AGRICULTURAL AND FORESTRY SCIENCES ACADEMY
"GHEORGHE IONESCU - SISESTI"

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The papers were presented at the Anniversary Conference of the Academy of Agricultural and Forestry Sciences "Gheorghe Ionescu-Șișești", May 30, 2024

VEGETABLE GROWING

CERTIFIED ORGANIC SEED PRODUCTION FROM VEGETABLE VARIETIES CREATED AT VRDS BACĂU

PRODUCERE DE SĂMÂNȚĂ CERTIFICATĂ ECOLOGIC DIN SOIURILE DE LEGUME CREATE LA SCDL BACAU

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Abstract
This research delves into certified organic seed production of vegetable varieties developed at the Vegetable Research and Development Station (VRDS) Bacău. The study places a significant emphasis on the paramount importance of biodiversity in sustainable agriculture, while cautioning against the pitfalls of monoculture, exemplified by historical events such as the Great Irish Famine. The role of VRDS Bacău in mitigating such risks and fostering agricultural resilience is underscored. Ultimately, this paper serves as a holistic exploration of certified organic seed production, integrating considerations of ongoing projects and the distinctive characteristics of the vegetable varieties developed. The findings aim to contribute to a deeper understanding of sustainable agriculture and inspire practices that prioritize ecological harmony and food security.

Keywords: *certified organic seeds, agricultural biodiversity, agricultural resilience, food security, sustainability.*

Rezumat
Această lucrare propune o investigație amănunțită a procesului de producție a semințelor ecologice certificate provenite din soiuri de legume dezvoltate la Stațiunea de Cercetare - Dezvoltare pentru Legumicultură (SCDL) Bacău. Studiul acordă o importanță deosebită rolului central al biodiversității în contextul agriculturii durabile, subliniind potențialele pericole asociate monoculturii, ilustrate prin evenimente istorice notorii precum Marea Foamete Irlandeză. Accentul este pus asupra implicării esențiale a SCDL Bacău în gestionarea acestor riscuri și în promovarea rezilienței în sectorul agricol. În esență, această lucrare se constituie ca o explorare comprehensivă a producției certificate de semințe ecologice, înglobând aspecte fundamentale privind proiectele în curs de desfășurare și caracteristicile distincte ale soiurilor de legume create în cadrul unității. Concluziile extrase își propun să contribuie la o înțelegere mai profundă a paradigmei agriculturii durabile, servind drept sursă de inspirație pentru implementarea practicilor agricole care prioritizează armonia ecologică și asigurarea securității alimentare.

Cuvinte cheie: *semințe ecologice certificate, biodiversitate agricolă, reziliență agricolă, securitate alimentară, sustenabilitate.*

INTRODUCTION

The intricate interplay between agrobiodiversity, nutrition, health and the environment, within the context of organic agriculture (OA), represents a dynamic system characterized by continuous change (Gomiero, 2021). The multidimensional connections among these factors and their collective impact on sustainable and resilient agricultural systems are paramount for achieving sustainability in current agricultural practices (Fig. 1).

Agrobiodiversity, encompassing a diverse array of crops, livestock, and microorganisms, forms the foundation of OA. The continuous evolution of agrobiodiversity contributes to the resilience of ecosystems, fostering adaptability to environmental changes and mitigating risks associated with pests, diseases, and climate variability (Kahane et al., 2013).

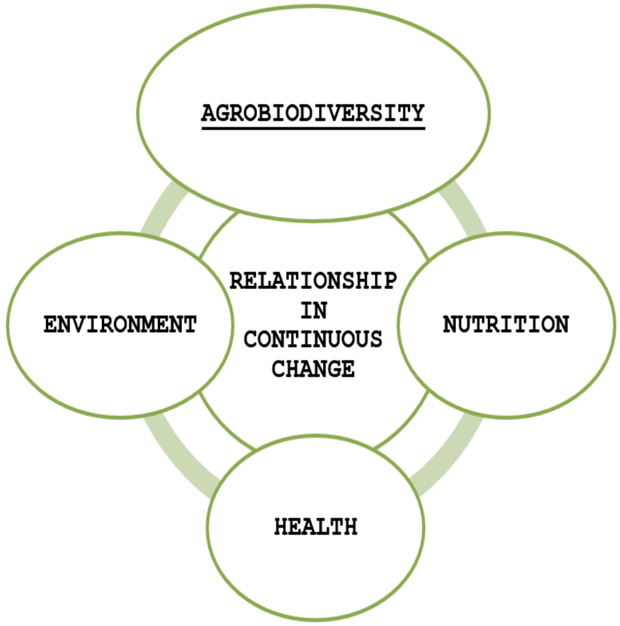

Fig. 1. Interdependencies within agricultural systems / Interacțiunile din cadrul sistemelor agricole

The dynamic nature of agrobiodiversity directly influences the nutritional composition of food produced in OA. Diverse crop varieties and species contribute to a more varied and nutrient-rich diet, addressing micronutrient deficiencies and promoting human health (Graham, 2001; Li, 2020).

The relationship extends beyond individual components to the overall health of ecosystems. Agrobiodiversity supports ecological balance, enhancing soil fertility, water retention, and pest control (Dwivedi et al., 2013). The continuous evolution of agrobiodiversity within OA contributes to the long-term health and resilience of agricultural landscapes.

The nutritional quality of diverse crops derived from agrobiodiversity positively impacts human health (Johns, 2007). A diet rich in diverse, nutrient-dense foods is associated with lower rates of malnutrition and diet-related diseases (Mustafa et al., 2021). Additionally, the reduced use of synthetic inputs in ecological agriculture minimizes the potential health risks associated with chemical exposure (Horrigan et al., 2002).

Organic agriculture, rooted in agrobiodiversity, emphasizes adaptive management strategies (Jackson et al., 2012). As environmental conditions evolve, diverse crop varieties exhibit varying degrees of resilience and adaptability, enhancing the system's capacity to withstand and recover from disturbances (Urruty et al., 2016).

Agrobiodiversity contributes to the provision of ecosystem services, including pollination, natural pest control, and water purification (Garbach et al., 2014). These services, in turn, enhance the sustainability of OA and positively impact both environmental health and agricultural productivity (Rehman, 2022).

The continuous change in agrobiodiversity, nutrition, health, and the environment form dynamic feedback loops. These loops create opportunities for continuous improvement, where scientific insights and innovations in OA contribute to enhanced understanding and informed decision-making for sustainable practices.

The wealth of plant species on Earth represents a vast and largely untapped resource for ensuring food security and sustaining human populations. The facts that approximately 30,000 out of the known 250,000 plant species are edible, with around 7,000 historically utilized for food and only 120 currently cultivated, underscore the immense potential of biological diversity in addressing global food challenges (Fig. 2).

The staggering number of plant species yet to be explored and integrated into our food systems highlights the untapped potential within biological diversity. Beyond the limited subset currently cultivated, a vast array of plant species remains unexplored, potentially offering valuable traits such as disease resistance, adaptability to climate change, and enhanced nutritional content. Diversifying our food sources by tapping into a broader range of edible plant species enhances the resilience of agricultural systems (Zsögön, 2022). A diverse array of crops is better equipped to withstand environmental stresses, including pests, diseases, and the impacts of a changing climate (Lamichhane, 2015).

The cultural and culinary diversity embedded in the utilization of various edible plant species enriches human diets and contributes to the preservation of traditional knowledge (Sarkar, 2020). Harnessing this diversity not only supports local economies but also promotes a more varied and nutritious global diet.

The utilization of a greater number of plant species can contribute to enhanced nutritional security by providing a wider spectrum of essential nutrients (Frison, 2011). This is particularly significant given the role of diverse diets in preventing malnutrition and diet-related health issues. Integrating a broader range of edible plant species into agricultural practices aligns with principles of sustainable agriculture. This approach promotes biodiversity conservation, reduces reliance on a few staple crops, and fosters agroecosystems that are more balanced and resilient over time (Barrios, 2020).

The fact that only nine plant species currently provide more than 75% of human food, and three species contribute to over 50%, underscores the vulnerability of our food systems. Expanding the range of cultivated and consumed plant species is crucial for building more robust and sustainable global food security.

The untapped biological diversity of edible plant species represents a critical frontier in addressing the challenges of food security, nutrition, and environmental sustainability (Ray, 2020). Exploring and integrating a broader spectrum of plant resources into our agricultural systems can contribute to building resilient, diverse, and sustainable food systems for the future (Rehman, 2022). This takes on added significance considering there are defining examples from the past illustrating what can happen when the food system relies on monoculture, with shortages in biodiversity having fatal consequences (see the case of the Irish Potato Famine caused by the potato blight).

The Irish Potato Famine, which occurred between 1845 and 1852, was a devastating event with profound implications for both Irish society and agricultural history (Powderly, 2019). From a scientific perspective, the primary cause of the famine was the introduction and rapid spread of the potato blight, a devastating plant disease caused by the pathogen *Phytophthora infestans*, an oomycete, a type of water mold, responsible for the potato blight, that thrived in the cool, moist climate of Ireland, creating ideal conditions for its rapid spread (Turner, 2005).

The Irish farmers primarily relied on a single potato variety, the Lumper, which was highly susceptible to the pathogen. This lack of genetic diversity made the entire potato crop vulnerable to the disease. The widespread adoption of monoculture, the cultivation of a single crop over extensive areas, contributed to the severity of the famine (Yoshida, 2013). Monoculture increases the risk of large-scale crop failure when a specific pathogen affects the favored crop (Gráda, 2004). The agricultural practices of the time, including the prevalence of small landholdings and the reliance on a single crop for sustenance, exacerbated the impact of the blight. The famine had a lasting impact on the genetic diversity of the Irish population (Kinealy, 2006). The population decline and migration resulting from the famine influenced the genetic composition of subsequent generations, with potential implications for disease susceptibility and adaptation.

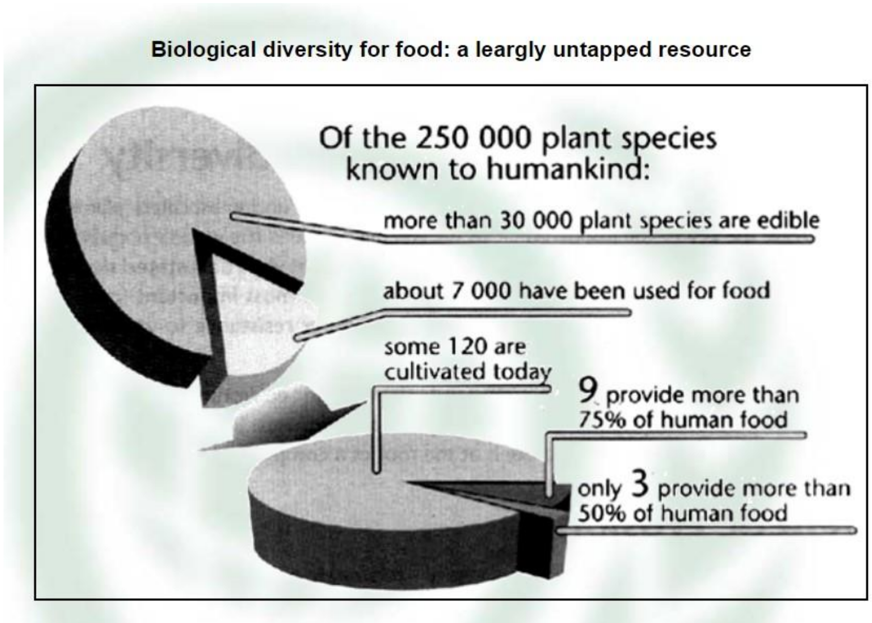

Fig. 2. Biological diversity for food (Source FAO – SEED OF LIFE) / Varietatea biologică în scop alimentar

Thus, the Irish Potato Famine serves as a cautionary tale for modern agriculture, emphasizing the importance of biodiversity and resistant crop varieties in mitigating the impact of plant diseases. Scientific advancements in breeding disease-resistant crops, genetic engineering, and sustainable agricultural practices have since been developed to address such challenges.

Fig. 3. Irish potato famine (www.unfortunatehistory.com) / Criza alimentară din Irland cauzată de mana cortofului

In light of the context outlined above, the production of certified organic seed from vegetable varieties represents a crucial endeavor for sustainable agriculture. It underscores the importance of preserving biodiversity and cultivating resilient, environmentally-friendly crops. This initiative not only guarantees the availability of high-quality organic seeds but also advocates for the long-term health and sustainability of our agricultural ecosystems.

MATERIALS AND METHODS

A thorough literature encompassed the significance of plant biodiversity, underlining its crucial role in sustainable agriculture. Insights from various sources were synthesized to portray the global context, with a specific focus on the impact of certified organic seed production. It includes a historical perspective on plant biodiversity, acknowledging its paramount importance in shaping agricultural practices over the centuries. Notable examples, such as the Irish Potato Famine, were examined to underscore the risks associated with monoculture and the vital role of diverse plant species. Afterwards, the role of VRDS Bacău was analyzed, emphasizing its pivotal contributions to agricultural research and development. Specific milestones, projects, and initiatives were identified to showcase the station's significant impact on local and global agricultural practices.

A proprietary database was created, incorporating data derived from internal records at the Vegetal Research and Development Station (VRDS) Bacău. This database included information on vegetable varieties developed at VRDS Bacău, their characteristics, and quantities produced over specific time periods. Data extraction from internal records included details on the origin, breeding history, and unique attributes of vegetable varieties developed at VRDS Bacău. Breeding techniques employed at VRDS Bacău for the development of organic vegetable varieties were reviewed. Emphasis was placed on understanding the methodologies and innovations applied to enhance the genetic diversity and adaptability of the seed stock. The final step involved synthesizing the collected data, identifying overarching themes, and providing a comprehensive study on certified organic seed production from vegetable varieties created at VRDS Bacău. Conclusions drawn from the paper aimed to contribute valuable insights to the broader scientific community.

RESULTS AND DISCUSSIONS

Overview

VRDS Bacau was founded on 1st September 1974, celebrating its jubilee this year. The institute is dedicated to several key areas, reflecting its commitment to sustainable agriculture and ecological practices. The main directions of VRDS Bacau are described in Figure 4 and include as follows:

Conservation of Vegetable Species Diversity - VRDS Bacau is actively involved in the preservation and conservation of diverse vegetable species. This includes efforts to safeguard genetic resources and maintain biodiversity within the agricultural landscape through mission collection, material exchange and breeding. The material is conserved ex situ and safety duplicated at `Mihai Cristea` Suceava Genebank

Plant Breeding for the Ecological and Conventional System - The institute focuses on developing and promoting breeding techniques that are suitable for both ecological and conventional farming systems. This approach aims to address the varied farmers demands according to different species challanges and particularities.

Development of Modern Technologies for Seed Production - VRDS Bacau is at the forefront of research and development in modern technologies related to seed production. This involves leveraging innovative methods to enhance the quality and efficiency of seed production for various vegetable species.

Elaboration and Implementation of Environmentally Friendly Cultivation Practices - The institute is dedicated to formulating and implementing environmentally friendly cultivation practices. This includes advocating for sustainable farming methods that minimize environmental impact while maintaining productivity.

On-Farm Validation - VRDS Bacau engages in on-farm validation activities to ensure that research findings and innovations are practical and effective in real-world agricultural settings. This approach helps bridge the gap between scientific advancements and on-the-ground application.

Education and Lifelong Learning - VRDS Bacau is committed to education and lifelong learning in the field of agriculture. This includes providing training and resources to farmers, researchers, and other stakeholders, fostering continuous improvement and knowledge dissemination.

Thus, VRDS Bacau stands as a prominent institution contributing to the advancement of sustainable agriculture, biodiversity conservation, and the adoption of modern technologies in seed production. The institute's multifaceted approach underscores its role in promoting environmentally friendly and innovative practices within the agricultural sector.

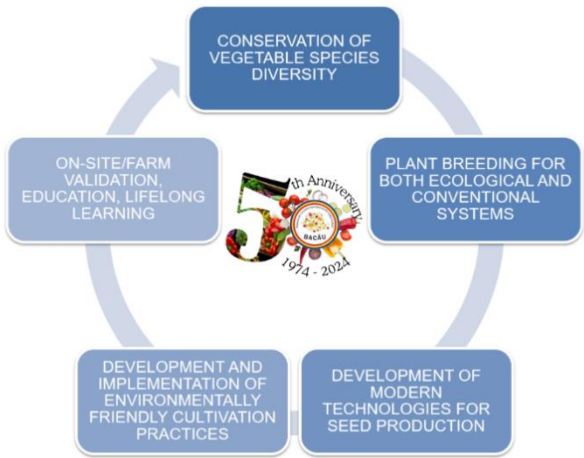

Fig. 4. VRDS Bacau mission and main objectives / Misiunea și principalele obiective ale SCDL Bacău

Pioneer in Organic Farming

In the early 1990s, at VRDS Bacău was established the first organic farming plot in Romania by the late Dr. Eng. Stoian Lucian, director of the unit.

The 1995 certification ensured the conditions for conducting extensive research for the development of practices and methodologies specific to the ecological system, which are continuously refined and successfully implemented on farms:

- Studies and research have been conducted regarding the suitability of new plant species and varieties for organic farming;
- Crop rotations and specific planting schemes for an organic vegetable farm have been implemented;
- Methodologies and practices for weed control have been developed and implemented on the organic farm; soil fertility management is also part of the overall approach;
- New methods and practices for combating pathogens and pests in organic crops have been experimented with;
- New techniques for seed production have been developed and implemented on the organic farm; the development of modern techniques for organic seed production includes the multiplication of organically certified vegetable seeds;

Overall, VRDS Bacău has certified 63 varieties (43 for vegetables, 20 for flowers and multi-purpose plants), both for conventional and organic system, out of which 32 are patented; it has also developed 115 cultivation and conservative breeding technologies.

The unit owns its own germplasm collection.

The VRDS Bacău mission is to actively contribute to local, regional, and national development by addressing issues arising from the current context of climate change, environmental pollution, and biodiversity loss: healthy food and an unpolluted environment.

The intrinsic relationship between VRDS Bacău and Organic Agriculture/International and national projects

Regarding organic agriculture within VRDS Bacău, the main focus is on obtaining new vegetable genotypes suitable for cultivation in organic agriculture and multiplying organically certified seeds from superior biological categories. A crucial emphasis on preserving the diversity of vegetable and flower species and conserving valuable genetic resources.

Knowing that collaborative efforts facilitate the exchange of knowledge and best practices, fostering innovation in organic vegetable breeding and supporting farmers in implementing successful and sustainable agricultural techniques, VRDS has been part in two major projects.

BRESOV (Breeding for Resilient, Efficient and Sustainable Organic Vegetable Production) It was carried out by a consortium of 22 partners from 13 countries in Europe, Asia, and Africa, with the overall objective of improving the competitiveness of three important vegetable species (broccoli, beans, and tomatoes) in an ecological and sustainable environment. The overall aim was to increase plant tolerance to biotic and abiotic stress and to adapt varieties to the specific requirements of organic production processes with minimal inputs.

The comprehensive RO_ECOBREED project `Agriculture for Tomorrow – Ensuring Environmental Sustainability through Increased Competitiveness in Organic Plant Breeding` included the implementation of four component projects and was carried out by a consortium comprising three R&D units for vegetable growing in Romania: VRDS Bacău, Iernut, and Buzău, a higher education institution: USAMV Iași, and a National R&D Institute for machinery and installations in agriculture and the food industry – INMA Bucharest.

The project's goals consisted of developing significant support through new knowledge and newly created genetic resources to strengthen the organic farming system in the imminent context of climate change. Creating feasible models for improving and cultivating other vegetable species in an organic system.

The challenges of the project included ensuring germplasm collections and working protocols for improving vegetable species, as well as obtaining resistant genotypes adapted to organic agriculture.

Planning organically certified seeds production at VRDS Bacău

The structuring of organic certified seed production at VRDS Bacău includes the following stages:

- Conservative selection and the production of basic seed - working methods based on knowledge of genetics (cytogenetics and population genetics), breeding (selection methods), and biometrics (Fig. 5);
- Multiplication and production of certified seeds;
- Conditioning, storage, and commercialization of seeds - the raw seed, obtained after the extraction operation, is brought to the specific technical quality conditions expressed by indicators provided by the current legislation (relative humidity, germination, physical purity, phytosanitary condition, etc.);
- Control and certification of seed quality - carried out by the National Inspection for Seed Quality (INCS) and the Territorial Inspectorates for Seed Quality and Planting Material (ITCSMS), which are under the authority of INCS. This stage is further divided into: 1. Crop inspection and certification consider the biological value of seeds as carriers of the characteristics of the variety; 2. Seed analysis in the laboratory and issuing cultural value certificates; 3. Post-control of seeds, which involves verifying the biological value of seeds after they have been produced.
- In addition, for organic seeds production, the certification authority conducts one or two inspections annually, following which a comprehensive inspection report is issued. This report, in turn, forms the basis for issuing the certificate of conformity for organic products.

Fig. 5. Work methodology for pre-breeding and breeding / Metodologia de lucru pentru etapele de preameliorare și ameliorare

Organically certified seeds yield from the last three years are succinctly presented in the Figures 6, 7 and 8.

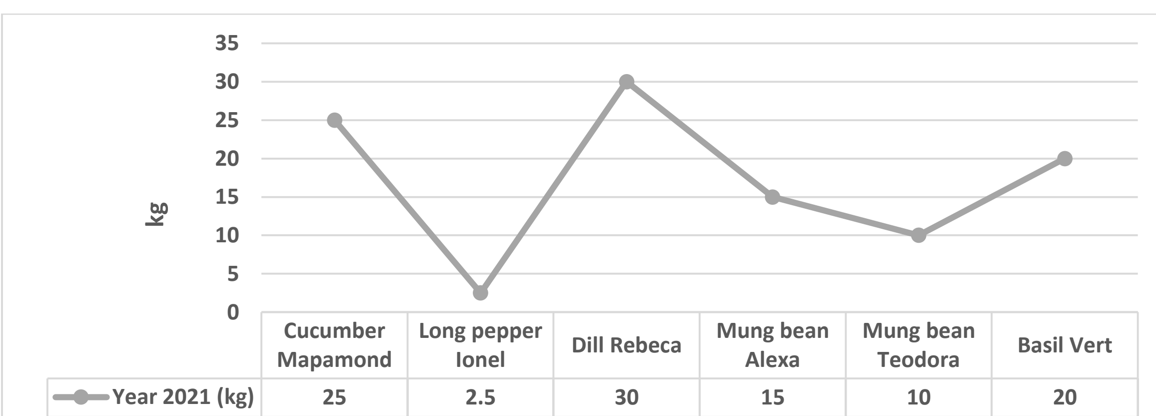

Fig. 6. Certified organic seed production by species and varieties for the year 2021 / Producția certificată de semințe ecologice pe specii legumicole și soiuri aferentă anului 2021

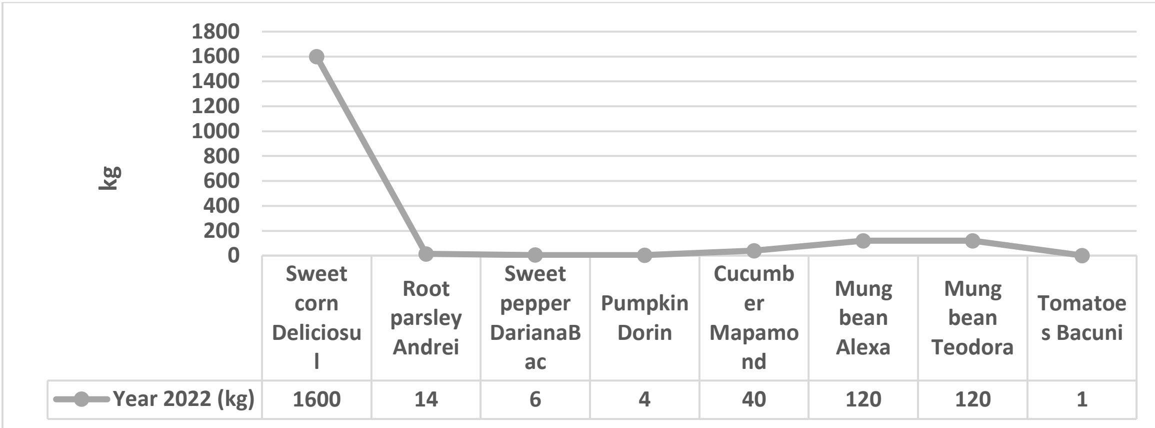

Fig. 7. Certified organic seed production by species and varieties for the year 2022 / Producția certificată de semințe ecologice pe specii legumicole și soiuri aferentă anului 2022

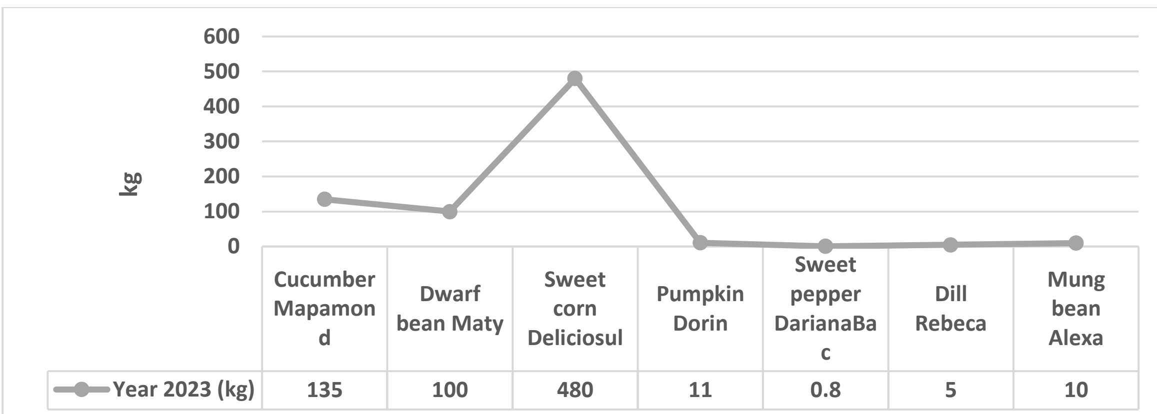

Fig. 8. Certified organic seed production by species and varieties for the year 2023 / Producția certificată de semințe ecologice pe specii legumicole și soiuri aferentă anului 2023

Producing new varieties of vegetables

VRDS Bacău provides seeds of superior biological category for a wide range of vegetable species, technological assistance in vegetable farms; diversification of the vegetable and flower assortment through the creation of new high-performance genetic resources; conservation of valuable plant genetic resources; development of modern cultivation technologies for both conventional and ecological systems.

The vegetable varieties available for commercialization in the year 2024 are described by Brezeanu and Brezeanu (2021), as follows:

'DELICIOSUL` sweet corn variety (Fig. 9) is distinguished by a high content of soluble carbohydrates, offering a pleasant and balanced taste. The cob has a cylindrical shape, ranging from 18 to 22 cm in length, with a fresh cob weight of 300 g. This variety exhibits high ecological plasticity, and the boiled or roasted kernels are highly appreciated by consumers, with a production potential exceeding 15 t/ha. It is resistant to pathogenic agents, making it a recommended choice for cultivation in organic farming systems.

Fig 9. 'DELICIOSUL' sweet corn variety / Soiul de porumb zaharat „Deliciosul”

'DARIANA BAC' bell pepper (Fig. 10) - plants exhibit moderate vigor and require 116-120 days until the onset of harvesting; at technological maturity, the fruits are yellow-green and turn to a bright red at physiological maturity; the average weight of the fruits ranges from 95-140 g, with dimensions between 9.5-11.5 cm in length, 7.5-8 cm in diameter, and pulp thickness of 8-9 mm; the fruits feature sweet, thick, and crunchy pulp, making them suitable for fresh consumption or various culinary preparations and processing.

Fig 10. 'DARIANABAC' bell pepper variety / Soiul de ardei gras „Darianabac”

'BACUNI' tomato variety (fig. 11) - was developed to meet the demands of growers seeking to reduce labor costs associated with the labor-intensive process of pruning, without compromising the quantity and quality of the yields obtained; the plants have a determinate growth habit, reaching heights between 65-75 cm; it requires 102-115 days from germination to the first harvest; the fruits are round and slightly flattened, with good firmness and resistance to cracking. They weigh between 90 and 150 g, with a dry matter content of over 6%, suitable for both fresh consumption and processing into juice and paste; advantages of the variety include: (a) successful cultivation without pruning and support systems; (b) sweet fruits with resistance to cracking, suitable for both fresh consumption and preservation.

Fig. 11. 'BACUNI' tomato variety / Soiul de tomate „Bacuni”

'CREOLICA' round pepper variety (fig. 12) - is a semi-early variety with a vegetation period of 120 days; the fruit arrangement is individual in a semi-erect position, with a round-flattened shape and a smooth surface; fruit color at technological maturity is green and at physiological maturity it is bright red; pericarp thickness is 14 mm and the average fruit weight is 195-250 g.

Fig. 12. 'CREOLICA' round pepper variety / Soiul de ardei gogoșar „Creolica”

`IONEL` long pepper variety (fig. 13) – early variety, with a vegetation period of 121 days until consumption maturity; plant height of 50-52 cm, with abundant foliage; the fruit has a sheath-like shape, with a length of 20-23 cm and a base diameter of 5.8-6.8 cm; the color is greenish-yellow at consumption maturity and bright red at physiological maturity; fruit ripening occurs gradually.

Fig. 13. 'IONEL' long pepper variety / Soiul de ardei lung „Ionel”

'MAPAMOND' cucumber variety (fig. 14) - early variety; during flowering, female flowers predominate in a 3:1 ratio; the color of the hairs is white-yellowish; length/thickness ratio – 3.5/1; Fruit color is dark green and the weight varies between 110 and 120 g; the yield is characterized by a very good quality for both fresh consumption and processing.

Fig. 14. 'MAPAMOND' cucumber variety / Soiul de castraveți „Mapamond”

`REBECA` dill variety (fig. 15) - anthocyanic coloration is present at the seedling stage; the position of the branches on the plant is semi-erect; plant height at flowering is moderate (1.1-1.3 m); the blue hue of the stem is weak, and the intensity of the glaucous green color is moderate; number of primary branches is small; stem diameter is medium, while the leaf shape is rhomboidai; leaflet density is moderate; the diameter of the main umbel is large (9-11 cm), with a high number of peduncles (24-31).


Fig. 15. 'REBECA' dill variety / Soiul de mărar „Rebeca”

`MATEI` carrot variety (fig. 16) - a semi-early variety, recommended for cultivation in all vegetable growing areas, with a vegetation period from mass emergence to the final root formation of 90 - 98 days; the plant forms an erect rosette (45-50 cm), with dark green leaves; the mid-divided leaf has a slightly depressed insertion on the collar, without anthocyanin or chlorophyll in the root epidermis; the root is slightly rounded and conical, intensely orange in color, with a length of 14-16 cm, and a collar diameter of 4-5 cm; it is succulent with a sweet taste; physiological characteristics per 100 g: soluble carbohydrate content 8.6%, proteins 0.92%, lipids 0.20%, water 88%, minerals 0.96%, β-carotene 8.4 mg/100g, dry Substance - 10.8%; very good resistance to root cracking and branching, as well as the emission of floral stems in the first year; root weight: 90 - 150 g.


Fig. 16. 'MATEI' carrot variety / Soiul de morcov „Matei”

`ALEXA` mung bean variety (fig. 17) – semi-early variety, characterized by a vegetation period of 41-45 days to consumption maturity and 80-85 days to physiological maturity of the bean; stable, clearly distinct from other varieties; the plant has a dwarf, determinate growth habit, with a height of 50-70 cm; the pod has a medium to large size; shape – circular in cross-section (at the bean level); color – green, and as the beans mature, the pod color becomes dark brown; flower – light cream color; beans – dark green in color; 100-seed weight – 50 g.


Fig. 17. 'ALEXA' mung bean variety / Soiul de fasoe mung „Alexa”

`TEODORA` mung bean variety (fig. 18) - early, stable, clearly distinct from other varieties; plant has a dwarf, determinate growth habit, with a height of 40-48 cm; the pod is circular in cross-section, dark green in color, with a sharp tip, and the parchment filament at the ventral suture is absent and its color turns light cream; the beans are reddish-brown in color; 100-seed weight – 91 g.



Fig. 18.'TEODORA' mung bean variety / Soiul de fasoe mung „Teodora”

`MARIAN` red beet variety (fig. 19) - recommended for cultivation in all vegetable growing areas, especially on light soils with a loamy-sandy texture; vegetation period: 75 - 85 days, from mass emergence to the final formation of the root; rosette leaves are large, long-petioled, heart-shaped, with a rounded tip and undulating blade, initially dark green, later turning reddish; the root is round, dark red, leaning towards burgundy. In cross-section, it presents concentric circles, lighter in color; characterized by very good resistance to cracking and branching of the roots, as well as the emergence of flower stems; root weight: 300-400 g.

Fig. 19. 'MARIAN' red beet variety / Soiul de sfeclă roșie „Marian”

`MATY` dwarf garden bean variety (fig. 20) – early variety, with a vegetation period of 50-60 days to pod consumption maturity and 85-90 days to physiological maturity of the beans; the plant has a dwarf, determinate growth habit, with a height of 45-50 cm; the pod is wide, straight, slightly curved, with a sharp green tip; moderate length, 10-14 cm, and width of 0.7-0.8 cm; the average number of pods per plant is 18-22; at physiological maturity, beans are red, with a 100-seed weight of 440 g; yield potential: 12-19 tons of pods per hectare and 1200-1500 kg of seeds per hectare.

Fig. 20. 'MATY' dwarf garden bean variety / Soiul de fasole pitică „Maty”

`ANDREI` root parsley variety (fig. 21) - biennial plant; the rosette foliage is upright to semi-erect; the leaves are dark green; length of the leaf blade is medium to long, with a small width; the leaflet shape is moderately triangular; the distance between the first and second pairs of leaflets is small; the margin of the leaflet has a slight wave; the petiole is long and thick: it forms thickened roots weighing 50-100 g and measuring 15-22 cm, conical-elongated, with a yellowish-white epidermis; the pulp is white, with a weak sponginess; it has a vegetation period of 140-150 days.

Fig. 21. 'ANDREI' root parsley variety / Soiul de pătrunjel de rădăcină „Andrei”

`INA` root celery variety (fig. 22) - biennial plant with an average height of 29.5 cm; the foliage is upright to semi-erect, with medium-sized leaflets: 7.3 - 7.1 cm; the length of the petiole is large, averaging 20.7 cm; the color of the leaves is dark green; the distance between the first and second pairs of leaflets is small; anthocyanin coloration of the petiole is present; the density of incisions on the leaf margin is rare; the tuberized root is large: 9.4-9.7 cm, with basal insertion of secondary roots; the protuberances present on the root are of medium size; sponginess is weak, and the presence of rusty spots in the pulp is also weak; the longitudinal section of the celery is round; the main color of the epidermis is whitish; the pulp is white with an average weight of 300-700 g.

Fig. 22. 'INA' root celery variety / Soiul de Țelină de rădăcină „Ina”

CONCLUSIONS

1. Agrobiodiversity directly impacts the nutritional quality of food produced in organic agriculture. Diverse crop varieties contribute to a more nutrient-rich diet, addressing micronutrient deficiencies and promoting human health. This nutritional diversity is crucial for combating malnutrition and diet-related diseases.
2. The example of the Irish Potato Famine serves as a cautionary tale, emphasizing the risks associated with monoculture. The dependence on a single potato variety led to devastating

consequences due to the lack of genetic diversity. This historical event underscores the importance of diverse crop varieties in mitigating the impact of plant diseases and ensuring food security.

3. The Vegetable Research and Development Station (VRDS) Bacău emerges as a pioneer in organic farming, actively contributing to sustainable agriculture, biodiversity conservation, and the adoption of modern technologies in seed production. Its multifaceted approach, including on-farm validation, education, and collaboration in international projects, showcases its commitment to advancing sustainable agricultural practices.
4. The production of certified organic seed from vegetable varieties is identified as a crucial endeavor for sustainable agriculture. This not only ensures the availability of high-quality organic seeds but also promotes biodiversity conservation, environmentally-friendly crop cultivation, and long-term health in agricultural ecosystems.

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CONTROL OF DAMAGE AGENTS ON TOMATO CROPS UNDER HIGH PLASTIC TUNNELS

CONTROLUL AGENȚILOR DE DĂUNARE LA CULTURILE DE TOMATE DIN SPAȚII PROTEJATE

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Abstract
The experiments were carried out in 2020, under high plastic tunnel conditions, in the I, II and extended crop cycles. In the first crop cycle, the efficacy of some combinations of fungicides in the simultaneous control of pathogens present in the crop (Alternaria solani, Botrytis cinerea, Fulvia fulva) was evaluated. Among the tested fungicide combinations, variant 1 stood out (Signum 0.15% + Cabrio Top 0.2%; average E=96.8%; yield 5.705 kg/m^2). In the second crop cycle, the complex control of pathogens and pests (Alternaria solani, Botrytis cinerea, Fulvia fulva, Tuta absoluta, Thrips tabaci, Helicoverpa armigera) was pursued through the use of combinations of fungicides and insecticides. Of these, variant 8 stood out (Amistar 0.1% + Alverde 0.1%; average E=86.1%; yield 6.510 kg/m^2). In the extended cycle, the efficacy of the same combinations of fungicides as in the first crop cycle was evaluated, for the simultaneous control of pathogens present in the crop (Alternaria solani, Botrytis cinerea, Colletotrichum coccodes). In this cycle, the best results were also obtained with variant 1 (Signum 0.15% + Cabrio Top 0.2%; average E=89.1%; yield 8.433 kg/m^2).

Keywords: *tomato, pathogens, pests, fungicides, insecticides.*

Rezumat
Experiențele au fost efectuate în anul 2020, în condiții de solar, în ciclurile de cultură I, II și prelungit. În ciclul I de cultură a fost evaluată eficacitatea unor combinații de fungicide în combaterea simultană a agenților patogeni prezenți în cultură (Alternaria solani, Botrytis cinerea, Fulvia fulva). Dintre combinațiile de fungicide experimentate s-a remarcat varianta 1 (Signum 0,15% + Cabrio Top 0,2%; E medie=96,8%; producția 5,705 kg/m^2). În ciclul II de cultură s-a urmărit combaterea în complex a agenților patogeni și dăunătorilor (Alternaria solani, Botrytis cinerea, Fulvia fulva, Tuta absoluta, Thrips tabaci, Helicoverpa armigera) prin utilizarea unor combinații de fungicide cu insecticide. Dintre acestea s-a evidențiat varianta 8 (Amistar 0,1% + Alverde 0,1%; E medie=86,1%; producția 6,510 kg/m^2). În ciclul prelungit a fost evaluată eficacitatea acelorași combinații de fungicide ca în ciclul I de cultură, pentru combaterea simultană a agenților patogeni prezenți în cultură (Alternaria solani, Botrytis cinerea, Colletotrichum coccodes). În acest ciclu cele mai bune rezultate s-au obținut tot la varianta 1 (Signum 0,15% + Cabrio Top 0,2%; E medie=89,1%; producția 8,433 kg/m^2).

