistenţă biologică complexă, cu, potenţial ridicat de adaptare la condiţiile ecopedoclimatice ale fiecărui areal viticol, şi caracteristici tehnologice valoroase. Răspunzând acestui deziderat în perioada 2020-2022, la SCDVV Odobeşti au fost studiate în vederea evaluării potenţialului agrobiologic, tehnologic şi oenologic, două elite hibride cu rezistenţă biologică: elita hibriă 2-5 (Galbenă de Odobeşti x Lydia) şi elita hibridă 10-18 (Riesling italian x Siebel 6720). Această lucrare prezintă potenţialul agrobiologic, tehnologic şi oenologic al celor două elite hibride în condiţiile climatice ale anilor viticoli 2020, 2021 și 2022. Rezultatele obținute în urma acestui studiu au arătat faptul că cele două elite hibride (E.H 2-5 și E.H. 10-18) au un potențial agrobiologic, tehnologic și oenologic ridicat, prezintă rezistență biologică ridicată la principalele boli ale viței de vie, putând fi propuse spre testare și aprobare la I.S.T.I.S., în vederea îmbunătățirii sortimentului național și practicarea unei viticulturi durabile.
Cuvinte cheie: rezistență biologică, soi vinifera, valoare agrobiologică și tehnologică

INTRODUCTION

Practicing sustainable viticulture in tandem with environmental and health concerns is currently one of the most important goals of the wine world. The diversification of viticultural genetic resources by creating varieties with tolerance to biotic stress factors has an important role in protecting the environment, it being known that native varieties have genes for tolerance and resistance to diseases and pests, ensuring its sustainable development at the national, regional level and local (Fregoni, 1998).

Community regulations only recognize grape varieties of the European species *Vitis vinifera* L. for the production of appellation wines, while disease-resistant grape varieties come from crosses between *Vitis vinifera* L. and other *Vitis* species (American and/or Asian, carrying resistance genes). The most promising option to reduce the need for fungicides in viticulture is the use of resistant varieties (Riaz et al., 2019, Bavaresco, 2019). Research programs at renowned viticultural research centers in Europe and America have resulted in the creation of new varieties to combat disease and weather challenges through crosses between so-called European vinifera and others native to North America and Asia, such as *V. riparia, V. labrusca* and *V. rotundifolia* (Ilnitskaya et al., 2019, Ollat et al., 2019). The research carried out in the last four decades in our country led to the creation of several grapevine genotypes with increased resistance to diseases, and the results were expressed in the creation of a base with valuable genetic material and the homologation of many varieties (Damian et al., 2012, Culcea et al., 2004; Pușcalău et al., 2018). In this context, the valorification of valuable genetic material with high productive and qualitative potential, with tolerance to diseases and resistance to stress factors, adapted to the ecopedoclimatic conditions of each wine-growing area, is one of the strategic objectives of research at RDSVO Odobeşti, where two varieties with biological resistance were approved only in the last ten years (Bosoi et al., 2020; Pușcalău et al., 2022).

MATERIALS AND METHODS

The study was carried out in a plantation over 30 years old, established on a leached chernozem type soil, located in the biological field of the Research and Development Station for Viticulture and Oenology (RDSVO) Odobești, with geographical coordinates 45º45′ north latitude, 27º06′ eastern length and an altitude of 150 m. The study was carried out during 2020-2022.

The biological material was represented by two hybrid elites with biological resistance: E.H. 2-5 (Galbenă de Odobeşti x Lydia) and E.H. 10-18 (Italian Riesling x Siebel 6720). The studied hybrid elites were grafted on Kobber 5 BB rootstock. The pruning system practiced was the Dr. Guyot system, with a fruit load between 38-44 buds/vine, distributed over 8-9 buds per fruit cane with 2 buds per spur, and a semi-high training form. To combat pathogens (*Plasmopara viticola, Uncinula necator, Botrytis cinerea*, etc.), six phytosanitary treatments were applied.

In order to establish the agrobiological potential, observations and determinations were made regarding: the phenological spectrum, the vigor of growth through measurements of the shoots during the period of intense growth; elements of fertility and productivity by calculating the percentage of fertile shoots (FS%), fertility coefficients (Cfa and Cfr) and productivity indices (Ipa and Ipr); behavior to the main vine diseases and stress factors (drought) by scoring from 1 to 9 according to the resistance scale developed by OIV (2009). To evaluate the technological potential, determinations were made regarding the quantity and quality of grape production (kg/but., t/ha; g/l sugars, g/l acidity tartaric acid). The oenological potential of the two hybrid elites was evaluated by determining the compositional profile of the obtained wines. Climate data for the study period were provided by the AgroExpert weather station and the multi-year climate database of RDSVO Odobești.

RESULTS AND DISCUSSIONS

Climate conditions. The research period (2020 - 2022) was characterized by high heliothermal availability, the thermal regime expressed by average annual temperatures (ºC) and the sum of useful temperature degrees (∑ºtu) registering much higher values than the multiannual values in the years 2020 and 2022, and values close to multi-year averages in 2021 year (Table 1). Compared to the multiannual values for these climatic elements (11.1 °C and 1630.8 °C, respectively), the average annual temperature recorded an excess of 2.3 °C in 2020 year and 1.6 °C in 2022, and for the sum of useful temperature degrees (∑ºtu), a thermal increase of 359.8°C was recorded in 2020 and 403.3°C in 2022.

Table 1. The main climatic parameters from the study period (Odobeşti, 2020 - 2022) // Principalii parametri climatici din perioada de studiu (Odobeşti, 2020 - 2022) *

Month	Climate parameter											
	Average temperature (°C)				The sum of the useful temperature degrees (°C)				Rainfall (mm)			
	Multi annual	2019/ 2020	2020/ 2021	2021/ 2022	Multi annual	2019/ 2020	2020/ 2021	2021/ 2022	Multi annnal	2019/ 2020	2020/ 2021	2021/ 2022
XI	5.2	9.0	5.3	7.6	9.9	49.4	0.0	11.7	46.8	68.2	12.2	12.0
XII	0.3	3.0	2.5	1.5	0.5	0.0	0.0	0.0	40.0	42.8	98.6	76.2
I	-1.5	1.7	0.6	1.9	0.1	0.0	0.0	0.0	32.5	0.4	47.0	6.4
II	0.0	5.6	1.6	4.9	0.9	2.3	2.0	0.8	32.4	9.0	4.4	4.8
III	4.5	8.6	4.6	4.9	12.3	30.8	0.4	23.3	33.0	20.2	46.8	1.2
IV	11.2	12.2	8.9	11.6	70.8	82.1	15,3	76.1	48.9	5.2	41.0	65.8
V	16.8	15.8	16.5	17.7	218.7	179,6	200.5	239.6	73.5	55.6	22.8	31.6
VI	20.2	21.8	20.3	22.7	312.5	353.3	309.0	380.6	84.6	85.2	134.6	48.2
VII	22.1	23.5	24.3	24.0	375.6	419,1	443.5	432.5	78.6	28.2	40.0	51.0
VIII	21.6	24.3	22.9	24.3	360.3	441.8	398.6	442.2	60.2	13.0	45.0	31.6
IX	17.0	20.6	16.7	17.2	212.1	317.5	199.8	214.6	45.6	31.4	6.2	26.8
X	11.0	14.2	10.6	13.8	66.1	123.7	35.1	221.7	45.2	66.0	9.4	1.2
Annual average/ amount	11.1	13.4	11.2	12.7	1639.8	1999.6	1604.2	2043.1	621.3	425.2	508.0	356.8
during the vegetation period	18.2	19.7	18.3	19.6	1550.0	1793.4	1568.7	1785.6	391.4	218.6	289.6	255.0

***Data provided by the weather station AgroExpert of RDSVO Odobesti** //
*Datele provin de la Stația meteo AgroExpert a SCDVV Odobesti

The precipitation regime during the three years of the study was deeply deficient, both during the year and during the vegetation period. Compared to the multiannual values recorded for the entire period of a wine-growing year and for the vegetation period (621.3 mm, respectively 391.4 mm), the amount of precipitation recorded represented only 68.4%, respectively 55.8% in 2020, 81.7%, respectively 74.0% in the year 2021 and 57.4%, respectively 65.1% in the year 2022. Another negative characteristic of precipitation in the three years of the study was represented by the defective quantitative distribution, more chosen during the vegetation period of the vine. From the point of view of the water regime, this situation shows the fact that the study period (years 2020-2022) was a dry one for the Odobești wine-growing area.

The phenological spectrum. In the climatic conditions specific to the study period (2020 - 2022), the processes of growth and development of the vine, respectively the development of the vegetation phases for the two hybrid elites taken in the study evolved relatively normally (Figure 1 and Figure 2).

Figure 1. Vegetation phases of the hybrid elite 2-5 // Fazele de vegetație la elita hibridă 2-5

Figure 2. Vegetation phases of the hybrid elite 10-18 // Fazele de vegetație la elita hibridă 10-18

Vegetation phases at the two hybrid elites were initiated and completed 5 - 15 days earlier in study years 2020 and 2022 compared to 2021 (Table 2).

Table 2. The phenological spectrum (Odobeşti, 2020 - 2022) // Desfăşurarea principalelor faze de vegetație (Odobeşti, 2020 -2022)

The hybrid elite	Year	The phenological stages								Active vegetation period (days)
		Disbudding		Flowering		Veraison		Full ripening		
		∑tu (°C)	Date	∑tu (°C)	Date	∑tu (°C)	Date	∑tu (°C)	∑tu (°C)	
E.H. 2-5	2020	13.IV	60,3	05.VI	268,5	04.VIII	791,1	15.IX	582,8	156
	2021	02.V	38,3	15.VI	299,7	12.VIII	807,7	20.IX	387,4	142
	2022	16.IV	74,7	04.VI	318,0	29.VII	1051,0	12.IX	566,6	151
Average		22.IV	57.7	09.VI	295,4	05.VIII	883.3	16.IX	512.3	150
E.H. 10-18	2020	14.IV	60,3	03.VI	248,1	02.VIII.	785,1	10.IX	541,0	150
	2021	01.V	27,3	10.VI	272,1	09.VIII	804,5	16.IX	399,9	139
	2022	16.IV	74,7	31.V	265,1	26.VII	1064,4	09.IX	576,5	148
Average		22.IV	54.1	05.VI	261.7	02.VIII	884.7	12.IX	505,8	146

The calendarically, with the exception of disbudding, for the phenophases of flowering and ripening of grapes, an advance of 2-5 days was recorded in hybrid elite 10-18, compared to hybrid elite 2-5. The duration of the active vegetation period varied between 142-156 days in hybrid elite 2-5 and 139-150 days in hybrid elite 10-18. The average value calculated over the study period (2020-2022) shows that for the initiation and development of the budding phenophase, hybrid elite 2-5 has needed a ∑tu°C of 57.7°C, with 3.6°C more compared to elite hybrid 10-18 (54.1°C).

The flowering phenophase occurred under the conditions of the accumulation of a sum of useful temperature degrees of 295.4 °C for hybrid elite 2-5, a higher value by 33.7°C compared to that recorded for hybrid elite 10-18 (261.7 °C). For the initiation and progression of the veraison phase, the two studied hybrid elites required a ∑tu°C around 884°C, and the bunch ripening phenophase required a sum of 512.3°C useful temperature for the hybrid elite 2-5 and 505.8°C ∑tu for hybrid elite 10-18.

Fertility and productivity. The fertility and productivity characteristics of the studied hybrid elites were evaluated by the percentage of fertile shoots, fertility coefficients and productivity indices (Table 3).

Table 3. The fertility and productivity characteristics (Odobeşti, 2020 - 2022) //
Caracteristicile de fertilitate şi productivitate (Odobeşti, 2020 – 2022)

The hybrid elite /year		Fertile shoots (%)	Fertility coefficients		Average weight grapes (g)	Productivity indices	
			Relative	Absolute		Relative	Absolute
E.H. 2-5	2020	66,5	1,07	1,60	172,4	184	276
	2021	81,5	0,97	1,18	211,7	205	250
	2022	61,7	0,71	1,16	211,0	150	245
Average		69,9	0,91	1,31	198,4	180	257
E.H. 10-18	2020	66,4	1,05	1,58	192,3	202	303
	2021	82,7	1,11	1,34	185,7	206	249
	2022	61,8	1,11	1,49	207,2	230	309
Average		70,3	1,09	1,47	195,1	213	287

The percentage of fertile shoots calculated during the study period recorded very close average values (69.9% for hybrid elite 2-5, respectively 70.3% for hybrid elite 10-18). Fertility coefficients (absolute and relative) recorded higher average values in the hybrid elite 10-18 (Cfa - 1.09; Cfr - 1.47) and lower in the hybrid elite 2-5 (Cfa 0.91; Cfr 1 ,31). Since the average values calculated for the mass of a grape were close (198.4 g for hybrid elite 2-5, respectively 195.1 g for hybrid elite 10-18), and the average values obtained for productivity indices (relative and absolute) have were higher for the hybrid elite 10-18 (Ipr – 213; Ipa – 287).

Vegetative growth of shoots. The climatic conditions of the years 2020 and 2022 were less favorable, affecting the physiological and metabolic processes that condition the growth and development of the shoots (Figure 3).

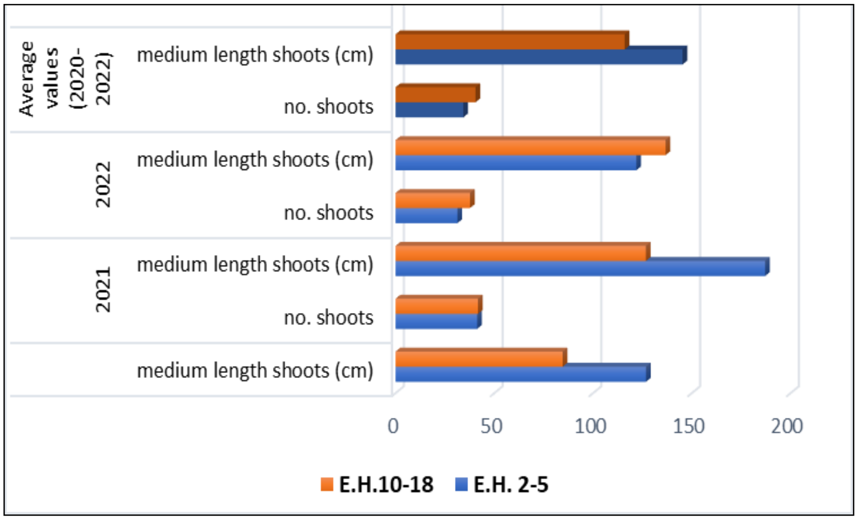

Figure 3. Vegetative growth - average values (Odobești, 2020-2022) //
Creșterile vegetative – valori medii (Odobești,2020-2022)

Compared to 2021, a year with climate parameter values close to multiannual values, vegetative growth in 2020 year recorded lower average values by 32.2% in hybrid elite 2-5 and by 33.2% in hybrid elite 10-18. Vegetative increases recorded in 2022 year had values 34.8% lower in hybrid elite 2-5 and relatively close to those of 2021 year in hybrid elite 10-18. The analysis of vegetative growth during the study period (2020–2022) shows that at an average number of 34.3 shoots/vine for hybrid elite 2-5, respectively 40.5 shoots/vine for hybrid elite 10-18, the average length of the main shoots was 145.3 cm in hybrid elite 2-5, respectively 116.0 cm at hybrid elite 10-18. Taking into account the average values obtained for the length of the shoots, the hybrid elites taken in the study were classified into vigor classes according to the OIV 351 descriptor, as follows: hybrid elite 2-5 with medium to high growth vigor (grade 5-7) and hybrid elite 10-18 with medium growth vigor (grade 5).

Behavior to cryptogamic diseases. Biological resistance to the main cryptogamic diseases was determined by calculating the degree of attack on leaves and grapes (Table 7). Under the influence of the climatic conditions during the vegetation period recorded during the study period (2020-2022), the values obtained for the degree of attack were sub-unit for the main pathogens of the vine. Determined by the different climatic conditions of the three years of the study, higher values were recorded in the year 2021.

Based on the data obtained, the resistance of the hybrid elites studied to the main diseases of the grapevine was assessed by the OIV ampelographic descriptors method, the scoring being done by assigning numbers according to the level of expression, the two elites being marked with grade 7 (high resistance) and grade 9 (very high resistance).

Table 4 .Behavior at the main diseases of the vine (Odobeşti, 2020 - 2022) //
Comportarea la principalele boli criptogamice ale viței-de-vie (Odobeşti, 2020 – 2022)

The hybrid elite	The plant organ	The degree of attack of cryptogamic diseases (DA)								
		Downy mildew (*Plasmopara viticola)*			Powdery mildew *(Uncinula necator)*			Gray rot *(Botrytis cinerea)*		
		2020	2021	2022	2020	2021	2022	2020	2021	2022
E.H. 2-5	Leaf	0.00	0.26	0,10	0.00	0.07	0,02	0.00	0.00	0,00
	Grape	0.03	0.19	0,12	0.00	0.19	0,13	0.27	0.03	0,13
E.H. 10-18	Leaf	0.00	0.23	0,13	0.00	0.10	0,04	0.00	0.00	0,00
	Grape	0.10	0.25	0,17	0.07	0.22	0,11	0.22	0.15	0,15

Drought resistance (OIV 403) - According to the *list of OIV descriptors for grape varieties and Vitis species*, 2nd edition, 2009. In the climatic conditions of the study period with two years 2020 and 2022, considered on the basis of recorded climatic data, some of the driest years in the Odobești vineyard, hybrid elite 2-5 showed high to very high tolerance (grade 7-9), and hybrid elite 10-18 medium tolerance to the phenomenon of atmospheric and pedological drought. The hybrid elites studied did not show specific manifestations of thermal and water stress (withering of shoot tips, yellowing leaves at the base of the trunk, wilting of grapes, etc.).

Technological potential. The study of the technological characteristics of grape production completed the elements of knowledge for the studied hybrid elites (Table 5 and Figure 4).

Table 5. The quantitative and qualitative characteristics of grape production (Odobeşti, 2020 - 2022) //
Caracteristicile cantitative şi calitative ale producției de struguri (Odobeşti, 2020 - 2022)

The hybrid elite		Weight grape (g)	Production grape		The juice		
			kg/vine	t/ha	Sugars g/l	Total acidity g/l acid tartric	Gluco acidimetric index
E.H. 2-5	2020	172.4	5.17	19.58	183	6.90	27
	2021	211.7	6.08	23.03	193	6.96	28
	2022	211,0	4,24	16,06	200	5,55	36
Average		198,4	5,16	19,55	192	6,47	30
E.H. 10-18	2020	192.3	6.73	25.49	206	6.33	33
	2021	185.7	6.85	25.95	222	7.42	30
	2022	207,0	6,76	25,60	211	6,15	34
Average		195,0	6,78	25,68	213	6,63	32

The main quantitative and qualitative characteristics of grape production refer to average grape weight, average grape yield (kg/vine; t/hectare), sugar content (g/l), total acidity (g/l tartaric acid) and the glucoacidimetric index of the juice.

The average value of the mass of grapes during the three years of the study was 198.4 g in hybrid elite 2-5 and 195.0 g in hybrid elite 10-18. The two hybrid elites recorded higher values of the average production of grapes per vine in the year 2021 compared to the years 2020 and 2022, the average over the three years of the study being 5.16 kg/vine in the hybrid elite 2-5 and 6.78 kg/vine for the elite 10-18.

a) **b)**

Figure 4. a) Hybrid Elite 2-5; b) Hybrid Elite 10-18 // a) Elita hibridă 2-5; b) Elita hibridă 10-18

The lack of precipitation and maximum temperatures higher than 30°C recorded for 55 days during the ripening period of the grapes influenced in 2020 the optimal development of the biochemical processes of sugar accumulation in the grains. Under these conditions, the two genotypes accumulated between 183 g/l sugars (E.H. 2-5) and 206 g/l sugars (E.H. 10-18), under conditions of a total acidity of 6.90 g/l tartaric acid, respectively 6.33 g/l tartaric acid. The average value of the amount of sugars accumulated in grapes during the three years of the study was 192 g/l in the elite 2-5 and 213 g/l in the hybrid elite 10-18, under the conditions of a total acidity content of 6, 47 g/l tartaric acid, respectively 6.63 g/l tartaric acid (Figure 5). Average values for the glucoacidimetric index were recorded between 30 for the 2-5 hybrid elite and 32 for the 10-18 hybrid elite.

The oenological potential of the two hybrid elites was evaluated by determining the compositional profile of the obtained wines, the harvests of 2020 and 2021 (Table 6).