Cuvinte cheie: *tomate, agenți patogeni, dăunători, fungicide, insecticide.*

INTRODUCTION

Among the vegetable species grown in our country under high plastic tunnels, tomatoes occupy the largest area (≈6000ha). Favorable conditions are met under high plastic tunnels (limited crop rotation, temperatures above 20°C, high atmospheric humidity, drops of water on the plant foliage) for the appearance and evolution of the attack of some pathogens and pests (*Alternaria solani, Botrytis cinerea, Fulvia fulva, Colletotrichum coccodes, Tuta absoluta, Thrips tabaci* and *Helicoverpa armigera*) that affect yield quantitatively and depreciate it qualitatively.

Alternaria solani can cause partial defoliation of tomato plants (Peralta et al., 2005; Chaerani, 2006). It is frequently found in areas with abundant precipitation, high atmospheric humidity and temperatures between 24 and 29°C (Chaerani, 2006). It can be combated by chemical and biological means (Costache et al., 2023).

Botrytis cinerea is a pathogen that attacks leaves, stems, flowers and fruits of plants (Elad, 2003; Elad et al., 2007; Zuparov et al., 2020) and can be controlled both biologically (Elad, 2003) and chemically (Zuparov et al., 2020).

Attack by *Fulvia fulva* can lead to yield losses of 10–25%, and even 50% (Zhao et al., 2022; Hu et al., 2023). It can be combated with hexaconazole and its binary mixtures with fludioxonil.

Colletotrichum coccodes affects especially tomato fruits. Depression lesions appear on their surface (Byrne et al., 1997). This pathogen which causes losses of 5 – 20% in tomato fruits before harvest and during storage, can be treated with bio-fungicides (Kumar and Kudachikar, 2022) or with chemical-based products (Costache et al., 2023).

Helicoverpa armigera is a polyphagous pest of tomato, pepper, eggplant and bean crops, causing yield losses of US$ 5 billion annually (Sharma et al., 2010; Ali et al., 2021). The pest attacks plant foliage, flowers and fruits, which lose their commercial value. Both chemical products and plant extracts can be used for its control (Hussain and Bilal, 2007; Ali et al., 2021).

Tuta absoluta is an important pest (Desneux et al., 2021) that attacks the aerial parts of tomato plants, in all phases of vegetation (Costache et al., 2023) and can only be combated efficiently through an integrated management (Şovărel et al., 2022).

Thrips tabaci is a polyphagous pest (Gulzar et al., 2021). Damage is mainly caused by larvae and adults, which feed on sap from leaf tissue (Gulzar et al., 2021; Macharia et al., 2015). The main means of control are both chemical and biological products (Şovărel et al., 2022).

The paper presents the results obtained in the control of the mentioned pathogens and pests by using combinations of fungicides for the simultaneous control of pathogens and fungicides with insecticides for the complex control of harmful organisms present in tomato crops under protected areas.

MATERIALS AND METHODS

The experiments were carried out in 2020, under high plastic tunnel, in the I, II and extended crop cycles. The appearance and evolution of the attack of pathogens and pests in correlation with climatic factors was followed.

In the I crop cycle, the efficacy of some combinations of fungicides in simultaneously control of the pathogens present in the crop was evaluated. There were used the following combinations of fungicides: Signum (boscalid 26.7% + pyraclostrobin 6.7%) + Cabrio Top (pyraclostrobin 5% + metiram 55%), Ortiva Top (azoxystrobin 200g/l + difenoconazole 125g/l) + Switch 62.5 WG (fludioxonil 25% + cyprodinil 37.5%), Cidely Top (difenoconazole 125g/l + cyflufenamide 15g/l) + Prolectus (fenpyrazamine 50%) and Dagonis (difenoconazole 50g/l + fluxapiroxad 75g/l) + Teldor 500 SC (fenhexamid 500g/l).

In the II crop cycle, the complex control of pathogens and pests was assured by using different combinations of fungicides and insecticides: Signum (boscalid 26.7% + pyraclostrobin 6.7%) + Poleci (deltamethrin 25g/l), Alverde (metaflumizone 240g/l) or Vertimec 1.8 EC (abamectin 18g/l), Cabrio Top (pyraclostrobin 5% + metiram 55%) + Poleci, Alverde or Vertimec 1.8 EC and Amistar (azoxystrobin 250g/l) + Poleci, Alverde or Vertimec 1.8 EC.

In the extended cycle, the efficacy of the same combinations of fungicides as in the first crop cycle was evaluated, for the simultaneous control of pathogens present in the crop.

The experiences were established on the dates of April, 3 (cycle I), July, 15 (cycle II) and April, 22 (extended cycle). In cycles I and II, the hybrid Precos F1 was used, and in the extended cycle the hybrid Beldine F1.

In the tomato crop from cycle I was applied 6 treatments, in the cycle II, 5 treatments and in the extended cycle, 8 treatments, at intervals of 7-10 days. Based on the data obtained, the efficacy of product combinations in the simultaneous control against pathogens or in a complex control of pathogens and pests was calculated.

In all cases, the yield on variants and repetitions was recorded, in dynamics, and finally the obtained data were processed by the variance analysis method.

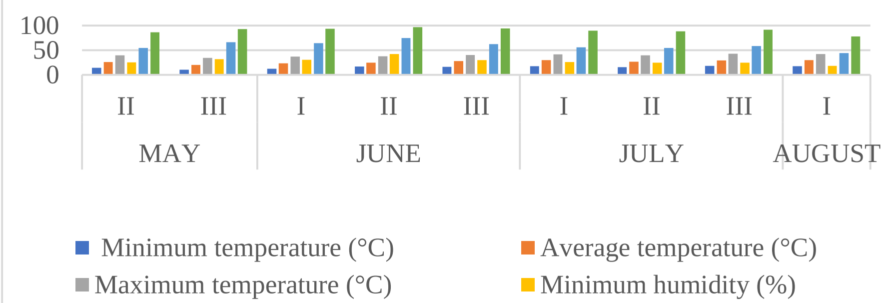
RESULTS AND DISCUSSIONS

In the I cycle, the tomato crop was attacked by the pathogens *Alternaria solani* (Fig. 1), *Botrytis cinerea* (Fig. 2) and *Fulvia fulva* (Fig. 3). The sequence of their appearance was: *A. solani* (June, 10), *B. cinerea* (June, 12) and *F. fulva* (July, 6).

a. Leaf / Frunză b. Fruit / Fruct
Fig.1 Alternariosis / Alternarioza
Alternaria solani

a. Leaf / Frunză b. Fruit / Fruct
Fig. 2 Grey mould / Putregaiul cenușiu
Botrytis cinerea

Fig. 3 Leaf mould / Pătarea cafenie
Fulvia fulva



Alternaria solani *	0	0	0	0.5	1.2	3.8	8.1	9.7	12.5
*Botrytis * cinerea*	0	0	0	0.8	2.5	4.6	10.3	13.1	17.1
*Fulvia * fulva*	0	0	0	0	0	0.8	2.3	5.1	7.2

**) the degree of attack (%) / *) gradul de atac (%)*

Figure 4. Influence of climatic factors on the appearance and evolution of the attack of pathogens on the tomato crop under high plastic tunnel (cycle I, 2020) / Influența factorilor climatici asupra apariției și evoluției atacului agenților patogeni la cultura de tomate din solar (ciclul I, 2020)

Their attack evolved gradually, being favored by the high atmospheric humidity from June-July (88.3-96.7%) so that, in the first week of August, the degree of attack recorded the following values: 12.5% (*A. solani*), 17.1% (*B. cinerea*) and 7.2% (*F. fulva*) (Fig. 4).

In the I crop cycle, the following results were obtained (table 1):

Table 1. Efficacy of some fungicides combinations in control of the pathogens on tomato crop under high plastic tunnel (cycle I, 2020) / Eficacitatea unor combinații de fungicide în combaterea agenților patogeni la cultura de tomate din solar (ciclul I, 2020)

Variant	Concen-tration (%)	The degree of attack (%)			Efficacy (%)			The average efficacy (%)
		Alternaria solani	*Botrytis cinerea*	*Fulvia fulva*	*Alternaria solani*	*Botrytis cinerea*	*Fulvia fulva*	
1. Signum + Cabrio Top	0.15+0.2	0.7	0.7	0	94.4	95.9	100.0	96.8
2. Ortiva Top + Switch	0.1+0.1	1.5	0.7	0	88.0	95.9	100.0	94.6
3. Cidely Top + Prolectus	0.1+0.12	2.7	2.1	0	78.4	87.7	100.0	88.7
4. Dagonis + Teldor	0.1+0.08	2.7	3.1	0	78.4	81.9	100.0	86.8
5. Untreated control	-	12.5	17.1	7.2	-	-	-	-

The product combinations Signum 0.15% + Cabrio Top 0.2%, Ortiva Top 0.1% + Switch 0.1%, Cidely Top 0.1% + Prolectus 0.12% and Dagonis 0.1% + Teldor 0 .08% ensured good protection of tomato plants against the attack of the pathogens *Alternaria solani*, *Botrytis cinerea* and *Fulvia fulva*, their average efficacy varied between 86.8% (Dagonis 0.1% + Teldor 0.08%) and 96.8% (Signum 0.15% + Cabrio Top 0.2%). The best efficacy was recorded in variants 1 (Signum 0.15% + Cabrio Top 0.2%; 96.8%) and 2 (Ortiva Top 0.1% + Switch 0.1%; 94.6%).

Regarding the obtained yields, the following variants were noted: 1 (Signum 0.15% + Cabrio Top 0.2%) with 5.705 kg/m^2 and 4 (Dagonis 0.1% + Teldor 0.08%) with 5.571 kg /m^2, as compared to 4.983 kg/m^2 in variant 5 (untreated control) (Table 2).

Table 2. Influence of treatments with different fungicides combinations on tomato yield under high plastic tunnel (cycle I, 2020) / Influența tratamentelor cu diferite combinații de fungicide asupra producției la tomate în solar (ciclul I, 2020)

Variant	Concentra-tion (%)	Yield (kg/m^2)	Relative yield (%)	The difference from the control (kg/m^2)	The significance
1. Signum + Cabrio Top	0.15+0.2	5.705	114.5	+0.722	***
2. Ortiva Top + Switch	0.1+0.1	5.458	109.5	+0.475	***
3. Cidely Top + Prolectus	0.1+0.12	5.438	109.1	+0.455	***
4. Dagonis + Teldor	0.1+0.08	5.571	111.8	+0.588	***
5. Untreated control	-	4.983	-	-	-

LD 5%=0.06; LD 1%=0.09; LD 0,1%=0.12

The yield differences, obtained in addition to the untreated check variant, between 0.455 kg/m^2 (V3) and 0.722 kg/m^2 (V1) were, in all cases, very significant.

In cycle II, the tomato crop was attacked by the following pathogens and pests: *Alternaria solani*, *Botrytis cinerea*, *Fulvia fulva*, *Tuta absoluta* (Fig. 5), *Thrips tabaci* (Fig. 6) and *Helicoverpa armigera* (Fig. 7). Their attack appeared in the following sequence: *T. absoluta* (July, 16), *T. tabaci*

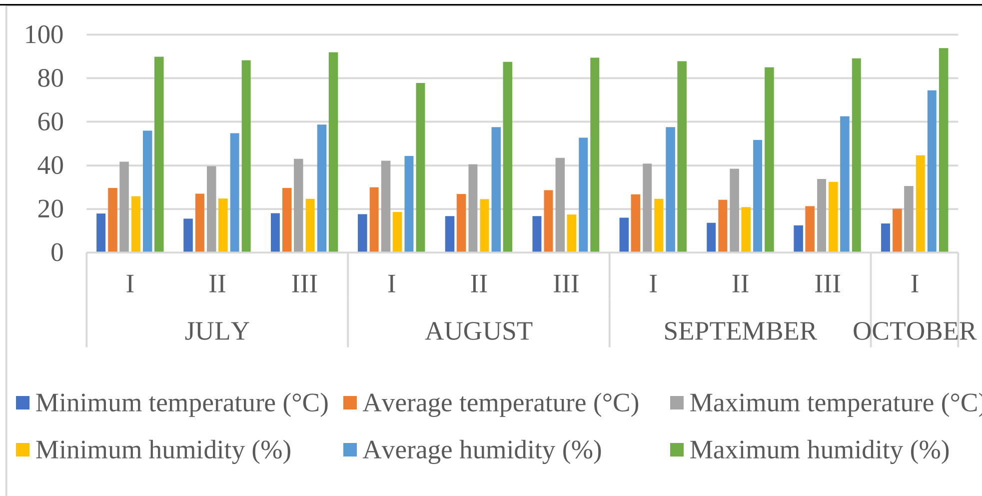
(August, 12), *F. fulva* (August, 14), *H. armigera* (August, 19), *A. solani* (August, 21) and *B. cinerea* (August, 24).

a. Leaf / Frunză **b. Fruit / Fruct**
Fig. 5 Tomato leafminer / Molia minieră
Tuta absoluta

Leaves / Frunze
Fig. 6 Thrips / Tripsul comun
Thrips tabaci

Fruit / Fruct
Fig. 7 Caterpillars / Omida fructelor
Helicoverpa armigera

Their attack evolved gradually, being favored by the climatic factors recorded under high plastic tunnel, especially high atmospheric humidity (85.1-89.4%) and moderate (33.8°C-38.5°C) - high temperatures (42 .2°C-43.4°C) from August to September, so that at the end of the first decade of October it recorded the following values: 15.9% (*A. solani*), 14.3% (*B. cinerea*), 12.7% (*F. fulva*), 28.4% (*T. absoluta*), 13.6% (*T. tabaci*) and respectively 5.7% (*H. armigera*) (Figure 8).



Alternaria solani *)	0	0	0	0	0	1.8	5.2	8.3	12.8	15.9
Botrytis cinerea *)	0	0	0	0	0	0.3	3.8	6.9	11.1	14.3
Fulvia fulva *)	0	0	0	0	0.9	1.5	4.9	6.7	9.2	12.7
Tuta absoluta *)	0	0.6	2.8	4.9	9.7	14.3	18.5	21.4	26.3	28.4
Thrips tabaci *)	0	0	0	0	0.3	1.9	4.5	7.2	10.9	13.6
Helicoverpa armigera **)	0	0	0	0	0.3	1.1	2.3	3.0	4.2	5.7

*) the degree of attack (%) / *) gradul de atac (%);
**) attack frequency (%) / **) frecvența atacului (%)

Figure 8. Influence of climatic factors on the appearance and evolution of the attack of pathogens and pests on the tomato crop under high plastic tunnel (cycle II, 2020) / Influența factorilor climatici asupra apariției și evoluției atacului agenților patogeni și dăunătorilor la cultura de tomate din solar (ciclul II, 2020)

In the II culture cycle, the following results were obtained (Table 3):

Table 3. Efficacy of some pesticide combinations in complex control of pathogens and pests on tomato crop under high plastic tunnel (cycle II, 2020) / Eficacitatea unor combinații de pesticide în combaterea în complex a agenților patogeni și a dăunătorilor la cultura de tomate din solar (ciclul II, 2020)

Product mix	Conc. (%)	The degree of attack(%)					A.F. fruits (%)	Efficacy (%)						The average efficacy (%)*
		A.s.	*B.c.*	*F.f.*	*T.a.*	*T.t.*	*H.a.*	*A.s.*	*B.c.*	*F.f.*	*T.a.*	*T.t.*	*H.a.*	
1. Signum + Poleci	0.15+ 0.05	0.9	1.0	0.8	14.5	1.2	1.2	94.3	93.0	93.7	48.9	91.2	78.9	90.2
2. Signum + Alverde	0.15+ 0.1	1.2	1.2	1.0	2.7	3.8	0.5	92.4	91.6	92.1	90.5	72.0	91.2	88.3
3. Signum + Vertimec 1,8 EC	0.15+ 0.08	1.0	1.4	1.2	12.7	1.4	2.3	93.7	90.2	90.5	55.3	89.7	59.6	91.0
4. Cabrio Top + Poleci	0.2+ 0.05	1.3	3.2	1.8	13.4	1.0	1.7	91.8	77.6	85.8	52.8	90.4	70.2	83.2
5. Cabrio Top + Alverde	0.2+ 0.1	1.1	3.0	2.0	3.0	4.1	0.4	93.1	79.0	84.2	89.4	69.8	93.0	84.7
6. Cabrio Top + Vertimec 1,8 EC	0.2+ 0.08	1.5	3.5	1.6	12.0	1.1	1.9	90.6	75.5	87.4	57.7	91.9	66.7	86.3
7. Amistar + Poleci	0.1+ 0.05	1.4	2.9	2.1	12.8	1.3	1.5	91.2	79.7	83.5	54.9	90.4	73.7	83.7
8. Amistar + Alverde	0.1+ 0.1	1.6	3.4	2.3	3.5	4.4	0.3	89.9	76.2	81.9	87.7	67.6	94.7	86.1
9. Amistar + Vertimec 1,8 EC	0.1+ 0.08	1.3	3.6	2.0	11.8	1.3	2.1	91.8	74.8	84.2	58.4	90.4	63.1	85.3
10.Untreated control	-	15.9	14.3	12.7	28.4	13.6	5.7	-	-	-	-	-	-	-

* When calculating the average efficacy, only values above 70% were taken into account; AF (%)=attack frequency.

A.s.=Alternaria solani; B.c.=Botrytis cinerea; F.f.=Fulvia fulva; T.a.=Tuta absoluta; T.t.=Thrips tabaci; H.a.=Helicoverpa armigera

The average efficacy of the tested combinations of pesticides, for the control of harmful organisms (*Alternaria solani, Botrytis cinerea, Fulvia fulva, Tuta absoluta, Thrips tabaci, Helicoverpa armigera*) varied between 83.2% (V4) and 91.0% (V3), noting the variants 3 (Signum 0.15% + Vertimec 1.8 EC 0.08%; average E=91.0%), 1 (Signum 0.15% + Poleci 0.05%; average E=90.2%) and 2 (Signum 0.15% + Alverde 0.1%; Average E=88.3%).

Referring to the obtained yields, the following variants were ranked in the first 3 places: 8 (Amistar 0.1% + Alverde 0.1%) with 6.510 kg/m^2, 5 (Cabrio Top 0.25 + Alverde 0.1%) with 6.475 kg/m^2 and 2 (Signum 0.15% + Alverde 0 .1%) with 6.468 kg/m^2, as compared to 5.515 kg/m^2 in variant 10 (untreated control) (Table 4).

The yield differences, obtained in addition, compared to the untreated control variant, between 0.675 kg/m^2 (V4) and 0.995 kg/m^2 (V8) were, in all cases, very significant.

In the extended cycle, the following pathogens were present in the tomato crop under high plastic tunnel: *Alternaria solani, Botrytis cinerea* and *Colletotrichum coccodes* (Fig. 9).

The sequence of their appearance was: *B. cinerea* (July, 22, on leaves), *A. solani* (July, 29, on leaves), *C. coccodes* (August, 10, on fruits) and *B. cinerea* (August, 19, on fruits).

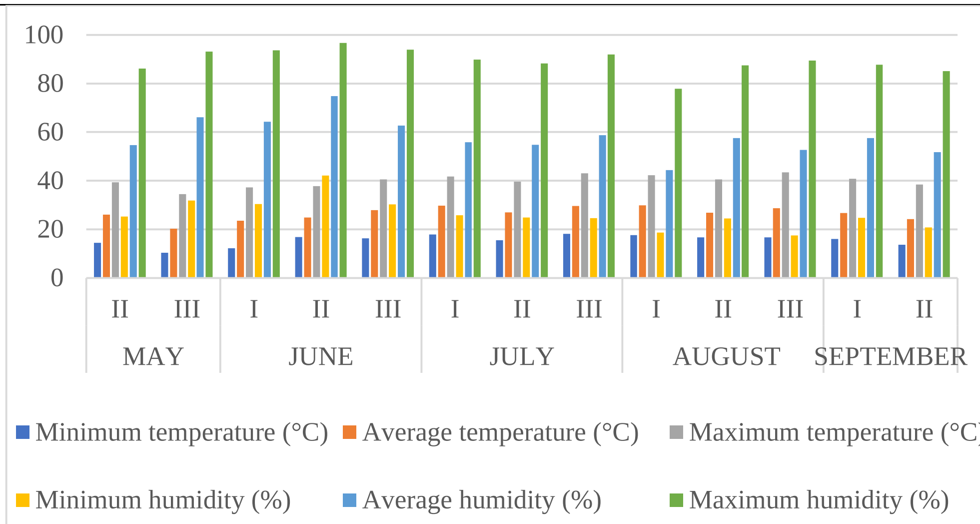
Table 4. Influence of treatments with different combinations of fungicides and insecticides on tomato yield under high plastic tunnel (cycle II, 2020) /
Influența tratamentelor cu diferite combinații de fungicide și insecticide asupra producției la cultura de tomate în solar (ciclul II, 2020)

Mix product	Concentration (%)	Yield (kg/m^2)	Relative yield (%)	The difference from the control (kg/m^2)	Significance
1. Signum + Poleci	0.15+0.05	6.225	112.9	+0.710	***
2. Signum + Alverde	0.15+0.1	6.468	117.2	+0.953	***
3. Signum + Vertimec 1,8 EC	0.15+0.08	6.275	113.8	+0.760	***
4. Cabrio Top + Poleci	0.2+0.05	6.190	112.2	+0.675	***
5. Cabrio Top + Alverde	0.2+0.1	6.475	117.4	+0.960	***
6. Cabrio Top + Vertimec 1,8 EC	0.2+0.08	6.223	112.8	+0.708	***
7. Amistar + Poleci	0.1+0.05	6.216	112.7	+0.701	***
8. Amistar + Alverde	0.1+0.1	6.510	118.0	+0.995	***
9. Amistar + Vertimec 1,8 EC	0.1+0.08	6.154	111.6	+0.639	***
10. Untreated control	-	5.515	-	-	-

LD 5%= 0.26; LD 1%= 0.36; LD 0,1%=0.47

Fig. 9 Anthracnose / Antracnoza
Colletotrichum coccodes

Their attack evolved gradually, being favored by the high maximum atmospheric humidity from June to September (85.1-96.7%) so that, in the second decade of September, it reached the following values: 16.3% (*A. solani*, on leaves), 18.2% (*B. cinerea*, on leaves), 7.5% (*B. cinerea*, on fruits) and respectively 5.5% (*C. coccodes*, on fruits) (Fig. 10).



*Alternaria solani**	0	0	0	0	0.7	1.8	4.2	7.9	9.2	11.1	13.2	14.8	16.3
*Botrytis cinerea (leaves)**	0	0	0	0	0.9	2.1	4.4	6.7	8.3	9.7	11.2	15.3	18.2
*Botrytis cinerea (fruits)**	0	0	0	0	0	0	0	0	0	0.5	1.7	4.8	7.5
*Colletotrichum coccodes (fruits)**	0	0	0	0	0	0	0	0	0.4	0.9	2.1	3.4	5.3

**) the degree of attack (%); / *) gradul de atac (%)*

Figure 10. Influence of climatic factors on the appearance and evolution of the attack of pathogens on tomato crops under high plastic tunnel (extended cycle, 2020) / *Influența factorilor climatici asupra apariției și evoluției atacului agenților patogeni la culturile de tomate din solar (ciclu prelungit, 2020)*

In the extended culture cycle, the following results were obtained (Table 5):

Table 5. Efficacy of some fungicides combinations in control of the pathogens on tomato crop under high plastic tunnel (extended cycle, 2020) / *Eficacitatea unor combinații de fungicide în combaterea agenților patogeni la cultura de tomate din solar (ciclu prelungit, 2020)*

Variant	Conc. (%)	Pathogens				Efficacy (%)				The average efficacy (%)
		A. s. (DA%)	*B. c.* leaves (DA%)	*B. c.* fruits (AF%)	*C. c.* (AF%)	*A. s.*	*B. c.* leaves	*B. c.* fruits	*C. c.*	
1. Signum + Cabrio Top	0.15+ 0.2	1.5	1.3	0.9	0.8	90.8	92.8	88.0	84.9	89.1
2. Ortiva Top + Switch	0.1+ 0.1	2.7	1.9	1.6	1.2	83.4	89.6	78.7	77.3	82.2
3. Cidely Top + Prolectus	0.1+ 0.12	3.0	2.4	2.0	1.4	81.6	86.8	73.3	73.6	78.8
4. Dagonis + Teldor	0.1+ 0.08	2.1	1.5	1.3	0.4	87.1	91.7	82.7	92.4	88.5
5. Untreated control	-	16.3	18.2	7.5	5.3	-	-	-	-	-

AF (%)=attack frequency; DA (%)=degree of attack;
A.s.=Alternaria solani; B.c.=Botrytis cinerea; C.c.=Colletotrichum coccodes.

The average efficacy of the tested fungicide combinations for the control of the pathogens *Alternaria solani*, *Botrytis cinerea* and *Colletotrichum coccodes* was between 78.8% (Cidely Top 0.15 + Prolectus 0.12%) and 89.1% (Signum 0, 15% + Cabrio Top 0.2%). The average efficacy of product combinations recorded the highest values in variants 1 (Signum 0.15% + Cabrio Top 0.2%; 89.1%) and 4 (Dagonis 0.1% + Teldor 0.08%; 88 ,5%).

Regarding the yields obtained, variants 1 (Signum 0.15% + Cabrio Top 0.2%) with 8.433 kg/m^2 and 4 (Dagonis 0.1% + Teldor 0.08%) with 8,350 kg/m^2 were in the first 2 places compared to 7,150 kg/m^2 in variant 5, untreated control (Table 6).

Table 6. Influence of treatments with different combinations of fungicides on tomato yield under high plastic tunnel (extended cycle, 2020) / *Influența tratamentelor cu diferite combinații de fungicide asupra producției la cultura de tomate din solar (ciclu prelungit, 2020)*

Variant	Concen- tration (%)	Yield (kg/m^2)	Relative yield (%)	The difference from the control (kg/m^2)	Significance
1. Signum + Cabrio Top	0.15+0.2	8.433	117.9	+1.283	***
2. Ortiva Top + Switch	0.1+0.1	8.270	115.7	+1.120	***
3. Cidely Top + Prolectus	0.1+0.12	8.225	115.0	+1.075	***
4. Dagonis + Teldor	0.1+0.08	8.350	116.8	+1.200	***
5. Untreated control	-	7.150	-	-	-

LD 5%= 0.28; LD 1%= 0.39; LD 0,1%= 0.56

The yield differences obtained in addition to the untreated control variant, between 1.075 kg/m^2 and 1.283 kg/m^2, were, in all cases, very significant.

CONCLUSIONS

1. In the I cycle of tomato grown under high plastic tunnels, the best efficacy in controlling the pathogens *Alternaria solani, Botrytis cinerea* and *Fulvia fulva* was recorded in variants 1 (Signum 0.15% + Cabrio Top 0.2%; average E = 96.8%) and 2 (Ortiva Top 0.1% + Switch 0.1%; average E =94.6%). Regarding the yields obtained, the following variants were noted: 1 (Signum 0.15% + Cabrio Top 0.2%) with 5.705 kg/m^2 and 4 (Dagonis 0.1% + Teldor 0.08%) with 5.571 kg /m^2, as compared to 4.983 kg/m^2 in variant 5, untreated control.
2. In the II cycle of tomato grown under high plastic tunnels, the efficacy of the tested combinations of pesticides, for the control of pathogens and pests (*Alternaria solani, Botrytis cinerea, Fulvia fulva, Tuta absoluta, Thrips tabaci, Helicoverpa armigera*) recorded the highest values for variants 3 (Signum 0.15% + Vertimec 1.8 EC 0.08%; average E =91.0%), 1 (Signum 0.15% + Poleci 0.05%; average E =90.2%) and 2 (Signum 0.15% + Alverde 0.1%; average E =88.3%). Referring to the obtained yield, the following variants were ranked in the first 3 places: 8 (Amistar 0.1% + Alverde 0.1%) with 6.510 kg/m^2, 5 (Cabrio Top 0.2% + Alverde 0 .1%) with 6.475 kg/m^2 and 2 (Signum 0.15% + Alverde 0.1%) with 6.468 kg/m^2, as compared to 5.515 kg/m^2 in variant 10 (untreated control).
3. In the extended crop cycle of tomatoes grown under high plastic tunnels, the average efficacy of the product combinations, in controlling the pathogens *Alternaria solani*, *Botrytis cinerea*, *Fulvia fulva* and *Colletotrichum coccodes*, recorded the highest values for variants 1 (Signum 0.15% + Cabrio Top 0.2%; 89.1%) and 4 (Dagonis 0.1% + Teldor 0.08%; 88.5%). Referring to the yields obtained, on the first two places were variants 1 (Signum 0.15% + Cabrio Top 0.2%) with 8.433 kg/m^2 and 4 (Dagonis 0.1% + Teldor 0.08%) with 8.950 kg/m^2 as compared to 7.150 kg/m^2 in variant 5, untreated control.

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CONTROL OF DAMAGE AGENTS ON MELONS AND CUCUMBERS CROPS UNDER HIGH PLASTIC TUNNELS

CONTROLUL AGENȚILOR DE DĂUNARE LA CULTURILE DE PEPENI GALBENI ȘI CASTRAVEȚI DIN SPAȚII PROTEJATE

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Abstract
The experiments were carried out in 2018, under high plastic tunnels conditions, in the first cycle (melons) and in the second cycle of crop (cucumbers). Pathogens and pests reported are common to melon and cucumber crops: Sphaerotheca fuliginea (powdery mildew), Pseudoperonospora cubensis (downy mildew), Alternaria cucumerina (alternaria leaf blight), Thrips tabaci (common thrips), Tetranychus urticae (two spotted spider mite) and Liriomyza trifolii (leaf miner). In the experiments of simultaneous control of pathogens in melons and cucumbers, the highest average efficacy was recorded for variant 2 (Melody Compact 49 WG 0.2% + Ortiva Top 0.1%; 88.7% on melons and 94.1% for cucumbers). With this variant, the highest yield was also obtained for melons (5.180 kg/sq.m.) and for cucumbers variant 4 (Aliette 80 WG 0.2% + Ortiva Top 0.1%; 3.698 kg/sq.m.). Referring to the complex control of pathogens and pests, for both melons and cucumbers, variant 5 (Ortiva Top 0.1% + Vertimec 1.8 EC 0.1%) stood out with an average efficacy of 88.9% and 91.1% respectively. This variant also recorded the highest yields: 8.920 kg/sq.m. for melons and 3.862 kg/sq.m. for cucumbers.

Key words: *melons, cucumbers, pathogens, pests, pesticides*

Rezumat
Experiențele au fost efectuate în anul 2018, în condiții de solar, în ciclul I de cultură (pepeni galbeni) și în ciclul II (castraveți). Agenții patogeni și dăunătorii semnalați sunt comuni pentru culturile de pepeni galbeni și castraveți: Sphaerotheca fuliginea (făinarea), Pseudoperonospora cubensis (mana), Alternaria cucumerina (alternarioza), Thrips tabaci (tripsul comun), Tetranychus urticae (păianjenul roșu comun) și Liriomyza trifolii (musca minieră). La experiențele de combatere simultană a agenților patogeni la pepenii galbeni și castraveți cea mai ridicată eficacitate medie s-a înregistrat la varianta 2 (Melody Compact 49 WG 0,2% + Ortiva Top 0,1%; 88,7% la pepenii galbeni și 94,1% la castraveți). La această variantă s-a obținut și cea mai mare producție la pepenii galbeni (5,180 kg/m^2), iar la castraveți varianta 4 (Aliette 80 WG 0,2% + Ortiva Top 0,1%; 3,698 kg/m^2). Referindu-ne la combaterea în complex a agenților patogeni și dăunătorilor, atât la pepenii galbeni cât și la castraveți s-a remarcat varianta 5 (Ortiva Top 0,1% + Vertimec 1,8 EC 0,1%) cu o eficacitate medie de 88,9% și respectiv 91,1%. La această variantă s-au înregistrat și cele mai mari producții: 8,920 kg/m^2 la pepenii galbeni și 3,862 kg/m^2 la castraveți.

Cuvinte cheie: *pepeni galbeni, castraveți, agenți patogeni, dăunători, pesticide*

INTRODUCTION

The experiments carried out at R.D.I.V.F.G. Vidra aimed to determine the compatibility of some fungicides for simultaneous control of pathogens and of some fungicides with different insecticides-acaricides for the complex control of pathogens and pests both in melon crops (cycle I of crop) and in cucumber crops (cycle II of crop).

The simultaneous control of pathogens and the complex of pathogens and pests aimed to reduce the number of treatments during the growing season (Costache et al., 2023).

The knowledge of the environmental factors involved in the appearance and evolution of the attack of pathogens on vegetable crops in protected areas is of particular importance both for establishing the optimal moments of application of treatments and for directing them to prevent the occurrence of diseases (Șovărel et al., 2022).

Cucumbers and melons are two important species grown under protected areas. The environmental conditions in the protected spaces, favorable to the growth and development of plants, are at the same time favorable for the appearance and evolution of the attack of harmful organisms that reduce yield quantitatively and depreciate it qualitatively.

Among the pathogens and pests with economic importance, which are common to melon and cucumber crops and occur practically every year, we mention: *Sphaerotheca fuliginea* (powdery mildew), *Pseudoperonospora cubensis* (downy mildew), *Alternaria cucumerina* (alternaria leaf blight), *Thrips tabaci* (common thrips), *Tetranychus urticae* (two spotted spider mite) and *Liriomyza* sp. (miner fly).

Powdery mildew, produced by *Sphaerotheca fuliginea*, forms visible white spots on the leaves surface, stems and petioles (Ni et Punja, 2021). The appearance of infections is favored by high relative humidity and the evolution of the attack at temperatures of 26-28°C (Ciu et al., 2022). Temperatures of 30 °C and higher are not favorable for powdery mildew development (Milod et al., 2021). Chemical-based fungicides and tolerant varieties are techniques used to control this pathogen (Rhouma et al., 2023). Difenoconazole is the active substance frequently used to control it (Elagamey et al., 2023).

Cucurbit downy mildew, caused by *Pseudoperonospora cubensis*, is an important disease affecting cucurbits worldwide (Kikiway et al., 2023). Infection occurs on cotyledons and true leaves (Cohen et al., 2014). Downy mildew causes significant yield losses under favorable environmental conditions: T=15-20°C, RH>95%, water droplets on plant foliage (Daunde et al., 2020, dos Santos et al., 2009). For *Pseudoperonospora cubensis*, the minimum temperature for infections is 1-9°C, and the maximum is 27-32°C. The optimum temperature is considered 15°C (Kenny, 2021).

The pathogen *Alternaria cucumerina* attacks the leaves, stem and fruit (Florea et Puia, 2020). Circular spots appear on the surface of the leaves (Mammetgulov et Yusubova, 2018). Humidity above 90% and high temperatures of 20°C-32°C are favorable for attack development (Yadav et al., 2022).

The thrips (*Thrips tabaci*), through its mode of feeding, affects foliage and flowers (Medshikar et al., 2022). The attack causes a reduced qualitative and quantitative yield (Wahsh et al., 2023).

The common red spider mite (*Tetranychus urticae*), is a polyphagous pest with a wide host range, including melons and cucumbers (Jawdah et al., 2024).

The miner fly (*Liriomyza trifolii*) is frequently encountered in melon crops, the larvae producing whitish galleries between the upper and lower epidermis of the leaves (Tahir et al., 2020).

MATERIAL AND METHODS

For melons, the control experiments were carried out in 2018, under high plastic tunnels conditions, in the first crop cycle, using the Festiv variety. They included 5 variants for simultaneous control and 7 variants for complex control, in 4 replicates, placed randomly.

The following products have been tested for pathogens and pests control: Melody Compact 49 WG 0.2% (iprovalicarb 84 g/kg+Cu as copper oxychloride 406 g/kg), King 0.05% (tebuconazole 250 g/l) , Ortiva Top 0.1% (azoxystrobin 200 g/l + difenoconazole 125 g/l), Aliette 80 WG 0.2% (aluminium fosetyl 80%), Mospilan 20 SG 0.04% (acetamiprid 20%), Vertimec 1.8 EC 0.1% (abamectin 18 g/l) and Laser 240 SC 0.05% (spinosad 240 g/l).

The experimental variants for the simultaneous control of pathogens in melons were: V1. Melody Compact 49 WG 0.2% + King 0.05%, V2. Melody Compact 49 WG 0.2% + Ortiva Top 0.1%, V3. Aliette 80 WG 0.2% + King 0.05%, V4. Aliette 80 WG 0.2% + Ortiva Top 0.1%, V5. Untreated control.

The experimental variants for the complex control of pathogens and pests in melons were: V1. Melody Compact 49 WG 0.2% + Mospilan 20 SG 0.04%, V2. Melody Compact 49 WG 0.2% +

Vertimec 1.8 EC 0.1%, V3. Melody Compact 49 WG 0.2% + Laser 240 SC 0.05%, V4. Ortiva Top 0.1% + Mospilan 20 SG 0.04%, V5. Ortiva Top 0.1% + Vertimec 1.8 EC 0.1%, V6. Ortiva Top 0.1% + Laser 240 SC 0.05%, V7. Untreated control. In both experiments, 4 treatments were applied, at 10-day intervals (June 26, 6, 16 and 26).

In cucumbers, the control experiments were carried out in the second crop cycle, using the Puccini F1 hybrid. The experimental variants for the simultaneous control of pathogens and in complex of pathogens and pests in cucumbers were the same as in melons. Five treatments were applied, at intervals of 10-11 days (September 3, 13, 24, October 4 and 15).

RESULTS AND DISCUSSIONS

In the experiments with melons, the attacks produced by *Sphaerotheca fuliginea* were manifested starting from the first decade of June (6.06; fig. 1), by *Pseudoperonospora cubensis* the third decade of June (21.06; Fig. 2) and by *Alternaria cucumerina* the first decade of July (9.07; Fig.3) being favored by the average temperature of ≈25°C and the relative humidity of ≈50% for *Sphaerotheca fuliginea*, by the average temperature of ≈23.0°C and the maximum relative humidity >95% for *Pseudoperonospora cubensis* and by the average temperature of ≈ 23°C and maximum relative humidity >80% for *Alternaria cucumerina*. The attack produced by *Thrips tabaci* started in the second decade of June (14.06), and that of *Liriomyza trifolii* in the third decade of June (26.06; Fig. 4).