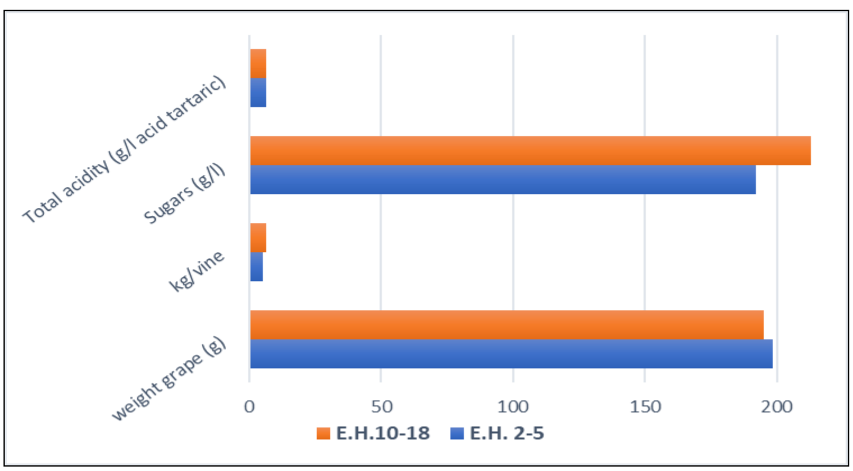

Figure 5. The quantitative and qualitative characteristics of grape production (Odobeşti, 2020-2022) //

Carateristicile cantitative şi calitative ale producţiei de struguri (Odobeşti,2020-2022)

Table 6. The compositional profile of wines - general composition analysis (Odobești, 2021, 2022) //
Profilul compozițional al vinurilor - analize de compoziție generală (Odobești, 2021,2022)

Elita hibridă		The general composition parameters								
		Free SO_2 (mg/l)	**Total SO_2** (mg/l)	**Density** (g/cm³)	**Alc. conc.** (% vol.)	**Total acidity** (g/l ac. tartric)	**Volatile acidity** (g/l ac acetic)	**Sugar reducing** (g/l)	**Total dry extract** (g/l)	**Non-reducer extract** (g/l)
E.H. 2-5	2021	38,24	117,28	0,9910	12,30	5,72	0,29	1,24	18,50	17,26
	2022	9,72	63,68	0,9908	12,15	5,66	0,26	3,81	20,85	16,99
Average		23,75	90,48	0,9909	12,22	5,69	0,27	2,52	19,67	17,04
E.H. 10-18	2021	40,79	122,64	0,9912	14,00	5,35	0,29	0,93	24,20	23,27
	2022	33,25	100,76	0,9910	12,86	5,35	0,36	0,61	24,88	24,27
Average		37,02	111,70	0,9911	13,43	5,35	0,32	0,77	24,54	23,77

The average values for the main compositional characteristics of the obtained wines, namely alcohol concentration (% vol.), total acidity (g/l tartaric acid) and total dry extract (g/l) demonstrate that from the hybrid elites 2-5 and 10-18 it is possible to obtain high quality wines with an alcoholic potential of over 12% vol alc. (12.22 g/l at hybrid elite 2-5, respectively 13.43% vol. alc. at hybrid elite 10-18), with a total acidity that varied between 5.35 g/l tartaric acid at E.H. 10-18 and 5.69 g/l tartaric acid at E.H. 2-5. The total dry extract (g/l) recorded average values that varied between 19.67 g/l in hybrid elite 2-5 and 23.77 g/l in hybrid elite 10-18. For wines obtained from varieties that have interspecific hybrids in their composition, especially red wines, a parameter of interest is the qualitative/quantitative presence of malvidin diglycoside. The qualitative analysis regarding the presence of this compound demonstrated the absence of malvidin in the wines obtained from the two hybrid elites.

The agrobiological, technological and oenological potential demonstrated by the hybrid elites 2-5 and 10-18 recommends their enrollment in the homologation process with a view to introduction into culture, to complete the assortment of varieties with biological resistance to the main cryptogamic vine diseases and with tolerance to abiotic stress factors (drought, frost).

CONCLUSIONS

1. Except for the 2021 wine year which recorded values close to the multiannual averages, the 2020 and 2022 wine years were some of the driest years recorded in the Odobești vineyard.
2. The hybrid elites studied showed a high fertility potential, the percentage of fertile shoots varying between 69.9% in hybrid elite 2-5 and 70.3% in hybrid elite 10-18.
3. The analysis of the growth of the main shoots during the vegetation period (2020–2022), shows that the hybrid elite 2-5 shows medium to high growth vigor (grade 5-7), compared to the hybrid elite 10-18 which presented growth vigor average (grade 5).
4. Hybrid elite 2-5 and hybrid elite 10-8 demonstrated during the three years of study high and very high resistance to the main vine diseases.
5. Under the conditions of some dry years (2020 and 2022), hybrid elites 2-5 and 10-18 showed a high to very high tolerance to the phenomenon of atmospheric and pedological drought.
6. Elite hybrids 2-5 and 10-18 demonstrated superior technological potential, achieving average grape yields of 5.16 kg/vine (E.H. 2-5) and 6.78 kg/vine (E.H. 10-18), with average sugar accumulations of 192 g/l (E.H. 2-5) and 213 g/l (E.H. 10-18), supported by good total acidity values (6.47 g/l tartaric acid at E.H. 2-5 and 6 .63 g/l tartaric acid at E.H. 10-18).
7. The hybrid elites 2-5 and 10-18 demonstrated a superior oenological potential, the obtained wines presenting an alcoholic concentration of over 12% vol., a total acidity of 5.69 g/l tartaric acid (EH 2-5) respectively 5, 35 g/l tartaric acid (E.H.10-18) and extractivity (17.04 g/l non-reducing dry extract at hybrid elite 2-5, respectively 23.77 g/l at hybrid elite 10-18).

8. The agrobiological, technological and oenological potential demonstrated by hybrid elites 2-5 and 10-18 recommends their promotion in culture in order to diversify the assortment of varieties with biological resistance to the main vine diseases and with tolerance to climate change.

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ANALYSIS OF SOME ECOLOGICAL INDICATORS OF INSECT SPECIES FROM A VINEYARD PLANTATION, CĀLINEȘTI – ARGEȘ

ANALIZA UNOR INDICATORI ECOLOGICI AI SPECIILOR DE INSECTE DINTR-O PLANTAȚIE VITICOLĂ, CĂLINEȘTI - ARGEȘ

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Abstract

The field research was carried out in a vineyard belonging to INCDBH, located in the south of Romania (Călinești, Argeș). Between June - August (2021-2022) Barber traps were placed to assess the ecological indicators of insects from this region with a temperate climate (species abundance, Simpson, Shannon, SHE analysis). The identified insect species were classified into 9 orders and 18 families, respectively: Araneae (Gnaphosidae, Sparassidae and Philodromidae), Coleoptera (Carabidae, Cerambycidae, Coccinellidae, Dermestidae, Mordellidae), Dermaptera (Forficulidae), Hemiptera (Anthocoridae, Rhyparochromidae), Homoptera (Cicadellidae), Hymenoptera (Formicidae), Neuroptera (Chrysopidae), Opiliones (Sironidae, Phalangiidae) and Orthoptera (Acrididae, Gryllidae). Thus, 29 species of insects were identified with 148 individuals in 2021 and 303 in 2022. The largest number of individuals identified throughout the study period in the Barber traps belong to the genera Lasius and Melanogryllus.

Keywords*: *Biodiversity, indexes Simpson and Shannon, SHE analysis, Bray-Curtis analysis

Rezumat

Cercetările în teren s-au efectuat într-o plantație viticolă ce aparține INCDBH, amplasată în sudul României (Călinești, Argeș). În perioada iunie – august (2021-2022) s-au amplasat capcane de tip Barber pentru a evalua indicatorii ecologici ai insectelor din această regiune cu climat temperat (abundența speciilor, Simpson, Shannon, analiza SHE). Speciile de insecte identificate au fost clasificate în 9 ordine și 18 familii, respectiv: Araneae (Gnaphosidae, Sparassidae și Philodromidae), Coleoptera (Carabidae, Cerambycidae, Coccinellidae, Dermestidae, Mordellidae), Dermaptera (Forficulidae), Hemiptera (Anthocoridae, Rhyparochromidae), Homoptera (Cicadellidae), Hymenoptera (Formicidae), Neuroptera (Chrysopidae), Opiliones (Sironidae, Phalangiidae) și Orthoptera (Acrididae, Gryllidae). Astfel, s-au identificat 29 de specii de insecte cu 148 de indivizi în anul 2021 și 303 în anul 2022. Cel mai mare număr de indivizi identificați pe toată perioada de studiu în capcanele de tip Barber aparțin genurilor Lasius și Melanogryllus.

Cuvinte cheie*: *Biodiversitate, indicii Simpson și Shannon, analiza SHE, analiza Bray-Curtis

INTRODUCTION

Agriculture is an important human activity that affects the ecosystems sustainability. The intensification of land use changes the function of agroecosystems by diminishing biodiversity, causing transformations in the functional composition (Cardinale B. J. *et al*., 2012).

Biological pest control is considered an important ecosystem service and a valuable alternative to chemical control, contributing to sustainable viticulture (Samways M. J., 2005). Insects are an important component of biodiversity in agroecosystems, being essential for maintaining soil structure and fertility, organic matter decomposition, seed dispersal, crop fertilization and pest control (Provost C. and Pedneault K., 2016). The presence of insects is usually positively correlated with vegetation richness and diversity (Soliveres S. *et al*., 2016). Among them, predatory insects represent a very important group of natural enemies of pests, and their community structure and composition have a substantial effect on the effectiveness of biological control (Rusch A. *et al*., 2015). Measures to combat pathogens and pests are essential for increasing production and profits because they can negatively affect biodiversity from the viticultural ecosystem (Tabaranu G. *et al*., 2018).

For knowing the diversity of insect species in a wine-growing area, Barber-type traps are mounted at ground level. They are made to be light, reliable (resistant), cheap and of different volumes. Barber traps are some of the oldest types of traps and most commonly are used to capture invertebrates (Woodcock B. A., 2008). In specialized literature, the most used solutions for fixing and preserving biological samples are considered: formaldehyde solution 4 - 5% (formalin); ethyl alcohol 80% (the concentration varies according to the group and the purpose of the investigation: 80% for genetic analyses; glycerinated liquid (95-96% ethyl alcohol - 1/3 + pure glycerin - 1/3 + distilled water - 1/3); Lugol's solution (2 g KI + 1 g I + 200 ml distilled water, with the possibility of adding approximately 20 ml glacial acetic acid) (Sîrbu I. and Benedek A. M., 2012).