Fig. 1. ***Sphaerotheca fuliginea*-**
Powdery mildew / Făinarea

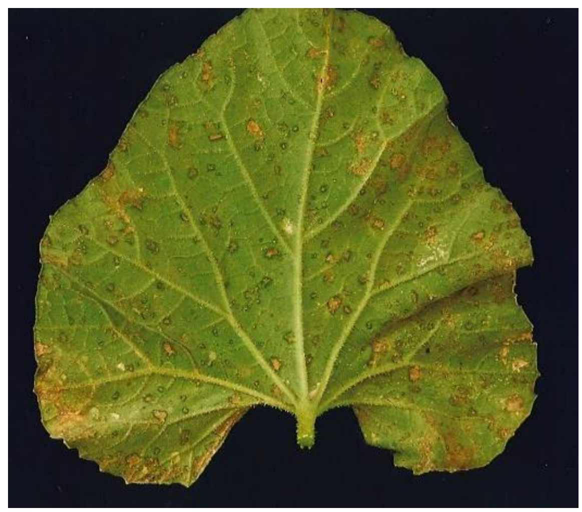


Fig. 2. ***Pseudoperonospora cubensis*-**
Downy mildew / Mana

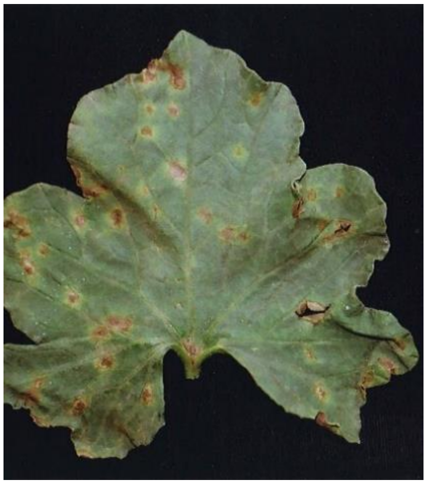
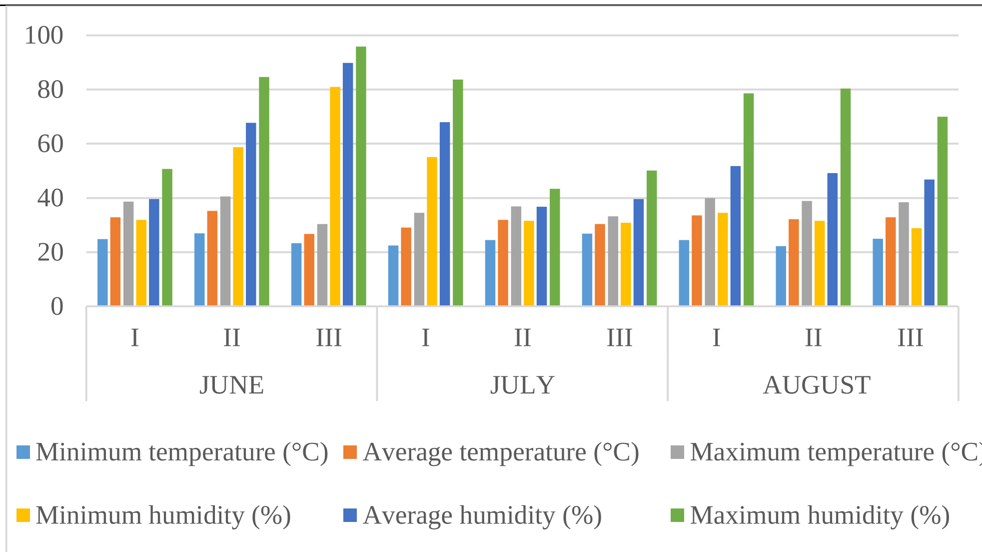


Fig. 3. *Alternaria cucumerina*-alternaria leaf blight / Alternarioza

Fig.4. *Liriomyza trifolii*-leaf miner / Musca minieră



Sphaerotheca fuliginea *	0.5	1.8	3.5	5.3	9.7	21.7	35.9	69.7	93.2
Pseudoperonospora cubensis *	0	0	0.8	1.7	2.9	4.5	6.1	7.8	10.3
Alternaria cucumerina *	0	0	0	0.4	1.2	2.7	4.1	6.9	8.2
Thrips tabaci *	0	0.4	0.9	1.8	4.5	9.2	14.2	19.3	26.6
Liriomyza sp. *	0	0	0.5	1.2	2.8	4.4	6.2	8.3	9.1

*) degree of attack
*) gradul de atac

Fig. 5. Influence of climatic factors on the appearance and evolution of the attack of pathogens and pests on the melons crop under high plastic tunnels (cycle I, 2018) /
Influența factorilor climatici asupra apariției și evoluției atacului agenților patogeni și dăunătorilor la cultura de pepeni galbeni din solarii (ciclul I, 2018)

The attack evolved gradually so that in the third decade of August it reached the following values: *Sphaerotheca fuliginea* (DA=93.2%), *Pseudoperonospora cubensis* (DA=10.3%), *Alternaria cucumerina* (DA=8.2%), *Thrips tabaci* (DA=26.6%) and *Liriomyza trifolii* (DA=9.1%; Fig. 5).

Combinations of the fungicides Melody Compact 49 WG 0.2% or Aliette 80 WG 0.2% with King 0.05% or Ortiva Top 0.1% ensured good protection of melon plants against the attack of pathogens *Sphaerotheca fuliginea*, *Pseudoperonospora cubensis* and *Alternaria cucumerina*, their average efficacy being between 77.5% (Aliette 80 WG 0.2% + King 0.05%) and 88.7% (Melody Compact 49 WG 0.2% + Ortiva Top 0.1%; Table 1).

Table 1. Efficacy of some fungicides combinations in simultaneous control of the pathogens on melon crop under high plastic tunnel (cycle I, 2018) /
Eficacitatea unor combinații de fungicide în combaterea simultană a agenților patogeni la cultura de pepeni galbeni din solar (ciclul I, 2018)

Var.	*Sphaerotheca fuliginea*		*Pseudoperonospora cubensis*		*Alternaria cucumerina*		Average efficacy (%)
	DA (%)	E (%)	DA (%)	E (%)	DA (%)	E (%)	
1.	14.7	84.3	3.2	87.1	2.1	83.5	85.0
2.	9.5	90.0	2.8	88.7	1.6	87.4	88.7
3.	17.8	81.2	4.1	83.5	4.1	67.7	77.5
4.	11.3	88.1	3.3	86.7	2.1	83.5	86.1
5.	94.9	-	24.9	-	12.7	-	-

DA=degree of attack

Regarding the obtained yields, the following variants were noted: V2 (Melody Compact 49 WG 0.2% + Ortiva Top 0.1%) with 5.180 kg/sq.m., V1 (Melody Compact 49 WG 0.2% + King 0.05%) with 5.120 kg/sq.m. and V4 (Aliette 80 WG 0.2% + Ortiva Top 0.1%) with 5.100 kg/sq.m. as compared to 3.180 kg/sq.m. for the V5 variant, untreated control, resulting in very significant differences (table 2).

Table 2. Influence of treatments with different fungicides combinations on melon yield under high plastic tunnel (cycle I, 2018) /
Influența tratamentelor cu diferite combinații de fungicide asupra producției la cultura de pepeni galbeni din solar (ciclul I, 2018)

Variant	Yield (kg/m^2)	The difference from the control (kg/m^2)	Relative yield (%)	Significance
1. Melody Compact 49 WG 0.2% + King 0.05%	5.120	+1.940	161.0	***
2. Melody Compact 49 WG 0.2% + Ortiva Top 0.1%	5.180	+2.000	162.9	***
3. Aliette 80 WG 0.2% + King 0.05%	4.950	+1.770	155.7	***
4. Aliette 80 WG 0.2% + Ortiva Top 0.1%	5.100	+1.920	160.4	***
5. Martor netratat	3.180	Mt	100.0	-

LD 5%=0.11; LD 1%=0.15; LD 0.1%=0.22

Referring to the complex control of pathogens and pests, the combinations of the fungicides Melody Compact 49 WG 0.2% or Ortiva Top 0.1% with Mospilan 20 SG 0.04%, Vertimec 1.8 EC 0.1% or Laser 240 SC 0.05% protected well melon plants against the attack of pathogens (*Sphaerotheca fuliginea, Pseudoperonospora cubensis* and *Alternaria cucumerina*) and pests (*Thrips tabaci* and *Liriomyza trifolii*), their average efficacy being between 81.2% (V1. Melody Compact 49 WG 0.2% + Mospilan 20 SG 0.04%) and 88.9% (V5. Ortiva Top 0.1% + Vertimec 1.8 EC 0.1%; table 3).

Table 3. Efficacy of some fungicides and insecticides-acaricides combinations in the complex control of the pathogens and pests on melon crop under high plastic tunnel (cycle I, 2018) /
Eficacitatea unor combinații de fungicide cu insecticide-acaricide în combaterea în complex a agenților patogeni și dăunătorilor la cultura de pepeni galbeni din solar (ciclul I, 2018)

Var.	*Sphaerotheca fuliginea*		*Pseudoperonospora cubensis*		*Alternaria cucumerina*		*Liriomyza trifolii*		*Thrips tabaci*		D.A. total (%)	Average efficacy (%)
	DA (%)	E (%)	DA (%)	E (%)	DA (%)	E (%)	DA (%)	E (%)	DA (%)	E (%)		
1.	69.8	25.1	2.2	78.6	1.9	76.8	4.4	51.6	1.7	93.6	10.2	81.2
2.	75.6	18.9	2.4	76.7	1.7	79.3	1.8	80.2	1.5	94.4	7.4	86.3
3.	71.6	23.2	2.5	75.7	2.2	73.2	2.5	72.5	2.8	89.5	10.0	81.5
4.	4.6	95.1	5.3	48.5	3.4	58.3	3.8	58.2	1.4	94.7	18.5	87.4
5.	4.9	94.7	5.0	51.4	3.7	54.9	1.6	82.4	1.2	95.5	16.4	88.9
6.	3.9	95.8	5.8	46.6	3.3	59.7	2.3	74.7	2.5	90.6	17.5	88.1
7.	93.2	-	10.3	-	8.2	-	9.1	-	26.6	-	54.2	-

The highest yields (table 4) were recorded for the V5 variants (Ortiva Top 0.1% + Vertimec 1.8 EC 0.1%) with 8.920 kg/sq.m., V6 (Ortiva Top 0.1% + Laser 240 SC 0.05%) with 7.970 kg/sq.m. and V4 (Ortiva Top 0.1% + Mospilan 20 SG 0.04%) with 7.860 kg/sq.m. as compared to 4.980 kg/sq.m. in V7, untreated control, resulting in very significant.

Table 4. Influence of treatments with different fungicides and insecticides-acaricides combinations on melon yield under high plastic tunnel (cycle I, 2018) /
Influența tratamentelor cu diferite combinații de fungicide și insecticide-acaricide asupra producției la cultura de pepeni galbeni din solar (ciclul I, 2018)

Variant	Yield (kg/m^2)	The difference from the control (kg/m^2)	Relative yield (%)	Significance
V1. Melody Compact 49 WG 0.2% + Mospilan 20 SG 0.04%	7.64	+2.660	153.2	***
V2. Melody Compact 49 WG 0.2% + Vertimec 1,8 EC 0.1%	7.78	+2.800	156.1	***
V3. Melody Compact 49 WG 0.2% + Laser 240 SC 0.05%	7.72	+2.740	154.9	***
V4. Ortiva Top 0.1% + Mospilan 20 SG 0.04%	7.86	+2.880	157.7	***
V5. Ortiva Top 0.1% + Vertimec 1,8 EC 0.1%	8.92	+3.940	178.9	***
V6. Ortiva Top 0.1% + Laser 240 SC 0.05%	7.97	+2.990	159.9	***
V7. Martor netratat	4.98	Mt	100.0	-

LD 5%=0.04; LD 1%=0.05; LD 0.1%=0.07

In the experiment with cucumbers, the attack of pathogens and pests manifested itself starting in September as follows: *Sphaerotheca fuliginea* (5.09; Fig 6), *Pseudoperonospora cubensis* (13.09; Fig. 7), *Alternaria cucumerina* (22.09), *Thrips tabaci* (15.09; Fig. 8) and *Tetranychus urticae* (21.09; Fig. 9). The attack of *Sphaerotheca fuliginea* was favored by the average temperature of ≈29.0°C, the attack of *Pseudoperonospora cubensis* was favored by the minimum temperature of ≈20.0°C and that produced by *Alternaria cucumerina* was favored by the average temperature of 23.0°C.

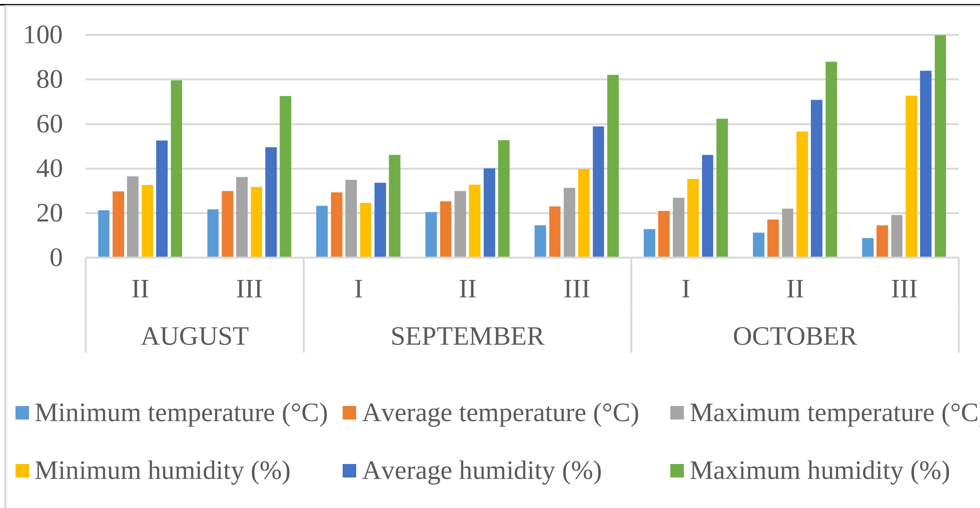
Fig. 6. ***Sphaerotheca fuliginea*-**
powdery mildew /
fãinarea

Fig. 7. ***Pseudoperonospora cubensis*-**
downy mildew /
mana

Fig. 8. ***Thrips tabaci*-common thrips /**
tripsul comun

Fig. 9. ***Tetranychus urticae*-**
two spotted spider mite /
păianjenul roșu comun

The observations made last time showed that the attack produced by *Sphaerotheca fuliginea* expanded (GA=58.7%), and the attack produced by *Pseudoperonospora cubensis* decreased considerably (GA=12.3%; Fig. 10).



*Sphaerotheca fuliginea**	0	0	0.7	3.5	15.8	32.4	47.3	58.7
*Pseudoperonospora cubensis**	0	0	0	0.2	1.3	3.9	8.1	12.3
*Alternaria cucumerina**	0	0	0	0	0.7	2.9	5.3	8.9
*Tetranychus urticae**	0	0	0	0	0.4	1.9	4.6	6.7
*Thrips tabaci**	0	0	0	0.5	1.9	5.8	9.1	11.0

*) degree of attack
*) gradul de atac

Fig. 10. Influence of climatic factors on the appearance and evolution of the attack of pathogens and pests on the cucumbers crop under high plastic tunnels (cycle II, 2018) / Influența factorilor climatici asupra apariției și evoluției atacului agenților patogeni și dăunătorilor la cultura de castraveți din solarii (ciclul II, 2018)

The combinations of the fungicides Melody Compact 49 WG 0.2% or Aliette 80 WG 0.2% with King 0.05% or Ortiva Top 0.1% ensured a good protection of cucumber plants against the attack of three pathogens, the average efficacy being between 93.0% (V3. Aliette 80 WG 0.2% + King 0.05%) and 94.1% (V2. Melody Compact 49 WG 0.2% + Ortiva Top 0.1%; Table 5).

Table 5 Efficacy of some fungicides combinations in simultaneous control of the pathogens on cucumbers crop under high plastic tunnel (cycle II, 2018) / Eficacitatea unor combinații de fungicide în combaterea simultană a agenților patogeni la cultura de castraveți din solar (ciclul II, 2018)

Var.	*Sphaerotheca fuliginea*		*Pseudoperono-spora cubensis*		*Alternaria cucumerina*		DA total (%)	Average efficacy (%)
	DA (%)	E (%)	DA (%)	E (%)	DA (%)	E (%)		
1	2.1	96.2	1.3	86.4	1.4	82.7	4.8	93.4
2	1.8	96.8	0.9	90.6	1.6	80.2	4.3	94.1
3	2.0	96.4	1.4	85.4	1.7	79.0	5.1	93.0
4	1.8	96.8	0.8	91.7	1.9	76.5	4.5	93.9
5	55.6	-	9.6	-	8.1	-	73.3	-

DA=degree of attack

Referring to the obtained yield (table 6), it can be seen that the highest values were recorded for the V4 variant (Aliette 80 WG 0.2% + Ortiva Top 0.1%) with 3.698 kg/sq.m. and V2 (Melody Compact 49 WG 0.2% + Ortiva Top 0.1%) with 3.693 kg/sq.m. as compared to 2.799 kg/sq.m. in the V5 variant, untreated control, resulting in very significant differences.

Table 6. Influence of treatments with different fungicides combinations on cucumbers yield under high plastic tunnel (cycle II, 2018) / Influența tratamentelor cu diferite combinații de fungicide asupra producției la cultura de castraveți din solar (ciclul II, 2018)

Variant	Yield (kg/m^2)	The difference from the control (kg/m^2)	Relative yield (%)	Significance
1. Melody Compact 49 WG 0.2% + King 0.05%	3.609	+0.810	128.9	***
2. Melody Compact 49 WG 0.2% + Ortiva Top 0.1%	3.693	+0.894	131.9	***
3. Aliette 80 WG 0.2% + King 0.05%	3.526	+0.727	125.9	***
4. Aliette 80 WG 0.2% + Ortiva Top 0.1%	3.698	+0.899	132.1	***
5. Martor netratat	2.799	Mt	100.0	-

LD 5%=0.04; LD 1%=0.06; LD 0.1%=0.08

Among the treatments variants, the best results in the complex control of pathogens (*Sphaerotheca fuliginea*, *Pseudoperonospora cubensis* and *Alternaria cucumerina*) and pests (*Thrips tabaci* and *Tetranychus urticae*) were obtained with the variants V5 (Ortiva Top 0.1% + Vertimec 1.8 EC 0.1%; average E =91.1%), V6 (Ortiva Top 0.1% + Laser 240 SC 0.05%; average E=87.3%) and V4 (Ortiva Top 0.1% + Mospilan 20 SG 0.04%; average E=86.1%; Table 7).

Table 7. Efficacy of some fungicides and insecticides-acaricides combinations in the complex control of the pathogens and pests on cucumbers crop under high plastic tunnel (cycle II, 2018) / Eficacitatea unor combinații de fungicide cu insecticide-acaricide în combaterea în complex a agenților patogeni și dăunătorilor la cultura de castraveți din solar (ciclul II, 2018)

Var.	*Sphaerotheca fuliginea*		*Pseudoperonospora cubensis*		*Alternaria cucumerina*		*Tetranychus urticae*		*Thrips tabaci*		DA total (%)	Average efficacy (%)
	DA (%)	E (%)	DA (%)	E (%)	DA (%)	E (%)	DA (%)	E (%)	DA (%)	E (%)		
1	26.7	54.5	2.6	79.4	2.1	76.4	3.8	43.3	2.7	77.1	37.9	61.6
2	25.3	56.9	3.1	75.4	1.9	78.6	0.5	92.5	2.5	78.8	33.3	66.3
3	23.7	59.6	2.8	77.8	1.7	80.9	3.2	55.2	1.5	88.1	32.9	66.7
4	1.8	96.9	3.7	70.6	2.0	77.5	4.1	38.8	2.1	82.2	13.7	86.1
5	1.6	97.3	3.4	73.0	1.8	79.8	0.3	95.5	1.7	85.6	8.8	91.1
6	1.9	96.8	3.3	73.8	1.6	82.0	3.8	43.3	1.9	84.0	12.5	87.3
7	58.7	-	12.6	-	8.9	-	6.7	-	11.8	-	98.7	-

DA=degree of attack

Referring to the obtained yields, the variants stood out: V5 (Ortiva Top 0.1% + Vertimec 1.8 EC 0.1%) with 3.862 kg/sq.m., V6 (Ortiva Top 0.1% + Laser 240 SC 0 .05%) with 3.780 kg/sq.m. and V4 (Ortiva Top 0.1% + Mospilan 20 SG 0.04%) with 3.753 kg/sq.m. as compared to V7, untreated control, with 2.993 kg/sq.m. (Table 8).

Table 8. Influence of treatments with different fungicides and insecticides-acaricides combinations on cucumbers yield under high plastic tunnel (cycle II, 2018) / Influența tratamentelor cu diferite combinații de fungicide și insecticide-acaricide asupra producției la cultura de castraveți din solar (ciclul II, 2018)

Variant	Yield (kg/m^2)	The difference from the control (kg/m^2)	Relative yield (%)	Significance
V1. Melody Compact 49 WG 0.2% + Mospilan 20 SG 0.04%	3.573	+0.580	119.4	***
V2. Melody Compact 49 WG 0.2% + Vertimec 1,8 EC 0.1%	3.692	+0.699	123.4	***
V3. Melody Compact 49 WG 0.2% + Laser 240 SC 0.05%	3.550	+0.557	118.6	***
V4. Ortiva Top 0.1% + Mospilan 20 SG 0.04%	3.753	+0.760	125.4	***
V5. Ortiva Top 0.1% + Vertimec 1,8 EC 0.1%	3.862	+0.869	129.0	***

V6. Ortiva Top 0.1% + Laser 240 SC 0.05%	3.780	+0.787	126.3	***
V7. Martor netratat	2.993	Mt	100.0	-

LD 5%=0.04; LD 1%=0.06; LD 0.1%=0.08

CONCLUSIONS

1. Melons and cucumbers crops grow under protected areas are attacked with an annual frequency by the pathogens *Sphaerotheca fuliginea, Pseudoperonospora cubensis, Alternaria cucumerina* and the pests *Thrips tabaci, Tetranychus urticae* and *Liriomyza trifolii*, which reduce yield quantitatively and depreciate it qualitative.
2. The product combination Melody Compact 49 WG 0.2% + Ortiva Top 0.1% provided the best average efficacy (88.7%) in the simultaneous control of pathogens in the melon crop. Regarding the obtained yield, the V2 variant (Melody Compact 49 WG 0.2% + Ortiva Top 0.1%) stood out, with 5.180 kg/sq.m., as compared to 3.180 kg/sq.m. for the V5 variant, untreated control.
3. The combination of products Ortiva Top 0.1% + Vertimec 1.8 EC 0.1% showed the best average efficacy (88.9%) in the complex control of pathogens and pests in melon culture. The highest yield was recorded for the V5 variant (Ortiva Top 0.1% + Vertimec 1.8 EC 0.1%) with 8.920 kg/sq.m., as compared to 4.980 kg/sq.m. for V7, the untreated control.
4. The fungicides combination Melody Compact 49 WG 0.2% + Ortiva Top 0.1% provided the best average efficacy (94.1%) in the simultaneous control of pathogens in cucumber crop. Referring to the obtained yield, it was found that the highest value was recorded for the V4 variant (Aliette 80 WG 0.2% + Ortiva Top 0.1%) with 3.698 kg/sq.m. as compared to 2.799 kg/sq.m. for the V5 variant, untreated control.
5. The combination of products Ortiva Top 0.1% + Vertimec 1.8 EC 0.1% had the best average efficacy (91.1%) in the complex control of pathogens and pests in cucumber crop. Regarding the obtained yield, the V5 variant (Ortiva Top 0.1% + Vertimec 1.8 EC 0.1%) stood out with 3.862 kg/sq.m., as compared to V7, the untreated control, with 2.993 kg/sq.m.

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BOOSTING TOMATOES NATIVE RESISTANCE TO ABIOTIC STRESS THROUGH EXOGENOUS SALICYLIC ACID UTILIZATION IN TISSUE CULTURE TECHNIQUES "IN VITRO"

STIMULAREA REZISTENȚEI NATURALE A PLANTELOR DE TOMATE LA STRESUL ABIOTIC PRIN INTEGRAREA ACIDULUI SALICILIC ÎN CULTURILE DE ȚESUTURI "IN VITRO"

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Abstract
Tomato (Solanum lycopersicum Mill.) is a vital crop facing increased abiotic stress due to climate change. Drought, salinity, and temperature fluctuations can severely impact growth and yield. This study examines using salicylic acid (SA) in tissue culture to enhance tomato plants' resistance to abiotic stress "in vitro." Tomato plants were cultured in controlled "in vitro" conditions with varying SA concentrations (1 mM/l, 0.5 mM/l, and 0.1 mM/l) in MS 1962 media. We assessed seed germination, shoot initiation, root development, and physiological parameters (phenolic and chlorophyll content). Results show that SA application significantly improves stress tolerance, enhancing plant growth and chlorophyll levels while reducing oxidative stress. SA-treated plants upregulate stress-responsive genes, activating defense mechanisms against abiotic stress. Using SA in tissue culture shows promise for sustainable agriculture by boosting tomato plants' native defenses against environmental challenges, mitigating yield losses, and enhancing food security and agricultural sustainability. This approach offers insights into developing strategies to improve crop resilience amid changing environmental conditions.

Keywords: *salicylic acid; in vitro; sustainable; vegetable; breeding.*

Rezumat
Cultura de tomate (Solanum lycopersicum Mill.) reprezintă o cultură importantă care se confruntă cu stresul abiotic crescut din cauza schimbărilor climatice. Seceta, salinitatea și fluctuațiile de temperatură pot avea un impact grav asupra creșterii și randamentului. Acest strudiu urmărește utilizarea acidului salicilic (SA) în cultura de țesuturi pentru a spori rezistența plantelor de tomate la stresul abiotic „in vitro". Plantele de tomate au fost crescute în condiții controlate „in vitro" cu diferite concentrații de SA (1 mM/l, 0,5 mM/l și 0,1 mM/l) în mediul MS 1962. A fost evaluată germinația semințelore, formarea lăstarilor, dezvoltarea rădăcinilor și parametrii fiziologici (conținutul de fenoli și clorofilă). Rezultatele arată că aplicarea SA îmbunătățește semnificativ toleranța la stres, sporind creșterea plantelor și nivelul de clorofilă, reducând în același timp stresul oxidativ. Plantele tratate cu SA reglează în mod pozitiv genele sensibile la stres, activând mecanismele de apărare împotriva stresului abiotic. Utilizarea SA în cultura de țesuturi se arată promițătoare pentru agricultura durabilă prin stimularea apărării native a plantelor de tomate împotriva provocărilor legate de mediu, atenuarea pierderilor de randament și sporirea securității alimentare și a durabilității agriculturii. Această abordare oferă perspective pentru dezvoltarea de strategii de îmbunătățire a rezistenței culturilor pe fondul schimbărilor condițiilor de mediu.

Cuvinte cheie*: acid salicilic; in vitro; sustenabilitate; legume; ameliorare.*

INTRODUCTION

In the contemporary context of agricultural sustainability, the quest for enhancing crop resilience to abiotic stressors has gained significant importance (Suprasanna, 2020). Amongst crops, tomatoes (*Solanum lycopersicum*) hold an important economic and nutritional value worldwide (Bai *et al.*, 2016; Kumar *et al.*, 2020, 2021). However, their susceptibility to various environmental stressors such as drought, salinity, and temperature extremes poses a formidable challenge to sustainable production. Conventional breeding efforts have often fallen short in conferring robust stress tolerance, necessitating novel approaches to fortify tomato plants against such adversities (Joseph, Jini and Sujatha, 2010).

In recent years, the regulatory role of salicylic acid (SA) in plant defense responses has garnered considerable attention. Beyond its well-established function in combating biotic stressors, SA has emerged as a key signaling molecule involved in orchestrating plant responses to abiotic stress. Its ability to activate defense mechanisms and regulate physiological processes makes it a promising candidate for boostering plant resilience to environmental challenges (Ahmed *et al.*, 2020; Lefevere, Bauters and Gheysen, 2020).

Tissue culture techniques “in vitro” represent a powerful tool for precise manipulation of plant physiology and genetics (Ghosh, Igamberdiev and Debnath, 2021). By providing controlled environments conducive to cellular proliferation and differentiation, tissue culture offers unparalleled opportunities for studying plant responses to exogenous compounds like SA. Moreover, the ability to manipulate growth conditions and hormone levels in vitro facilitates the optimization of SA uptake and utilization by tomato tissues (Joseph, Jini and Sujatha, 2010; Ngullie, Tank and Bhanderi, 2014; Giri and Giri, 2022; Singh *et al.*, 2023).

This paper aims to delve into the intricate interplay between exogenous SA application, tissue culture methodologies, and tomato stress resilience. Through a comprehensive review of existing literature and experimental findings, we seek to elucidate the underlying mechanisms by which SA enhances tomato plant tolerance to abiotic stressors. Firstly, we will explore the molecular mechanisms underlying SA-mediated stress responses in tomato plants. By examining the activation of defense-related genes, modulation of antioxidant systems, and regulation of stress-responsive signaling pathways, we aim to unravel the intricate network through which SA confers stress tolerance. Secondly, we will delve into the optimization of tissue culture protocols for SA application in vitro. This will include discussions on callus induction, organogenesis, and regeneration techniques tailored to maximize SA uptake and integration into tomato tissues. Furthermore, we will assess the efficacy of SA in mitigating specific abiotic stressors commonly encountered by tomato plants, including drought, salinity, and temperature extremes. Through a series of controlled experiments, we aim to quantify the impact of SA supplementation on plant growth, physiological parameters, and yield under stress conditions. Finally, we will discuss the broader implications of our findings for sustainable agriculture. By elucidating the potential of SA-mediated stress mitigation in tomato production, we hope to contribute to the development of innovative strategies for enhancing crop resilience and ensuring food security in the face of escalating environmental challenges.

In summary, this paper represents a comprehensive exploration of the synergistic relationship between exogenous SA application, tissue culture techniques, and tomato stress resilience. By bridging the gap between fundamental research and practical applications, we aspire to pave the way for the development of sustainable agricultural practices tailored to the challenges of the 21st century.

MATERIALS AND METHODS

Seeds of the Roma genotype were selected as the plant material for this study. The experiments were conducted at the Vegetable Research and Development Station in Bacau, within the Laboratory of Tissue Culture "in vitro." The primary objective was to assess the impact of exogenous salicylic acid (SA) application on tomato plants' response to abiotic stress. The seeds underwent surface sterilization to ensure aseptic conditions for subsequent tissue culture experiments. This process involved immersion in a 0.1% mercuric chloride ($HgCl_2$) solution for 10 minutes, followed by thorough rinsing with sterile distilled water to remove any residual sterilizing agent. Murashige Skoog (MS, 1962) medium was selected as the basal growth medium. The medium was supplemented with 30 g/l sucrose to provide a carbon source for plant growth. Agar was added at a concentration of 8.0 g/l to solidify the medium. Three different concentrations of salicylic acid (1 mM, 0.5 mM, and 0.1 mM) were incorporated into the medium to evaluate their effects on plant growth and stress tolerance. The pH of the medium was adjusted to 5.8 using appropriate buffer solutions.

Sterilized seeds were plated on the prepared MS medium and placed under controlled conditions conducive to germination and seedling growth. The germination indices were recorded to assess the efficacy of various salicylic acid concentration. One-week-old seedlings were utilized as a source of explants for subsequent tissue culture experiments. The apical and hypocotyl explants were excised from the one-week-old seedlings and transferred to the prepared MS medium supplemented with different concentrations of salicylic acid. Four treatment variants were established: V0 (control without SA), V1 (1 mM SA), V2 (0.5 mM SA), and V3 (0.1 mM SA). Each variant was replicated three times to ensure the reliability of the results. The tissue cultures were maintained under controlled environmental conditions. The incubation temperature was set at 26±1°C to provide optimal conditions for plant growth and development. A 16-hour photoperiod with a light intensity of 5000 lx was maintained to simulate natural light conditions conducive to photosynthesis.

Sub-culturing of the tissue cultures was performed at 30-day intervals to prevent overcrowding and ensure continued growth. Daily observations were made to monitor the growth and development of the explants, as well as any morphological or physiological changes induced by the different SA concentrations. The rooted plantlets underwent a transition to hydroponic conditions within bottles to facilitate acclimatization, while concurrently, the newly formed shoots were transplanted into fresh media to advance the microclonation stage of development. To ensure optimal growth conditions, pots containing the hydroponic solution, which included Previcur 0.15%, were enveloped in clear bags, maintaining a relative humidity of 100%. These setups were then positioned within an acclimatization room characterized by a 16-hour light/8-hour dark photoperiod and temperatures ranging between 20°C and 23°C.

Subsequently, the acclimatized plants were transferred into a potting mixture comprising sterilized sand and vermiculite in a 1:1 ratio, accommodated within plastic cups. These plants underwent a hardening process within a mist chamber, where relative humidity levels were maintained at 80%, for a duration of 2 weeks prior to their eventual transfer to the greenhouse environment.

Chlorophyll content was assessed following the methodology outlined by Lichtenthaler (1987). Fresh plant samples weighing 0.1 g were homogenized and subjected to extraction using 80% acetone. The resulting mixture was centrifuged for 10 minutes at 3,530 rpm using the Hettich Universal Centrifuge 320 | 320 R. Subsequently, the supernatant (SN) was collected, and the absorbance at wavelengths of 470 nm, 647 nm, and 663 nm was measured using a UV-VIS spectrophotometer.

The concentrations of chlorophyll a (Cla), chlorophyll b (Clb), and carotenoids (Car) were determined utilizing the following formulas:

Chlorophyll a (Cla) concentration (mg/L) = 12.25 * Abs 663 nm - 2.79 * Abs 647 nm

Chlorophyll b (Clb) concentration (mg/L) = 21.50 * Abs 647 nm - 5.10 * Abs 663 nm

Carotenoids (Car) concentration (mg/L) = (1000 * Abs 470 nm - 1.82 * Cla - 85.02 * Clb)/198

The data obtained from the tissue culture experiments were subjected to statistical analysis using analysis of variance (ANOVA) to determine the significance of the observed effects. Mean values and standard deviations were calculated for each treatment variant to facilitate comparison and interpretation of the results.

RESULTS AND DISCUSSIONS

In our experimental investigation of cultivation techniques, particularly focusing on the impact of varying concentrations of salicylic acid (SA), we observed a notable delay in seed germination associated with the application of 1 mM SA. Specifically, compared to control conditions without SA supplementation, seeds subjected to this concentration exhibited a delay in germination of nearly three days. This delay suggests a significant alteration in the physiological processes governing seed dormancy release and germination initiation in response to SA.

Furthermore, upon germination, plants exposed to 1 mM SA exhibited conspicuous root deficiencies, manifesting as a spectrum of developmental anomalies ranging from a complete absence of root formation to the production of markedly stunted and aberrant root structures. This observation indicates a disruption in root development and elongation processes under the influence of elevated SA levels (figure 1 a, b).

Additionally, the abnormal morphology of roots observed in SA-treated plants, characterized by reduced size and irregular architecture, further underscores the detrimental effects of excessive SA concentrations on root growth and differentiation. Such aberrant root phenotypes may compromise the plant's ability to efficiently explore soil resources and establish a robust root system essential for optimal growth and productivity.

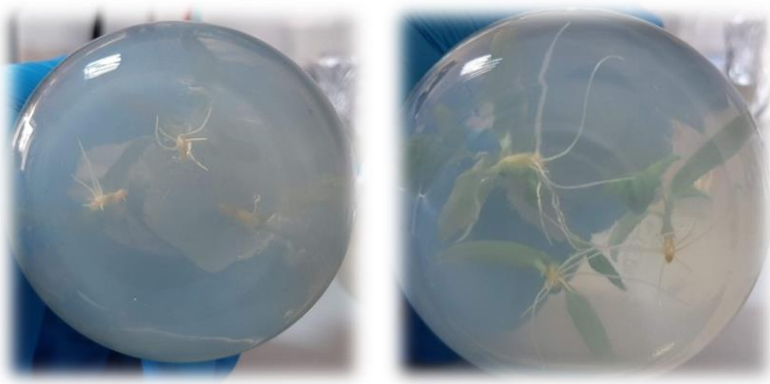

Figure 1 a,b. Root development under the influence of salycilic acid / *Figura 1 a,b. Dezvoltarea rădăcinilor sub influența acidului salicilic*

Our investigation unveiled a contrasting scenario with the application of a 0.1 mM SA concentration. In this instance, seed germination dynamics mirrored those of the control variant, with no discernible delay observed. Notably, the presence of SA in the culture medium exerted a positive influence on both germination rates and shoot growth, leading to enhanced seedling vigor and development. This augmentation in growth parameters indicates a stimulatory effect of SA at lower concentrations, whereby the hormone serves as a growth-promoting agent, facilitating the progression of seedling development.

The contrasting responses elicited by different SA concentrations underscore the importance of dosage-dependent effects in modulating plant physiological processes. While higher SA concentrations impede germination and root development, lower concentrations can elicit beneficial effects on seedling growth and vigor. These findings highlight the intricacies of SA-mediated signaling pathways and their nuanced impacts on plant growth and development.

Regarding the morphogenetic response of explants, our observations revealed distinct outcomes depending on the type of explant utilized. Apexes emerged as the more favorable choice for cultivation, exhibiting pronounced morphogenetic activity. Notably, new shoots rapidly initiated at the base of the apex explants, showcasing robust shoot proliferation and elongation. The addition of 0.1 mM SA further augmented this process, promoting enhanced shoot multiplication and elongation, thus underscoring the positive impact of low SA concentrations on shoot development.

In contrast, hypocotyls demonstrated a distinct morphogenetic pattern, primarily yielding roots with limited shoot formation. Interestingly, at the base of some hypocotyl explants, shoots emerged, progressing into fully developed plants (figure 2). This observation suggests a dynamic response of hypocotyls to SA treatment, with the potential for both root and shoot development depending on the local microenvironment and hormonal cues.

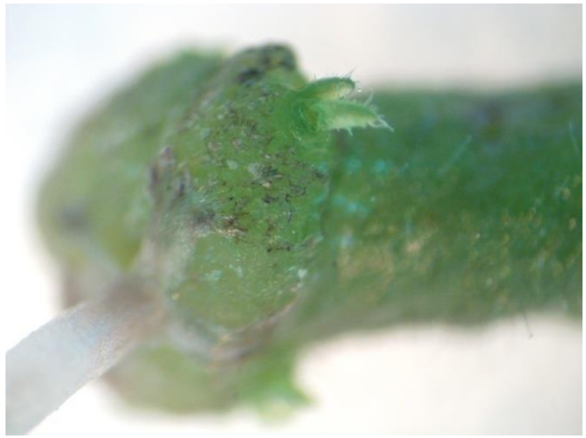

Figure 2. Shoots emerging from hypocotyl tissue / *Figura 2. Lăstari care apar din țesutul hipocotilului*

Quantitatively, the percentage of explants generating shoots varied across different SA concentrations. In media with reduced SA concentrations, approximately 90% of explants exhibited shoot formation, indicating a high level of responsiveness to the culture conditions. However, a notable decrease in explant response was observed with the highest SA concentration (1 mM), with only 68.00% of explants generating shoots. This reduction in shoot-producing explants suggests a dose-dependent effect of SA on morphogenetic responses, wherein higher concentrations may exert inhibitory effects on shoot initiation and development. Our findings revealed compelling evidence of SA's pronounced influence on the temporal dynamics of shoot initiation, as well as its significant enhancement of shoot and root elongation compared to the control variant.