Different trap characteristics have been reviewed and researched in recent decades to improve and standardize trap designs (Buchholz S. et al., 2010), the presence and colour of the rain cover (Buchholz S. and Hannig K., 2009; Csázár P. *et al.*, 2018), sampling intervals (Schirmel J. et al., 2010), spatial distribution (Ward D. F. *et al.*, 2001), different preservatives (Schmidt M. H. *et al.*, 2006; Skvarla M. J. *et al.*, 2014), as well as trap diameter and the use of funnels (Csázár P. *et al.*, 2018; Lange M. *et al.*, 2011). A meta-analysis by Brown G. R. and Matthews I. M., (2016) makes suggestions for standardizing different trap parameters (diameter, depth, colour, rain cover, preservative and funnel use). Different families of insects can be captured in these traps, such as: *Carabidae*, *Staphylinidae*, *Silphidae*, *Scarabaeidae*, *Rhysodidae*, *Nitidulidae*, *Lucanidae*, *Leiodidae*, *Geotrupidae*, *Elateridae*, *Curculionida*, *Cerambycidae*, *Chrysomelidae*, *Cicadidae*, *Anthicidae*, *Tettigoniidae*, *Gryllidae*, *Gryllotalipdae*, *Tetrigidae*, *Acrididae* (Beye H. *et al.*, 2023; Isaia G. *et al.*, 2023; Preda C. *et al.*, 2020).

MATERIALS AND METHOD

In the vineyard located on the territory of Călinești (located in the Ștefănești viticultural center), Barber traps were placed to evaluate the main ecological indicators of insects from this region with a temperate climate (species abundance, Simpson, Shannon indices, SHE analysis) and Bray-Curtis analysis. The determinations were made between June and August of 2021 compared to the same period of 2022. During the two years of the study, no treatments were carried out with substances that are part of the category of pesticides with use to combat insects in the vineyard. In recent years, it has been maintained as a black field, the soil is loosened and cleared of weeds by autumn and spring ploughing. At the same time, during the vegetation period, in the space between the rows, the soil was maintained with the help of the disk harrow. The entomological traps were set up so that they could retain insects in the monitored habitat for a period of two weeks. Thus, pits were made on the grapevine rows where jars (450 ml) were inserted, and subsequently filled with 2/3 formaldehyde solution in a 4% concentration. The jars were placed with the upper edge at ground level to facilitate the entry of insects easily into the collection jar (figure 1).

The traps were placed on the grapevine rows so as not to be damaged during the agrotechnical works carried out in the vineyard. The captured insects were removed from the collection jar of the trap together with the formaldehyde solution and with the help of the funnel they were emptied into plastic bottles (500 ml) to keep them intact and to facilitate their transport from the field to the laboratory. Each container was labelled with collected information (collection date, collection area, row, plot).

After collection, within the laboratory of Technologies - Plant Protection - Virology in Horticulture, samples of faunal material were analysed and operations were carried out to separate the biological material from plant residues and other impurities. The resulting insects were rinsed with water to remove the formaldehyde solution and identified using an IMP-scope digital microscope

(Spectrum Technologies, USA) and an Optika SZM-2 trinocular stereomicroscope equipped with an Optika CP 8 camera (Optika, Italy).

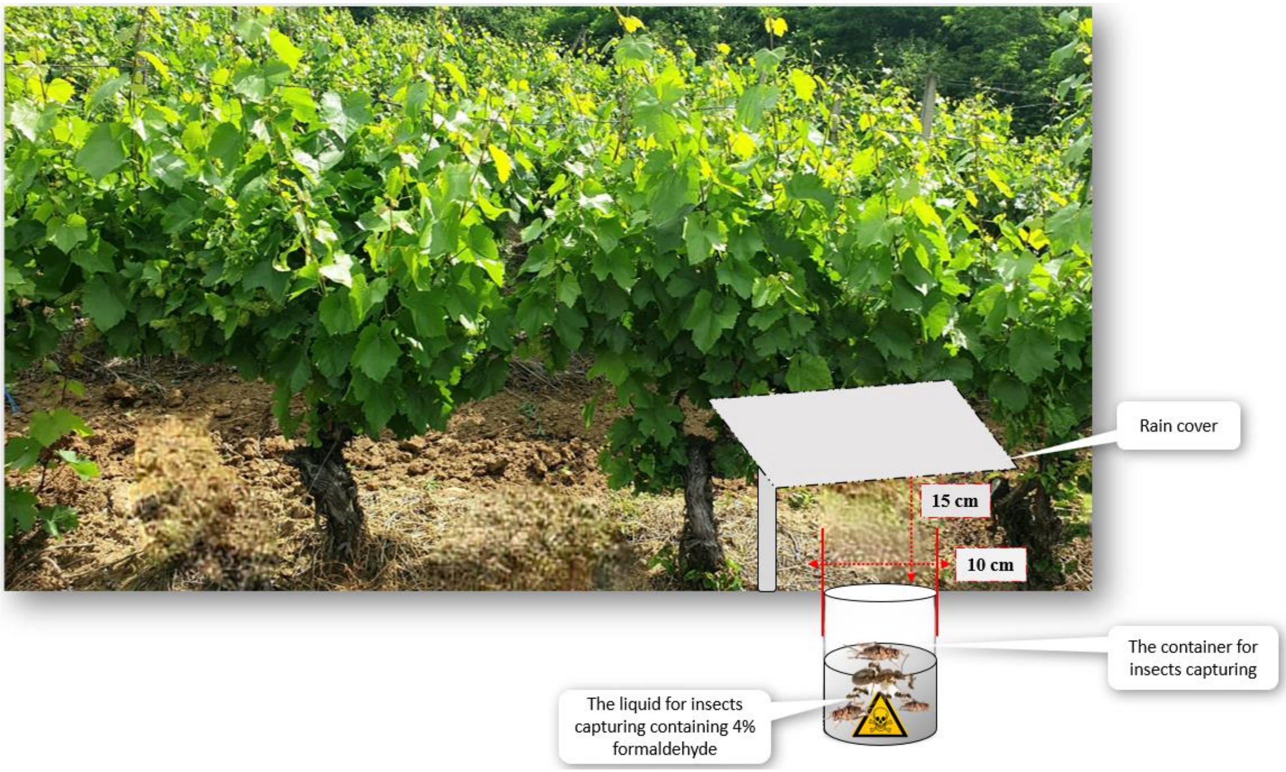

Figure 1. Installing the Barber trap on the grapevine rows // Instalarea capcanei Barber pe rândurile de viță-de-vie

RESULTS AND DISCUSSIONS

In the specialized literature, the total number of insect species on Earth is still not known exactly, but it is estimated that there are between 5 and 15 million species. Insects make up the most numerous groups of organisms on earth, approximately 66% of all animal species, by dispersing and exploiting all types of organic matter, they are found widespread in almost all habitats, forming an important part of every ecosystem (Jankielsohn A., 2018).

Between June and August 2021, 21 species with 148 individuals were captured: *Acheta domesticus*, *Calliptamus italicus*, *Camponotus* sp., *Chrysoperla carnea*, *Cyphophthalmus duricorius*, *Gnaphosa lucifuga*, *Gryllus campestris*, *Harmonia axyridis*, *Lasius* sp., *Melanogryllus desertus*, *Micrommata virescens*, *Modicogryllus frontalis*, *Mordella aculeata*, *Opilio* sp., *Opiliones* sp., *Pezotettix giornae*, *Phalangium opilio*, *Raglius alboacuminatus*, *Scaphoideus titanus*, *Scymnus* sp., *Thanatus arenarius*, *Scotophaeus blackwalli*. In the same period, but in 2022, a number of 14 species with a total of 303 individuals were recorded: *Attagenus* sp., *Camponotus* sp., *Dorcadion fulvum*, *Forficula auricularia*, *Harpalus* sp., *Lasius* sp., *Melanogryllus desertus*, *Modicogryllus frontalis*, *Orius sp.*, *Pezotettix giornae*. Among all the identified species, *Chrysoperla carnea* is the only beneficial species that feeds on the *Helicoverpa armigera* caterpillar, *Bemisia tabaci*, aphids (ex: *Aphis pomi*), mites, bedbugs, coccids, small hemipteran pests, as well as the grapevine pest *Jacobiasca lybica* (Rehman H. *et al.*, 2020; Usman M. *et al.*, 2012; Kumar A. *et al.*, 2019; Hagley E. A. C., 1989; Khfif K. *et al.*, 2023; Pinzón-Hamón D. A. *et al.*, 2018) and *Mordella aculeata* pollinates plants (Rather Z. A. *et al.*, 2023). During the study, the species *Harmonia axyridis* was also identified, which is a predator of aphids but also feeds on ripe fruits, grapes, pollen and nectar (Jovičić I. *et al.*, 2020).

In table 1 it can be seen that 29 species were captured and identified, of which 148 individuals in 2021 and 303 individuals in 2022. Among them, the largest number of individuals identified in Barber traps belongs to the *Lasius genus*. According to specialized studies, it has been proven that certain subgenera of *Lasius* such as *Chthonolasius* and *Dendrolasius* use fungi (ascomycetes) to bind masticated wood and soil to strengthen the walls of their nests (Brown B.E. *et al*., 2022).
Ants are widely distributed in both tropical and temperate regions, feeding on decaying plant material while also being predators (Sheikh A. H. *et al*., 2018). The genus *Lasius* is a group of northern temperate ants with 107 existing species. The genus is ecologically important and often serves as a model for studying insect biology. *Lasius* ants are particularly known for their symbiotic relationships with dew-producing insects and for temporary social parasitism (Boudinot B. E. *et al.*, 2022). This means parasitic queens invading the nests of other *Lasius*, killing the host queen, and using the subordinate host ants to raise their own workers, leading to damage to the host, eventually leaving a colony of only parasitic conspecifics. At the same time, ants provide the fungi with nutrients and prevent the growth of competing fungal species (Boudinot B. E. *et al.*, 2022). Social parasitism is known in species currently classified in the subgenera *Austrolasius Faber*, *Acanthomyops Mayr*, *Chthonolasius Ruzsky* and *Dendrolasius Ruzsky* (Raczkowski J. M. and Luque G. M., 2011).

Tabel 1. Species richness collected in Barber traps // Bogăția speciilor colectate în capcanele Barber

No.	Order	Family	Species	June 2021	June 2022	July 2021	July 2022	August 2021	August 2022
1.	Araneae	Gnaphosidae	*Gnaphosa lucifuga*	1					
2.			*Scotophaeus blackwalli*		1				
3.		Sparassidae	*Micrommata virescens*			1			
4.		Philodromidae	*Thanatus arenarius*		1				
5.	Coleoptera	Carabidae	*Carabus coriaceus*		1			1	
6.			*Harpalus* sp.		2				
7.		Cerambycidae	*Dorcadion fulvum*		1				
8.		Coccinellidae	*Harmonia axyridis*	1					
9.			*Scymnus* sp.					4	
10.		Dermestidae	*Attagenus* sp.		1				
11.		Mordellidae	*Mordella aculeata*					1	
12.			*Tomoxia bucephala*					2	
13.	Dermaptera	Forficulidae	*Forficula auricularia*		1				1
14.	Hemiptera	Anthocoridae	*Orius* sp.		1		1		
15.		Rhyparochromidae	*Raglius alboacuminatus*			1			
16.	Homoptera	Cicadellidae	*Scaphoideus titanus*					1	
17.	Hymenoptera	Formicidae	*Camponotus* sp.	1		5	1	4	
18.			*Lasius* sp.	7	79	8	56	17	26
19.	Neuroptera	Chrysopidae	*Chrysoperla carnea*					1	
20.	Opiliones	Sironidae	*Cyphophthalmus duricorius*					5	
21.		Phalangiidae	*Opilio* sp.			1		6	
22.			*Phalangium opilio*	2					
23.	Orthoptera	Acrididae	*Calliptamus italicus*	2				2	
24.			*Chorthippus* sp.		1				
25.			*Pezotettix giornae*		1	1	3	10	1
26.		Gryllidae	*Gryllus campestris*	1				5	
27.			*Melanogryllus desertus*	10	74	5	4	18	2
28.			*Modicogryllus frontalis*	6	37	8	7	5	
29.			*Acheta domesticus*					5	
Total month/year				**31**	**201**	**30**	**72**	**87**	**30**
Total year 2021				**148**					
Total year 2022				**303**					

Another species that has recorded a large number of individuals belongs to the genus *Melanogryllus*, which has great economic importance in agriculture. Its mode of nutrition is zoophytophagous, with both larvae and adults partially or completely devour leguminous cereals, forages, as well as the shoots of industrial plants (cotton, hemp, sunflower, rapeseed, etc.). It is widespread in Europe, North America, and Central Asia (Stahi N., 2007; Kuralbaevich B. M., 2022).

Also, in Ștefănești vineyard center, but in a different location, between the years 2020-2021, 37 insect species were identified in Barber soil traps, with 8 more species than in the vineyard in the locality of Călinești. The only common species were: *Acheta domesticus*, *Micrommata virescens*, *Carabus coriaceus*, *Scymnus* sp., *Tomoxia bucephala*, *Raglius alboacuminatus*, *Scaphoideus titanus*, *Camponotus* sp., *Lasius* sp., *Cyphophthalmus duricorius*, *Opilio* sp., *Calliptamus italicus*, *Pezotettix giornae*, *Gryllus campestris*, *Melanogryllus desertus*, *Modicogryllus frontalis*, and *Acheta domesticus* (Vizitiu D. et al., 2022).

The average air temperature in the year 2021 ranged from 1.06°C (January) to 25.18°C (July), while in the year 2022 it varied from 1.80°C (January) to 23.72°C (July). In the months of July and August of 2021 and 2022, the highest temperature increases compared to the multi-year average of 1979-2011 were recorded. However, these months showed the largest increases in the year 2021, with 3.5°C and 2.64°C higher than the multi-year average, respectively (figure 2).

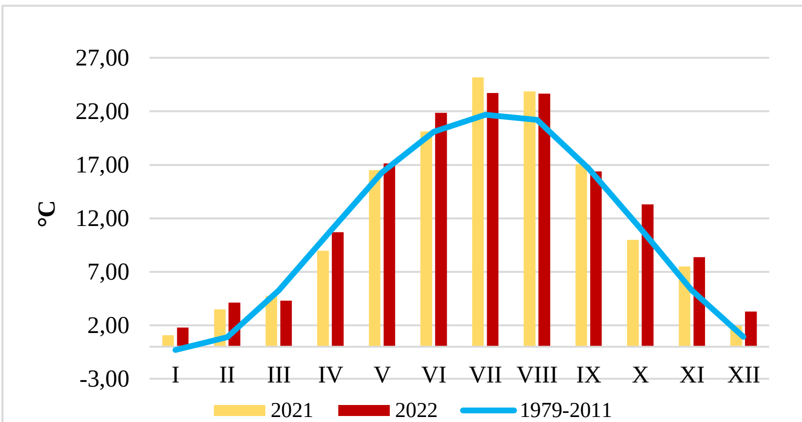

Figure 2. The evolution of daily average temperatures in the years 2021 and 2022 compared to multi-year temperatures (1979-2011) // Evoluția temperaturii medii zilnice în anii 2021 și 2022 comparativ cu temperaturile multianuale (1979-2011)

In the year 2021, 770.8 mm of precipitation were recorded, while in 2022, 680.4 mm were recorded, with 104.91 mm and 16.51 mm more than the multi-year average (1979-2011). The highest amount of precipitation was recorded in August of 2022, which represented a surplus of 111.34 mm compared to the multi-year average (figure 3).

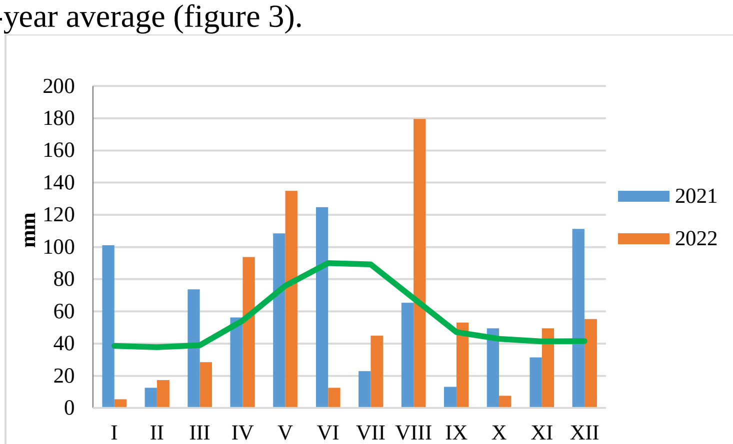

Figure 3. The evolution of precipitation in the years 2021 and 2022 compared to multi-year precipitation (1979-2011) // Evoluția precipitațiilor în anii 2021 și 2022 comparativ cu precipitațiile multianuale (1979-2011)

The Shannon diversity index is a common index used to characterize species diversity within a community and takes into account both the abundance and evenness of species distribution (Popov C. et al., 2009). The abundance of insect species was most evenly distributed in August 2021 and least evenly distributed in August 2022 (figure 4), possibly due to the abundant precipitation recorded in that month.

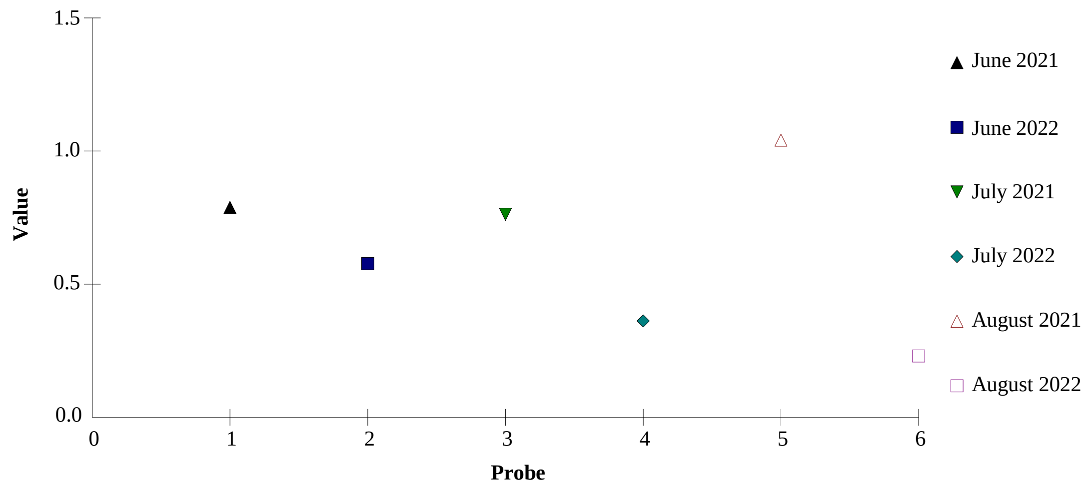

Figure 4. Shannon index calculated in the 2021 and 2022 years conditions //Indicele Shanon calculat în condițiile anilor 2021 și 2022

The Simpson diversity index is used in ecology to describe the diversity of a habitat and takes into account the number of species present and the abundance of each species (Popov C. et al., 2009). Regarding the Simpson index, the data in figure 5 show that the lowest diversity of insect species, throughout the study period, was recorded in August 2022, while the highest diversity of species was recorded in August of 2021.

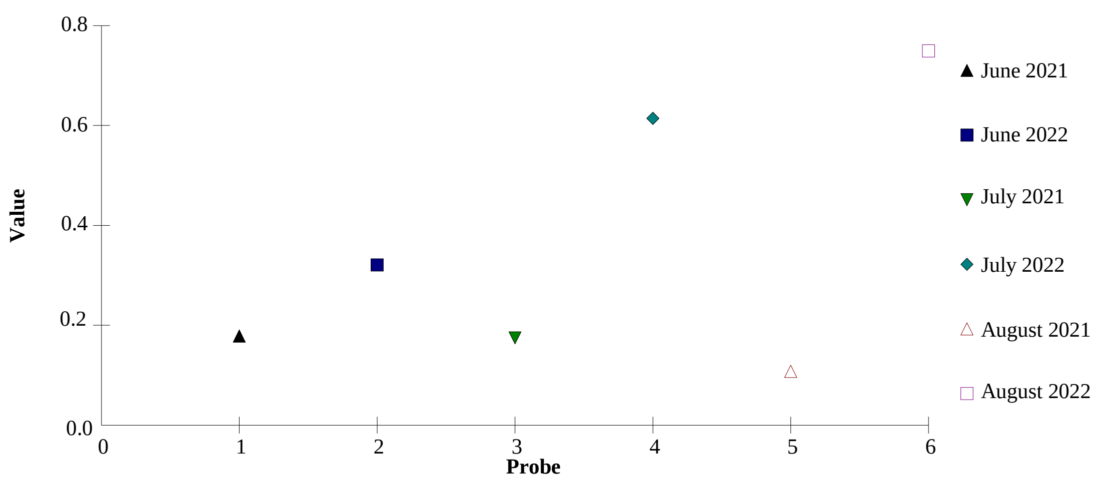

Figure 5. Simpson index calculated in the 2021 and 2022 years conditions // Indicele Simpson calculat în condițiile anilor 2021 și 2022

The SHE analysis (figure 6) has shown that there is a balance between species richness and evenness throughout the study period, except for the month of June 2021.