The application of SA at concentrations of 0.1 mM and 0.5 mM exerted a remarkable effect on the timing of shoot initiation. We observed a notable reduction in the time required for shoot initiation in SA-treated samples compared to the control group. This accelerated onset of shoot emergence suggests that SA plays a pivotal role in stimulating the transition from meristematic to shoot-forming tissues, thereby expediting the initiation of shoot development.

Furthermore, our analyses unveiled a striking increase in both shoot and root elongation in response to SA supplementation. Shoots exhibited enhanced elongation rates, resulting in taller and more vigorous plantlets compared to those in the control group. Additionally, roots displayed a similar trend of accelerated growth, with SA-treated plants manifesting longer and more extensively developed root systems. This augmentation in shoot and root elongation highlights the growth-promoting properties of SA, which act synergistically to enhance overall plant vigor and development.

Notably, the magnitude of these effects was particularly pronounced at SA concentrations of 0.1 mM and 0.5 mM, surpassing the performance of the control variant. This observation underscores the dose-dependent nature of SA's influence on shoot and root growth, wherein optimal concentrations stimulate maximal growth responses while higher concentrations may lead to diminishing returns or even inhibitory effects (Table 1).

Table 1. Effects of different concentrations of SA in MS medium for multiple shoot induction at tomatoes after 60 days of culture – means ±SE / *Tebel 1.* *Efectele diferitelor concentrații de SA în mediul MS pentru inducerea de lăstari multipli la tomate după 60 de zile de cultură - medii ±SE*

Variant / Varianta	**% of explant showing response /** % explante care au reactionat	**Average no. of shoots /** Nr. mediu de lastari
V0 - Control	75.1	21.6±1.1
V1-1 mM SA	68.0	9.0±0.6
V2-0,5 mM SA	88.3	32.1±0.5
V3-0.1 mM SA	97.2	38.9±1.8

Overall, our detailed analysis highlights the intricate interplay between exogenous SA application and the morphogenetic responses of tomato explants (Figure 3). The differential effects observed between apexes and hypocotyls, as well as the influence of SA concentration on shoot formation, provide valuable insights into the regulatory mechanisms governing plant growth and development in tissue culture settings.

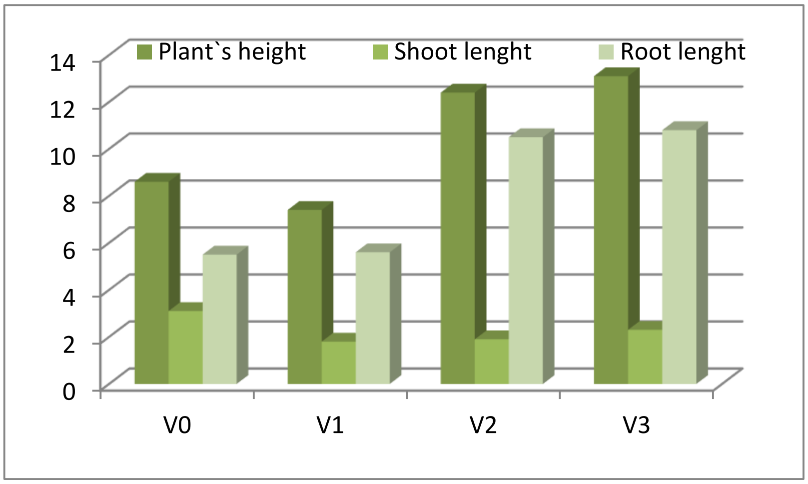

Figure 3. Biometric measurements on tomatoes plants cultivated on media supplemented with different concentration of SA / *Măsurători biometrice la plantele de tomate cultivate pe medii suplimentate cu diferite concentrații de SA*

Following root development, the plantlets (Figure 4) were transitioned into hydroponic conditions within bottles. To prepare them for this new environment, a hardening process was initiated. During the initial week of hardening, the plantlets were exposed to high humidity levels, maintained at 90% RH. Subsequently, the humidity was gradually reduced over the following days. This meticulous adjustment in environmental conditions contributed to the successful acclimatization of the plantlets to hydroponic cultivation. Notably, this method resulted in an impressive survival rate of over 95%, indicating the effectiveness of the hardening process in ensuring the plantlets' adaptation to their new growing conditions.

Figure 4. Tomatoes plants in hydroponic conditions / *Figura 4. Plante de tomate în condiții hidroponice*

The inclusion of the SA elicitor at a concentration of 0.1 mM in the culture medium resulted in a notable increase in total chlorophyll content compared to the control group. Conversely, when higher concentrations of SA were added to the media, the chlorophyll a (Chl a) content remained similar to or slightly lower than that of the control samples. These findings are consistent with previous research conducted on various crops, as reported by Khan et al. (2003) and Khodary (2004).

This observed enhancement in total chlorophyll content with the addition of 0.1 mM SA suggests a stimulating effect of this concentration on chlorophyll biosynthesis or retention within plant tissues. However, at higher SA concentrations, any potential benefits to chlorophyll content may become saturated or offset by other physiological responses induced by elevated SA levels.

Furthermore, our results underscore the importance of SA in modulating photosynthetic pigment content and, consequently, photosynthetic efficiency across different plant species. This aligns with the broader understanding of SA as a signaling molecule capable of regulating various physiological processes related to plant growth and stress responses.

CONCLUSIONS

At a concentration of 1 mM SA, our experiments revealed a pronounced delay in seed germination, with the emergence of seedlings occurring nearly three days later compared to the control variants devoid of SA supplementation. This delay underscores a notable alteration in the temporal regulation of germination processes, likely influenced by the exogenous application of SA. Concurrently, examination of root development in plants subjected to this concentration revealed significant deficiencies, ranging from the complete absence of root structures to the formation of exceedingly small and morphologically aberrant roots. These observations collectively suggest a disruption in the normal developmental trajectory of roots, attributable to the inhibitory effects of elevated SA levels on root growth and differentiation processes.

Our detailed analyses demonstrate that SA, when applied at concentrations of 0.1 mM and 0.5 mM, significantly accelerates shoot initiation, enhances shoot and root elongation, and promotes overall plant growth in tomato tissue culture. These findings shed light on the mechanisms underlying SA-mediated growth regulation and have important implications for the optimization of tissue culture protocols aimed at improving plant propagation and productivity.

The results show that a concentration of 1mM SA inhibited both seed germination and shoot development, which is probably related with supression of GA-mediated pathway. Instead, the addition of 0.1 mM SA stimulated shoot proliferation rate, shortened the time for shoot initiation and increased shoot and root elongation. The content in phenolyc and chlorophyll was higher in plants regenerated on this variant also, which indicates the beneficial effect of addition of 0.1mM SA on defence related processes. Our results provide the foundation of further studies related to the plant`s agronomic performances when cultivated in the field.

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EVALUATION OF ENTOMOPATHOGENIC ACTIVITY OF NATIVE FUNGAL STRAINS AGAINST HORTICULTURAL PESTS

CERCETĂRI PRIVIND PATOGENICITATEA UNOR TULPINI FUNGICE ENTOMOPATOGENE AUTOHTONE ASUPRA UNOR DĂUNĂTORI HORTICOLI

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Abstract
The discovery of effective entomopathogens with biotechnological potential offers a potentially sustainable and cost-effective approach to managing insect pest populations. From a biological control perspective, the defining characteristic of these microorganisms is their host-specific pathogenicity and virulence towards target insect pests. Native fungal strains often outperform imported commercial strains due to their better adaptation to local soil microbiome, climate, and agricultural conditions. The primary objective of this study was to investigates the potential of native entomopathogenic fungi, isolated from natural outbreaks in Romania, in controlling both two key insect pests of protected crops, the green peach aphid (Myzus persicae) (Sulzer) (Hemiptera: Aphididae) and the greenhouse whitefly (Trialeurodes vaporariorum) (Westwood) (Homoptera: Aleyrodidae). In the laboratory trials, all tested isolates significantly reduced M. persicae populations by 62-73% at all three concentrations, demonstrating their effectiveness in controlling aphid populations. Whitefly nymphs exhibited the lowest susceptibility to the treatments, with mortality rates not exceeding 55%, fourteen days after exposure. The integration of bioinsecticides (based on these selected strains) with compatible biological control methods offers a promising strategy for the management of aphids and whiteflies. Further investigation is crucial to evaluate the efficacy and long-term viability within an IPM framework.

Keywords: *entomopathogens, green peach aphid, greenhouse whitefly, IPM*

Rezumat
Descoperirea unor entomopatogeni cu potențial biotehnologic oferă o abordare sustenabilă și rentabilă pentru gestionarea dăunătorilor. Din perspectiva controlului biologic, caracteristica definitorie a acestor microorganisme este patogenitatea și virulența față de insectele dăunătoare țintă. Tulpinile fungice autohtone depășesc adesea performanțele tulpinilor comerciale importate, datorită adaptării lor superioare la microbiota solului, la climă și la condițiile agricole. Obiectivul principal al acestui studiu a fost investigarea potențialului unor tulpini fungice, izolate din focare naturale din România, pentru controlul a doi dăunători cheie din culturile protejate: Myzus persicae (Sulzer) (Hemiptera:Aphididae) și Trialeurodes vaporariorum (Westwood) (Homoptera:Aleyrodidae). În testele de laborator, toate tulpinile testate au redus semnificativ populațiile de M. persicae cu 62-73% la toate cele trei concentrații, demonstrând eficacitatea lor în controlul populațiilor de afide. Larvele musculiței albe au prezentat cea mai scăzută sensibilitate la tratamente, cu rate de mortalitate care nu au depășit 55% la 14 zile după expunere. Integrarea bioinsecticidelor (formulate cu aceste tulpini selectate) cu metode compatibile de control biologic oferă o strategie promițătoare pentru gestionarea afidelor și musculiței albe. Investigații suplimentare sunt necesare pentru a evalua eficacitatea și viabilitatea pe termen lung în cadrul unui program de Management Integrat al Dăunătorilor.

Cuvinte cheie: *entomopatogeni, păduchele verde al piersicului, musculița albă de seră, IPM*

INTRODUCTION

Plant-parasitic insects with piercing-sucking mouthparts, such as whiteflies and aphids, cause direct feeding injury and act as primary vectors for plant viruses and bacterial pathogens. Alongside aphids, whiteflies rank among the world's most devastating insect pests, inflicting substantial economic losses on a diverse range of crops in temperate and tropical regions (Emden and Harrington, 2022). These damaging pests target a wide variety of crops, from grains and brassicas to potatoes, vegetables, fruits, and ornamentals. Organic greenhouse and tunnels production in Romania faces a significant challenge in controlling these pests. High annual crop losses in organic farms from Romania highlight the limitations of current biocontrol methods, such as organic products, mineral oils, and arthropod predators or parasitoids. Romania's sole authorized commercial entomopathogen, as listed in the EU Pesticides Database, is *Paecilomyces fumosoroseus* (Wize) Brown and Smiths (Ascomycota: Hypocreales), strain Fe9901. This fungus-based product is approved for controlling the western flower thrips - *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) and the greenhouse whitefly (*T. vaporariorum*) in tomato, pepper, eggplant, pumpkin, zucchini, green beans, lentils, watermelon, cucumber, and ornamental plant crops.

Developing alternative solutions is crucial to ensure economic sustainability in horticultural and agricultural production. An evident expansion in the volume of agricultural land under organic farming (including land in conversion and maintenance) has been registered in Romania since 2017. By 2021, this area had reached 578,718 hectares, reflecting a remarkable 123% growth compared to 2017, demonstrating Romania's unwavering commitment to a sustainable agricultural development (EC, 2023; Eurostat, 2024).

Fungal pathogens have emerged as a prominent area of research in biological control for insects, weeds, and diseases over the past 60 years (Jackson et al., 2009; Faria & Wraight, 2001; Charudattan, 2001). Entomopathogenic fungi constitute a unique class of soil-inhabiting microorganisms capable of infecting and causing mortality in insects and other arthropods by penetrating their protective cuticles. Although entomopathogenic fungi are currently used in agriculture for insect pest management, research suggests a broader range of applications. These fungi can act not only as insect biocontrol agents but also as endophytes, benefiting plants by promoting growth and resistance to pathogens (Mantzoukas et al., 2022).

The superior performance of native (=autochthonous=indigenous=local) strains over exotic (imported) commercial strains can often be attributed to their enhanced interactions with the resident soil microbial community and their optimal adaptation to local agro-ecological and climatic conditions (Jofre et al., 2023; Knežević, et al., 2022; Pérez-Rodriguez et al., 2020).

Some authors consider that selection of autochthonous strains mitigates the risk of foreign strain introduction, thereby safeguarding the indigenous microbiome and maintaining ecosystem stability (Paganin et al., 2024). Extensive research supports their superior performance within their natural climatic zones, suggesting a paradigm shift in bio-fertilizer functionality and effectiveness compared to existing approaches. The potential of native microorganisms for agriculture has generated significant research interest in recent years: native plant growth-promoting bacteria exhibit advantages as bio-fertilizer agents for wheat due to their local adaptation (Asghar et al., 2023), native Rhizobium exhibit superior performance compared to non-native strains in improving nodulation and productivity of French bean (Phaseolus vulgaris L.) (Athul et al., 2022), a study revealed that using native microbial consortia significantly enhances the development of both shoots and roots in maize plants (Guardiola-Márquez et al., 2021). The importance of utilizing native strains of microorganisms is also echoed in other fields, such as: poultry farming - indigenous microbial consortia, when included in chicken diets, led to a statistically significant increase in body weight compared to the use of commercial probiotic supplements (Laenoi et al., 2015), fish immunology - autochthonous strains mixture significantly increased growth, survival, and both innate and adaptive immune parameters in juvenile cobia (Amenyogbe et al., 2022), winemaking - where research reveals advantages in selecting autochthonous strains adapted to local conditions (Crespo et al., 2023).

This study explored the efficacy of native entomopathogenic fungi, isolated from natural outbreaks in Romania, for controlling two major insect pests of protected crops: the green peach aphid (*M.persicae)* and the greenhouse whitefly (*T. vaporariorum*).

MATERIAL AND METHODS

Fungal isolates

For this experiment, we use 12 fungal isolates maintained in the collection of the Research-Development Institute for Plant Protection in Romania (RDIPP). The isolates were grown on potato dextrose agar (PDA) medium and stored at a temperature of 4 °C.

Initial screening tests, performed on each species separately, identified the most pathogenic isolates. Aphids and 4th nymphal instars of whiteflies were briefly exposed (5 minutes) to fungal spores (conidia) by transferring them to Petri dishes containing sporulated fungal cultures grown on Potato Dextrose Agar (PDA) of each of the fungal isolates. Following exposure, the whiteflies were gently transferred in separate insect chambers and aphids were transferred to individual plastic boxes containing detached leaves on agar. Insects were maintained under controlled conditions for 7 days: the temperature was kept between 21°C and 24°C, and the relative humidity was maintained above 80%, and monitored daily for signs of infection. Dead insects were collected and examined under a microscope to identify signs of fungal infection (mycosis). Subsequently, they were transferred to a Petri dish containing sterile, moistened filter paper to create a moist chamber environment. Maintained in the dark at 25 °C for 7 days, the dead insects were monitored for fungal growth. Subsequently, they were subjected to fungal isolation procedures.

Following the initial screening, three isolates of *Beauveria* sp. exhibiting the highest mortality rates in both insect species were selected for further evaluation in a controlled laboratory trial. For these experiments, we re-isolated entomopathogenic fungi from insect hosts that were artificially infected during the initial screening process. Fungal isolates were cultivated on PDA for 12-16 days at 25°C in the dark before use. Spores were harvested from sporulated colonies using a sterile inoculation shovel. Each isolate was then suspended in a 0.02% Tween 80® water solution and homogenized with a vortex mixer. Spore concentration was determined using a Burker Turk hemocytometer, and the suspension was diluted to the desired concentration of CFU/mL.

Insects

Insects used for this study originated from a mixed-crop tunnel on a southern Romanian organic farm (Vâlcea district, Drăgășani area), where they colonized tomato and sweet pepper plants.

Treatments

During the laboratory trial, insects were sprayed with 0.1 ml of aqueous formulations of spore suspension, with three different concentrations of conidia (10^5, 10^7, and 10^9 CFU/ml). The control group was sprayed with sterile water with 0.02% Tween® 80. Each strain was replicated five times and each replicate had 20 individuals. The detached leaf bioassay was chosen as the evaluation method for the aphids. (Fig.1).

Figure 1. Detached leaves on agar in separate plastic boxes / Frunze decupate pe agar, în containere separate

To ensure uniformity in tratments of *T. vaporariorum*, only fourth-instar nymphs (late developmental stage) were chosen for treatment. These nymphs can be identified by their oval case surrounded by a ring of upright waxy rods, also known as a fake pupa or puparium. To enhance the visibility of developing muscardine infection, the nymphs were meticulously removed from the leaves with a brush and transferred to colored cardboard. Inspired by commercially available cardboard strips containing natural enemies for whitefly control (Figure 2), this method adapts the concept for laboratory experiments to treat whitefly nymphs. For the control group, healthy nymphs were identified as those that successfully completed development and emerged as adults.

(a) (b)

Figure 2. The method of arranging nymphs for treatment (a) mimics commercial cardboard strips with natural enemies (b) / Metoda de aranjare a nimfelor pentru tratament (a) imită modelul comercial de utilizare a benzilor de carton cu dușmani naturali (b)

Evaluation of treatment efficacy

The efficacy of different fungal isolates against aphids and whiteflies was determined by measuring their cumulative mortality rate. To analyse treatment group differences, we performed an ANOVA on arcsine-transformed data representing the proportion of infected insects.

RESULTS AND DISCUSSIONS

The efficacy was statistically similar for all three doses (10^5, 10^7, and 10^9 CFU/ml) in both insect groups (aphids and whiteflies). In addition, analysis of cumulative mortality in both insect groups at 7 days post-treatment revealed statistically significant differences between all experimental groups and the control, indicating a strong effect of the treatments.

Laboratory trials showed all tested isolates (12023, 022023 and 072023) significantly reduced green peach aphid (*M. persicae*) populations by 62-73%.The cumulative mortality of green peach aphid (*M. persicae*) treated with three different fungal isolates under laboratory conditions is presented in Figure 3.

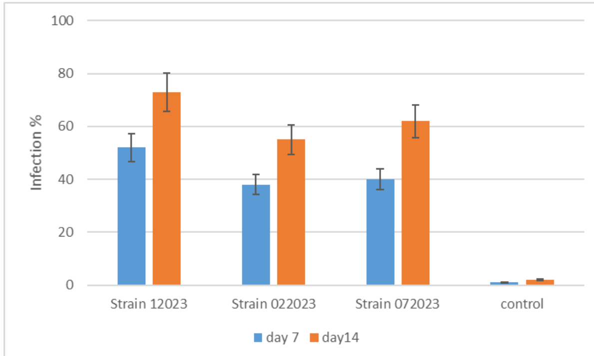

Figure 3. Cumulative mortality % mean of *M. persicae* treated with four entomopathogenic fungal strains at 7 and 14 days, post exposure / Procentele cumulate de mortalitate a afidelor *M. persicae* tratate cu trei tulpini fungice entomopatogene, la 7 și 14 zile după expunere (media ± abaterea standard)

The ability to reproduce persisted even in infected aphids, as they continued to produce nymphs. Vu et al. (2007) found that higher doses of *Beauveria bassiana* (Bals.) Vuill. (Hypocreales: Cordycipitaceae) were crucial for controlling *M. persicae*. Their experiment showed similar efficacy with 10^7 and 10^8 CFU/ml.

Whitefly nymphs were least affected by the treatments. The cumulative mortality of greenhouse whitefly (*T. vaporariorum*) treated with different fungal isolates under laboratory conditions is presented in Figure 4.

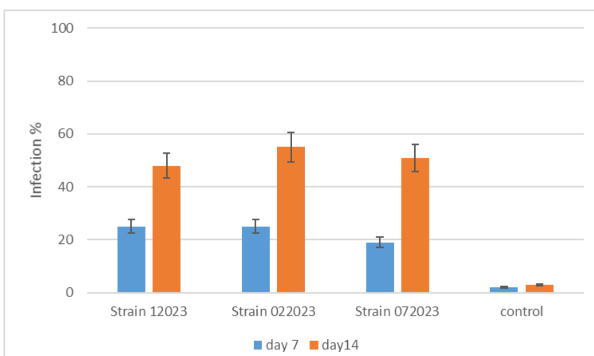

Figure 4. Cumulative mortality % mean of *T. vaporariorum* treated with four entomopathogenic fungal strains at 7 and 14 days, post exposure / Procentele cumulate de mortalitate a musculițelor *T. vaporariorum* tratate cu trei tulpini fungice entomopatogene, la 7 și 14 zile după expunere (media ± abaterea standard)

Several commercially available fungal strains have shown promise in controlling whiteflies: *B. bassiana* (ATCC 74040 and GHA), *Isaria fumosorosea* (Wize) Brown & Smith (Hypocreales: Cordycipitaceae) (Apopka 97 and FE9901), *Lecanicillium muscarium* Petch *(*formerly *Verticillium lecanii* Zimmerman*)* (Hypocreales: Cordycipitaceae) (Ve-6), and *Metarhizium brunneum* Petch (formerly *M. anisopliae* Metschnikoff) (Hypocreales: Clavicipitaceae) (Bipesco 5 and F52). *Beauveria bassiana* is particularly well-documented for its effectiveness against whiteflies like *Bemisia tabaci* and *T. vaporariorum* (Jang et al., 2023). However, in our study, treatment with three *B. bassiana* isolates resulted in a maximum mortality rate of only 55% for whitefly nymphs fourteen days after exposure.

CONCLUSIONS

Promising results were obtained in laboratory trials, where all strains significantly reduced green peach aphid's colonies by 62-73%. Despite the relatively low mortality rate of 55% against whiteflies in our virulence assay, the identified strains warrant further investigation to explore their potential as biocontrol agents. Future studies should focus on assessing their efficacy under controlled greenhouse and field conditions, considering factors such as application method, environmental conditions, and target whitefly species.

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ASSESSING THE INFLUENCE OF CLIMATE CHANGE ON COMMON BEAN PEST POPULATIONS AND DAMAGE: A LITERATURE REVIEW

EVALUAREA IMPACTULUI SCHIMBĂRILOR CLIMATICE ASUPRA POPULAȚIILOR ȘI PAGUBELOR PROVOCATE DE PRINCIPALII DĂUNĂTORI AI FASOLEI: O TRECERE ÎN REVISTĂ A LITERATURII DE SPECIALITATE

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Abstract
The review examines how climate change affects pest populations (black bean aphid, western flower thrips, greenhouse whitefly, two-spotted spider mite, and cotton bollworm) and the resulting damage to common bean crops. A systematic search strategy was used across academic databases and Google Scholar with primary keywords like "climate change", "common bean", "pest", and secondary keywords related to climate factors and pest dynamics. The paper highlights how temperature and precipitation changes can affect pest abundance, distribution, and phenology, potentially leading to increased pest pressure and damage to crops. Also the work outlines strategies to manage pests in common bean crops under changing climatic conditions, focusing on sustainable and environmentally friendly approaches. In conclusion the paper's focus on the urgent need for comprehensive strategies to address the impact of climate change on common bean agriculture, particularly in relation to pest-related issues..

Keywords: *climate change, common bean, pest, population dynamics, yield loss*

Rezumat
Această lucrare prezintă modul în care schimbările climatice afectează populațiile de dăunători (păduche negru al fasolei, tripsul californian, musculița albă de seră, acarianul roșu comun și omida fructelor) și daunele rezultate în culturile de fasole. S-a utilizat o strategie de căutare sistematică în bazele de date academice și în Google Scholar folosind cuvinte-cheie primare precum "schimbări climatice", "fasole comună", "dăunător" și cuvinte-cheie secundare legate de factorii climatici și dinamica dăunătorilor. Lucrarea evidențiază modul în care schimbările de temperatură și precipitațiile pot afecta abundența, distribuția și fenologia dăunătorilor, ceea ce ar putea duce la o presiune accentuată a dăunătorilor și la pagube asupra culturilor. De asemenea, lucrarea prezintă strategii de gestionare a dăunătorilor în culturile de fasole în condițiile schimbărilor climatice, punând accentul pe abordări durabile și ecologice. În concluzie, articolul pune accentul pe nevoia urgentă de strategii cuprinzătoare care să răspundă consecințelor pe care le au schimbările climatice asupra culturii de fasole, în special cu privire la aspectele legate de dăunători.

Cuvinte cheie*: schimbări climatice, fasole, dăunător, dinamica populației, pierderi de randament*

INTRODUCTION

Common beans (*Phaseolus vulgaris* L.) are an important food source due to their high nutritional value and genetic diversity. They are rich in proteins, dietary fiber, minerals and bioactive compounds such as phenolic compounds and resistant starch (Alfaro Diaz et al., 2023; Uebersax et al., 2023). Incorporating common bean ingredients into regular foods can improve their nutritional profile without significantly affecting their taste (Vidak et al., 2023). Common beans have been reported to have positive effects on gut microbiome, weight control and the reduction of the risk of developing noninfectious diseases (Díaz-Batalla et al., 2023). Additionally, common beans are a sustainable crop with low carbon footprint, short growth cycle and the ability to fix nitrogen, reducing the need for fertilizers (Shobhanee and Ram, 2022). Therefore, beans provide excellent material for selection and improvement of agronomic traits and the creation of modern cultivars (Vidak et al., 2023). They also provide genetic variability for breeding and improving agronomic traits. Also, increases the levels of secondary metabolites with positive effects on human health, such as quercetin and kaempferol, improves the expansion index after extrusion processing (Alves de Paiva et al., 2018). Common beans are a staple food in sub-Saharan Africa and a significant source of iron for anemic people. In Romania, the common beans are a significant component of food strategies, providing essential vitamins, minerals and carbohydrates (Rotaru et al., 2020). However, challenges such as pests, soil and weather conditions, long cooking time and high levels of phytic acid and polyphenols limit their production and health benefits (Amongi et al., 2023). Efforts have been made to develop new common bean genotypes with reduced antinutritional compounds, but the potential negative or positive effects on plant performance and technological properties need further investigation (Ugwuanyi et al., 2022).

Studies have shown that increasing temperatures and changes in precipitation patterns can have a negative effect on bean yields (Li et al., 2021). The concerns surrounding climate change and its potential impact on common bean culture include low productivity, drought, low soil fertility, lack of improved crop management practices, and insect and disease problems (Mohammed and Feleke, 2022). This is particularly concerning in regions such as Africa and Latin America, where common bean is a staple crop, as these areas are projected to become less suitable for cultivation due to heat and dry stresses (Ramirez-Cabral, Kumar and Taylor, 2016). The Ethiopian drylands, where common bean is a vital protein source, are particularly vulnerable to food insecurity exacerbated by climate variability and change, population pressure, and subsistence farming practices (Mohammed and Feleke, 2022). In Brazil, the main producer of common beans, climate change may lead to an increase in yield due to the rise in atmospheric CO_2 concentration, although this could also lead to a higher production risk (Antolin, Heinemann and Marin, 2021). The impact of climate change on common bean agriculture in Romania is a significant concern, with potential effects on development, grain yield and water balance (Cuculeanu, Marica and Simota, 1999). The rehabilitation or construction of irrigation systems is considered a crucial adaptation measure by farmers (Sima et al., 2015).

Additionally, common bean contains high levels of phytates, which can inhibit the absorption of important nutrients like iron and zinc (Asif et al., 2022). Elevated temperatures and water stress are key limiting factors for bean yield, and climate change is projected to enhance these risks (Kimani et al., 2023). Rising temperatures and changes in CO_2 levels can affect crop physiology and yield potential, with different crop species responding differently to elevated CO_2 levels (Roy and Rakshit, 2022). Farmers are already experiencing these changes, with rising temperatures and unpredictable rainfall leading to reduced agricultural production (Karki, Burton and Mackey, 2020). These findings highlight the urgent need for adaptation strategies to mitigate the impact of climate change on common bean agriculture. Reducing greenhouse gas emissions from the agriculture sector, including the common bean industry, presents challenges that require technological, investment and policy solutions (Nagothu, 2023).

Climate change is expected to significantly impact the activity, diversity, distribution and population dynamics of insect pests, including those that affect common bean crops (Sharma et al., 2015). These changes may lead to increased pest pressure and damage (Mansfield et al., 2021). The influence of climate change on pest populations and damage is further compounded by crop management practices, with no-tillage and crop residue retention being potential strategies to reduce infestation by foliar insect pests and increase the abundance of predators and detritivores (Pereira et al., 2010). The relative influence of local crop management and landscape context on insect pest populations and crop damage is also a key consideration (Rusch et al., 2013).

The climate change has had a significant impact on the Transylvanian Plain in Romania, altering its climatic indicators and requiring special measures for soil conservation (Rusu et al., 2014;

Rusu 2015). This has likely influenced the occurrence and distribution of common bean pests, which are expected to expand their habitats and increase their number of generations per year (Kocmánková et al., 2011). Additionally, the ban on neonicotinoid insecticides in Romania, which are used to treat seeds, may have further implications for common bean pest populations and damage (Ionel, 2014).

This literature review aims to analyze comprehensively the existing studies and research articles to understand how changing environmental conditions, particularly climate change, affect pest populations (black bean aphid - *Aphis fabae* Scopoli, 1763; western flower thrips - *Frankliniella occidentalis* Pergande, 1895; greenhouse whitefly - *Trialeurodes vaporariorum* Westwood, 1856; two-spotted spider mite - *Tetranychus urticae* C. L. Koch, 1836; and cotton bollworm - *Helicoverpa armigera* Hübner, 1808) and the resulting damage to common beans. The paper also examines the complex links between climate change factors. It explores temperature fluctuations, atmospheric changes, and the dynamics of pest populations that impact common bean crops. The overall objective is to provide insights into the potential challenges that climate change poses for common bean agriculture, with a particular focus on pest-related issues.

MATERIAL AND METHOD

This review focuses on how climate change influences populations of black bean aphids, western flower thrips, greenhouse whitefly, two-spotted spider mite, and cotton bollworm, five major pests of common beans in Romania. We analyze the impact of climate changes on these pest populations and their potential to damage common bean crops.

To comprehensively analyze existing research, a systematic search strategy was employed across several academic databases including ScienceDirect, Web of Science, Scopus, and CAB Abstracts. Google Scholar was used to supplement the search. The following primary keywords were used ”climate change”, ”common bean”, ”pest”, and secondary keywords used are ”population dynamics”, ”temperature”, ”precipitation”, ”drought”, ”CO_2”, ”damage”, and ”yield loss”. Primary keywords ensure that all retrieved articles address climate change, common beans, and pests. The use of secondary keyword groups allows for flexibility within each group. For example, an article might focus on temperature or precipitation changes, not necessarily both. This ensures that retrieved articles connect climate change factors with pest population dynamics and their impact on common beans.

To ensure a comprehensive and high-quality selection of studies for this literature review, a systematic approach was employed. Studies will be selected based on their relevance to the topic of climate change impacts on common bean pest populations and resulting damage. This includes research investigating how factors like temperature fluctuations, precipitation changes, or CO_2 levels influence pest dynamics and their effect on common bean crops. Peer-reviewed research articles and reviews published in reputable scientific journals will be the primary focus. Depending on availability, relevant conference proceedings or theses with strong methodologies may also be considered. To capture the latest information on climate change impacts, priority will be given to recent studies (past 15 years). However, highly relevant older studies providing historical context may also be included. The selected studies will be further evaluated based on the quality of research design, data collection methods, and data analysis techniques. Additionally, the validity of findings and their contribution to knowledge will be assessed. Studies offering new insights or significantly advancing our understanding of the connections between climate change, pest populations, and common bean damage will be prioritized. Ultimately, by applying these selection and evaluation criteria, we aim to identify studies that directly contribute to the objectives of this review, ensuring a well-founded analysis of the complex interplay between climate change, pest populations, and their impact on common bean crops.

IMPACT OF CLIMATE CHANGE ON ENVIRONMENTAL CONDITIONS

Climate change variables such as temperature, precipitation, and extreme weather events significantly impact common bean production. These variables can lead to abiotic stresses, including drought, cold temperature, soil nutrient deficiencies, and can increased susceptibility to pests and diseases which in turn affect the resilience and productivity of common bean crops (Lone et al., 2021; Beebe et al., 2014; Assefa et al., 2019; Thompson et al., 2017). Agronomic practices, including breeding for increased yield, selection of genotypes adapted to semi-arid conditions, and appropriate sowing densities, are crucial in mitigating these effects (Karavidas et al., 2022). The health benefits of common beans, such as reducing LDL cholesterol and the risk of cardiovascular disease, further underscore the importance of sustaining their production in the face of climate change (Nchanji and Ageyo, 2021). Temperature changes can affect the growth and development of common beans, with higher temperatures potentially leading to reduced yields (Santos et al., 2009). Similarly, changes in precipitation patterns can impact water availability, which is crucial for bean growth (Trehan et al., 2015). Extreme weather events, such as droughts and floods, can also have detrimental effects on bean production (Mohiseni et al., 2011). These variables underscore the vulnerability of common bean production to climate change and the need for adaptive strategies to mitigate these impacts. Therefore, it is essential to develop climate-resilient bean varieties that can withstand these environmental challenges and maintain their nutritional value. To address these challenges, research has focused on developing crops with enhanced resilience to these abiotic stresses, with a particular emphasis on genetic improvement and the use of wild relatives and closely related species to adapt common bean to climate change (Porch et al., 2013; Li et al., 2021) found that increasing precipitation has a positive effect on bean yields, while rising temperatures have a negative impact. This is further supported by Ramirez-Cabral (2016), who identified heat and dry stresses as key factors limiting common bean distribution. Heinemann et. al (2022) highlighted the importance of air temperature, solar radiation, and rainfall in driving yield variation, with different impacts across regions and seasons. Elias et. al (2021) underscored the role of specific genomic regions and candidate genes in the common bean's adaptation to bio-climatic variables, particularly those related to temperature and precipitation. These studies collectively emphasize the need for climate-smart strategies in common bean production, including the development of drought-tolerant cultivars.

The changes in environmental factors, such as temperature and precipitation, are expected to impact the suitability of common bean for pests, the abundance of natural enemies, and the overwintering success of pests. For example, the bean maggot, a common pest of common bean, is expected to be affected by changes in temperature and precipitation, which can impact its overwintering success (Etana, 2022). Similarly, the abundance of natural enemies, such as parasitoids and predators, can be influenced by changes in temperature and precipitation, which can in turn impact the population dynamics of pests (Ndakidemi et al., 2021). Furthermore, the use of agronomic, biological, and botanical practices, as well as breeding for resistance, can help mitigate the impact of these changes on common bean pests (Mwanauta, Mtei and Ndakidemi, 2015; Singh et al., 2011). Rising temperatures and changing precipitation patterns are likely to expand the geographic range of insect pests, increase their overwintering survival, and alter their interaction with host plants and natural enemies (Skendžić et al., 2021). The changes in environmental factors are expected to have specific impacts on aphids. For example, the suitability of common bean as a host plant for aphids may be influenced by the presence of defensive symbionts (Gimmi and Vorburger, 2021). Similarly, the abundance of natural enemies, such as parasitoids, may be affected by the emission of volatile compounds by aphid-infested plants (Ismail et al., 2021). The presence of field margin plants can enhance the population of natural enemies, potentially impacting overwintering success (Ndakidemi et al., 2022). Lastly, changes in feeding behavior induced by plant viruses can also impact the transmission of these viruses by aphids (Wamonje et al., 2020). These changes in climate and weather could also affect the population dynamics and status of insect pests of crops (Cammell and Knight, 1992). The fitness of natural enemies may be altered, leading to a potential decrease in their effectiveness in controlling pests (Thomson, Macfadyen and Hoffmann, 2010). Furthermore, the abundance and activity of natural enemies may be altered through adaptive management strategies adopted by farmers to cope with climate change, potentially leading to a mismatch between pests and enemies (Selvaraj, Ganeshamoorthi and Pandiaraj, 2013).

INFLUENCE ON PEST POPULATIONS AND DAMAGE

Black bean aphids, western flower thrips, greenhouse whitefly, two-spotted spider mite and cotton bollworm pose a significant threat to Romanian common bean agriculture, and understanding how changing environmental conditions impact their populations in the world is crucial for developing effective mitigation strategies.

Distribution, Abundance and Phenology:

Aphis fabae Scopoli, 1763

Changes in the geographic range or abundance of black bean aphids in response to climate change have been investigated in several studies. Sandrock et. al (2011) found that the distribution of life cycle variation in aphids, including *A. fabae*, is determined by climate, with aphids from areas with cold winters investing more in sexual reproduction than aphids from areas with mild winters. Crossley et. al (2022) examined the activity of black bean aphids in relation to temperature and precipitation and found that increasing temperature and precipitation can affect the flight phenology of aphids, including *A. fabae*. Barton and Ives (2014) showed that climate warming can break down ant-aphid mutualism and reduce aphid abundance. Harmon et. al (2009) studied the ecological and evolutionary responses of pea aphids, including *A. fabae*, to increased heat shocks and found that predator species and genetic differences in heat tolerance can influence aphid population growth. Also, Fuchs et. al (2017) demonstrated that phenology shifts in aphids can desynchronize predator-prey and plant-microorganism interactions, potentially increasing the probability of pest outbreaks. Schwarz and Frank (2019) found that rising temperature can increase aphid consumption by lady beetle species, leading to higher aphid biomass consumption and larval body weight gain. Whitney et. al (2016) found that aphids abundance is positively related to growing season precipitation and negatively affected by precipitation during the non-growing season, as well as being influenced by landscape. Changes in pest life cycles can have significant effects on bean phenology, potentially leading to altered synchrony between the two (Skendžić et al., 2021). In addition, earlier spring activity due to climate change can also affect bean phenology, potentially affecting the synchronization of *A. fabae* with bean phenology (Badeck et al., 2004; Peñuelas and Filella, 2009; Costache et al., 2003; Shovărel et al., 2020). These studies highlight the complex and varied responses of aphids to climate change, emphasizing the need for considering both temperature and precipitation changes when predicting changes in aphid populations.

Frankliniella occidentalis Pergande, 1895

Research on western flower thrips has shown that its abundance and distribution are influenced by a variety of factors, including flower nitrogen status (Brodbeck et al., 2001), host plant type and nutritional quality (Baez et al., 2011), and fertilization levels (Chau and Heinz, 2006). For example, higher nitrogen fertilization rates have been found to increase the abundance of western flower thrips on certain host plants (Brodbeck et al., 2001; Chau and Heinz, 2006). In central Chile, the thrips is a serious pest on a wide range of plant species, with its populations being significantly aggregated in certain hosts (Ripa et al., 2009). The species' response to climate change is likely to be influenced by its population dynamics and habitat availability (Mair et al., 2014). Similar to the black bean aphid, warmer temperatures may lead to an increase in the number of generations (voltinism) per year (K. Wang and Shipp, 2001; J. C. Wang et al., 2014; Costache et al., 2003). This could result in a larger overall population and potentially more damage to crops like beans. These findings suggest that climate change, which can affect nitrogen levels and host plant distribution, may have an impact on the geographic range and abundance of *F. occidentalis*. However, further research is needed to directly examine the effects of climate change on this species.

Trialeurodes vaporariorum Westwood, 1856

Greenhouse whitefly is primarily pest of greenhouse tomatoes and green beans, but has been spreading to pumpkins and kale (Lourenção et al., 2008). The life history parameters of this insect on dry bean cultivars are temperature-dependent. Higher temperatures lead to increased fecundity, while lower temperatures result in decreased longevity (Manzano and van Lenteren, 2009). But, research on the impact of climate change on the geographic range and abundance of *T. vaporariorum* is limited. However, studies on other species suggest that climate change can lead to shifts in geographic range and abundance. Asner and Vitousek (2005) and Honnay et. al (2002) both found that biological invasion and habitat fragmentation, respectively, can alter the distribution of species. Miller-Rushing and Inouye (2009) and Lloret et. al (2004) further demonstrated that changes in flowering phenology and reduced diversity of seedlings can occur in response to climate change. Other researchs indicating that rising temperatures can alter the voltinism and geographical distribution of insect pests (Karuppaiah and Sujayanad, 2012). A temperature-dependent phenology model for greenhouse whitefly has been developed, which can be used to predict its distribution potential and adjust pest management measures (Gamarra et al., 2020). These changes in population dynamics can have significant implications for pest life cycles and their synchronization with bean phenology, potentially leading to increased pest abundance and the need for adaptations in plant protection strategies (Stoeckli et al., 2012). These findings suggest that climate change could potentially lead to changes in the geographic range and abundance of *T. vaporariorum*. However, further research specifically on this species is needed to confirm these potential impacts.

Tetranychus urticae C. L. Koch, 1836

Research on two-spotted spider mite, has revealed its ability to adapt to various climatic conditions, with populations from different regions showing different responses to drought stress (Migeon et al., 2021). Studies have shown that warmer and drier conditions can lead to disruptions in the natural regulation of two-spotted spider mite populations, potentially leading to more frequent outbreaks (Urbaneja-Bernat et al., 2019). Additionally, climate change can disrupt the biological control of *T. urticae* by its predators, such as the phytoseiids *Euseius stipulatus*, *Neoseiulus californicus*, and *Phytoseiulus persimilis* (Urbaneja, Bernat and Jaques, 2021). The mite's performance is also influenced by the quality of its host plants, with certain cultivars of common pea and bean being more suitable hosts (Abou-Elella and Abdel-Khalek, 2020). However, the mite's response to salinity and drought stresses in its host plants can lead to a decrease in its reproductive rate (Khodayari et al., 2021). The specific changes in the species' distribution and abundance are subject to large uncertainties, including the prevalence of the species, the modelling method used, and the variability in environmental responses (Meynard, Migeon and Navajas, 2013). Despite these uncertainties, genetic studies have shown that two-spotted spider mite populations are influenced by both geographical distance and ecological parameters, such as habitat type and host plant species (Navajas, 1998; Tsagkarakou et al., 1998; Șovărel et al., 2020). Overall, climate change can alter the population dynamics, reproduction rates, and survival of *T. urticae*, potentially leading to changes in pest life cycles and their synchronization with bean phenology. The geographic range and abundance may be also influenced by climate change.

Helicoverpa armigera Hübner, 1808

Research on the impact of climate change on the geographic range and abundance of cotton bollworm, has revealed significant findings. Huang (2020 and 2021) found that the population size of *H. armigera* increased with climate warming, particularly in the third generation, and that this increase was more pronounced in lower latitudes, affecting its voltinism, reproduction rates and survival (Sravan Kumar et al., 2020; Eigenbrode and Adhikari, 2023). Changes in temperature and precipitation patterns can influence the development of different generations of the insect, with rising temperatures and increased precipitation having varying effects (Huang and Hao, 2020). Climate change can also affect the synchronization between the pest's life cycle and the phenology of its host plants, such as beans (Skendžić et al., 2021). These changes in population dynamics and synchronization can have implications for crop production and may require adaptive management strategies to mitigate the impact of the pest. These studies also highlighted the importance of crop planting structure and the potential for asynchrony in the responses of cotton bollworm to climate change. Srivastava (1990) and Jakhar (2016) further supported these findings, with Srivastava noting spatial and temporal variations in the abundance of *H. armigera* in India, and Jakhar identifying a significant negative correlation between the population of *H. armigera* and maximum temperature. These changes in population dynamics and synchronization may have implications for crop production and may require adaptive management strategies to mitigate pest impacts. The studies reviewed suggest that climate change is likely to have a significant impact on the geographic range and abundance, but further research is needed to understand the specific effects of climate change on cotton bollworm and to develop effective pest management tactics.

The common bean faces a range of pest threats, including bacterial and fungal diseases, viral infections, and insect infestations (S. P. Singh and Schwartz, 2010; Beebe et al., 2014; Mwanauta, Mtei and Ndakidemi, 2015). These threats are likely to shift and evolve due to climate change and other environmental factors, potentially leading to the emergence of new pest threats (Porch et al., 2013). To address these challenges, ongoing research is focused on breeding for disease resistance, improving drought resistance, and exploring alternative pest control methods (Singh and Schwartz, 2010; Beebe et al., 2014; Mwanauta, Mtei and Ndakidemi, 2015). However, further efforts are needed to fully understand and mitigate the potential shifts in common bean pest communities.

In Romania, the potential shifts in common bean pest communities are influenced by various factors. Hamburdă (2014) highlights the potential for runner bean cultivation in intercropping systems, which can create a more favorable microclimate and potentially impact pest communities. Modiga (2018) discusses the impact of salinity on bean genotypes, which could lead to changes in pest resistance. Galan (2023) emphasizes the importance of conserving plant germplasm, which could be a source of resistance to abiotic stress factors, potentially influencing pest communities. Grozea (2011) suggests that the *Diabrotica virgifera virgifera*, a potential pest, may be attracted to other plants such as beans, indicating a need for protective measures. These studies collectively suggest that changes in pest communities and the emergence of new threats in Romania's common bean crops are influenced by a range of factors, including cultivation practices, environmental stress, genetic diversity and pest behavior.

Damage Potential:

Climate change has significant impacts on pest-induced damage in common beans, including yield losses and quality reduction (Table 1.). Rising temperatures and elevated CO_2 levels accelerate the metabolism and growth of insect pests, leading to increased population densities and greater crop injury and damage (Amiri, Khebiza and Messouli, 2023; Kaur et al., 2023). Climate change also affects the distribution and dynamics of pests, increasing the risk of invasive species occurrence and reducing the effectiveness of biological control and integrated pest management strategies (Satpathy, Gotyal and Babu, 2022). Changes in climate variables can also influence the host plant resistance to insect pests, further exacerbating the damage (Tonnang et al., 2022). To mitigate these impacts, it is crucial to develop adaptation practices such as improved pest management, monitoring of climate and pest populations, and the development of integrated models for predicting climate change and pest dynamics (Akram et al., 2022). Additionally, the development of climate-smart crops and the adoption of advanced cropping systems and methods can help minimize pest-induced damage in common beans.

Climate change can have potential interactions with other stressors such as pesticide resistance and pathogens, which can impact pest damage. Elevated temperatures, high CO_2 levels, and erratic precipitation patterns associated with climate change can lead to changes in pest populations, including the expansion of their distribution, increased infestation intensity, and changes in pest biology and physiology (Shrestha, 2019). Additionally, climate change can reduce the efficacy of current integrated pest management strategies and the success of biological control, further exacerbating pest damage (Skendžić et al., 2021). Furthermore, climate change can affect plant-pathogen interactions, altering the life cycle of pathogens, disease severity, and the distribution of pathogens (Elad and Pertot, 2014; Singh et al., 2023). Moreover, climate change can contribute to the development of pesticide resistance in pests, as demonstrated by the increased resistance levels observed in overwintering sites compared to seasonal occurrence sites (Ma et al., 2021; Ibrahim, 2014). These interactions between climate change and other stressors highlight the complex nature of pest damage and the need for comprehensive strategies to mitigate their impacts.

Table 1. The impact of five common pests (black bean aphid, western flower thrips, greenhouse whitefly, two-spotted spider mite, and cotton bollworm) on common bean plants in the context of climate change / Impactul a cinci dăunători comuni (păduchele negru al fasolei, tripsul californian, musculița albă de seră, păianjenul roșu comun și omida fructelor) asupra plantelor de fasole în contextul schimbărilor climatice.

Pests *(Dăunători)*	**Direct Damage** *(Pagube directe)*	**Indirect Damage** *(Pagube indirecte)*	**Impact of climate change** *(Impactul schimbărilor climatice)*	**Source** *(Sursă)*
Black bean aphid (*Aphis fabae*)	Feeding on plant sap, leading to stunted growth and reduced vigor, affecting the production of common bean.	Act as vectors for plant viruses, including Bean Common Mosaic Virus (BCMV), compromising plant health.	Climate change may influence aphid populations and distribution, impacting common bean production.	Etana, 2022
	Aphid feeding can cause a reduction of about 7–33% of crude protein levels in the leaf tissue. This reduction increases with increasing infestation levels and time.	*A. fabae* has the ability to transmit the bean common mosaic virus (BCMV), further impacting plant health and productivity.	Changes in temperature and precipitation patterns can influence the abundance and distribution of *A. fabae*.	Gamal, Salman, and Abdel-Rahman, 2022
	Injure leaves during feeding, affecting the plant's photosynthetic capacity.	Excrete honeydew, promoting sooty mold growth that interferes with photosynthesis. *A. fabae* also indirectly transmits common mosaic viruses, leading to early plant death.	Climate change affects the population dynamics of crop pests, potentially leading to increased infestations.	Mwanauta, Mtei, and Ndakidemi., 2015
	Feeding on plants' phloem, resulting in significant impairment of plant growth and yield.	Physiological processes and virus transmission (approximately 30 plant viruses), their excretion of honeydew can lead to the growth of sooty molds.	Changes in temperature and precipitation patterns can affect the distribution and abundance.	Esmaeili-Vardanjani et al., 2013
	Feeding activities can lead to reduced plant vigor, stunted growth, and distortion of plant parts.	Promoting the growth of fungi and other pathogens	Elevated levels of CO_2 and O_3 can alter the feeding efficiency of aphids by changing the secondary metabolites in plants. Specifically, increased CO_2 can improve plant growth but may decrease plant	Yan et al., 2018

			nitrogen concentrations, affecting aphid nutrition. Climate change can also influence the life cycle and population genetics of *A. fabae.*	
Western flower thrips (*Frankliniella occidentalis*)	Feeding on common bean plants, causing damage to leaves and flowers.	Act as vectors for tospoviruses, affecting plant health and productivity.	Climate change may influence thrips populations and distribution, impacting common bean production.	Kumar, Swamy and Reddy, 2016
	Feeding on plants can result in distorted growth, silvering of leaves, and reduced plant vigor.	Transmission of tospoviruses.	Changes in temperature and humidity levels can affect the population dynamics and behavior of thrips species.	Schausberger, Çekin and Litin , 2021
Greenhouse whitefly (*Trialeurodes vaporariorum*)	Feeding on common bean plants, causing damage to leaves and flowers.	Act as vectors for tospoviruses, affecting plant health and productivity.	Climate change may influence whitefly populations and distribution, impacting common bean production.	Alizamani, Fazeli,and Mirab-balou, 2022
	Feeds on the underside of leaves, sucking phloem sap from the plant.	Excretion of honeydew, promoting fungal growth that reduces photosynthetic capacity of affected plants.		Karamoozian, Yali, and Ahmadi , 2021
	Feeding on phloem sap	Excreting honeydew that promotes sooty mold development, reducing plant photosynthesis. transmission of tospoviruses.	Changes in temperature and humidity levels may influence the survival, reproduction, and behavior of the whitefly	Manzano and van Lenteren, 2009
		Impact on yield due to feeding on susceptible hosts, leading to total yield losses. Can be vectors for viruses.	Climate change, including drought and heat, has facilitated the development and dissemination of *T. vaporariorum*.	Gamarra et al. 2020
Two-spotted spider mite (*Tetranychus urticae*)	Feeding on common bean plants, causing damage to leaves and flowers.	Act as vectors for tospoviruses, affecting plant health and productivity.	Climate change may influence spider mite populations and distribution, impacting common bean production.	Sarkar, Timsina, and Chakraborti , 2013; Tahmasebi et al. , 2011
	Feeding on plant tissues, reducing photosynthesis and nutrient uptake. Also, they can produce discoloration, stippling, and webbing on plant leaves, impacting plant health and productivity.	Promoting fungal growth due to their feeding activities, leading to secondary infections. Can also act as vectors for plant viruses	Climate change can potentially create more favorable environments for *T. uticae* infestations, leading to increased populations and damage to crops	Shoorooei et al. , 2018
		Transmission of tospoviruses.		Mohammadi et al., 2021
	Feeding activity causes stippling on leaves, which appears as tiny yellow or white spots, leading to reduced photosynthesis and plant vigor.	The mites act as vectors, transmission of plant viruses while feeding on plants.	Warmer temperatures and changes in precipitation patterns associated with climate change can create more favorable conditions for the rapid reproduction and development of these mites.	Etana , 2022
Cotton bollworm (*Helicoverpa armigera*)	Feeding on common bean plants, causing damage to reproductive and vegetative parts of host plants like flowers, buds, and stems.	Economic impact due to reduced crop productivity and increased management costs.	Climate change may influence *H. armigera* populations and distribution, impacting common bean production.	Jafari et al, . 2023
	Feeding on plant tissues, leading to defoliation, pod feeding, and reduced crop yield.	Economic losses due to reduced crop quality, increased management costs, and potential yield losses caused by the pest's feeding activities	Changes in temperature and precipitation patterns may influence the pest's life cycle, migration patterns, and population dynamics.	Haile, Nowatzki, and Storer, 2021
	Feeding on various plant parts such as stems, leaves, flower heads, and fruits.	Need for chemical pesticide control due to the economic impact of the direct damage.	Climate change can influence the distribution and behavior of *H. armigera* due to temperature variations.	Naseri et al., 2014
	The larvae of *H. armigera* feeding lead to defoliation, stem girdling, and pod damage.	Resistance to synthetic insecticides, prompting investigations into alternative pest management approaches.	Changes in temperature and precipitation patterns can affect the life cycle, development, and distribution of *H. armigera*.	Fite and Tefera, 2022
	The large larvae of *H. armigera* are voracious feeders, consuming plant parts such as leaves, fruits, and pods	Use of broad-spectrum insecticides to control the pest. disrupting the ecosystem's balance and leading to increased pest populations.	Favorable climatic conditions, such as drought and high temperatures, can lead to increased pest activity and reproduction	Călin et al., 2012

POTENTIAL ADAPTATION STRATEGIES FOR PEST MANAGEMENT

Adaptation strategies for pest management in a changing climate include the use of resistant varieties, biological control agents, and climate-smart practices. These strategies have been shown to be effective in mitigating the negative impacts of climate change on crop yields. For example, the use of resistant varieties can help protect crops from pests and diseases that may become more prevalent under changing climatic conditions (Chen et al., 2023). Biological control agents, such as predators and parasitoids, can also be used to control pest populations and reduce the need for chemical pesticides (Jungers et al., 2023). Additionally, implementing climate-smart practices, such as integrated pest management and precision agriculture, can help optimize pest control while minimizing environmental impacts (Chen et al., 2023). Overall, these adaptation strategies offer promising solutions for managing pests in a changing climate and ensuring sustainable crop production (Abramoff et al., 2023).

Biological control, in particular, has been identified as having the greatest potential for managing pests in this farming system (Rossbacher and Vorburger, 2020). For aphids, biological control with parasitoid wasps has shown promise, although the presence of heritable bacterial endosymbionts in aphids can hinder control efforts (De Ron et al., 2019). Understanding the genetic diversity of the common bean and the genes that control important traits such as pest resistance is crucial for future improvement efforts (Mazur, Mazur and Dmytrenko, 2023). Additionally, selecting varieties of common beans that are less responsive to changing growing conditions can help ensure stable and above-average yields, even under adverse conditions (Casals et al., 2019). Breeding programs that aim to adapt materials to different local environments can contribute to the conservation of biodiversity in crops.

The most effective biological control methods for managing aphids (*A. fabae* Scopoli, 1763) in common bean crops include the use of natural enemies such as predators and parasitoids (Zhang et al., 2022; Piffer et al., 2023; Ismail et al., 2023). Conservation biological control (CBC) is a recommended approach, where natural enemies are conserved in the field to suppress aphid populations (Gesraha and Ebeid, 2022). Ladybirds (*Coccinella undecimpunctata*) and green lacewings (*Chrysoperla carnea*) have shown to be effective predators in reducing aphid populations (Francis et al., 2022). Additionally, the use of entomopathogenic fungi and plant volatile organic compounds (VOCs) in an attract and kill strategy can also be effective in managing aphids. It is important to note that the effectiveness of these methods may vary depending on the specific conditions and the presence of other factors such as aphid resistance in the crop.

Effective biological control methods for managing thrips (*F. occidentalis*) in common bean crops include the use of entomopathogens and behavioral control techniques. Entomopathogens such as the insect pathogenic fungus *Beauveria bassiana* and the entomopathogenic nematode *Heterorhabditis bacteriophora* have shown significant decreases in thrips populations and crop damage (Rodríguez and Coy-Barrera, 2023). Additionally, the use of behavioral control techniques, such as the application of alarm and aggregation pheromones, has been effective in reducing thrips density in flowers and monitoring traps (Wakil et al., 2023). These methods have the potential to provide control of *Thrips tabaci*, a similar thrips species, in onion crops (Kim, Khan and Kim, 2023). However, it is important to note that some combinations of biological control agents and chemical insecticides may be harmful to non-target organisms, highlighting the need for careful consideration of the potential impacts on biodiversity (Khan, Kim and Kim, 2023).

Biological control methods for managing greenhouse whitefly (*T. vaporariorum*) in common bean crops include the use of autodissemination techniques with *Metarhizium anisopliae* fungi (Berardo et al., 2022). The autodissemination technique involves inoculating an autodissemination device with dry conidia of *M. anisopliae*, which is then used to control adult whiteflies. This method has shown high mortality rates in whiteflies exposed to specific fungal isolates, such as ICIPE 18 and

ICIPE 69 (Shafiee, Ghadamyari and Mosallanejad, 2023). Additionally, the use of natural and organic insecticidal products, such as Tamarlassi, fermented buttermilk, fermented cow urine, Dashparni, Darekastra, and vermiwash, has also been effective in controlling greenhouse whitefly nymphs (Paradza et al., 2022). These products have shown increasing levels of lethality with higher concentrations, with Tamarlassi being the most toxic (Karamoozian, Yali and Ahmadi, 2021). These biological control methods provide environmentally friendly alternatives to synthetic pesticides for managing greenhouse whitefly populations in common bean crops.

The most effective biological control methods for managing two-spotted spider mite (*T. urticae*) in common bean crops include the use of predatory mites such as *Phytoseiulus persimilis* and *Neoseiulus californicus* (Perera and Senanayake, 2022). These biological agents have been found to effectively control the population of *T. urticae*, resulting in a significant reduction in mite numbers (Samaras et al., 2023). Additionally, the application of acaropathogenic fungi such as *B. bassiana*, *Nomuraea anisopliae*, *Lecanicillium lecanii* and *Hirsutella thompsonii* has shown promising results in reducing mite populations (Baskaran et al., 2023). Furthermore, the use of plant strengtheners such as acibenzolar-s-methyl has been found to negatively affect the survival, egg production, and feeding damage of *T. urticae* (Adly, 2022). These biological control methods offer an alternative to chemical pesticides and can contribute to the suppression of spider mite populations in common bean crops.

Biological control methods for managing cotton bollworm (*H. armigera*) in common bean crops include the use of artificial biological control methods, such as *Bacillus thuringiensis* (Bt) proteins and foliar insecticides (Shokirova and Juraev, 2023). These methods have shown efficacy in reducing bollworm populations and protecting crops from damage. Additionally, the use of biopesticides, such as *B. bassiana* and nucleopolyhedrovirus, has been found to be effective in reducing the numbers of *H. armigera* and minimizing damage to cotton crops (Shokirova and Juraev 2023). Integrated pest management (IPM) strategies, which combine various control methods, including biological control, targeted insecticide applications, and globally accepted IPM practices, have been recommended for sustainable pest management (Godbold et al., 2023; Z. Wang et al., 2023). Collaborative efforts among researchers, farmers, policymakers, and industry representatives are crucial in developing and implementing advanced control measures for bollworm management (Malinga and Laing, 2022). By incorporating scientific advances and adopting integrated approaches, bollworm infestations can be contained while safeguarding agricultural productivity and minimizing environmental risks.

Adaptation strategies for mitigating climate change impacts on common bean pests include utilizing underexploited species as alternative crops, implementing well-planned pest management approaches, modifying monitoring tools, developing climate-adaptable technologies, and adopting modeling strategies for forecasting pest dynamics (Singh et al., 2023). These strategies aim to reduce the projected increases in pest risk in agriculture by implementing preventive measures and effective phytosanitary regulations (Satpathy, Gotyal and Babu, 2022). Underexploited species, such as yam, caahua, bambara groundnut, and tepary bean, offer cost-effective and practical food production alternatives in marginal environments (Singh et al., 2023). Pest management approaches need to consider the effects of climate change on pest diversity, abundance, distribution, and host-plant resistance (Satpathy, Gotyal and Babu, 2022). Additionally, biosecurity measures are crucial for sustainable pest management, including globally coordinated diagnostic and surveillance systems (Kaur et al., 2023). Monitoring tools should be modified to detect changes in pest distribution, damage assessment, and population ecology (Akram et al., 2022). Climate-adaptable technologies are required for effective pest management under global warming conditions (Gullino et al., 2022). Modeling strategies can help forecast changes in pest dynamics and guide pest management strategies (Srinivasa Rao et al., 2022). The sustainable management of pests requires holistic solutions, such as pest risk modeling and analysis, and preparedness for pro-active management (Amiri, Khebiza and Messouli, 2023). However, challenges exist in implementing these strategies, including the need for in-depth studies on the impact of climate change on the interaction between agricultural pests and crops (Gullino et al., 2022). Furthermore, the contribution of strategies that incorporate the environment and physical resources, as well as social and financial benefits for farmers, is essential. Overall, a holistic approach that includes diverse management regimes, such as resistant cultivars, natural enemy preservation, thresholds, selective insecticides, and biological control, is critical for managing common bean pests in a changing climate.

CONCLUSIONS

1. Common beans are important for their nutritional value and potential for improvement through breeding and genetic research, and the unpredictability of natural phenomena, including those related to climate change, poses a challenge to the agriculture sector.
2. The review underscores the significant influence of climate change on pest populations and damage to common bean crops. It highlights the need for adaptive strategies to mitigate these impacts, emphasizing sustainable and environmentally friendly approaches.
3. Understanding the complex connections between climate factors and pest dynamics is crucial for developing effective pest management strategies. Resistant varieties, biological control agents and climate-smart practices are needed to combat the challenges of changing environmental conditions.
4. The necessity for ongoing research is evident to further understand the specific effects of climate change on common bean agriculture. The review calls for the development of climate-resilient bean varieties and the implementation of advanced cropping systems to ensure sustainable production.
5. Addressing the challenges of climate change on common bean agriculture requires a combination of technological, investment, and policy solutions. This includes the rehabilitation or construction of irrigation systems and the development of new genotypes with reduced antinutritional compounds.

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THE INFLUENCE OF THE CULTIVATION OF DIFFERENT SPECIES OF CUCURBITACEAE ON THE CHEMICAL COMPOSITION OF THE SUBSTRATE/SOIL

INFLUENȚA CULTIVĂRII DIFERITELOR SPECII DE CUCURBITACEAE ASUPRA COMPOZIȚIEI CHIMICE A SUBSTRATULUI/ SOLULUI

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Abstract
The current work aims to evaluate the chemical composition of the substrate/soil in order to observe the influence on the development of vegetable plants. Work was done in the SCDL Buzau greenhouse, plot A504, protected area. A culture of melons, the Fondant variety, was established with a 60-day-old seedling, 40 cm between the plants, and a cucamelon culture, the Victor variety, with a 70-day-old seedling, approx. 70 cm between the plants. They were monitored for the entire vegetation cycle and the soil/substrate samples were collected after the end of the 2023 crop, before the establishment of the 2024 crop. The soil analyzes were carried out at ICPA Bucharest.

Key words: *soil, substrate, Cucurbitaceae*

Rezumat
Lucrarea de fata isi propune sa evalueze compozitia chimica a substratului/ solului cu scopul observarii influentei asupra dezvoltarii plantelor legumicole. S-a lucrat in sera SCDL Buzau, sola A504, spatiu protejat. S-a infiintat o cultura de pepeni galbeni soiul Fondant cu un rasad in varsta de 60 zile, 40 cm intre plante si o cultura de cucamelon soiul Victor cu un rasad in varsta de 70 zile, cca 70 cm intre plante. Acestea au fost monitorizate pentru tot ciclul de vegetatie iar probele de sol/ substrat au fost recoltate dupa desfiintarea culturii din anul 2023, inainte de infiintarea culturilor din anul 2024. Analizele de sol au fost efectuate la ICPA Bucuresti.

Cuvinte cheie: *sol, substrat, Cucurbitaceae*

INTRODUCTION

Recent climate changes have led to the direct influence of biomass production, respectively to the direct influence of food. The adaptation of new plants in areas where they are not typical, the disappearance of some species or the difficult cultivation of others have direct consequences on the traditional culinary culture.

The vegetation factors that directly influence plant development are water, food, light, temperature (Madjar et Davidescu, 2009). Agriculture in protected areas is rapidly developing in America and Asia as an effective management method to improve and create a suitable culture environment (Zhou et al., 2024) with the direct advantage of monitoring and controlling environmental factors. The role of the soil is to produce vegetable resources with multiple uses (ICPA), food and fodder being essential.

Appropriate management practices can transform soils into reservoirs for atmospheric carbon and mitigate global warming. Alvarez, in 2024, conducted a study to determine how crop residue management affects soil organic carbon content. Different forms of residue removal had different impacts on soil organic carbon content; harvest residues reduced the stock of soil organic carbon significantly more than burning it (Alvarez, 2024). Nitrogen substitution practices could improve soil quality in red soil in southern China by regulating soil characteristics and microbial community composition (Chen et al., 2024). Also, the plant, through its fraction of inorganic nature, is a key factor of the hygroscopic response of the smoke (Gulick et al., 2023) and of the absorption of gases and air components. Land use change can influence the content, structure and composition of organic matter in rhizosphere soils (Zhang et al., 2024). Changes in the microenvironment of the rhizosphere resulting from land use change on the surface of fields have different effects on the structure and composition of humic acid and fulvic acid in organic matter (Zhang et al., 2024). Different agricultural systems have different management practices, such as water table depth, method of fertilization and tillage, and different nutrient inputs. Indirect activities can also disturb the soil and act as a form of cultivation (Wu et al., 2024). The type of fertilization has different influences depending on the type of fertilizer (Shi et al., 2024).

In Romania, the soils are varied, the data being presented in Figure 1.

The Romanian Soil Map database at the scale 1:1000000 contains several parameters: soil type, surface and subsurface textural class, slope class, agricultural limitations, parent material, minimum and maximum altitude, land use, depth the textural change, the depth at which the roots encounter an obstacle, the presence of an impermeable layer, the class of the medium water regime, data regarding the soil work system.

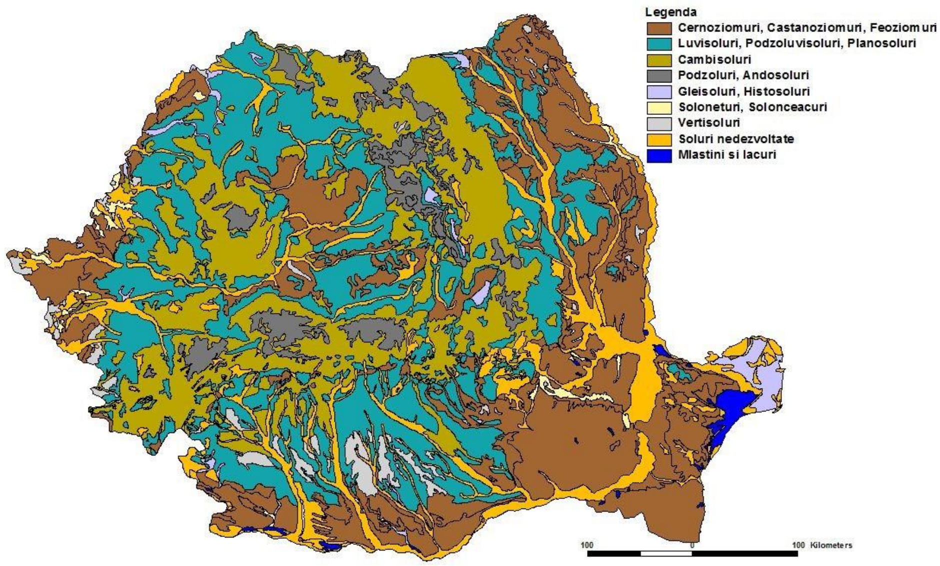

Figure 1. Soil map of Romania at scale 1:1000000 (https://icpa.ro/harti-sol/) / Harta solurilor României la scara 1:1000000 (https://icpa.ro/harti-sol/)

MATERIALS AND METHOD

The work was done in the SCDL Buzău greenhouse, plot A504, protected area. A culture of 'Fondant' cultivar of melons was established with a 60-day-old seedling, with a distance of 40 cm between plants. This is an early ripening cultivar of melon created at SCDL Buzau, in 1996, with a vegetation period of 74 days, from mass emergence (75% of the plants), to the beginning of the technical maturity (10% of the fruits). The fruit has the basic color of the epidermis, green-gray before maturity and yellow at technical maturity. The shape of the longitudinal section is circular. The ditches are present and are green in color. The color of the shell is cream. The pulp has a cream (orange) base color. The taste of the pulp is tender. Resistance to cracking and transport is very good (SCDL Buzau, 2009).

'Victor' cultivar was used to establish a cucamelon (Mexican cucumber) culture, with a 70-day-old seedling, using a distance of 70 cm between plants. This is a late ripening cultivar of Mexican cucumber created at SCDL Buzau in 2022, with a vegetation period of 120 days, from mass emergence (75% of the plants), to the beginning of the technical maturity (10% of the fruits). The basic color of the fruit epidermis is green before maturity and whitish green with dark green stripes, at technical maturity. The shape of the longitudinal section is oval (SCDL Buzau, 2022).

The substrate was prepared as follows: 4 parts garden soil, 1 part peat, 1 part perlite, 0.5 parts pelletized poultry manure.

Culture technology respected the basic principles regarding the maintenance, sanitation and irrigation of crops. Irrigation was done by drip, as needed.

The experimental variants were set up as follows:

V1: soil from the root zone of the 'Fondant' cultivar of melon from the large compartment of the greenhouse

V2: soil from the rootless area of the 'Fondant' cultivar of melon culture in the large compartment of the greenhouse

V3: substrate from large bags in which the 'Fondant' cultivar of melon was grown in the large compartment of the greenhouse

V4: soil from the root zone of the 'Victor' cultivar of Mexican cucumber in the greenhouse compartment

V5: uncultivated substrate from the greenhouse.

The soil/substrate harvest was carried out after the end of the vegetation cycle of the plants in 2023, before the preparation of the land for the establishment of crops in 2024. The soil analyzes were carried out to the Laboratory of Physical-Chemical Analysis of ICPA Bucharest.

RESULTS AND DISCUSSIONS

The above-mentioned cultures were established in soil or substrate. The physical aspect is presented in the Figure 2.

Figure 2. Sample of substrate and soil / Eșantion de substrat și sol

In Figure 3 and Figure 4, the appearance of the crop is presented during the vegetation period. There are also details regarding the development of the plant, at different phenophase stages and the physical appearance.

Figure 3. Aspects and details of the 'Fondant' melon cultivar in culture / Aspecte şi detalii din cultura de pepene galben soiul 'Fondant'

Figure 4. Aspects and details of cucamelon culture, 'Victor' cultivar / Aspecte si detalii din cultura de cucamelon, soiul 'Victor'

Environmental factors have a direct influence on plant development. They are corroborated and it is not possible to make a clear delimitation of the impact of each one.

The role of the soil is to ensure the nutritional elements for the development of a plant. The evaluation of the chemical characteristics can offer solutions regarding the correction of the composition for the purpose of the optimal development of the plants, implicitly of higher productions.

In Figure 5, it can be seen that the soil has higher pH values, contained in the neutral zone, unlike the substrate. Also, the cultivated substrate has a pH value of 6.71, with a neutral tendency, while the control substrate has 5.4, with 1.31 units less.

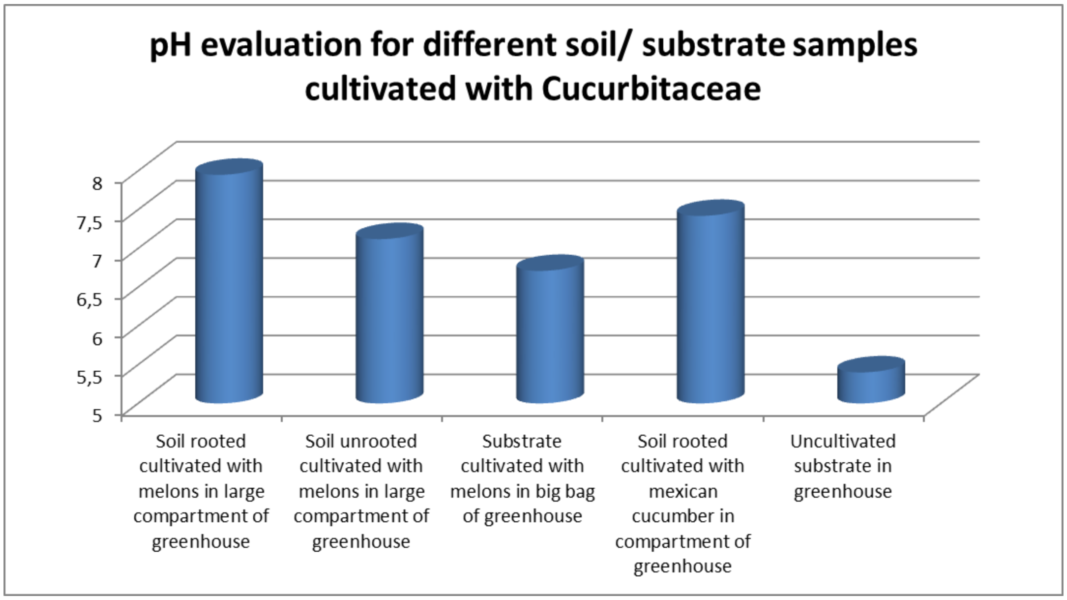

Figure 5. The pH evaluation of different types of soil/substrate cultivated with *Cucurbitaceae* /
Evaluarea valorii pH a diferitelor tipuri de sol/substrat cultivat cu specii din familia *Cucurbitaceae*

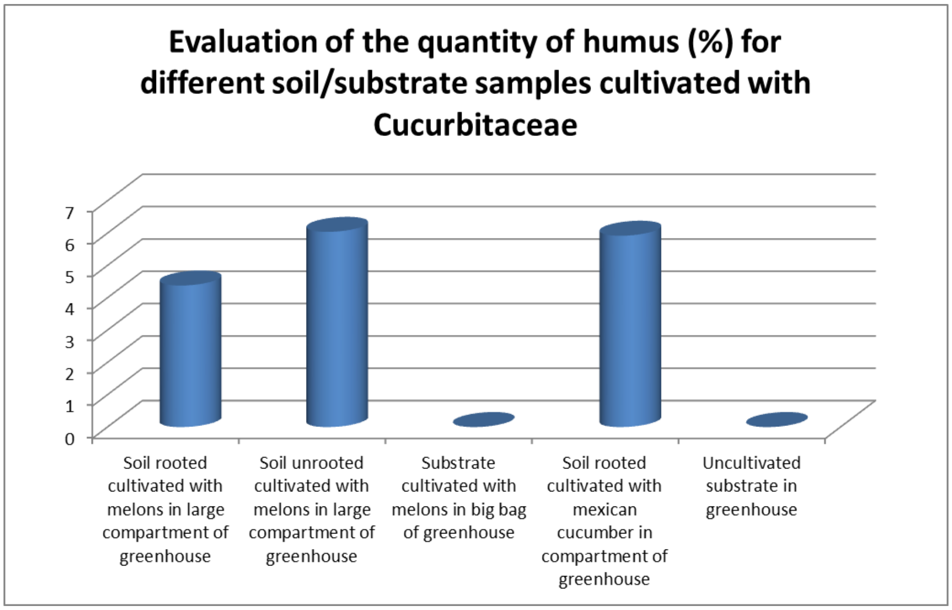

Figure 6. Evaluation of humus content of different types of soil/substrate cultivated with *Cucurbitaceae* /
Evaluarea continutului de humus al diferitelor tipuri de sol/substrat cultivat cu specii din familia *Cucurbitaceae*

The evaluation of the content of humus in the soil and substrate shows that it is missing from the substrate (according to Figure 6). Its use from the soil can be observed in the case of the samples collected from the root area of the melons (4.38%) compared to 6.04% determined in the case of the samples collected from the rootless area of the melon culture. The analysis of the soil in the area cultivated with Mexican cucumbers shows a content of 5.92% in humus.

The amount of organic carbon contained in different samples is differentiated according to their type. This can be seen in Figure 7, where the soil has a much smaller amount of organic carbon than in the substrate. Also, the amount of organic carbon is noticeably lower than in the control, which can be assumed to be a direct consequence of cultivation.