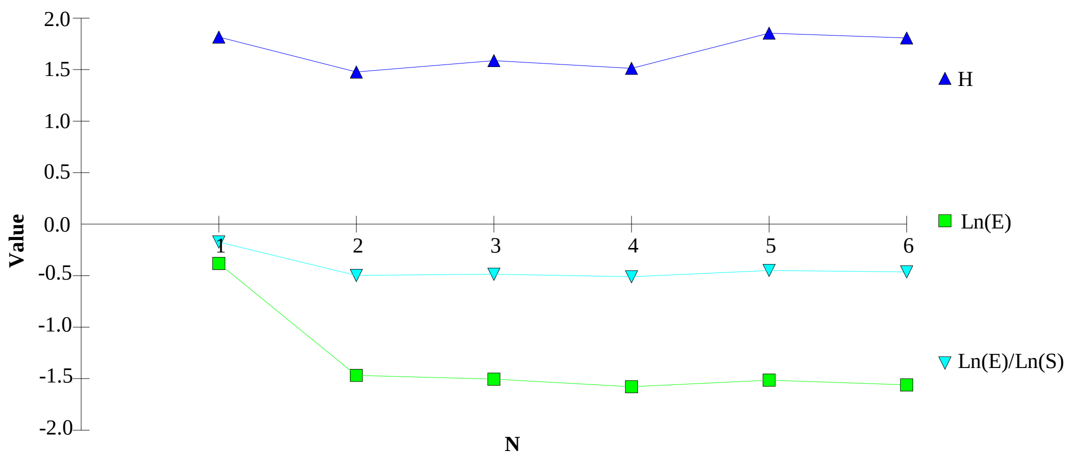

Figure 6. SHE analysis // Analiza SHE

To determine the degree of similarity in species composition, a Bray-Curtis analysis was performed. Thus, it can be observed in figure 7 that there is no similarity between the two years, but only between the months of the same year. The highest similarity is between the months of July and August of 2022, followed by June - July 2021.

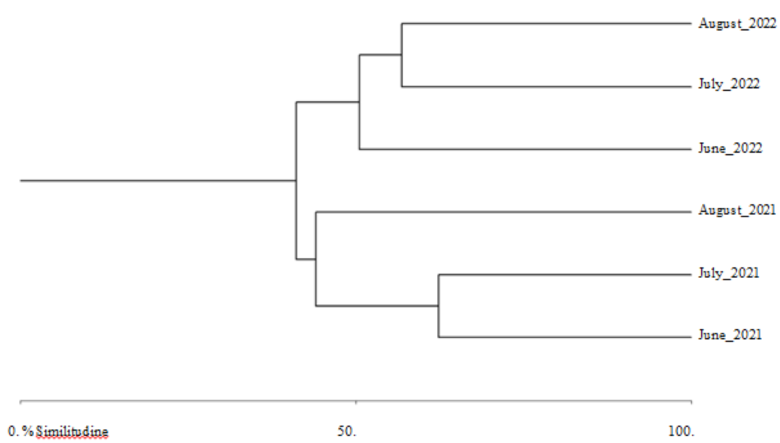

Figure 7. Bray-Curtis analysis // Analiza Bray-Curtis

Shannon and Simpson indices were used in this paper, some of the most widely used biodiversity indicators (Kim B. R. *et al*., 2017).

CONCLUSIONS

Throughout the two-year monitoring period (2021-2022), the insect species with the highest number of individuals captured using Barber traps were representatives of the *Lasius* and *Melanogryllus* genera. During the two-year study, a total of 148 individuals were recorded in 2021 and 303 individuals in 2022.

The abundance of insect species was distributed most evenly in August 2021 and most unevenly in August 2022. The lowest diversity of insect species was recorded in August 2022 due to the high amount of precipitation (179.6 mm), while the highest diversity was observed in August 2021 when the precipitation amount was lower (65.4 mm). Therefore, the abundance of dominant species is closely related to the precipitation levels recorded in 2021-2022. The species with the highest number of individuals did not meet optimal conditions for their habitat in August of both study years. The two predominant species, *Lasius* sp. and *Melanogryllus desertus*, because of their ecology prefer a habitat with high temperatures, habitats with sparse vegetation, and low precipitation amounts. The highest similarity in species composition was recorded between July and August in 2022, followed by June-July 2021.

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EVOLUTION OF THE PRECIPITATION REGIMEN AND HUMIDITY RESERVES IN THE SOIL OF VINEYARDS IN THE NORTH-EASTERN PART OF ROMANIA

EVOLUŢIA REGIMULUI DE PRECIPITAŢII ŞI A REZERVEI DE UMIDITATE DIN SOL ÎN PLANTAŢIILE VITICOLE DIN ZONA DE NORD-EST A ROMÂNIEI

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Abstract
Insufficient precipitations and their poor distribution associated to other meteorological elements generate critical periods for the vine from physiological point of view that are reflected in grape production. The paper presents the evolution of precipitations from the vineyard ecosystem of Iasi vineyard between 1989 – 2022, based on which a series of biochemical coefficients, deviations from multiannual average values, as well as their influence on the dynamics of soil humidity (accessible humidity and water deficit) in the 2000 – 2022 period, were calculated. Based on the analysis of registered data we observed a lowering of the precipitation regimen usually unevenly distributed, represented by torrential rains that alternate with long draught periods. The increasingly lower precipitation quantities and high temperatures have caused a sharp decrease of accessible humidity in the soil, considerably below the optimal values for vine and an increase of deficit.

Key words: *vineyard, precipitation, accessible humidity, water deficit*

Rezumat
Insuficienţa precipitaţiilor şi distribuţia lor necorespunzătoare asociată altor elemente meteorologice generează pentru viţa-de-vie perioade critice din punct de vedere fiziologic, care se reflectă în producţia de struguri. În lucrare este prezentată evoluţia precipitaţiilor din ecosistemul viticol al podgoriei Iaşi înregistrate în perioada 1989 – 2022, pe baza cărora s-au calculat o serie de coeficienţi bioclimatici, abaterile faţă de valorile medii multianuale, precum și influența acestora asupra dinamicii umidităţii solului (umiditatea accesibilă şi deficitul de apă) din perioada 2000 – 2022. Din analiza datelor înregistrate s-a remarcat o diminuare a regimului de precipitaţii distribuit frecvent neuniform, reprezentat prin ploi torenţiale, care alternează cu perioade lungi de secetă. Cantitățile tot mai mici de precipitaţii şi temperaturile mari au determinat scăderea accentuată a valorilor umidităţii accesibile din sol, cu mult sub valorile optime pentru viţa-de-vie şi creşterea deficitului.

Cuvinte cheie: *plantaţii viticole, precipitaţii, umiditatea accesibilă, deficit apă*

INTRODUCTION

The effects of climate change in Romania have been felt more and over the last decades through the increase of the incidence of freeze, draught and flood phenomena, generating a negative effect on the yield of cultures and reduction of fauna and flora biodiversity. Analyzing the monthly and seasonal averages of precipitations between 1901 – 2000 we noticed a decrease tendency of annual precipitation quantities and a modification of their distribution, especially in the vegetation period (Dumitrescu A. *et al.*, 2015, Sandu I. *et al.*, 2010).

For the climate area in the north-east of the country we have registered certain periods (years) with normal pluviometric characteristics, but certain excess and deficit periods deviating from the norm stand out. The time distribution of the excess/deficit precipitation periods has a certain regularity. The contrasting periods follow each other in such a way that after a rainy period there is no normal period, nut several years of draught (Berbecel *et al*., 1970).

During the agricultural year, the autumn and winter seasons are the period when the humidity reserves of the soil is built, due to the relatively abundant rainfall, and mainly due to low water loss through evaporation. The increase of the draught pfenomenen frequency may have destructive effects for vineyards when in the autumn and winter of the previous years there is a precipitation deficit ant the quantities registered in the spring are not sufficient to replenisch the water rezerves in the deep layers of the soil from which the vines take their water (Zaldea *et al*., 2017; Zaldea *et al.*, 2021). In the context, the paper has the purpose of underlining the climate modifications over the last decades in Copou ecosistem, Iași vineyard, which in the decrease of precipitation regimen, increase of dry years and their impact on the humidity reserve of the soil.

MATERIAL AND METHOD

The study was based on a series of daily meteorological parameters recorded at the SCDVV Iaşi weather station, located in the northern part of the municipality of Iaşi, at 191 m altitude, 47°12`18`` north latitude and 27°32`04`` east longitude. The analysed period covered a series of homogeneous data for the last 34 years (1989-2022), based on which were calculated precipitation coefficient (Constantinescu Gh., 1964), hydrothermal coefficient (Selyanianov, 1928) and Martonne aridity index (De Martonne, 1926).

In order to establish soil moisture, the oven drying method was used (Canarache, 1964). Thus, for each month in the growing season, sampling by layers was performed every 10 cm, up to a depth of 150 cm; the results were first expressed in percentage compared to the weight of dry soil, then in volume percentage. Based on the hydrophysical indices values, the soil moisture available at a given time (Macc), expressed in mm and %. In order to establish the degree of available plant water supply, the available moisture (Macc) was compared to the useful water capacity (UWC), previously calculated for the Copou Iaşi wine centre.

RESULTS AND DISCUSSIONS

In the Copou-Iași wine centre, the precipitation multiannual average (1981-2010) is 579.6 mm, with 398.1 mm during the growing season (April-September).

The analysis of annual precipitations for the interval 1989 - 2022 highlights a wetter period between 1991 and 2005, with values above average, followed by a period of pluviometric deficit, between 2006 and 2022, with values below the period average (Figure 1). The lowest amount of annual precipitation was recorded in 2015 of 365.5 mm, and the highest in 1991 of 829.5 mm.