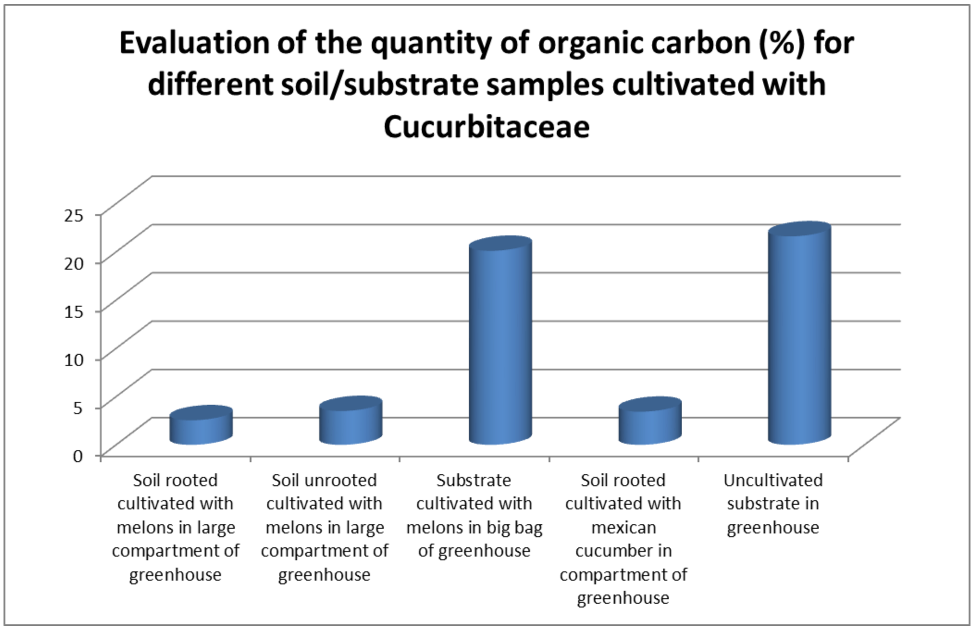

Figure 7. Evaluation of the organic carbon content of different types of soil/substrate cultivated with *Cucurbitaceae* /
Evaluarea continutului de carbon organic al diferitelor tipuri de sol/substrat cultivat cu specii din familia *Cucurbitaceae*

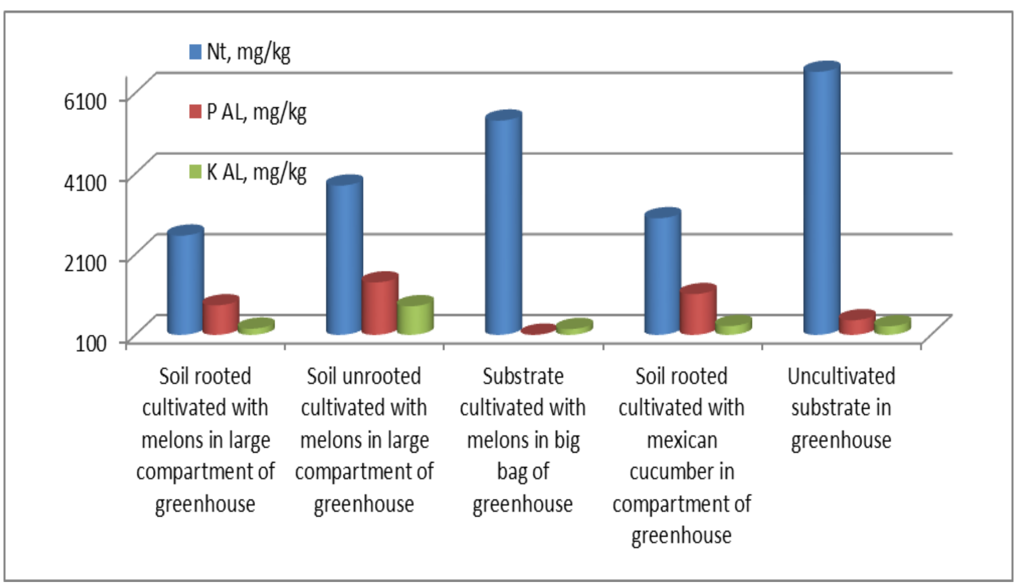

Figure 8. Evaluation of the N, P, K content of different types of soil/substrate cultivated with *Cucurbitaceae* /
Evaluarea continutului N, P, K al diferitelor tipuri de sol/ substrat cultivat cu specii din familia *Cucurbitaceae*

Plants absorb macronutrients from the soil. Soil enrichment is usually done with nitrogen, phosphorus and potassium. However, it is recommended that this be done based on an evaluation of their content, in order to use the optimal formula.

According to Figure 8, it can be seen that the highest nitrogen content is found in the substrate, the highest amount being 6600 mg/kg in the control substrate, and 5410 mg/kg in the one cultivated with melons. Also, the lowest amount of nitrogen of 2560 mg/kg is found in the case of the sample collected from the area of the roots of the yellow melon, while the sample from the area without roots has a value of 3800 mg/kg.

The lowest amount of phosphorus is observed in the case of the substrate samples, visibly lower in the case of the cultivated substrate (106 mg P/kg substrate), compared to the uncultivated substrate (463 mg P/kg substrate).

In the case of soil samples, the lowest amount of phosphorus was observed in the sample collected from the melon root area (832 mg P/ kg soil), while the sample from the area without roots is noticeably higher (1400 mg P/ kg soil). A greater amount of phosphorus is observed in the soil harvested from cucamelon culture (1110 mg P/ kg soil).

As shown in the previous figure, it can be seen that in the cultivation substrate, the amount of potassium is 312 mg K /kg substrate, in the case of the control version and 244 mg K /kg substrate, in the one cultivated with melons. There is also a considerable decrease in the amount of potassium in the soil harvested from the area of the melon roots (254 mg K/ kg soil), compared to the amount of 810 mg K/kg soil, from the area of unrooted soil from the melon culture.

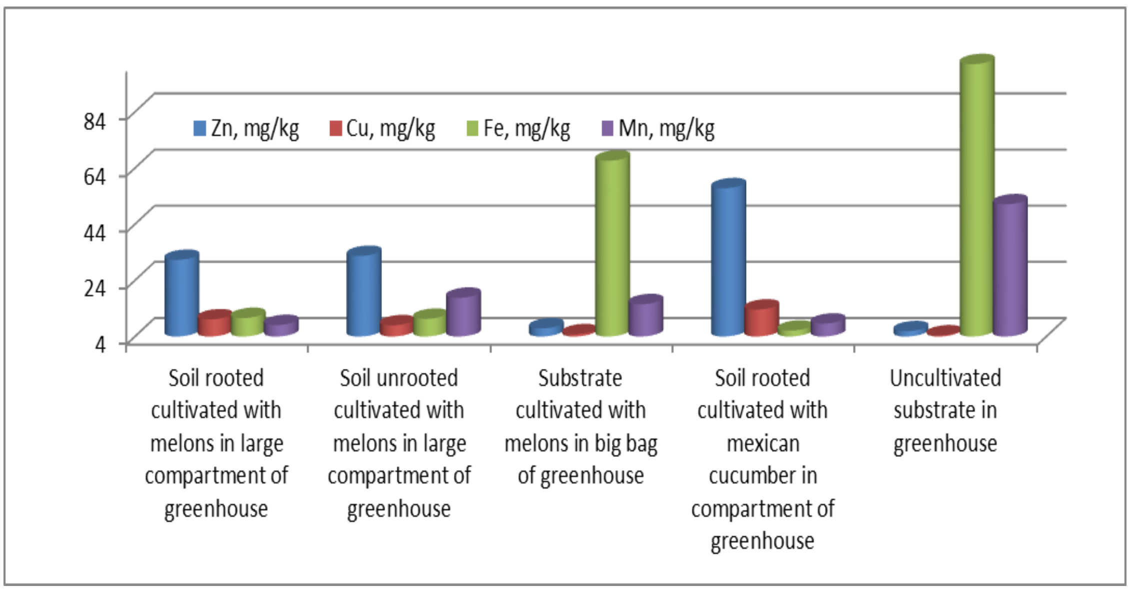

Figure 9. Evaluation of Zn, Cu, Fe, Mn content of different types of soil/substrate cultivated with *Cucurbitaceae* /
Evaluarea continutului în Zn, Cu, Fe, Mn al diferitelor tipuri de sol/substrat cultivat cu specii din familia *Cucurbitaceae*

The role of microelements is essential. These are needed by a plant in much smaller quantities. They influence the respiration of the plant with the role of activator and inhibitor of respiratory enzymes (Fe, Cu, Mn, Zn, Co, which act as coenzymes and increase the intensity of cellular respiration) (Madjar and Davidescu, 2009).

The quantity is also differentiated according to the type of plant, and its development is directly influenced by their presence or lack.

The plant needs about 40 times more Mg than Fe (Madjar et Davidescu, 2009).

Figure 9 shows an evaluation of the soil/substrate content in Zn, Cu, Fe, Mn.

It is observed that in the case of zinc, the amount in the substrate is much lower than in the soil, according to figure no. 9. In the cultivated substrate we have 6.9 mg Zn / kg substrate, while in the control it is 5.9 mg Zn / kg substrate. In the case of the soil samples, in the one collected from the melon root zone, the zinc is 31.3 mg / kg soil, slightly lower than the soil sample from the area without roots, 32.7 mg Zn / kg soil. The highest value of the amount of zinc was 56.8 mg Zn/kg soil in the case of the sample collected from the cucamelon culture. This may mean that cucamelon plants use zinc in a very small amount or the microbiome specific to the soil enriches it.

In the case of copper, the analysis revealed a quantity of 4.8 mg Cu / kg substrate, a value close to the amount of Cu in the cultivated substrate, being 4.3 mg Cu / kg substrate. It is observed that the copper value is lower in the soil area without roots (8 mg Cu / kg soil) compared to the area with melon roots (10.1 mg Cu / kg soil). A value of 13.6 mg Cu/kg soil was found in the cucamelon soil sample.

This may mean that the melon and cucamelon plants enrich the soil with the amount of copper through the specific microbiome.

In the case of iron, larger quantities are observed in the substrate than in the soil (according to figure no. 9). It is remarkable that the substrate has an increased value (101 mg Fe /kg substrate), this being visibly low in the case of the cultivated substrate (66.6 mg Fe /kg substrate). Comparing the soil samples in the case of the area with melon roots, a value (10.6 mg Fe /kg soil) is observed close to the soil samples collected from the area without melon roots (10.3 mg Fe /kg soil). In this case, a decrease of four units is observed in the value (6.1 mg Fe /kg soil) compared to the melon culture in soil.

It is observed that the value of manganese is more than 3 times higher in the case of the control (51.1 mg Mn /kg substrate) compared to the cultivated substrate (15.5 mg Mn /kg substrate). The same trend with a lower rate is also observed in the case of the soil sample from the area of melon roots (8.1 mg Mn/kg soil), compared to the sample from the area without roots (17.8 mg Mn/kg soil).

From the centralization of the data, according to figure no. 9, in the case of growing melons in the substrate, copper, iron, manganese decrease in value, with the exception of zinc, which increases.

When growing melons on the ground, it was observed that zinc and manganese decrease, and copper and iron increase; while in cucamelon the value of iron and manganese decreases, while the value of zinc and copper increases.

CONCLUSIONS

From the conducted study, it can be concluded:

1. The pH of the soil/substrate tends to increase through cultivation.
2. The amount of humus is not directly correlated with the amount of organic carbon.
4. Manganese decreases in all cases, the other microelements alternate, depending on the variants.
5. The study is ongoing, these being only a first stage of evaluation, the multi-year repeatability and the evaluation of several variants will be evaluated.

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DYNAMICS OF AREAS AND PRODUCTIONS OF PEPPER CULTIVATION IN ROMANIA AND THE EUROPEAN UNION

DINAMICA SUPRAFEȚELOR ȘI A PRODUCȚIILOR LA CULTURA DE ARDEI DIN ROMÂNIA ȘI UNIUNEA EUROPEANĂ

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Abstract:
The purpose of this paper is to analyze the dynamics of cultivated areas and production of pepper crops in Romania and the European Union. The research method used in this paper consists of the comparative analysis between the technical indicators of pepper cultivation in Romania and the EU. This analysis aims to provide a more detailed understanding of trends and changes in the expansion of pepper area, as well as the evolution of pepper production in the European agricultural context.

Key words: *agriculture, areas, productions*

Rezumat:
Scopul acestei lucrării este de a analiza dinamica suprafețelor cultivate și a producției la cultura de ardei din România și Uniunea Europeană. Metoda de cercetare utilizată în această lucrare constă în analiza comparativă dintre indicatorii tehnici a culturii de ardei în Romania și UE. Această analiză are ca scop să ofere o înțelegere mai detaliată a tendințelor și a schimbărilor în ceea ce privește extinderea suprafețelor cultivate cu ardei, cât și evoluția producției în această cultură în contextul agricol european.

Cuvinte cheie: *agricultură, suprafețe, producții*

INTRODUCTION:

The pepper crop (*Capsicum spp.*) is one of the most important vegetable crops, both in Romania and in the European Union. Peppers are widely valued due to their culinary versatility and high content of vitamins, especially vitamin C, and antioxidants. In the context of European agriculture, peppers represent a significant component of crop diversity and contribute to food security but also to the rural economy.

Vegetables are a particularly important and valuable food category in a healthy and varied diet. FAO/World Health Organization (WHO) representatives recommend the consumption of approx. 400 grams of vegetables per day, but world production, as well as that of the EU, is insufficient to cover the daily dose recommended by the FAO.

The agricultural policies of the European Union have an important role in the dynamics of areas and productions of pepper cultivation. The Common Agricultural Policy (CAP) provides financial support for farmers, encouraging investment in modern technologies and sustainable practices. In Romania, access to European funds has allowed the modernization of agricultural infrastructure and the improvement of production capacity.

Pepper cultivation in Romania, but also in the European Union, is a dynamic sector, with a major importance for both the agricultural economy and food security. The careful assessment of cultivated areas and productions, together with support policies and technological innovations, will play a key role in ensuring the sustainable development of this sector.

MATERIALS AND METHOD

The purpose of this study is to research the pepper crop in Romania, for the 2013-2022 analysis period and the economic efficiency of this crop in agricultural enterprises in Romania, at the level of the European Union, through different methods, procedures and techniques. In order to achieve the goal, the comparative method, the quantitative and qualitative data analysis method, used in the literature, was used.

RESULTS AND DISCUSSIONS

By performing a brief analysis of the pepper crop, the areas cultivated with peppers in the field and in protected areas and the production obtained at the level of the European Union were identified and evaluated. This analysis was carried out for the period 2013-2022, referring to the areas cultivated with peppers in the field, as follows, they are summarized as follows:

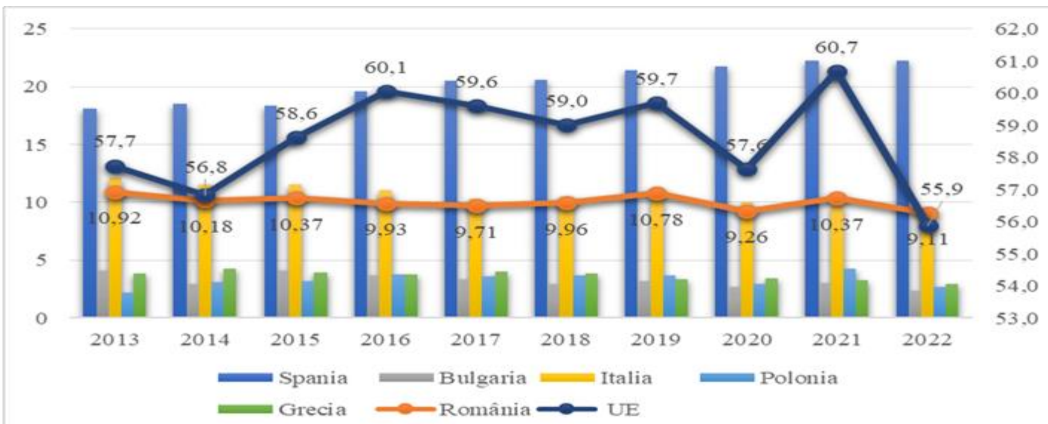

Figure 1. Areas cultivated with peppers in the field at the level of the European Union in the period 2013-2022 (1000 ha) / Suprafețele cultivate cu ardei în câmp la nivelul Uniunii Europene, în perioada 20213-2022 (1000 ha)

In first place among the EU member countries with the largest area cultivated with peppers in the field is Spain (22.26 thousand hectares in 2022). In Spain, the areas cultivated with peppers increased at an annual rate of 21%, so that in 2022 the level of 2013 was exceeded by 22.9%.

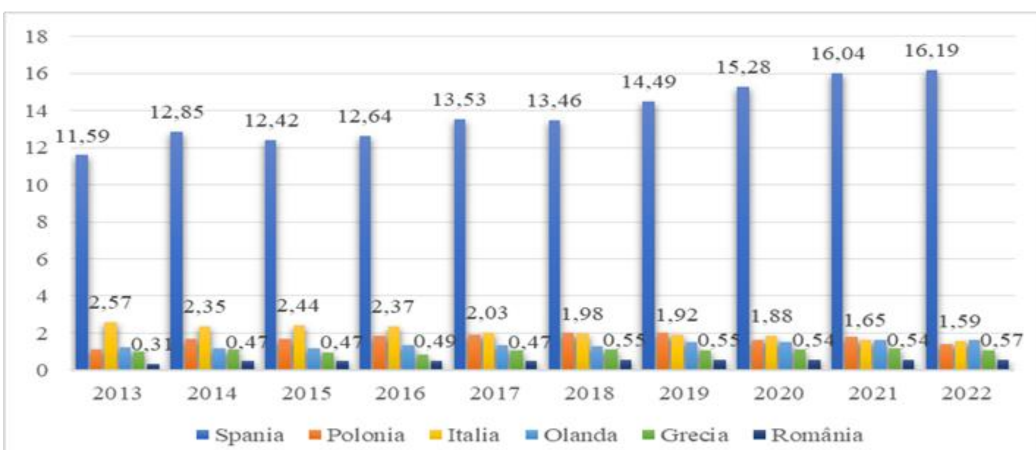

Figure 2. Areas cultivated with peppers in protected areas at the level of the European Union, in the period 2013-2022 (1000 ha) / Suprafețele cultivate cu ardei în spații protejate la nivelul Uniunii Europene, în perioada 20213-2022 (1000 ha)

As for the area cultivated with peppers in protected areas, the first place is occupied by Spain, which in 2022 exploited an area of 16.19 thousand hectares, up 39.7% compared to the area cultivated in 2013 (11.59 thousand hectares).

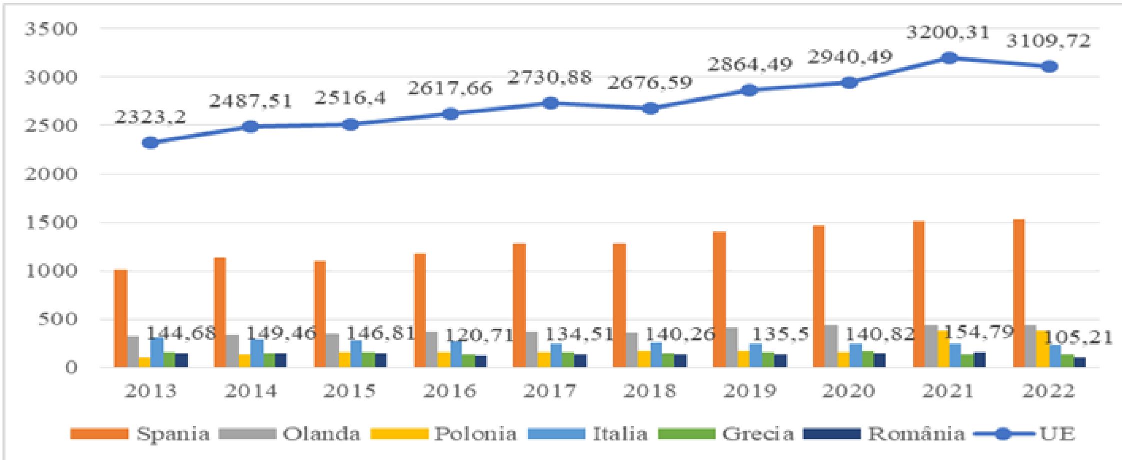

Figure 3. Pepper production at European Union level 2013-2022 (1000 t) / Producția de ardei la nivelul Uniunii Europene 2013-2022 (1000 t)

The largest producer of peppers among EU countries in 2022 was Spain with a production of 1533.28, representing almost half of the total production harvested in the EU.

In terms of pepper production in protected areas in 2022, Spain is also in first place with a quantity of 1,297.76 thousand tons.

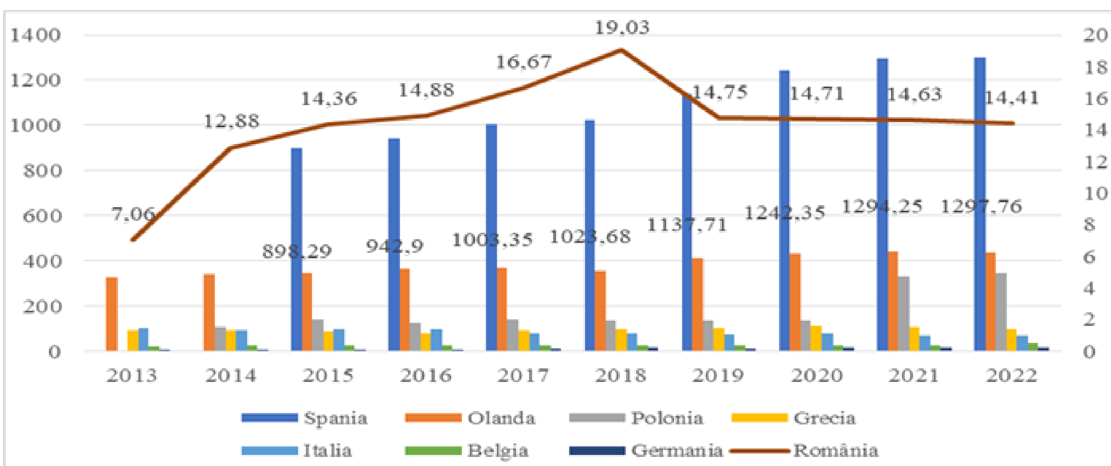

Figure 4. Production of peppers in protected areas at the level of the European Union in the period 2013-2022 (1000 t) / Producția de ardei în spații protejate la nivelul Uniunii Europene în perioada 2013-2022 (1000 t)

CONCLUSIONS

1. In the European Union, the largest area cultivated with peppers was recorded in 2020, of 60.7 thousand hectares. In 2022, there was an area cultivated with peppers of 55.9 thousand hectares (lower by 3.2% compared to 2013 and by 7.9% compared to 2020), being the lowest in the analyzed period.

2. At European Union level, in the period 2013-2022, an average production of peppers of 2,746.73 thousand tons was obtained, the highest being recorded in 2021 of 3,200.31 thousand tons.

3. Romania ranks 8th in the EU in terms of pepper production in protected areas, with a quantity from 7.06 thousand tons in 2013 that doubles in 2022 (14.41 thousand tons).

4. Careful monitoring and management of the challenges will be essential to ensure a sustainable and competitive development of pepper cultivation in the region.

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STUDIES ON *MAJORANA HORTENSIS* AT VRDS BUZAU

STUDII ASUPRA *MAJORANA HORTENSIS* LA SCDL BUZĂU

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Abstract
Majorana hortensis is a perennial herbaceous plant, native to North Africa and Southwest Asia, with sweet aromas of pine and citrus. The plant contains valuable active principles such as polyphenolic compounds; monoterpenes, sesquiterpenes macro and microelements, pectins, phytoncides, and vitamins (due to which it has multiple uses). As a result, the plants of Majorana hortensis are used in dry form in the food industry, in the form of medicinal bioproducts, or in the form of biopreparations intended for plant protection, due to its content in bioactive principles, that inhibit the development of nematodes, defoliating insects and phytopathogenic microorganisms. Due to increased interest in the bioproducts derived from Majorana hortensis, different accessions of marjoram, currently in the VRDS Buzau plant collection, were introduced in a breeding process, to obtain varieties with improved properties.

Keywords: *active biomolecules, marjoram*

Rezumat
Majorana hortensis este o plantă erbacee perenă, originară din Africa de Nord și Asia de Sud-Vest, cu arome dulci de pin și citrice. Planta conține principii active valoroase precum compuși polifenolici; monoterpene, macro și microelemente sesquiterpene, pectine, fitoncide și vitamine (datorită cărora are utilizări multiple). Ca urmare, plantele de Majorana hortensis sunt utilizate sub formă uscată în industria alimentară, sub formă de bioproduse medicinale, sau în formă de biopreparate destinate protecţiei plantelor, datorită conţinutului în principii bioactive, care inhibă dezvoltarea nematozilor, insectelor defoliatoare şi microorganismelor fitopatogene. Datorită interesului crescut pentru bioprodusele derivate din Majorana hortensis, diferite accesii de maghiran aflate în prezent în colecţia de plante a SCDL Buzău, au fost introduse într-un proces de ameliorare, pentru a obține soiuri cu proprietăți îmbunătățite.

Cuvinte cheie: *biomolecule active, maghiran*

INTRODUCTION

Medicinal and aromatic plants have been used since ancient times for various medicinal and culinary purposes. The herbal system of medicine is not only the oldest form of health care, but also an integral part of the development of modern civilization. Even in the modern world, the vast majority of the human population, especially in developing countries, rely on herbal medicine systems and herbal products for their primary health care needs. Aromatic plants are generally dried, ground and packaged for household needs and then presented to the consumer (PRERNA GOEL et al., 2015).

Aromatic and medicinal plants play a very important role in the drug discovery and development process of this sector, through the inclusion and use of bioactive secondary metabolites. Flavonoids are a broad class of secondary plant phenolics characterized by the flavan nucleus. Flavonoids have been reported to exhibit a large number of biological activities. Aromatic and medicinal plants possess odorous substances, and the characteristic aroma is due to a wide range of complex chemical compounds. These compounds and their derivatives are used in the pharmaceutical industry and contain a vast reservoir of bioactive constituents that are still unexplored for medicinal properties. The demand of herbal medicines over synthetic medicines is increasing day by day because these herbal medicines have no side effects while every synthetic medicine are some side effects. So, plant-derived products are potential candidates to be next-generation drug products (FATEMEH BINA et al., 2016).

Aromatic plants are generally referred to as "natural bio-chemical factories" or "chemical gold mines". Not all of these natural chemicals can be synthesized in the lab. Aromatic plants possess odorous volatile substances which are found as essential oil, green exudate, balsam and oleoresin in one or more parts, namely root, lignified parts, stem, foliage, flowers and fruit (ROULA M. ABDEL-MASSIHA et al., 2009). They are called volatile or essential oils because they evaporate when exposed to air at ordinary temperatures.

The demand and price of herbal products and essential oils are constantly increasing in the national and international markets due to the strong pro-consumer movement. In the world of fragrances and flavors industry, essential oils contribute about 17%. The degree of use of essential oils is 55-60% for flavors in the food industry, 15-21% for perfumes in the perfumery/cosmetics industry, 10-20% as raw material for isolation of components, 5-10% as active substances in the preparation pharmaceuticals and 2-5% for natural products. Essential oils and aromatic chemicals constitute a major group of industrial products (F. PANK, 2002). These oils form indispensable ingredients needed in many spheres of human activities. They are additives in cosmetics, soaps, pharmaceuticals, perfumery, confectionery, ice creams, carbonated waters, disinfectants, tobacco, and a number of related products.

Also, aromatic and medicinal plants are also used in the field of plant protection in the form of bioprotection and bioprotector. Biostimulants and bioprotectants are derived from natural sources and can increase crop growth and protect them from pests and pathogens, respectively. They have gained attention in recent decades and are contributing to a more sustainable and ecological agricultural system. Despite not being extensively explored, plant extracts and their secondary metabolites, including phenolic compounds, have been shown to have biostimulatory effects on plants, including growth and yield attributes, as well as bioprotective effects, including antimicrobials, insecticides, herbicides and nematocides effects.

MATERIALS AND METHODS

Majorana hortensis Moench., family *Lamiaceae (Labiatae)*, is a perennial herbaceous plant, with sweet aromas of pine and citrus, pleasantly smelling, native to North Africa and South-West Asia (modern Turkey), being used since ancient times. For a long time, oregano was also known as "wild marjoram" and this only because they are the same kind of spices. Italians and some botanists believe that marjoram and oregano are practically indistinguishable.

The marjoram has a straight, tetragonal stem, up to 20-30 cm high and much branched at the base; the leaves arranged oppositely, small, elliptic - oval, are petiolate, with entire edges, gray - green on both sides, due to the numerous hairs that cover them (LOBNA MOUSSA, 2008). The white / light pink / purple flowers are small, arranged in straight spikes, with a felty calyx, reduced to a single obovate leaflet, with a bilabiate corolla and the androecium consisting of 4 stamens longer than the corolla. It blooms from July to September (MOHAMMAD B. et al., 2011)

Majorana hortensis is one of over 200 genera in the Family *Lamiaceae* (mint family), and the genus includes edible, aromatic, medicinal and ornamental plants. Herbaceous perennials or subshrubs, plants of *Majorana hortensis* are native to the Mediterranean and Eurasia and grow in mountainous areas with rocky, calcareous soil. Some species grow in bushes only 5-7.5 cm high, while others grow erect, up to 100 cm high. All members of the genus have flowers that appear on spikes; for most species they form a panicle with multiple branched stems growing from a central stem (SENYE WANG et al., 2018).

In *O. onites* the spikes grow into a "false corymb", forming an open convex or flat-topped inflorescence. Corollas can be purple, pink or white, depending on the species. In some species the flowers are arranged in spirals. The calyx, or small vase-shaped receptacle that supports and protects the corolla and reproductive organs of the flower, may be bell-shaped or tubular, with one or two ligules.

In some cases, the bracts are so beautiful and colorful that an untrained observer might mistake them for flowers. In these cases, the flower is actually hidden inside the bracts. In some species, such as *O. rotundifolium* and *O. dictamnus*, the bracts overlap and resemble hops. Both the stems and leaves of *Majorana hortensis* are often covered with fine hairs. Leaves can be of various shapes, including round, heart-shaped or oval, and can be glossy/waxy or diffusely hairy. Stems can be woody or non-woody. All species also produce small brown fruits called acorns (F. EL-SHINTINAWY et al., 2021)

When most people think of oregano, they think of pizza and pasta sauce. Oregano and marjoram seem more familiar and simple to use to the average cook, but in reality these common herbs have a very complicated taxonomic history (ABEDULLA KHAN KAYAMKANI et al., 2017).

According to Dr. Arthur O. Tucker, "it is best to think of oregano as an aromatic herb rather than a genus or species". Plants in several genera, including *Lippia* and *Plectranthus*, are also considered oregano due primarily to the presence of carvacrol, which is largely responsible for oregano's distinctive odor and flavor (LE THI YEN and JOONHO PARK, 2020). According to current estimates there are 44 species, 6 subspecies, 3 varieties (botanical varieties) and 18 natural hybrids. Because *Majorana hortensis* taxa are so variable and interbreed easily, there are hundreds of unclassified hybrids growing in gardens, where proximity favors cross-pollination that is probably not encountered in the wild (ABEDULLA KHAN KAYAMKANI et al., 2017)

Today, two types of marjoram are grown in gardens – for leaves and for flowers. The leaf species is a plant with a strongly branched stem with dense foliage, but there are few flowers on such a plant. The species for flowers does not have such strong stems and roots, although it does not bloom profusely. Both species are cultivated as ornamental, seasoning and medicinal plants. The best and cultivated varieties of marjoram are: Lakomka, Tushinsky, Semko, Termos and Scandi.

RESULTS AND DISCUSSIONS

In 2022, 3 accesions / varieties of marjoram were studied:

1. Marjoram L3, Marjoram OPAL, PLOVDIV, Bulgaria;
2. Marjoram L4 Marjoram from the S.C.D.L. Buzau collection;
3. Marjoram L5 Marjoram LEGUTKO, purchased from the GRADINA MAX website.

The marjoram seeds were sown on 06.03.2022, having an interval of 15-20 days for them to sprout. Culture in the field and in protected space was established on 04.07.2022.

With a view to homologation and patenting during the 3-year period of the doctoral degree, we have selected an accession that we believe is highlighted from the 3 mentioned above.

In the marjoram culture, established in open field, in the organic polygon of VRDS Buzau, we noticed a Marjoram accesion, having a dark green foliage, different from the three varieties established in the spring, in the Figure 1 having the accesion L9 presented.

Fig. 1 Appearance of accesion L9 Marjoram selected for homologation / patenting / *Aspect accesia L9 Maghiran selectat în vederea omologării / brevetării*

Table 1. Biometric data characteristic / Caracteristici biometrice

Variety	Plant Height (cm)	Plant Diameter (cm)	No. of twigs	No. of leaves / twigs	No. of buds / twigs	No. of flowers	Leaf colour
L 3	24	36	81	30	24	10	bright green
L 4	26	36	93	41	56	17	bright green
L 5	28	37	89	37	48	12	bright green
L 9	31	40	95	44	62	10	dark green

CONCLUSIONS

1. *Majorana hortensis* is a perennial herbaceous plant, with sweet aromas of pine and citrus, pleasantly smelling, originally from Arabia and Egypt.

2. It has a straight, tetragonal stem, up to 20-30 cm high and much branched at the base; the leaves arranged oppositely, small, elliptic - oval, are petiolate, with entire edges, gray - green on both sides, due to the numerous hairs that cover them.

3. The white / light pink / violet flowers are small, arranged in straight spikes, with a felty calyx, reduced to a single obovate leaflet, with a bilabiate corolla and the androecium consisting of 4 stamens longer than the corolla. It blooms from July to September.

4. The best and most commonly cultivated varieties of marjoram are: Baikal, Lakomka, Tushinsky, Semko, Termos and Scandi.

5. *Marjorana hortensis* is individualized by the quality of the strong, aromatic and pleasant perfume.

ACKNOWLEDGEMENTS

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FRUIT GROWING

BREEDING PROGRAMS AT RESEARCH INSTITUTE FOR FRUIT GROWING PITESTI, ROMANIA FOR ENHANCE FRUIT PRODUCTION

PROGRAME DE AMELIORARE LA INSTITUTUL DE CERCETARE-DEZVOLTARE PENTRU POMICULTURĂ PITEȘTI, ROMÂNIA PENTRU ÎMBUNĂTĂȚIREA PRODUCȚIEI DE FRUCTE

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Abstract

The creation and introduction in the fruit growing sector of new cultivars with high biological and nutritional value, adapted to the various pedo-climatic conditions from Romania are the main means of improvement of the fruits quality and the diversification of their destination, as well as of increasing the economic efficiency in fruit growing. Over time, the assortment structure has improved not only quantitatively, but also qualitatively by introducing the cultivars tolerant or resistant to diseases and pests, with large and constant yield, with fruits quality that respond to the requirements of cultivators, consumers and processor of the food industry. The results of the breeding programs carried out in Romania have materialized by registering 480 cultivars of fruit trees and berries. Of these, 70 cultivars of apple, pear, plum, sweet and sour cherry were created at RIFG Pitesti, Romania. The value of these assortments has been demonstrated by propagation in the fruit nursery and extension in the commercial orchards. Thus, out of the total propagated trees, about 50% are Romanian cultivars. Since 2014, the National Plan for Rural Development issued a special measure for investments in fruit growing sector. Through this measure, new orchards were established, the share of Romanian cultivars being very high due to their adaptability to the pedo-climatic conditions from our country.

Keywords: *breeding, production, fruit growing, species, cultivars.*

Rezumat

Crearea și introducerea în practica pomicolă a unor soiuri noi cu valoare biologică și nutrițională ridicată, adaptate la condițiile pedo-climatice variate din România constituie principalul mijloc de îmbunătățire calitativă a fructelor și diversificare a destinației acestora, cât și de creștere a eficienței economice în pomicultură. De-a lungul timpului structura sortimentală s-a îmbunătățit nu numai cantitativ, ci și calitativ prin introducerea unor soiuri tolerante sau rezistente la boli și dăunători, cu potențial agroproductiv mare și constant, cu fructe de calitate care răspund cerințelor cultivatorilor, consumatorilor și procesatorilot din industria agroalimentară. Rezultatele programelor de ameliorare derulate în România s-au concretizat prin înregistrarea a 480 de soiuri de pomi și arbuști fructiferi. Dintre acestea, 70 de soiuri de măr, păr, prun, cireș și vișin au fost create la ICDP Pitești, România.Valoarea acestor creații sortimentale a fost demonstrată prin înmulțirea lor în pepinierele pomicole și extinderea în plantațiile comerciale. Astfel, din totalul pomilor înmulțiți, 50% sunt soiuri românești. Începând cu anul 2014, Planul Național de Dezvoltare Rurală a lansat o măsură specială de relansarea a pomiculturii în țara noastră. În cadrul acestei măsuri, s-au înființat noi plantații de pomi fructiferi, ponderea soiurilor românești fiind foarte mare datorită adaptabilității lor la condițiile pedoclimatice din țara noastră.

Cuvinte cheie*: ameliorare, producție, pomicultură, specii, soiuri.*

INTRODUCTION

The agricultural area of Romania is 147 million hectares, of which the fruit trees occupy 138,000 hectares (under 1%). Total fruit production is 1.4 million tones, over 90% being provided by plum, apple, pear, sweet and sour cherry species (FAO Statistics Division, 2024) (Tabel 1).

The importance of fruit trees cultures for our country is due, on the one hand to the concordance that exists between the ecological conditions in different areas and natural basins, and on the other, the requirements of the different species and varieties. There are natural basins in which the main fruit species, apple, pear, plum, sweet and sour cherry, find optimal conditions for growth and fruiting.

Table 1. Fruit growing surface and production in Romania / Suprafața pomicolă și producția de fructe din România

No.	Species	Surface		Production	
		ha	%	t	%
1	Plum	66,710	48.34	665,730	47.25
2	Apple	54,070	39.18	543,380	38.56
3	Pear	3,200	2.32	42,320	3.00
4	Sweet cherry	3,310	2.40	34,320	2.43
5	Sour cherry	2,570	1.86	28,970	2.06
6	Other species	8,140	5.90	94,280	6.70
	Total	**138,000**	**100**	**1,409,000**	**100**

Modern fruit growing must solve problems caused by: energy crisis; competition between different fruit production countries, as a result of increasing production and extension of fruit growing in new, non -traditional areas; the increasing demands of consumers and the speed of changes of consumers' tastes (e.g. disadvantage of sweet and aromatic apples – type 'Golden delicious' and preference for sour and astringent apples - type 'Granny Smith', etc.).

What is required of a good cultivar in the current stage?

One could respond with a single word - efficiency. But in order to have good efficiency, the cultivars must respond to at least three desires: high production, genetic resistance to diseases and pests and environmental factors, taste and technological qualities corresponding to market requirements (Branişte et al., 2007, 2008; Butac et. al., 2021).

Another trend is the concentration of cultures in consecrated basins and centers, which offer edaphic and climatic conditions requested by the cultivar-rootstock association in order to ensure a good biological potential. In general, the intensive orchards are concentrated in large basins and centers, with possibilities of irrigation, such as: the basin of Argeş, Dâmbovița, Prahova, etc. (Butac et al., 2014; Coman et. al., 2014).

In general, the assortment of some area is not permanent due to the creation of other better cultivars, changes of consumers' tastes, the sensitivity of the cultivars existing to different diseases and pests, climatic changes, etc.

That's why the creation and introduction in the fruit growing sector of new cultivars with high biological and nutritional value, adapted to the various pedo-climatic conditions from Romania are the main means of improvement of the fruits quality and the diversification of their destination, as well as of increasing the economic efficiency in fruit growing.