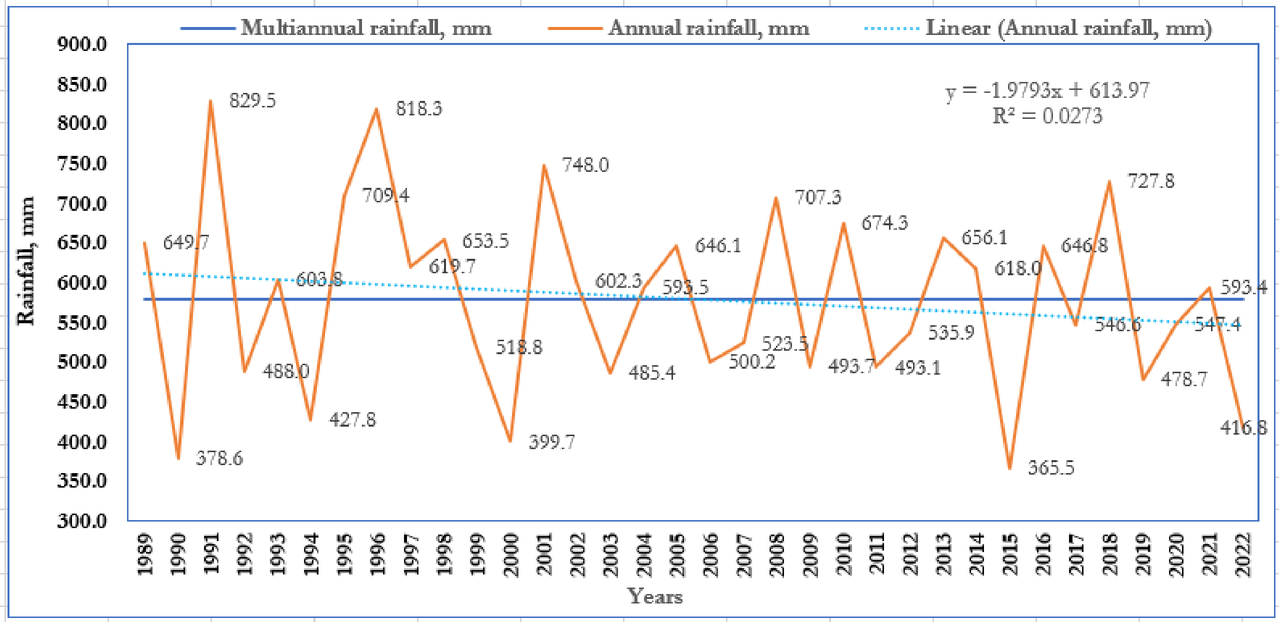

Fig. 1. Evolution of annual precipitations recorded in the Copou-Iaşi wine centre (1989 - 2022) /*Evoluţia precipitaţiilor anuale înregistrate în centrul viticol Copou Iaşi (1989 - 2022)*

In order to highlight the variations in annual precipitations, the deviations from the average were calculated; this allowed for their characterisation according to the Hellman criterion. The graphical representation shows a decrease in quantities towards the end of the analysed interval (Figure 2).

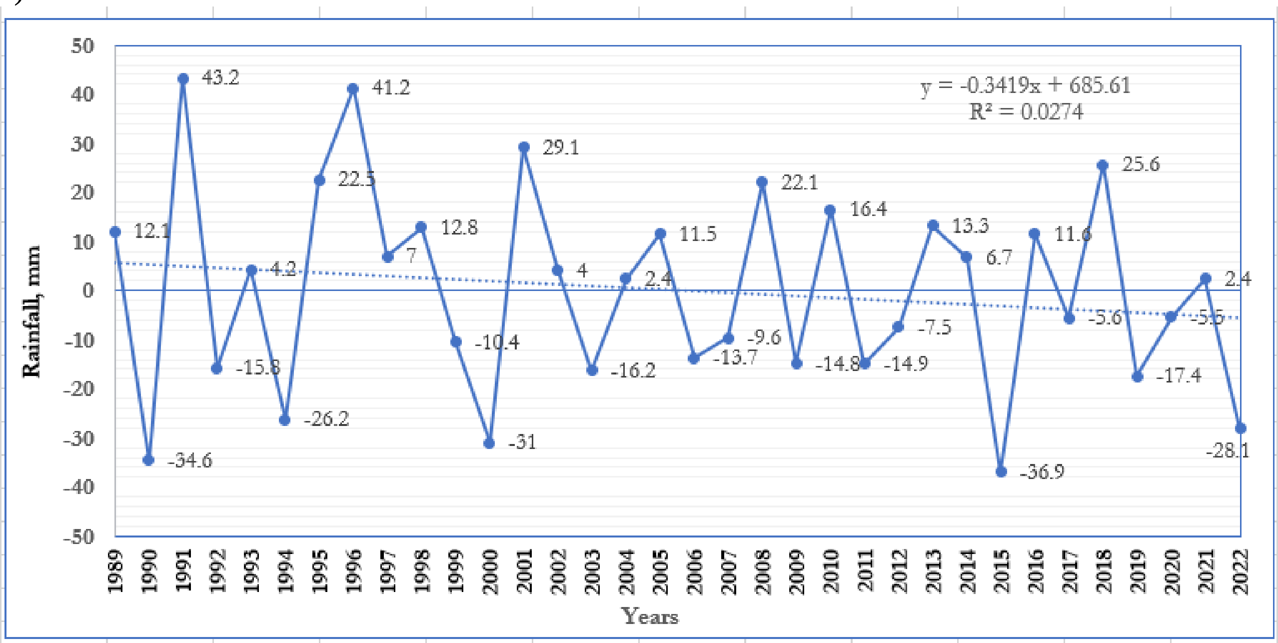

Fig. 2. Deviations of annual precipitations compared to the multiannual average (1989 -2022)/*Abaterea precipitaţiilor anuale faţă de media multianuală (1989 -2022)*

As regards the annual deviations from the average, it can be noticed that in 47.06% of the analysed years, the total precipitation was below average, while in 52.94% the values were higher than the multiannual average.

By calculating the frequency of annual precipitations recorded in the Copou-Iaşi wine centre, their probability was established (Table 1). Thus, it was observed that the probability of annual precipitation with values between 601-650 mm is 20,59%, and between 401-450 mm of 5.88%.

Table 1. **Frequency of annual precipitation and its probability/*Frecvenţa precipitaţiilor anuale şi probabilitatea acestora***

Precipitation, mm	No. of years	Probability, %	Precipitation, mm	No. of years	Probability, %
351-400	3	8.82	601-650	7	20.59
401-450	2	5.88	651-700	3	8.82
451-500	6	17.65	701-750	4	11.76
501-550	5	14.71	751-800	0	0.00
551-600	2	5.88	801-850	2	5.88
Total nr. ani	**34**				

Depending on the deviations from the average rainfall, it was noted that of the 34 years included in the study (1989-2022), only five are considered normal in terms of rainfall, and most of them - 15 years - had little precipitation, characterised from "moderately dry" (4 years), to "dry" (3year), "very dry" (3 years) and 5 "extremely dry" years (Table 2).

Table 2. Precipitations regime and characterisation of the analysed interval 1989 – 2022/*Regimul precipitaţiilor şi caracterizarea anilor în intervalul 1989 – 2022*

Deviation against average %	Hellman criterion	No. of cases	Years
<-20.0	exceedingly droughty	5	1990, 1994, 2000, 2015, 2022
-20.0….-15.1	very droughty	3	1992, 2003, 2019
-15.0….-10.1	droughty	3	2006, 2009, 2011
-10.0….-5.1	moderately droughty	4	2007, 2012, 2017, 2020
-5.0….5.0	normal	5	1993, 1999, 2002, 2004, 2021
5.1….10.0	moderately rainy	3	1997, 2014, 2016
10.1….15.0	rainy	4	1989, 1998, 2005, 2013
15.1….20.0	very rainy	1	2010
>20.0	exceedingly rainy	6	1991, 1995, 1996, 2001, 2008, 2018

High temperatures and drought caused by climate change also led to significant changes in multiannual bioclimatic coefficients and indicators, directly correlated with the average annual temperature, the active heat balance (Σ t°a), the amount of annual precipitations and precipitation in the growing season (Table 3).

Table 3. **The values of the main synthetic bioclimatic indicators from in the Copou Iaşi wine centre (1989 – 2022)/*Valorile principalilor indicatori bioclimatici cu caracter sintetic din centrul viticol Copou Iaşi (1989 – 2022)***

Year	The hydrothermal coefficient	The precipitation coefficient	The "de Martonne" aridity index	Year	The hydrothermal coefficient	The precipitation coefficient	The "de Martonne" aridity index
1989	1.9	3.4	31	**2006**	1.1	1.9	25
1990	0.8	1.5	18	**2007**	0.8	1.7	24
1991	2.5	4.3	43	**2008**	1.7	3.2	34
1992	1.2	2.1	25	**2009**	0.6	1.2	24
1993	1.4	2.3	31	**2010**	1.3	2.5	34
1994	1.2	1.6	20	**2011**	1.2	2.3	25
1995	1.8	3.2	36	**2012**	0.8	1.6	26
1996	1.9	3.4	43	**2013**	1.6	3.0	32
1997	1.5	2.6	33	**2014**	1.2	2.0	31
1998	1.1	2.0	33	**2015**	0.5	1.0	17
1999	1.0	2.0	28	**2016**	1.0	1.9	31
2000	0.8	1.5	19	**2017**	0.9	1.6	26
2001	1.8	2.9	38	**2018**	1.3	2.6	35
2002	1.4	2.3	30	**2019**	1.0	2.0	22
2003	0.9	1.7	25	**2020**	0.9	1.8	25
2004	1.3	2.2	30	**2021**	1.4	2.6	30
2005	1.4	2.6	33	**2022**	0.9	1.8	20

The hydrothermal coefficient, which represents the ratio between the sum of precipitations during the growing season and the active heat balance, reached minimum values of 0.5 in 2015 and maximum values of 2.5 in 1991. The trend of this coefficient is decreasing, as a result of the decreasing amounts of precipitations during the growing season. Values of the hydrothermal coefficient below 0.8 substantiate the need for vineyards irrigation.

The precipitation coefficient, established by the ratio between the amount of precipitation during the growing season and the duration of the bioactive period, registered lower values in the dry years and higher values in the rainy years (from 1.0 in 2015 and 4.3 in 1991).

The "de Martonne" aridity index, which expresses the ratio between the sum of annual precipitation and the useful temperature, registered a minimum value of 17 in 2015 and a maximum of 43 in 1991 and 1996. These values indicate that during 1989 - 2022, in the Copou – Iaşi wine centre there were both years that were part of a semi-arid climate, and years with a semi-humid and humid climate.

The values of these synthetic indicators confirm that during the analyzed period the driest year was 2015 and the rainiest was 1991.

The small amounts of precipitation corroborated with the high temperatures, led to a marked decrease in the values of the soil accessible moisture (Macc) during certain periods, far below the optimal ones for the vineyard culture. It is known that the optimal soil moisture for vineyard culture is between 50-80% of the useful water capacity (UWC), higher values being favourable for growing shoots, and the lowest for grain maturation (Moţoc M., 1968). In addition, during the long periods of drought (lasting for 2-3 years), the water reserve in the deep layers of the soil of 100-150 cm decreases.

Monitoring the monthly distribution of accessible soil humidity during 2000-2022 has highlighted the low values in the dry and very dry years: 2000, 2007, 2009, 2011, 2012, 2015, 2017, 2019, 2020 and 2022 (Table 5). Among these, the year 2020 stand out with extremely low values registered in almost all the months of the growing season – between 23-39%, on the whole depth of the soil profile (0-150 cm). At the same time, in the 0-20 cm layer, the accessible soil humidity values were below the wilting coefficient. In these conditions, the water deficit was very high, even in the deep layers (100-150 cm), from 54% in May to 82% in August (Table 6). During the years when the drought caused significant damage, the precipitation deficit started from the previous year (summer or autumn), continued during the winter, as well as in the spring and summer of the following year. Such situations were recorded for the years 2006-2007, 2011-2012, 2019-2020, 2021 -2022 and had negative effects on the growth of the stocks (Figure 3).