MATERIAL AND METHODS

The objectives of breeding programs are similar to those on the international level and consist in increasing the quantity and quality of fruit production, reducing the resources allocated for phytosanitary protection and reducing the pollution of the environment (Butac et al., 2018).

For all five species the breeding programs started in the 60's and were carried out in several stages. In the first stage, the main objective was to achieve cultivars superior to those existing in the culture (e.g. 'Domnesc', 'Crețesc', 'Șovari', 'Călugăresc' at apple; 'Orzatice', 'Sintiliești', 'Pepenii', 'Tămâioase' at pear; 'Tuleu gras', 'Grase romanesti' and 'Vinete romanesti' at plum; 'Boambe de Cotnari', 'Pietroase de Leordeni', 'Drăgănele de Pitești', 'Bășicate', 'Germersdorf', 'Hedelfinger' at sweet cherry; 'Crișana', 'Mocănești' at sour cherry).

In the following stages it was considered the improvement of the assortment and the replacement of local varieties by new ones tolerant to diseases and pests (scab, powdery mildew and fire blight at apple, fire blight and *Psylla* sp. at pear, Plum Pox Virus and bacteria at plum, fungi and bacteria at sweet and sour cherry), yielding more, with superior fruits from a taste point of view, various ripening seasons and providing a longer season for the fresh market (Braniște et al., 2007; Militaru et al., 2009, 2010; Militaru, 2010; Butac et al., 2014, 2018; Butac, 2020) (Table 2).

Among the most used breeding methods are conventional ones such as controlled hybridization, mutagenesis, open pollination and selection in wild and cultivated flora. In the last decades, new techniques have also developed, in the field of biotechnology, which shortens the duration of the breeding process. The genetic progress registered so far in the breeding was mainly due to the use of the classic methods – controlled hybridization that involves the use of potential genitors for each objective selected from the genebank collections.

Table 2. The main breeding objectives of fruit trees species in Romania / Principalele obiective de ameliorare a speciilor pomicole în România

No.	Species	Main objectives	
		Current	Perspective
1	Apple	- Resistance to scab and powdery mildew; - Fruits quality (similar to 'Jonathan' and 'Golden delicious' cvs.); - Low vigour and fruiting on short branches.	- Resistance to fire blight and pests; - Columnar type with resistance to diseases (specially scab); - Selection of apple genotypes regarding scab resistance by using molecular markers.
2	Pear	- Resistance to fire blight and *Psylla*; - Winter cultivars with long storage; - Fruits quality (similar to 'Williams' cv.).	- Immunity to diseases and pests; - Good compatibility with quince rootstocks; - Low vigour; - Introduction in breeding program of red flesh genotypes.
3	Plum	- Tolerance / resistance to viruses (specially Plum Pox); - Fruits quality (similar to 'Tuleu gras' cv.); - Different ripening time.	- Immunity to Plum Pox Virus by using immune or resistant gene sources; - Low vigour and fruiting on short branches; - Resistance to late frost and late flowering; - Self fertility.
4	Sweet cherry	- Fruits size (over 10 g, respectively over 30 mm caliber); - Low vigor; - Earliness and lateness; - Resistance to diseases (*Blumeriella jaapii, Monilia* sp.).	- Low vigour and fruiting on short branches; - Fruits size and quality; - Resistance to late frost and late flowering; - Self fertility.
5	Sour cherry	- Fruits quality, designated for fresh market; - Self fertility; - Resistance to diseases (*Blumeriella jaapii, Monilia* sp.).	- Possibility of mechanized harvesting; - Fruits quality and red flesh; - Self fertility; - Resistance to late frost and late flowering.

RESULTS

For all five fruit species, over time, thousands cross combination was carried out, millions of flowers have been pollinated, thousands of seeds, stones and hybrid plants have been obtained, and finally 70 new cultivars have been registered, of which; 12 apple cultivars, 13 pear cvs., 23 plum cvs., 15 sweet cherry cvs. and 7 sour cherry cvs. (Cociu et al., 1997; Braniște et al. 2007; Butac et al., 2014, 2018, Ștefan et al., 2018) (Table 3, 4, 5, 6, 7).

The registered of these valuable cultivars which have completed and enriched the zonal assortments also meant their promotion in commercial orchards by annual propagation in the nurseries throughout the country. In this sense there is a permanent concern for the spread of new autochthonous cultivars in the Romanian plantations (Table 8).

Table 3. Apple cultivars created at RIFG Pitești, Romania / Soiuri de măr create la ICDP Pitești, România

No.	Cultivar	Year of registration/Authors	Genitors	The main characteristics
1	Romus 1	1984/Braniște N., Cociu V., Hough L.F.	F4 hybrid seeds from the Rutgers University, U.S.A.	Summer cultivar, resistant to scab
2	Romus 2	1984/Cociu V., Braniște N.	Camuzat x FCF 9-100 (F4 interspecific hybrid)	Summer cultivar, resistant to scab
3	Romus 3	1984/Cociu V., Hough L.F., Braniște N.	F4 hybrid seeds from the Rutgers University, U.S.A.	Summer cultivar, resistant to scab
4	Remus	1994/Braniște N., Amzăr V., Rădulescu M.	Camuzat x PCF 9-100 (interspecific hybrid from	Summer cultivar, resistant to scab

			Malus floribunda 821).	
5	Romus 4	1999/Braniște N., Amzăr V., Rădulescu M.	Romus 3 x Prima	Autumn cultivar, resistant to scab
6	Romus 5	2003/Braniște N.	Romus 3 x Prima	Autumn cultivar, resistant to scab, good yielding capacity, attractiveness of fruits
7	Rebra	2003/Braniște N.	Florina x Idared	Winter cultivar, resistant to scab
8	Nicol	2005/Braniște N., Militaru M.	Mc Intosh Wijcik x Pionier	Autumn cultivar, resistant to scab, columnar type
9	Colmar	2006/Braniște N., Militaru M.	Mc Intosh Wijcik x Florina	Autumn cultivar, resistant to scab, columnar type
10	Colonade	2007/Braniște N., Militaru M.	Pionier x Mc Intosh Wijcik	Autumn cultivar, resistant to scab, columnar type
11	Rustic	2008/Braniște N.	Florina x Pionier	Winter cultivar, resistant to scab
12	Rumina	2021/Isac Il. Voica Gh., Militaru M., Călinescu M.	Natural mutation of the Golden delicious	Winter cultivar, resistant to scab, yellow fruits with rust on the epidermis

Table 4. Pear cultivars created at RIFG Pitești, Romania / Soiuri de păr create la ICDP Pitești, România

No.	Cultivar	Year of registration/Authors	Genitors	The main characteristics
1	Trivale	1982/Braniște N., Gheorghiu E., Amzăr V.	Napoca x Beurre Giffard	Summer cultivar, fruits with good taste
2	Triumf	1983/Braniște N.	Napoca x Beurre Giffard	Summer cultivar, fruits with good taste
3	Argessis	1985/Braniște N.	Napoca x Beurre precoce Morettini	Summer cultivar, fruits with good taste
4	Daciana	1989/Braniște N., Amzăr V., Rădulescu M., Isac M.	Napoca x Beurre precoce Morettini	Summer cultivar, fruits with good taste
5	Carpica	1989/Braniște N., Amzăr V., Rădulescu M., Isac M.	Napoca x Beurre precoce Morettini	Summer cultivar, fruits with good taste
6	Getica	1994/Braniște N., Amzăr V., Stoiculescu E.	Napoca x Beurre precoce Morettini	Summer cultivar, fruits with good taste
7	Monica	1994/Braniște N., Amzăr V., Stoiculescu E.	Santa Maria x Principe di Gonzaga	Autumn cultivar, tolerant to fire blight
8	Ervina	2003/Braniște N.	(*Pyrus serotina* x Williams) x Napoca	Autumn cultivar, tolerant to fire blight
9	Paramis	2008/Braniște N., Militaru M.	Monica x Passe Crassane	Autumn cultivar, fruits with good taste
10	Paradise	2010/Braniște N.	H 26-67-73 P x Păstrăvioare	Autumn cultivar, fruits with red colour
11	Paradox	2010/Braniște N.	Monica x Păstrăvioare	Autumn cultivar, fruits with good taste
12	Isadora	2012/Braniște N., Militaru M.	Haydeea x Tse Li	Winter cultivar, tolerant to fire blight and *Psylla*
13	Pandora	2019/Braniște N., Militaru M.	Euras x Tse Li	Winter cultivar, tolerant to fire blight and *Psylla*

Table 5. Plum cultivars created at RIFG Pitești, Romania / Soiuri de prun create la ICDP Pitești, România

No.	Cultivar	Year of registration/ Authors	Genitors	The main characteristics
1	Tuleu timpuriu	1967/Cociu V.	Tuleu gras x Peche	Earliness, for fresh market, male sterile
2	Superb	1968/Cociu V.	Tuleu gras x Abbaye d'Arton	Lateness, male sterile
3	Gras ameliorat	1968/Cociu V.	Grase românești-self pollination	Self fertile, large fruit
4	Centenar	1978/Cociu V., Bumbac E.	Tuleu gras x Early Rivers	Earliness, for fresh market, male sterile
5	Silvia	1978/Cociu V., Minoiu N.	Renclod Althan x Early Rivers	Large fruit, for fresh market
6	Albatros	1978/Cociu V., Gozob T.	Tuleu gras open pollination	For fresh market, male sterile
7	Pescăruș	1979/Cociu V., Roman R.	Renclod Althan x Wilhelmina Spath	Earliness, for fresh market, good yielding capacity
8	Ialomiţa	1981/Cociu V., Bumbac E., Roman R.	Renclod Althan x Early Rivers	Earliness, for fresh market, self fertile
9	Piteştean	1981/Cociu V., Roman R.	Tuleu timpuriu x Early Rivers	Earliness, large fruits, for fresh market, good yielding capacity, male sterile
10	Carpatin	1981/Cociu V., Roman R.	Tuleu gras x Early Rivers	Earliness, large fruits, for fresh market, male sterile
11	Dâmboviţa	1981/Cociu V., Roman R.	Tuleu gras x Anna Spath	Lateness, large fruits, for fresh market, male sterile
12	Diana	1981/Cociu V.	Renclod Althan x Early Rivers	Earliness, large fruits, for fresh market, self fertile
13	Minerva	1984/Cociu V., Bumbac E., Roman R., Minoiu N.	Tuleu timpuriu x Early Rivers	Earliness, for fresh market, male sterile
14	Flora	1989/Cociu V.	Tuleu gras x Renclod violet	Tolerance to Plum Pox Virus, male sterile
15	Sarmatic	1989/Cociu V., Bumbac E., Băncilă M., Mutașcu N.	Tuleu timpuriu x Early Rivers	Earliness, for fresh market, good yielding capacity, male sterile
16	Bărăgan 17	1989/Cociu V., Mutașcu N., Băncilă M., Gozob T.	Tuleu gras x Early Rivers	Earliness, for fresh market, male sterile
17	Renclod de Caransebeș	1990/Cociu V., Bumbac E., Băncilă M., Mutașcu N.	Renclod Althan x Wilhelmina Spath	Earliness, for fresh market
18	Tita	1991/Cociu V., Roman R., Bumbac E., Stroe D.	Tuleu gras, irradiation stones	Earliness, large and tasty fruits, for fresh market, good yielding capacity, male sterile
19	Alina	1991/Cociu V., Bumbac E., Nicolaescu M., Roman R.	Tuleu gras, irradiation stones	Earliness, large fruits, for fresh market, male sterile

20	Agent	2004/Duțu I., Mazilu Cr., Ancu S.	Individual selection in a seedlings population resulting from open pollination	Tolerance to Plum Pox Virus, high content in sugar, for dehydration
21	Roman	2004/Roman R., Butac M., Isac M., Ancu S., Bulgaru L.	Tuleu Gras x Early Rivers	Tolerance to Plum Pox Virus, large fruit, for fresh market, male sterile
22	Romanța	2012/Butac M.	Stanley x Vâlcean	Tolerance to Plum Pox Virus, large fruit, for fresh market, self fertile
23	Milenium	2022/Dragoi D., Butac M., Dragomir I.	Unknown	Tolerance to Plum Pox Virus, large fruit, for fresh market, self fertile

Table 6. Sweet cherry cultivars created at RIFG Pitești, Romania / Soiuri de cireș create la ICDP Pitești, România

No.	Cultivar	Year of registration/Authors	Genitors	The main characteristics
1	Cerna	1984/Gozob T.	Thurn und Taxis open pollination	Low vigour, large fruit
2	Ponoare	1989/Gozob T., Micu Ch., Rudi Ev., Chiriac St., Isac M., Stoiculescu E.	Pietroase negre de Odesa X Ramon Oliva	Good yielding capacity, large fruit
3	Izverna	1989/Gozob T., Micu Ch., Rudi Ev., Amzăr V., Isac M., Stoiculescu E., Chiriac St.	Ramon Oliva X Germersdorf	Good yielding capacity, large fruit
4	Colina	1989/Gozob T., Micu Ch., Rudi Ev., Amzăr V., Isac M., Budan S., Chiriac St.	Pietroase negre de Odesa X Germersdorf	Good yielding capacity, large fruit, good quality
5	Severin	1993/Gozob T., Micu Ch., Rudi Ev., Amzăr V., Isac M., Budan S.	Thurn und Taxis X Germersdorf	Large fruit, tolerance to diseases and pests
6	Daria	1993/Gozob T., Budan S., Micu Ch., Rudi Ev.	Boambe de Cotnari X Thurn und Taxis	Large fruit, tolerance to diseases and pests
7	Tentant	1996/Gozob T., Budan S.	Germersdorf X Schneider Spathe	Good yielding capacity, large fruit, good quality
8	Simbol	1996/Gozob T., Budan S.	Bigarreau Dönissen X Germersdorf	Yellow fruit, for processing
9	Clasic	1996/Gozob T., Budan S.	Bigarreau Dönissen X Hedelfinger	Yellow fruit, for processing
10	Amara	1983/ Gozob T., Micu Ch., Amzăr V., Isac M., Rudi Ev.	Local selection	Bitter tasty, for processing
11	Silva	1983/ Gozob T., Micu Ch., Isac M., Rudi Ev.	Local selection	Bitter tasty, for processing
12	Superb	2002/Gozob T., Budan S., Isac M.	Boambe de Cotnari X Thurn Taxis	Good yielding capacity, large fruit, good quality
13	Sublim	2006/Budan S.	Muncheberger fruhe X BigarreauMoreau	Earliness, large fruit, good quality
14	Spectral	2008/Budan S.	Muncheberger fruhe X Bigarreau Burlat	Earliness, good quality
15	Special	2012/Budan S., Popescu R., Butac M., Militaru M., Chițu E.	Local selection	Bitter taste, for processing

Table 7. Sour cherry cultivars created at RIFG Pitești, Romania / Soiuri de vișin create la ICDP Pitești, România

No.	Cultivar	Year of registration/ Authors	Genitors	The main characteristics
1	Crișana 2	1975/Cociu V.	Local selection	High vigour, for processing
2	Mocănești 16	1975/Cociu V.	Local selection	Good yielding capacity, for processing
3	Dropia	1982/Cociu V.	Vladimirscaia 33/23 open pollination	Good yielding capacity, for processing and fresh market
4	Timpurii de Pitești	1982/Parnia P., Mladin Gh.	Local selection	Earliness, large fruit, for processing and fresh market
5	Țarina	1984/Cociu V., Gozob T.	Engleze timpurii X Vişin tufă	Earliness, large fruit, for processing and fresh market
6	Rival	2004/Budan S.	Griot Moscovski x Nana	Good yielding capacity, for processing and fresh market
7	Stelar	2008/Budan S.	Mocănești 16 x Engleze timpurii	Good yielding capacity, for processing and fresh market

Thus, at the apple species, the most propagated cultivars were: ‘Romus 3’ (over 10,000 trees), ‘Romus 4’ (about 5,000 trees), ‘Rebra’ and ‘Rustic’ (about 3,000 trees) and ‘Rumina’ (about 1,000 trees). It should be noted that all these cultivars have genetic resistance to scab, type Vf.

This demonstrates the interest of growers for cultivars that require a less polluting and expensive technology.

At the pear species, the situation of propagation to newly autochthonous cultivars is less relevant, due to the increased of sensitivity to fire blight. The data shows that in the last years have multiplied in the nursery the following cultivars: ‘Monica’ (10,000 trees), ‘Carpica’, ‘Argessis’, ‘Getica’, ‘Trivale’, ‘Triumf’ (3,000 trees on each cultivar). The last two pear cultivars created (‘Isadora’ and ‘Pandora’) with resistance to fire blight and *Psylla* were increasingly requested by private farmers and be multiplied by 2,000 trees each. Moreover, some cultivars (‘Monica’, ‘Isadora’ and ‘Paradise’) were also studied in different research centers from Italy, Belgium and Netherland and were highly appreciated.

At the plum species, as a basic species in Romania's fruit growing, the propagation of the new cultivars was great and is reflected in the large number of grafted trees. In descending order the most multiply cultivars were: ‘Centenar’ (20,000 trees), ‘Pescăruș’ (5,000 trees), ‘Ialomița’ (5,000 trees), ‘Piteștean’ (3,000 trees), ‘Tita’ (3,000 trees) and ‘Romanța’ (1,000 trees). Noticed the interest of farmers for plum cultivars designated for fresh consumption.

At the sweet cherry species, most trees were grafted from ‘Daria’ (2,500 trees), ‘Ponoare’ (2,000 trees), ‘Superb’ (1,500 trees), ‘Special’ (1,000 trees). In this case, it is necessary an increased promotion of the Romanian cultivars which are much better adapted to the pedo-climatic conditions from, our country.

Of the new sour cherry cultivars, lately, besides ‘Crișana 2’ and ‘Mocanești 16’, have been multiplied the cultivars ‘Țarina’, ‘Timpurii de Pitesti’ and ‘Rival’. These cultivars are designated for both fresh and processing consumption.

Table 8. The situation of the spread of newly cultivars in the Romanian orchards / Situatia răspândirii soiurilor noi în plantațiile din România

No.	Species	No. of cultivars registered	No. of patents	Wide spread
1	Apple	12	1	Romus 3, Romus 4, Rebra, Rustic, Rumina
2	Pear	13	2	Monica, Getica, Carpica, Argessis, Trivale, Triumf, Paradise, Isadora, Pandora
3	Plum	23	2	Centenar, Pescăruș, Ialomița, Tita, Romanța
4	Sweet cherry	15	1	Daria, Ponoare, Superb, Special
5	Sour cherry	7	-	Țarina, Timpurii de Pitești, Rival

Since 2014, the National Plan for Rural Development issued a special measure for investments in fruit growing sector. Through this measure, new orchards were established, the share of Romanian cultivars being very high due to their better adaptability to the pedo-climatic conditions from our country (Table 9).

Table 9. The situation of the surfaces cultivated with apple, pear, plum, sweet and sour cherry through Sub-measure 4.1.A / Situația suprafețelor cultivate cu măr, păr, prun, cireș și vișin prin Sub-măsura 4.1.a

No.	Species	Surface (ha)	% of Romanian cultivars
1	Apple	980	10
2	Pear	430	5
3	Plum	755	12
4	Sweet cherry	811	5
5	Sour cherry	125	1

CONCLUSIONS

The results of the breeding programs carried out in RIFG Pitesti, Romania have materialized by registering 70 cultivars of apple, pear, plum, sweet and sour cherry.

The value of these assortments has been demonstrated by propagation in the fruit nursery and extension in the commercial orchards.

Thus, out of the total propagated trees, about 50% are Romanian cultivars.

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THE RESPONSE OF SOME PLUM CULTIVARS TO *STIGMINA CARPOPHILA* LÉV. INFECTIONS UNDER THE CLIMATE CONDITIONS OF BISTRIŢA AREA

COMPORTAREA UNOR SOIURI DE PRUN LA INFECȚILE CU *STIGMINA CARPOPHILA* LÉV. ÎN CONDIȚIILE CLIMATICE DIN ZONA BISTRIȚEI

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Abstract

The plum (Prunus domestica L.) holds the position of dominant fruit tree species in Romania, as reported by the FAOSTAT (2024) database. On a global scale, Romania ranks the second place on total production of plums in 2022, following China. This species is vulnerable to several economically diseases, including shot hole, caused by Stigmina carpophila Lév. The occurrence and frequency of disease damage are significantly influenced by climatic conditions. Therefore, in the context of favourable climatic condition for its development along the vegetative period of in the year 2023 at the FRDS Bistrița, the effects of Stigmina carpophila infections were monitored on 26 plum cultivars. Throughout the growing stage, 12 conventional phytosanitary treatments were applied up to harvest time. The visual observations were conducted in the field after harvesting the fruits from each cultivar. The response to shot hole infection on the limb of the leaf varies across studied cultivars. The results indicate that there were no infections with Stigmina carpophila in cultivars such as 'd'Agen', 'Matilda', 'Elena', 'Zamfira', 'Iulia', 'Flora', 'Andreea', 'Doina', and 'Carpatin'. However, there were some cultivars that exhibited symptoms and a high percentage of infected leaves, such as 'Jojo', 'Empress' and 'Centenar'. All the results obtained are statistically supported. These findings are encouraging, as they allow selection of tolerant cultivars to shot hole disease, especially considering the increasing impact of climate change. Furthermore, the global trend toward organic farming necessitates the use of resistant cultivars to effectively manage problematic pathogens in agriculture.

Keywords: *plum, shot hole infection, cultivars, fungal disease, leaf*

Rezumat

Specia prun (Prunus domestica L.) ocupă poziția dominantă în cultura pomilor fructiferi din România, conform bazei de date FAOSTAT (2022). La nivel global, România se află pe locul al doilea la productia totala de fructe obtinuta in anul 2022, după China,. Această specie este vulnerabilă la mai multe boli cu impact economic, inclusiv la ciuruirea micotică a frunzelor, cauzată de Stigmina carpophila. Prezența și frecvența atacului provocat de această boală sunt semnificativ influențate de condițiile climatice. Prin urmare, în contextul unor *conditii climatice favorabile dezvolării patogenului de-a lungul perioadei de vegetație din anul 2023, la SCDP Bistrița, s-a monitorizat comportarea a 26 de soiuri de prun la infecțiile cu Stigmina carpophila. Pe parcursul etapelor fenologice, au fost aplicate 12 tratamente fitosanitare convenționale până la momentul recoltării. Observațiile vizuale au fost efectuate în câmp, după recoltarea fructelor de la fiecare soi. Răspunsul la infecția cu ciuruirea micotică a frunzelor a variat în funcție de soi. Rezultatele relevă că nu au existat infecții cu Stigmina carpophila la soiuri precum 'd'Agen', 'Matilda', 'Elena', 'Zamfira', 'Iulia', 'Flora', 'Andreea', 'Doina' și 'Carpatin'. Totuși, au existat și soiuri care* au prezentat *simptome și un procent ridicat de frunze infectate,* cum ar *fi 'Jojo', 'Empress' și* Centenar*. Toate rezultatele obținute sunt susținute statistic. Aceste constatări sunt încurajatoare, deoarece permit selecția unor soiuri cu sensibilitate redusă la* ciuruirea micotică a frunzelor, mai *ales având în vedere impactul tot mai accentuat al schimbărilor climatice. În plus, tendința globală către agricultura organică impune utilizarea de soiuri rezistente pentru gestionarea eficientă a agenților patogeni* *problematici.*

Cuvinte cheie: *prun, ciuruirea micotică a frunzelor, soiuri, condiții climatice, frunze*

INTRODUCTION

Prunus domestica L., commonly known as the European plum, is esteemed globally for its delicious and nutritious fruits. Rich in essential vitamins and antioxidants, plums are recommended for a healthy diet, with an advised consumption of 2-4 fruits daily (Wills et al., 1983; Gil et al., 2002). According to FAOSTAT data, China leads the world in plum fruit production, with an impressive quantity, 6,752,221 tons (FAOSTAT, 2024). Romania also holds a significant position in plum production, ranking the second globally, with a production of 665,730 tons. Plums are enjoyed in various forms, including fresh consumption, processing into dried fruits, jams, and preserves, as well as distillation for the production of alcoholic beverages like plum brandy (Botu și colab., 2008; Butac și colab., 2013). The popularity of this fruit species is on the rise, fueled by the global presence of over 2,000 plum cultivars and varieties (Sottile et al., 2022).

The plum species is affected by more than 60 major pests and diseases, consisting of 4 bacteria, 19 fungi, 6 viruses, 4 nematodes and 36 insects that have been documented to attack plum trees (Janick and Paull, 2008).

The shot hole disease, caused by *Stigmina carpophila* Lev. (Ellis, 1959), is a significant threat to *Prunus* species across various temperate to semi-arid regions worldwide. *Stigmina carpophila* overwinters in dormant buds of stone fruits and spreads from twig cankers through water splashing (Shaw et al., 1990). This pathogen is notorious for its annual occurrence on plum leaves (Alexandru et al., 2019; Gheorghieş and Geamăn, 2003), leading to substantial losses in plum production (Yousefi and Shahri, 2014). It remains one of the most important foliar diseases affecting *Prunus* species.

In Romania, the fungus is widespread, particularly prevalent in less frequented meadows, lacking protection from the fungus, causing significant losses during favorable weather conditions. Infections are most severe from April to June during periods of frequent rainfall. During the summers, when temperatures exceed 30°C, fungal activity diminishes, halting infections. However, in autumn, with decreasing temperatures and the onset of rains, new branch infections occur, persisting through winter if temperatures remain above 2°C. Therefore, the critical periods for bud and branch infections occur in autumn until early winter, and also in spring, when trees begin to leaf out (Văcăroiu et al., 2009).

The measures recommended to control the fungus *Stigmina carpophila* include the cutting of severely affected branches, spraying with copper-based substances after pruning and sprays with systemic or contact fungicides during the growing season. The synthetic fungicides recommended for treatments during the growing season are based on difenoconazole, tebuconazole, boscalid or captan. Treatments should be applied throughout the vegetation period starting after petals fall. In case of highly susceptible cultivars it is recommended to continue the sprays after harvesting the fruits until leaves drop.

The aim of this study was to evaluate some plum cultivars to *Stigmina carpophila* infections and to establishing those who have the best behavior to this fungal disease in the conditions of the Bistrita area.

MATERIAL AND METHOD

The investigation was performed in a young plum orchard (Figure 1) esthablished in the spring of 2020 at the Fruit Research and Development Station Bistrița (FRDS Bistrița). The study encompassed 26 distinct plum cultivars, including both Romanian cultivars: 'Matilda', 'Elena', 'Ivan', 'Gras ameliorat', 'Tuleu gras', 'Zamfira', 'Iulia', 'Agent', 'Flora', 'Andreea', Delia' 'Jubileu 50', 'Minerva', 'Doina', 'Centenar', 'Carpatin', 'Diana' and foreign ones: 'French Improved', 'Jojo', 'Blue free', 'Anna Spath', 'President', 'd'Agen', 'Victoria', 'Stanley'and 'Empress', each with varying ripening periods. Throughout the entire growing season, these cultivars were closely monitored to evaluate their response to different pathogens. Specifically, this study focused on the sensitivity of plum cultivars to shot hole infection caused by *Stigmina carpophila*. All data were meticulously collected from the same plot, under consistent environmental conditions, and using identical agricultural methodologies.

Fig. 1. The plum crops where the investigation was carried out / Plantația de prun unde s-au efectuat studiile

Throughout the growing season, a total of 12 conventional phytosanitary treatments were applied, spread out across the vegetative period. The chemicale active substances applied in this study was detailed in Table 1. The concentrations used are in accordance with the manufacturer's recommendations.

Table 1. Chemical fungicide treatments applied to plum in experimental plot / Tratamentele chimice cu fungicid aplicate în cultura experimentală de prun

I.	**Winter treatments**	Copper (Cu) 380 g/l **(3.3 l/ha)**
II.	**Growing season treatments**	
a.)	*Contact treatments*	Copper (Cu) 380 g/l **(1.5 l/ha)**
b.)	*Systemic treatments*	Cyprodinil 500 g/kg **(0.5 kg/ha)**
		26.7% Boscalid, 6.7% Piraclostrobin **(0.5 kg/ha)**
		Cyprodinil 375 g/kg, Fludioxonil 250 g/kg **(1 kg/ha)**

To establish the susceptibility of the cultivars to shot hole infection, the damage degree (DD%) of disease on leaf was assessed. Six trees of each cultivar (3 repetitions x 2 trees) were selected for this assessment. One hundred leaves were randomly collected from each tree, followed by laboratory assessments to determine the frequency (F%), intensity (I%), and damage degree (DD%), according to the phytosanitary methodology described in Table 2.

Table 2. The phytosanitary methodology used for determining damage degree (DD%) for *Stigmina carpophila* / Metodologia fitosanitară utilizată pentru determinarea gradului de atac (GA%) pentru *Stigmina carpophila*

The scale used to assess the intensity of infection	
Intensity mark	Foliar surface affected by symptoms (%)
0	0
1	0.1-5
2	5-10
3	11-25
4	26-50
5	51-75
6	>75

I% =(n x 5 + n x 10 + n x 25 + n x 50 + n x 75 + n x 100)/ N
n = the number of leaves with symptoms of each level of intensity N= total number of leaves with symptoms

$$F\% = \frac{total\ number\ of\ affected\ leaves}{total\ number\ of\ analysed\ leaves} x\ 100$$

Damage degree was calculated using the formula:
DD = (F x I) / 100

Symptoms on leaves caused by *Stigmina carpophila* were primarily observed in spring, specifically in the first decade of May. Observations were conducted in the field for all cultivars in the last decade of August. The disease symptoms mainly affected the leaves, and lesser the shoots and fruits. The attack on leaves appears as round elliptical spots of light brown color with a reddish halo. Over time, the affected area necrotizes, and the spots detach and fall, creating a shot hole appearance on the leaf (fig. 2).

Fig. 2. Specific symptoms on leaves after infection with *Stigmina carpophila* in plum species / Simptome tipice ale infecției cu *Stigmina carpophila* la specia prun

Throughout the study, various climatic indices which favoured the shot hole infection, including average monthly temperature, air humidity, and precipitation levels, were monitored. The summer exhibited hot and humid conditions, while the winter was characterized by dry and cold weather. Micrometeorological parameters were recorded using an Adcon Telemetry automated weather station situated within the orchard. Statistical analysis was conducted to assess variations in shot hole susceptibility among plum cultivars.

Data analysis was carried out using XLSTAT by Addinsoft software (version 2019.3.2 - Addinsoft. XLSTAT, 2019), integrated into the MS Office Excel Professional Plus 2019 platform. The XLSTAT program facilitated analysis of variance (ANOVA - Fisher, R.A., 1925), followed by Duncan's Multiple Range Test (Duncan, D.B., 1955) to examine differences between different variants, with significance set at $p < 0.0001$.

RESULTS AND DISCUSSIONS

From climatic point of view, the year 2023 stood out as atypical, due to the substantial rainfall recorded during the growing season, totaling over 350 mm (Table 3). This abundance of rainfall, coupled with high humidity and elevated temperatures, fostered an environment conducive to the emergence and proliferation of shot hole disease.

Table 3. Climatic conditions recorded at FRDS Bistrita during vegetative period of the year 2023 / Condiții climatice înregistrate la SCDP Bistrița în perioada de vegetație 2023

Month	April	May	June	July	August	September
T. med (˚C)	8.4	14.12	20.89	17.9	21.4	18.52
Air humidity (%)	63.5	56.63	70.38	69.02	58.75	61.66
Rainfall (mm)	80.2	33.2	108.2	86.8	70.8	14.2

As expected, there was variability in the response to *Stigmina carpophila* infection among different cultivars (fig. 3). Analysis of the damage inflicted by shot hole on plum leaves indicated that 'Jojo' exhibited the highest susceptibility (39.17%), followed by 'Empress' (32.5%), and 'Centenar' (30.0%) cultivars.

Among the plum cultivars studied, those displaying the highest tolerance to shot hole infection on leaves, as indicated by the damage degree (DD%), were found to be: 'd'Agen', 'Matilda', 'Elena', 'Zamfira', 'Iulia', 'Flora', 'Andreea', 'Doina', and 'Carpatin', as presented in Figure 3. Field observations revealed that the damage degree of shot hole infection was also influenced by favorable climatic conditions conducive to disease spread.

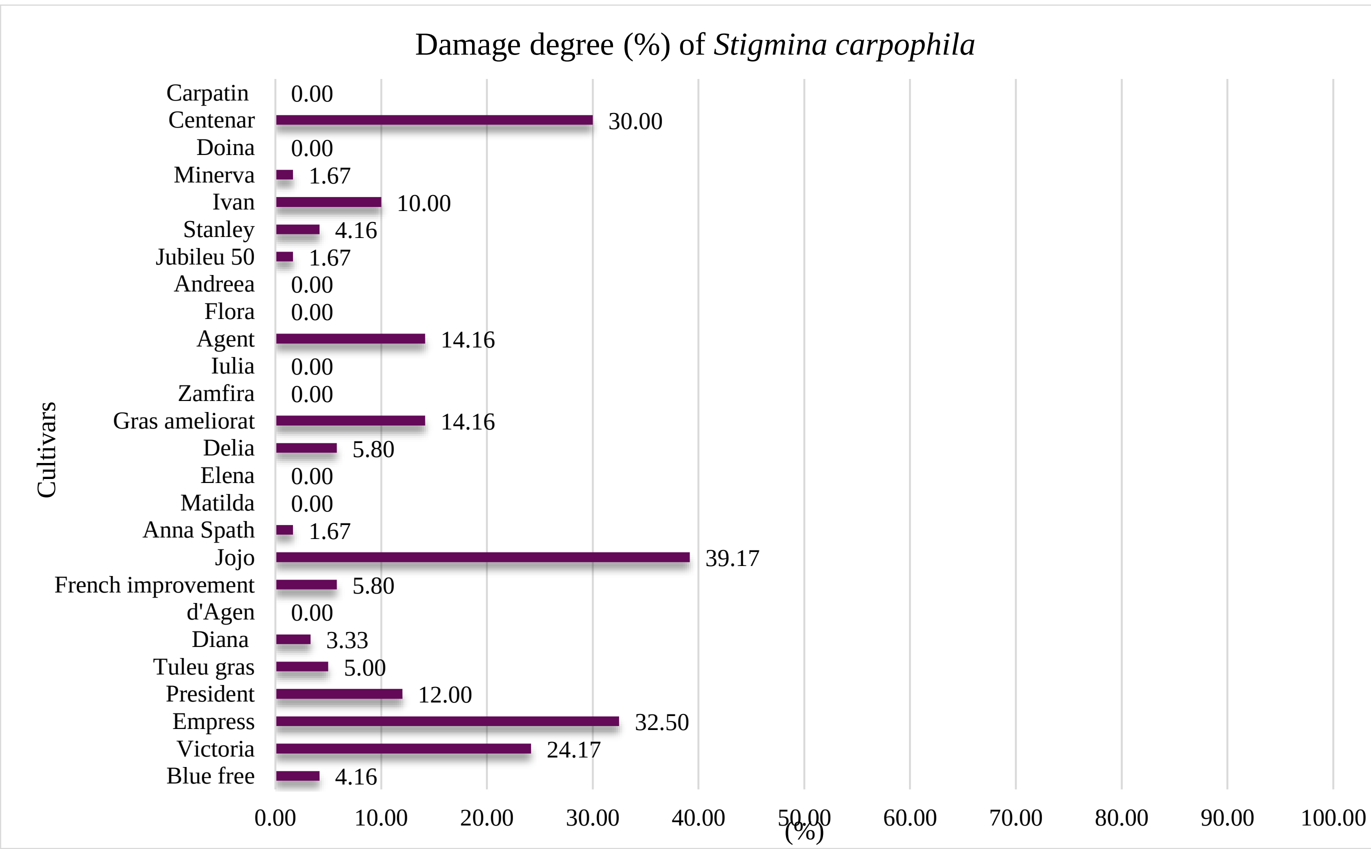

Figure 3. The damage degree of shot hole infection on leaf in plum experimental plot (2023) / Gradul de atac al infecției provocată de ciuruirea micotică a funzelor în parcela experimentală de prun (2023)

Statistical analysis was conducted to assess the variances among plum cultivars regarding susceptibility to shot hole infection. Using analysis of variance (ANOVA) followed by Duncan's Multiple Range Test, the cultivars were categorized into 9 significance classes, as outlined in Table 4. Based on damage degree, the studied cultivars were clasificated into four large categories according to their reaction to the *Stigmina carpophila* infection, under our climatic conditions and treatments. Thus, according to the final results, out of the total of 26 cultivars, nine can be considered whit no damage degree, nine low damage degree, five medium damage degree and three high damage degree.

Table 4. Statistical analysis of *Stigmina carpophila* damage degree (DD%) on plums / Analiza statistică a gradului de atac (GA%) provocat de *Stigmina carpophila* la specia prun

No.	Plum cultivar	Shot hole infection (DD%)	Degree of plum cultivars sensitivity
1	Jojo	39.173 ± 1.210 a	*high damage degree (31-60%)*
2	Empress	32.500 ± 2.123 b	
3	Centenar	30.000 ± 1.318 b	
4	Victoria	24.173 ± 1.672 c	*medium damage degree (11-30%)*
5	Gras ameliorat	14.160 ± 0.580 d	
6	Agent	14.157 ± 0.369 d	
7	President	11,997 ± 1.406 e	
8	Ivan	10,003 ± 0.431 e	
9	Delia	5.803 ± 0.313 f	*low damage degree (1-10%)*
10	French improved	5.797 ± 0.432 f	
11	Tuleu gras	4.997 ± 0.506 f	
12	Stanley	4.160 ± 0.202 g	
13	Blue Free	4.157 ± 0.239 g	
14	Diana	3.333 ± 0.699 g	
15	Anna Spath	1.670 ± 0.468 h	
16	Minerva	1.670 ± 0.540 h	
17	Jubileu 50	1.667 ± 0.678 h	
18	Matilda	0.000 ± 0.000 i	*no damage degree (0%)*
19	Flora	0.000 ± 0.000 i	
20	Elena	0.000 ± 0.000 i	
21	d'Agen	0.000 ± 0.000 i	
22	Andreea	0.000 ± 0.000 i	
23	Iulia	0.000 ± 0.000 i	
24	Zamfira	0.000 ± 0.000 i	
25	Doina	0.000 ± 0.000 i	
26	Carpatin	0.000 ± 0.000 i	
	Pr > F(Model)	< 0.0001	
	Significant	Yes	

Note: The values presented in the table are averages of damage degree of shot hole to every plum cultivar studied. Averages followed by different letters indicate differences at $p < 0.0001$ according to Duncan`s Multiple Range Test.