Table 5. ***Monthly distribution of available soil humidity, average values by layers*** **/Distribuţia lunară a umidităţii accesibile din sol, valori medii pe straturi**

Year	Depht, cm	Available humidity (%) from the vegetation period						Year	Depht, cm	Available humidity (%) from the vegetation period					
		IV	V	VI	VII	VIII	IX			IV	V	VI	VII	VIII	IX
2000	0 - 20	8	18	10	2	36	35	2012	0 - 20	43	60	14	11	18	24
	20 - 50	55	61	53	45	55	48		20 - 50	82	55	19	14	15	22
	50 -100	79	71	67	63	61	45		50 -100	94	81	43	23	20	24
	100 - 150	108	100	92	85	96	54		100 - 150	88	125	74	41	45	46
2001	0 - 20	26	48	62	20	27	42	2013	0 - 20	39	58	62	33	24	39
	20 - 50	57	62	72	39	32	67		20 - 50	67	69	78	53	17	41
	50 -100	40	68	86	58	42	63		50 -100	74	76	83	71	46	48
	100 - 150	50	61	114	87	65	42		100 - 150	121	127	135	112	94	65
2002	0 - 20	48	45	34	55	59	74	2014	0 - 20	49	63	36	43	26	21
	20 - 50	61	61	42	80	68	71		20 - 50	62	72	57	49	28	31
	50 -100	74	67	48	77	70	51		50 -100	80	85	67	48	32	38
	100 - 150	114	107	92	92	105	71		100 - 150	141	118	100	70	41	54
2003	0 - 20	56	32	32	58	42	35	2015	0 - 20	53	33	33	10	9	66
	20 - 50	69	60	52	53	53	42		20 - 50	65	46	48	36	25	34
	50 -100	77	66	50	57	49	48		50 -100	93	75	56	37	30	28
	100 - 150	117	103	84	83	76	74		100 - 150	111	119	81	46	63	54
2004	0 - 20	40	32	45	55	73	71	2016	0 - 20	61	59	53	23	14	9
	20 - 50	77	67	60	56	63	70		20 - 50	71	77	63	30	24	26
	50 -100	80	76	67	54	64	65		50 -100	82	73	53	35	32	22
	100 - 150	126	120	101	82	76	56		100 - 150	63	57	76	40	33	42
2005	0 - 20	64	66	49	65	62	42	2017	0 - 20	62	32	39	30	17	8
	20 - 50	77	83	60	65	66	59		20 - 50	71	60	45	34	32	23
	50 -100	85	99	72	68	69	63		50 -100	82	79	55	32	36	23
	100 - 150	126	134	117	113	95	90		100 - 150	122	134	82	71	55	45

2006	0 - 20	64	62	59	52	52	45	**2018**	0 - 20	27	23	67	39	24	17
	20 - 50	77	76	71	49	54	53		20 - 50	61	36	73	55	35	38
	50 -100	85	75	76	57	55	55		50 -100	100	70	79	73	58	37
	100 - 150	126	126	117	87	79	70		100 - 150	156	104	87	93	97	56
2007	0 - 20	35	32	4	29	65	36	**2019**	0 - 20	51	72	61	31	32	1
	20 - 50	69	61	43	26	56	54		20 - 50	63	67	70	46	22	7
	50 -100	58	54	40	30	33	52		50 -100	88	86	89	68	41	26
	100 - 150	72	67	56	38	37	55		100 - 150	119	124	152	122	82	37
2008	0 - 20	65	61	58	63	50	23	**2020**	0 - 20	40	59	57	21	12	-22
	20 - 50	75	66	65	67	51	69		20 - 50	28	24	35	34	22	24
	50 -100	101	93	66	87	57	62		50 -100	29	32	37	32	18	28
	100 - 150	148	117	70	124	68	64		100 - 150	28	46	39	43	38	36
2009	0 - 20	35	70	49	11	9	6	**2021**	0 - 20	55	46	47	42	26	24
	20 - 50	70	69	63	34	26	9		20 - 50	56	82	70	52	31	32
	50 -100	83	73	72	33	22	18		50 -100	76	72	84	68	40	32
	100 - 150	118	100	91	75	42	38		100 - 150	80	114	119	98	78	62
2010	0 - 20	72	47	48	56	59	61	**2022**	0 - 20	69	48	6	13	17	24
	20 - 50	64	65	75	77	75	70		20 - 50	69	60	13	41	18	23
	50 -100	90	77	85	86	85	74		50 -100	66	47	22	40	28	32
	100 - 150	145	126	128	128	120	89		100 - 150	71	70	27	54	48	39
2011	0 - 20	59	40	70	52	29	32								
	20 - 50	72	66	84	64	33	36								
	50 -100	88	73	88	84	38	39								
	100 - 150	135	110	116	116	50	63								

Fig. 3. Aspects of vineyards affected by drought/*Aspecte din plantațiile viticole afectate de secetă*

Table 6. **Monthly distribution of soil humidity deficit, average values by layers/*Distribuția lunară a deficitului de umiditate din sol, valori medii pe straturi***

Year	Depht, cm	Soil humidity deficit (%) from the vegetation period						Year	Depht, cm	Soil humidity deficit (%) from the vegetation period					
		IV	V	VI	VII	VIII	IX			IV	V	VI	VII	VIII	IX
2000	0 - 20	92	82	90	98	64	65	**2012**	0 - 20	57	40	86	89	82	76
	20 - 50	45	39	47	55	45	52		20 - 50	18	45	81	86	85	78
	50 -100	21	29	33	37	39	55		50 -100	6	19	57	77	80	76
	100 - 150	-	-	8	15	4	45		100 - 150	12	-	26	59	55	54
2001	0 - 20	74	52	38	80	73	58	**2013**	0 - 20	61	42	38	67	76	61
	20 - 50	43	38	28	61	68	33		20 - 50	33	31	22	47	83	59
	50 -100	60	32	14	42	58	37		50 -100	26	24	17	29	54	52
	100 - 150	50	39	-	13	35	58		100 - 150	-	-	-	-	6	35
2002	0 - 20	52	55	66	45	41	26	**2014**	0 - 20	51	37	64	57	74	79
	20 - 50	39	39	58	20	32	29		20 - 50	38	28	43	51	72	69
	50 -100	26	33	52	23	30	49		50 -100	20	15	33	52	68	62
	100 - 150	-	-	8	8	-	29		100 - 150	-	-	-	30	59	46
2003	0 - 20	44	68	68	42	58	65	**2015**	0 - 20	47	67	67	90	91	34
	20 - 50	31	40	48	47	47	58		20 - 50	35	54	52	64	75	66
	50 -100	23	34	50	43	51	52		50 -100	7	25	44	63	70	72
	100 - 150	-	-	16	17	24	26		100 - 150	-	-	19	54	37	46
2004	0 - 20	60	68	55	45	27	29	**2016**	0 - 20	39	41	47	77	86	91
	20 - 50	23	33	40	44	37	30		20 - 50	29	23	37	70	76	74
	50 -100	20	24	33	46	36	35		50 -100	18	27	47	65	68	78
	100 - 150	-	-	-	18	24	44		100 - 150	37	43	24	60	67	58

2005	0 - 20	36	34	51	35	38	58	**2017**	0 - 20	38	68	61	70	83	92
	20 - 50	23	17	40	35	34	41		20 - 50	29	40	55	66	68	77
	50 -100	15	1	28	32	31	37		50 -100	18	21	45	68	64	77
	100 - 150	-	-	-	-	5	10		100 - 150	-	-	18	29	45	55
2006	0 - 20	36	38	41	48	48	55	**2018**	0 - 20	73	77	33	61	76	83
	20 - 50	23	24	29	51	46	47		20 - 50	39	64	27	45	65	62
	50 -100	15	25	24	43	45	45		50 -100	-	30	21	27	42	63
	100 - 150	-	-	-	13	21	30		100 - 150	-	-	13	7	3	44
2007	0 - 20	65	68	96	71	35	64	**2019**	0 - 20	49	28	39	69	68	99
	20 - 50	31	39	57	74	44	46		20 - 50	37	33	30	54	78	93
	50 -100	42	46	60	70	67	48		50 -100	12	14	11	32	59	74
	100 - 150	28	33	44	62	63	45		100 - 150	-	-	-	-	18	63
2008	0 - 20	35	39	42	37	50	77	**2020**	0 - 20	60	41	43	79	88	122
	20 - 50	25	34	35	33	49	31		20 - 50	72	76	65	66	78	76
	50 -100	-	7	34	13	43	38		50 -100	71	68	63	68	82	72
	100 - 150	-	-	30	-	32	36		100 - 150	72	54	61	57	62	64
2009	0 - 20	65	30	51	89	91	94	**2021**	0 - 20	45	54	53	58	74	76
	20 - 50	30	31	37	66	74	91		20 - 50	44	18	30	48	69	68
	50 -100	17	27	28	67	78	82		50 -100	24	28	16	32	60	68
	100 - 150	-	-	9	25	58	62		100 - 150	20	-	-	2	22	38
2010	0 - 20	28	53	52	44	41	39	**2022**	0 - 20	31	52	94	87	83	76
	20 - 50	36	35	25	23	25	30		20 - 50	31	40	87	59	82	77
	50 -100	10	23	15	14	15	26		50 -100	34	53	78	60	72	68
	100 - 150	-	-	-	-	-	11		100 - 150	29	30	73	46	52	61
2011	0 - 20	41	60	30	48	71	68								
	20 - 50	28	34	16	36	67	64								
	50 -100	12	27	12	16	62	61								
	100 - 150	-	-	-	-	50	37								

CONCLUSIONS

Analyzing the annual precipitation in the interval 1989 and 2022 we notice a wetter period between 1991 and 2005 with values above the average, following by a deficient pluviometric deficit period between 2006 and 2022. Low quantities of precipitations, corroborated with high temperatures have caused a sharp decrease of the values of humidity accessible from the soil, in certain periods, considerably under the optimum for vine culture.These have usually been higher in the first two months of the vegetation period (April and May), and then there was a decrease of available humidity from one month to another and an increase of the deficit up to the deep layers (100 – 150 cm).

The evolution of precipitation quantities registered in the last 34 years in the Iași vineyard indicate an increase of the frequency of the drought phenomenon, especially after the year 2000, largely affecting vineyards. Under these circumstances, it is increasingly necessary to create Vinifera varieties and drought-resistant rootstocks and to generalization and expend the irrigation system at the national level.

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