Susceptibility of various plum cultivars to shot hole fungus infection in the Northern Transylvania region revealed that most of the cultivars studied exhibiting a shot hole damage degree below 10% (Carpatin, Doina, Zamfira, Iulia, Andreea, d'Agen, Elena, Flora, Matilda, Jubileu 50, Minerva, Anna Spath, Diana, Blue Free, Stanley, Tuleu gras, French improved, Delia), which may take into account as suitable candidates for establishing orchards within ecological production systems or integrated pest management (IPM) programs with a lower reliance on phytosanitary treatments. Five cultivars displayed shot hole infection damage degree between 10% and 25% (Ivan, President, Agent, Gras ameliorat and Victoria), while the other three cultivars recorded a damage degree of 30-40% (Centenar, Empress and Jojo). This short term investigation warrant further extended evaluation across multiple growing seasons to elucidate their response under diverse environmental conditions.

Similar results as our study were reported in Hungary, where 'Stanley' and 'Blue Free' cultivars were found to be resistant to *Stigmina carpophila* infection in a two-years study, while 'President' was susceptible to the disease (Molnár et al., 2018).

The forthcoming investigations will focus to exploring this issue regarding the reaction of studied plum cultivars to shot hole infections, to gain a more comprehensive understanding of their behavior.

CONCLUSIONS

The response of 26 plum cultivars to shot hole leaf infection under the favourable climatic conditions of the year 2023 to FRDS Bistrita for the patogen development, enabled the identification of nine plum cultivars ('Carpatin', 'Doina', 'Zamfira', 'Iulia', 'Andreea', 'd'Agen', 'Elena', 'Flora', and 'Matilda') that exhibited like resistance to shot hole infection since they were not at all affected. Conversely, tree plum cultivars ('Jojo', 'Empress', and 'Centenar') experienced significant susceptibility to the disease.The results of our investigation provide some encouraging data and offer valuable insights into the relative susceptibility of plum cultivars to shot hole disease in the context of a changing climate and the growing adoption of organic fruit production practices by farmers.

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DETECTION OF *APRICOT LATENT VIRUS* TO PEACH IN CONSTANTA AREA

DETECTAREA *APRICOT LATENT VIRUS* LA PIERSIC ÎN ZONA CONSTANȚA

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Abstract
Starting from the fact that recently the pathogen Apricot Latent Virus has been reported in many areas of the world, in order to identify a possible presence in our country, was evaluations biological material from the Constanța area. Raluca, Monica, Tomis 1 peach genotypes were evaluated both by visual observations and by laboratory tested following the molecular RT-PCR method, using 5'-GGAATAGAGCCCCAAGAAG-3' and 5'-AGCAAGGTAAACGCCAAC-3'primers. The extraction was carried out with the help of the "ISOLATE II Plant RNA/DNA Kit". Evaluation of the PCR product was performed using horizontal electrophoresis on a 2% agarose gel (Cleaver), 1X TBE buffer and staining with RedSafe Nucleic Acid Staining. After testing, the diagnosis was positive for the Monica variety.

Key words: *virus, diagnosis, molecular, primers*

Rezumat
Pornind de la faptul că, în ultimul timp patogenul Apricot Latent Virus a fost semnalat în cât mai multe zone ale lumii, pentru identificarea unei eventuale prezențe la noi în țară, au fost făcute evaluari pe material biologic din zona Constanța. Genotipurile de piersic Raluca, Monica și Tomis 1 au fost evaluate prin observații vizuale și prin testare de laborator aplicând metoda moleculară RT–PCR, cu utilizarea primerilor 5'-GGAATAGAGCCCCAAGAAG-3' și 5'-AGCAAGGTAAACGCCAAC-3'. Extracția a fost realizată cu ajutorul kitului "ISOLATE II Plant RNA / DNA Kit". Evaluarea produsului PCR a fost realizată cu ajutorul electroforezei orizontale pe gel de agaroză 2% (Cleaver), tampon TBE 1X şi colorare cu RedSafe Nucleic Acid Staining. În urma testărilor diagnosticul a fost pozitiv la soiul Monica.

Cuvinte cheie: *virus, diagnostic, molecular, primeri*

INTRODUCTION

Apricot latent virus (ApLV) is a species in the *Foveavirus* genus *Betaflexiviridae* family, Tymovirales order (Martelli, 1998; Adams et al. 2004; Martelli et al. 2007. *ApLV* has identified first time in Moldavia (Zemtchik, Verderevskaya, 1993).

The virus produce yellow-green spots on leaves of infected peach seedlings.

Although it is not highly prevalent, *ApLV* was identified in a number of countries to date, including Moldavia (Zemtchik, Verderevskaya 1993), France and Italy (Gentit et al. 2001a), Turkey (Gümüs et al. 2004), Iran (Sanchez-Navarro et al. 2005), Palestine (Abou Ghanem-Sabanadzovic et al.

2005), Egypt (El Maghraby et al. 2006), Lebanon (Jarrar et al. 2007), Spain (García-Ibarra et al. 2010), and the Czech Republic (Grimová 2011).

Virus detection can be obtained using biological indexing. *ApLV* can be detected by grafting, budding or chip-budding infected plant material onto peach GF 305 seedlings. The symptoms appear within a few months under green house conditions or within one year in the open field (Nemchinov, Hadidi 1998; Nemchinov et al. 2000; Gentit et al. 2001a; Abou Ghanem-Sabanadzovic et al. 2005;). The virus can also be experimentally transmitted to herbaceous hosts, including *N. occidentalis* Wheeler (accession 37B) and *N. occidentalis* ssp. *obliqua*, with apparent symptoms developing 10–15 days after inoculation. The method must be combined with a laboratory method.

Serological and nucleic acid based assays. *ApLV* accumulates in very low amounts in *Prunus* and its herbaceous hosts and thus does not allow the preparation of purified particles that are suitable for antibody production and the development of serological methods (Zemtchik et al. 1998; Jarrar 2006). Cross-reactions were obtained when extracts of *ApLV* infected *N. occidentalis* were tested with antiserum to *Apple steam pitting virus* (*ASPV)* using DAS-ELISA, immunosorbent electron microscopy, and western blot assays (Nemchinov, Hadidi 1998; Zemtchik et al. 1998) and with the polyclonal antiserum to *Plum pox virus (PPV)* within western blot analyses (Nemchinov, Hadidi 1998). Consequently, the presence of uniformly distributed common epitopes on the virions of *ApLV, ASPV* and *PPV* was suggested (Nemchinov, Hadidi 1998).

Many different nucleic acid based techniques have been developed for the precise diagnosis of *ApLV*, such as: RT-PCR analyzes (Nemchinov and Hadidi 1998; García-Ibarra et al. 2010; Grimová 2011; Gumus et al., 2007; Gentit et al. al., 2001a, b; Abou Ghanem-Sabanadzovic et al., 2005), molecular hybridization with different *ApLV*-specific digoxigenin riboprobes (Nemchinov et al., 2000; Gentit et al., 2001a; Abou Ghanem-Sabanadzovic et al., 2005; Grimová, 2011).

MATERIALS AND METHODS

Sampling and plant material.

Samples were represented by leaves were randomly collected around the canopy from each individual tree and represented one sample from Raluca, Monica cv, Tomis 1 rootstock.

RNA extraction for *Apricot latent virus (ApLV),*

For the molecular diagnosis of *ApLV* were used set of 5'-GGAATAGAGCCCCAAGAAG-3' 5'-AGCAAGGTAAACGCCAAC-3' primers sequence (F + R), Tm58^{0}C Magnified product size 200 pb (Nemchinov & Hadidi, 1998)

The RNA used in the RT-PCR reaction was extracted using the "ISOLATE II Plant RNA / DNA Kit", according to the manufacturer's protocol, Bioline.

RT-PCR amplification for *ApLV* was performed in an amplification reaction volume of 20 µl, including the following components in the final concentration: 13 µl 2x MyTaq One-Step Mix, each of primers F and R: 1 µl primer (5 µM / µl in the final reaction volume), 3 µl RNA (10 ng / µl), 0.2 µl Reverse transcriptase, 0.4 µl RiboSafe RNase Inhibitor and 1.4 µl ultrapure water.

RT-PCR amplifications were performed in a FastGene PCR analyzer under the following conditions: reverse transcription at 45°C for 20 min., followed by 35 cycles of 45 sec. at 95°C, 45 sec. at the annealing temperature of the primer 58°C, 1 min. at 72°C and 10 min. at 72°C for final extension. Evaluation of the PCR product was performed using horizontal electrophoresis on a 2% agarose gel (Cleaver), 1X TBE buffer and staining with RedSafe Nucleic Acid Staining. The gel was read using a Uvitec Cambridge Essential high quality imaging system with UVITec1D analysis software.

RESULTS

The observation concluded that to the Raluca peach variety dont't identified the symptoms that could be associated with viral diseases (Table 1).

Table 1. The results of the visual assessment / Rezultatele evaluării vizuale

Genotypes	No. evaluated plants	No. plants with visual symptoms
Raluca	11	0
Monica	13	2
Tomis 1	13	0

To Monica variety from 13 trees monitored at the same time intervals as the other two genotypes Raluca and Tomis 1, it was possible to observe the appearance of spots whose edge was marked with yellow spots that appeared especially in the area of the veins. Out of a total of 13 trees evaluated, these symptoms could be observed in 2 trees. Also, to the Tomis 1 rootstock, we don't identified the symptoms that could be associated with viral diseases.

In the case of molecular testing for better detection of *ApLV* by RT-PCR was neccesary optimisation of some parameters. Thus, the gel was optimized at a concentration of 2% to make it difficult to move the amplified DNA, so that, at a voltage of 70 V, the distance between the base pairs associated with the presence of the viral RNA and the non-specific amplifications allow the correct identification of those 200 bp. In case of the dye, the optimization that occurred consisted in the fact that from the tests carried out between two variants, a volume of 4 µl / 100 ml tempon TBE 1X and 8 µl / 150 ml tempon TBE 1X, in our study we worked with 8 µl / 150 ml tempon TBE 1X.

Analyzing figure 1 is confirmed that *ApMV* is present in the peach species in Romania. The genotype with sensitivity to this virus was Monica (Figure 1) where the testing by molecular methods indicates the fragments amplified with the pair of *ApLV* primers used for the diagnosis of the virus. Regarding to the presence of the virus in the tested genotypes, it is also found that, although the trees from which the leaves were in neighboring rows and implicitly in the same conditions, the genotype infected was only Monica with an incidence of 61,50 % infected plants (Figure 2). Raluca (Figure 1) și Tomis 1 (Figure 3), did not show positive reaction.

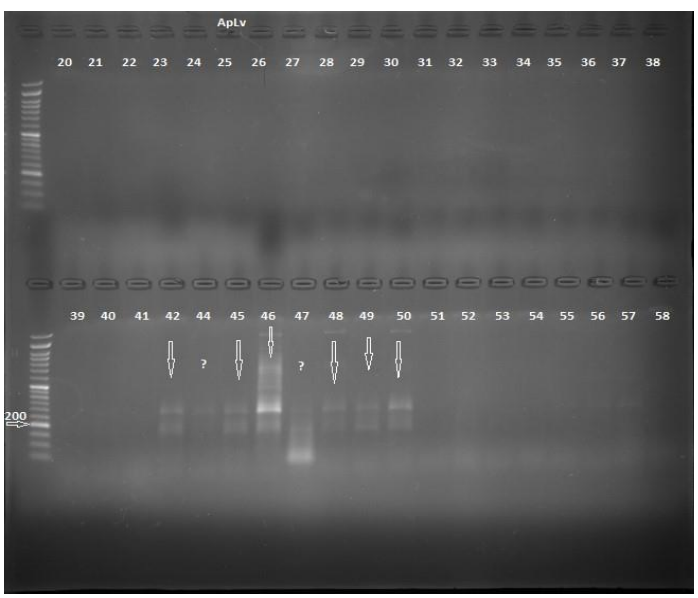

Figure 1. Electrophoretic profile for the *ApLV* primer pair (F+R), position 31-41 - Raluca variety, position 42-55 - Monica variety, position 56-58 – Tomis 1 rotstock / Profilul electroforetic la soiul Raluca

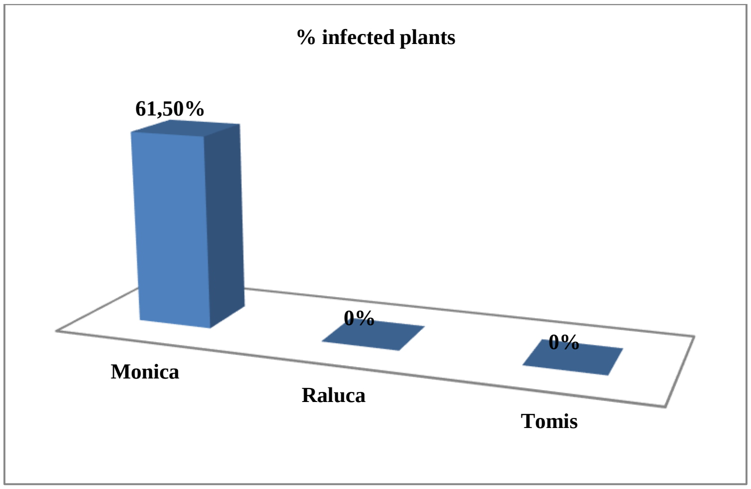

Figure 2. The degree of infection (%) of the peach plants tested / Gradul de infecţie (%) al plantelor de piersic testate

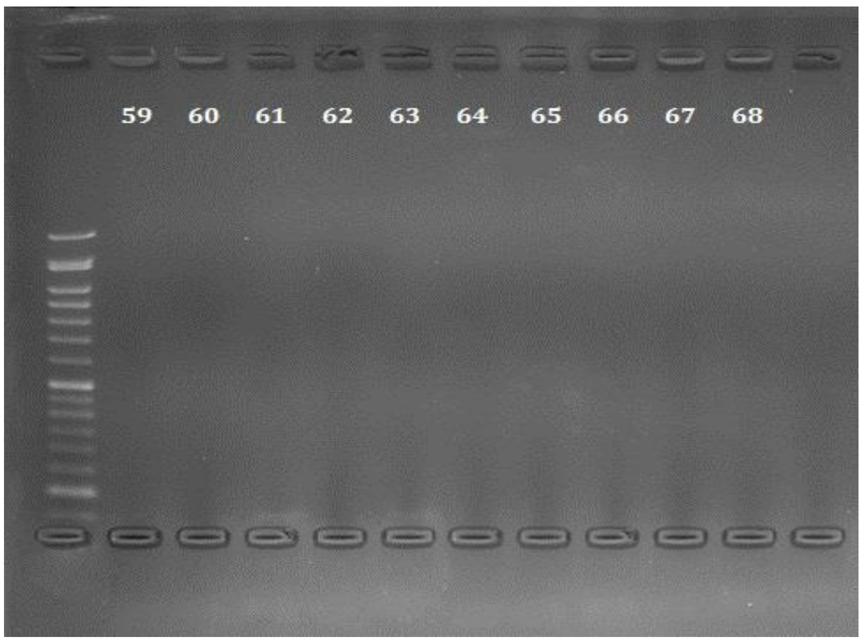

Figure 3. Electrophoretic profile for the *ApLV* primer pair (F+R) positions 59-68 (Tomis 1 variety) / Profilul electroforetic la portaltoiul Tomis 1

The study of the sequences of the 37 samples (figure 1 and figure 3) was carried out by analyzing the electrophoretic profiles obtained following PCR amplification with specific primers. The length of the obtained fragments was measured in relation to the bands of the Ladder 50pb Biolone marker thus observing that individualized bands were generated at 42, 44, 45, 46, 47, 48, 49 and 50 positons which correspond to samples from Monica variety. The length of the obtained sequences fell within the value of 200 bp.

CONCLUSIONS

Analysing the results of this study we can say that the *ApLV* is presently in peach trees from Constanța area.

The optimizations realized regarding the concentration of the agarose gel at 2% and the use of the dye in the amount of 8 µl/150 ml TBE 1X buffer compared to 4 µl /100 ml TBE 1X buffer, allowed clear amplifications for the applied technique.

The presence of this virus is a big alarm signal due to the fact that in the new legislation regarding the certification of fruit propagation and planting material, it is mentioned for both peach and apricot.

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VITICULTURE AND OENOLOGY

DOWNY MILDEW *(PLASMOPARA VITICOLA)* ATTACK IN THE GRAPEVINE PLANTATIONS OF SCDVV BLAJ IN 2023

ATACUL DE MANĂ (*PLASMOPARA VITICOLA*) ÎN PLANTAȚIILE VITICOLE DE LA SCDVV BLAJ, ÎN ANUL 2023

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Abstract

The present study addresses the relationship between grape cultivars, grapevine downy mildew the evolution of climatic factors in the year 2023. The analysis was conducted during the vegetation period of 2023, on the varieties Astra, Amurg, Blasius, Selena, Fetească albă, Muscat Ottonel, Sauvignon blanc, Neuburger, and Rhine Riesling. The assessment of the infestation was determined on leaves and grapes. The severity of the downy mildew on the studied cultivars manifested differently among the analyzed varieties. The most affected was Sauvignon blanc with a degree of attack (AD) of 36.43% on grapes and 18.6% on leaves, and the least affected on leaves was the Rhin Riesling variety, with an AD of 2% and on grapes the least was Blasius with an AD of 0.1%. For the Sauvignon blanc variety, a higher AD was recorded on grapes than on leaves, compared to other varieties where the AD on leaves was higher than on grapes. This information provides a database for developing downy mildew management strategies, with differentiated treatments for specific climatic conditions, and grape varieties.

Keywords: *climatic conditions, grapevines, cultivars, downy mildew, Târnave wineyards*

Rezumat

Prezentul studiu abordează relația dintre soiurile de viță de vie, mana viței de vie și evoluția factorilor climatici în anul 2023. Analiza a fost efectuată pe parcursul perioadei de vegetație a anului 2023, pe soiurile Astra, Amurg, Blasius, Selena, Fetească albă, Muscat Ottonel, Sauvignon blanc, Neuburger și Riesling de Rhin. Evaluarea atacului a fost determinată, pe frunze și struguri. Severitatea manei pe soiurilor studiate s-a manifestat diferențiat între soiurile analizate. Cel mai afectat a fost Sauvignon blanc cu grad de atac (AD) de 36.43% la struguri și de 18,6% la frunze, iar cel mai puțin afectat la frunze a fost soiul Riesling de Rhin, cu AD de 2% iar la struguri cel mai putin a fost Blasius cu AD de 0.1%. La soiul Sauvignon blanc, s-a înregistrat AD mai mare la struguri decât la frunze, comparativ cu celelate soiuri la care AD la frunze a fost mai mare decât la struguri. Aceste informații oferă o bază de date pentru dezvoltarea strategiilor de gestionare a manei, cu tratamente diferențiate pentru anumite condiții climatice, și soiuri de viță de vie.

Cuvinte cheie: *condiții climatice, viță de vie, cultivare, mana, podgoria Târnave*

INTRODUCTION

The vineyards of SCDVV Blaj, which are located on the right bank of the Târnava Mare River, Crăciunelu de Jos wine region, Blaj wine center, inside Târnave Vineyard (Transylvanian Plateau - Romania), benefit from a unique microclimate, favorable to viticulture (Comsa et al., 2023; Răcoare et al., 2022; Călugăr et al., 2018). Despite this, almost every year there are fairly consistent rainfall events during the summer months (June, July). Due to these environmental conditions, downy mildew of grapevines, caused by the pathogen *Plasmopara viticola*, finds favorable conditions for development and is considered the most widespread disease in this wine growing area (Tomoioagă et al., 2013; Mihai et al., 2010). The climate is considered a key driving force of the agroecosystem, and climate change favors an increase in the number of diseases caused by various pathogens in most crops, especially in grapevines (Michael C. Fontaine et al., 2020).

The pathogen of downy mildew, *Plasmopara viticola*, exhibits a life cycle that causes both primary and secondary infections (Chen et al., 2019; Rossi and Tito, 2011). It overwinters as oospores (resting sexual spores) in the soil within the leaf litter (Rossi et al., 2009). In the spring, under favourable temperature and humidity conditions, the oospores germinate to produce macroconidia, which release zoospores (asexual spores) capable of infecting if they come into contact with the tissues of the host plant. The germination of oospores occurs gradually over the vegetation period or even in subsequent seasons (Caffi et al., 2011; Rossi et al., 2008). The main source of spores has proven to be the leaves due to their surface area, stomatal structure, and lack of protection against pathogen invasion. Depending on the temperature, humidity, and susceptibility of the grapevine variety, the complete disease cycle lasts from 5 to 18 days (Agrios, 2005, cited by Kolendenkova et al., 2022). Successful colonization by the pathogen occurs when the defence of the susceptible host plant fails, and the infection culminates with the appearance of conidiophores and conidia on the dorsal side of the leaves. These give the white and later grey fluffy appearance of the mildew, and produce zoospores that are released by wind or rain, carrying out secondary infections. The zoospores infect the tissues through stomata in the presence of water from precipitation or dew at temperatures below 32°C (Tofallatti et al., 2018). The pathogen attacks all green organs of the grapevine, especially leaves, young shoots, and grapes. Grapevine leaves are receptive to mildew infection throughout the vegetation period, while grapes lose receptivity once they enter veraison, when they close their stomata (Maddalena et al., 2020).

Grapevine downy mildew has a significant negative impact on the viticulture industry worldwide. In addition to the costly price, phytosanitary treatments have negative effects on both the environment and wine products (Koledenkova et al., 2022; Massi et al., 2021; Orlandini et al., 2008). Managing the disease generally requires the use of fungicides applied multiple times during the growing season (Leal and Gramaje, 2024; Massi et al., 2021). Despite the high level of protection against harmful plant diseases, chemical control faces some challenges. The timing of fungicide application depends on the characteristics of the pathogen and the weather conditions. The influence of climatic factors on the efficacy of downy mildew control fungicides has been evaluated by several researchers. Phytosanitary products are effective in controlling downy mildew only under low disease pressure caused by environmental conditions unfavorable for the disease. Under favorable disease conditions (precipitation, high humidity and temperature), it is difficult to control, often resulting in production losses (Massi et al., 2021; Rățoi et al., 2014; Hamada et al., 2008; Czermainski and Sônego, 2004). An additional problem is related to the development of acquired resistance to fungicides and the emergence of new pathogen strains resistant to pesticides (Campbell et al., 2021; Massi et al., 2021).

For the control strategies to be effective, it is necessary to have an in-depth understanding of the biology of the *Plasmopara viticola* pathogen and the environmental conditions that promote its development. Understanding how various grapevine varieties respond to downy mildew, in a specific area (under certain environmental conditions) is essential. This knowledge helps choosing the varieties that exhibit the greatest tolerance or resistance (Boso et al., 2014).

MATERIALS AND METHODS

Plant material and plot characteristics: The study was conducted on the cultivars from the vineyard plantations at the Research and Development Station for Viticulture and Enology Blaj (SCDVV Blaj): Astra, Amurg, Blasius, Selena, Fetească albă, Muscat Ottonel, Sauvignon blanc, Neuburger, and Rhine Riesling, during the vegetation period of the year 2023. These are located in the experimental viticultural base of Crăciunelu de Jos. The vines are planted at a distance of 2x1.2 m, having a density of 4166 vines/ha. The cultivation system in 2023 was demi-high Guyot with periodic replacement arms. The identification data of the plots studied are detailed in Table 1. The soil maintenance system was a plowed field alternated with a naturally grassed system. All plots received the same treatment. In 2023, 10 treatments with specific phytosanitary products against downy mildew were applied (Figure 1).

Table 1. Parcel Identification Data //. Date de identificare a parcelelor

Nr	Variety	Grape color	Year of planting	Crop load (number of buds)	Altitude (m)	Exposure	GPS Coordinates	
							Lat.	Long.
1	Astra	white	2016	20	241	plateau	46,17267	23,85111
2	Amurg	red	2021	20	241	plateau	46,17268	23,85211
3	Blasius	white	2016	20	241	plateau	46,17247	23,85214
4	Selena	pink	2021	20	241	plateau	46,17295	23,85187
5	Muscat Ottonel	white	2012	30	241	plateau	46,17310	23,84907
6	Fetească albă	white	2016	30	241	plateau	46,17315	23,85215
7	Rhine Riesling	white	2012	30	241	plateau	46,17293	23,84915
8	Neuburger	white	2020	30	241	plateau	46,17263	23,84998
9	Sauvignon blanc	white	2016	30	241	plateau	46,17323	23,85211

Evaluation method: The infection with downy mildew in the varieties studied occurred naturally. The evaluation of the severity of the downy mildew symptoms was conducted at BBCH – 77 – cluster tightening, 35 days after the appearance of the primary infections. The intensity of the infection was assessed visually, by examining 50 leaves and 50 grapes from each variety (25 from the left side and 25 from the right side of the row), from all areas of the vine, expressed in percentage of the affected organ (I %). The frequency was determined as the number of leaves or grapes with symptoms out of the total analyzed, (F %). Based on these, the degree of attack (AD %) on leaves and grapes was calculated.

Climatic conditions: The climatic data were obtained from the Adcon Telemetry GmbH meteorological station, located within SCDVV Blaj. These data were processed (average daily temperatures, average daily humidity, and total daily precipitation) and correlated with the developmental stages of the grapevine (BBCH) and the pathogen *Plasmopara viticola*.

Statistical analysis: The experimental data were statistically analyzed using Statview 5.0, performing a one-way analysis of variance (ANOVA) and the Two-Way ANOVA test. P-values less than 0.05 were considered significant, while p-values between 0.05 and 0.1 were considered non-significant.

RESULTS AND DISCUSSIONS

The infection processes and sporulation of downy mildew are heavily influenced by environmental conditions such as light, temperature, wind, relative humidity, and the presence of free water (Romaric et al., 2020). The climatic conditions during the vegetation period of 2023 at SCDVV Blaj were favorable for the development of the pathogen *Plasmopara viticola*, including critical periods for managing this disease. The average annual temperature was 11.6°C, with the hottest months being July and August, featuring an absolute maximum temperature of 36.5°C recorded in August. Regarding the absolute minimum temperature in 2023, it was -14.8°C, which is much higher compared to the freezing limit of grapevines (-18°C). The total precipitation in 2023 was 547.6 mm, which is 64.5 mm less than the multi-year average of 613.6 mm (1990-2022). The average air temperature during the vegetation period was 17.7°C, and the total precipitation was 372.2 mm, with June being the wettest month at 93.4 mm and May the driest at 34.8 mm. Of the 20 days with precipitation greater than 10 mm/m^2, 16 occurred during the vegetation period (Figure 1). Under these conditions, downy mildew of grapevines, *Plasmopara viticola*, typically the most frequent disease in the Târnave vineyard, appeared at the beginning of June 2023. Analyzing based on the date of the appearance of downy mildew symptoms on leaves, which were observed on June 5, 2023, we can estimate that the primary infections occurred between May 26 and 29, when the zoospores had favorable conditions for germination: 9.6 mm of precipitation, an average temperature of 17°C, average leaf humidity of 6.6 hours daily, and BBCH – 55 with separated floral buds, and seven days since the last treatment. The incubation period was 6-8 days during which the average temperature ranged from 16.9 to 19.5°C, and the average air humidity between 69.2 and 85.3%. In 2023, a total of 10 phytosanitary treatments with fungicides against downy mildew were applied in the experimental plots located at Crăciunelu de Jos as per the scheme in Figure 1.

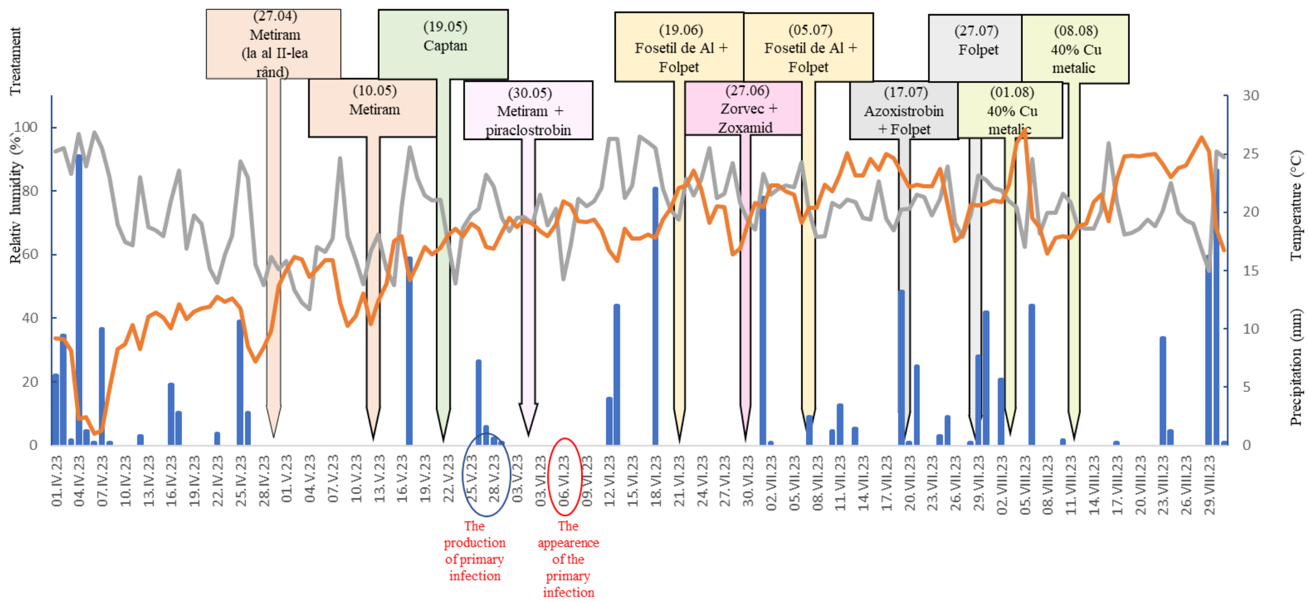

***Figure 1*. The scheme of phytosanitary treatments applied in the experimental plots, the manifestation of downy mildew and climatic conditions - Crăciunelu de Jos 2023** // *Schema de tratamente fitosanitare aplicată în loturile experimentale, manifestarea manei și a condițiilor climatice -Crăciunelu de Jos 2023*

Despite the climatic conditions experienced during the vegetation period of 2023, downy mildew of grapevines was present on all varieties studied, both on leaves and grapes. The data collected from field observations were statistically processed according to Table 2. Regarding the F% on leaves, statistically, there are differences between the studied cultivars, in that the Sauvignon blanc cultivar has a higher percentage (71.6%) compared to Astra, Muscat Ottonel, Fetească albă, and Selena, and significantly higher than Amurg, Blasius, Rhine Riesling, and Neuburger. As for the intensity on leaves, statistically, there are no differences between the studied cultivars. The attack rate (AD%) on leaves was significantly higher in the Sauvignon blanc cultivar compared to Amurg, Selena, Rhine Riesling, and Neuburger, and higher compared to Astra, Blasius, Muscat Ottonel, and Fetească albă. The lowest AD% on leaves was recorded in the Rhine Riesling variety (2.05%).

For grapes, statistically, the F% (frequency of infection) is significantly higher in the Sauvignon blanc cultivar (91.9%) compared to all other cultivars. A relatively high frequency on grapes was also recorded for the Muscat Ottonel cultivar, followed by Astra and Fetească albă. The intensity (I%) on grapes is significantly higher for Sauvignon blanc compared to all other cultivars, among which there are no statistical differences. Also, the highest AD% (attack degree) was recorded in Sauvignon blanc, with a significantly larger difference compared to all other cultivars. The lowest AD% on grapes was recorded for the Blasius variety (0.1%), followed by Amurg (0.11%). In most cultivars, the leaves were more severely affected by mildew, but for the Sauvignon blanc cultivar, the grapes showed higher values in terms of F%, I%, and AD%.

Table 2. Downy mildew evaluation scale for 2023 // Evaluarea atacului de mană 2023

Leaf									
Cultivars	F%			I%			AD%		
Astra	41.91	±2.795	ab	25.38	±4.484	a	10.63	±1.913	ab
Amurg	26.10	±4.285	b	16.09	±6.921	a	4.65	±2.410	b
Blasius	42.30	±12.372	b	16.96	±2.067	a	7.45	±2.691	ab
Selena	26.10	±2.600	ab	20.80	±12.001	a	5.19	±2.723	b
Muscat Ottonel	44.00	±1.707	ab	22.88	±9.338	a	10.08	±4.070	ab
Fetească albă	50.25	±6.349	ab	20.01	±2.237	a	10.03	±1.484	ab
Riesling de Rhin	18.01	±0.400	b	11.28	±2.635	a	2.05	±0.498	b
Neuburger	30.02	±6.842	b	17.13	±4.442	a	4.92	±1.484	b
Sauvignon blanc	71.60	±10.800	a	26.44	±4.628	a	18.61	±4.004	a
Grape									
Cultivars	F%			I%			AD%		
Astra	28.07	±2.348	c	8.93	±0.670	b	2.50	±0.208	b
Amurg	6.13	±3.610	d	2.00	±1.000	b	0.20	±0.115	b
Blasius	2.10	±2.100	d	1.67	±1.667	b	0.10	±0.100	b
Selena	9.93	±3.835	d	3.77	±1.386	b	0.43	±0.240	b
Muscat Ottonel	46.07	±5.448	b	8.53	±1.033	b	4.00	±0.872	b
Fetească albă	25.73	±8.360	c	10.20	±2.406	b	2.33	±0.484	b
Riesling de Rhin	8.23	±5.551	d	10.41	±6.009	b	0.70	±0.361	b
Neuburger	6.13	±3.610	d	5.00	±2.887	b	0.40	±0.200	b
Sauvignon blanc	91.90	±2.200	a	39.65	±13.248	a	36.43	±12.619	a

* results are presented as mean of 3 replicates ± standard error
**the variants with different letters are statistically different ($p < 0.05$), the differences of the variants with the same letter are statistically insignificant.

To analyze the effect of the interaction between varieties and organs (leaves and grapes), the Two-Way ANOVA test was used. The results regarding the F% of downy mildew attack are represented in Figure 2. It can be observed that across organs, regardless of cultivar, the highest F% was on leaves. The highest frequency among the grapevine varieties, regardless of the organ, was in Sauvignon blanc and the lowest in Rhin Riesling. Significant differences between F% on leaves and F% on grapes are notable in the Blasius cultivar, with a significantly higher F% on leaves and lower on grapes. In the Sauvignon blanc variety, the frequency is significantly higher on grapes compared to leaves (Figure 2).

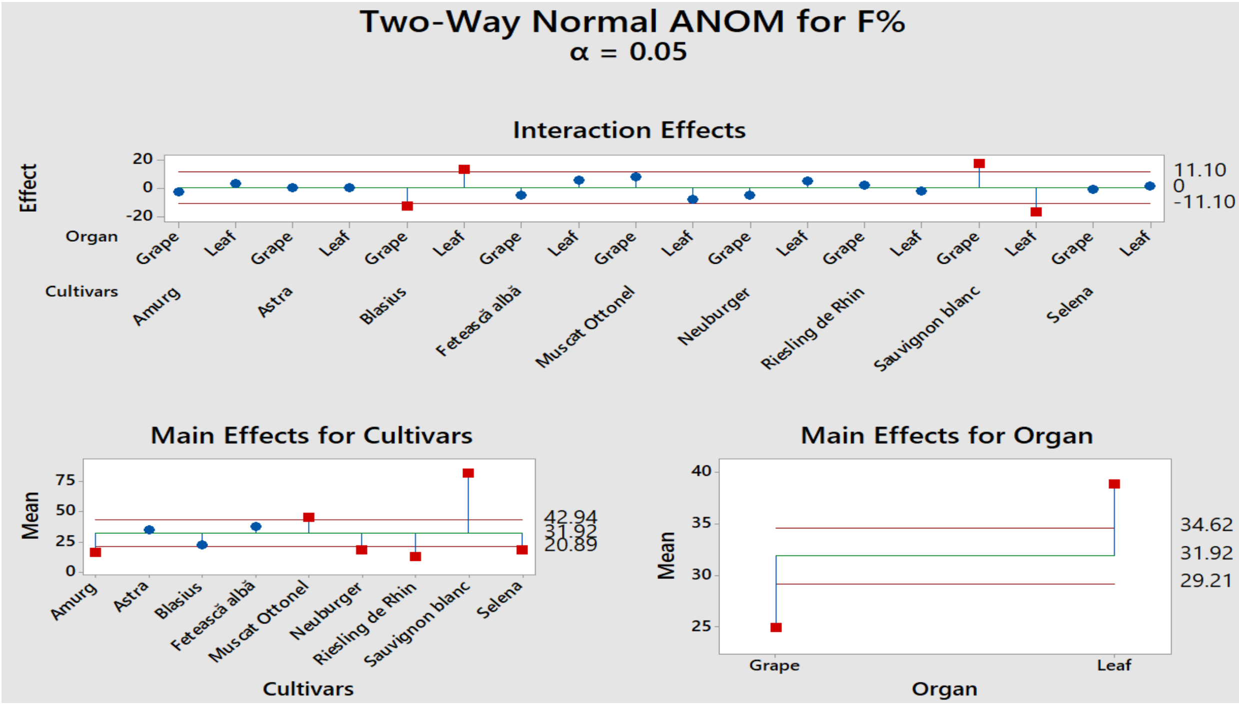

Figure 2. Graphical representation of the interactions effect of the cultivar and plant part on the downy mildeu attack //
Reprezentarea grafică a efectului interactiunii dintre soi și organ asupra atacului de mană

CONCLUSIONS

The climatic conditions during the vegetation period of 2023 in the Târnave vineyard were favourable to the development of grapevine downy mildew.

In 2023, downy mildew was manifested on all the cultivars studied, with the degree of attack showing certain particularities. Sauvignon blanc cultivar was the most affected in terms of downy mildew attack, with the highest AD% on both leaves and grapes. It is noteworthy that for the Sauvignon blanc cultivar, compared to other cultivars, the AD% was higher on grapes than on leaves. The least affected by downy mildew among the cultivars, under the climatic conditions of 2023, were Blasius and Neuburger.

From the analysis of these data, it can be stated that the downy mildew attack in the Târnave vineyard largely depends on the interaction between environmental factors, grapevine cultivar, and the climatic conditions. This scenario highlights the importance and necessity of analysing the climatic conditions each year during vegetation in correlation with the biological cycle of the pathogen, in order to adjust phytosanitary treatments accordingly.

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RESEARCH ON IMPROVING THE QUALITY OF WINES FROM AUTOCHTHONOUS VARIETIES GROWN IN THE MURFATLAR VITICULTURAL CENTER

CERCETĂRI PRIVIND ÎMBUNĂTĂȚIREA CALITĂȚII VINURILOR DIN SOIURI AUTOHTONE CULTIVATE ÎN CENTRUL VITICOL MURFATLAR

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Abstract

Wine is an important source of antioxidants and phenolic compounds. The purpose of this paper was to evaluate the influence that the addition of certain adjuvants has on quality improvement of Romanian Fetească regală, Fetească neagră and Mamaia wines. These adjuvants are an inactivated yeast (Longevity Pure Less) and an antibacterial product obtained from Aspergillius Niger (Bactiless). The following parameters were monitored: total polyphenolic content, wine dissolved oxygen, antioxidant activity and organoleptic properties. Control wines treated only with SO_2 were used for comparison. During the studied period, it was observed that the inactivated yeasts based product led to a significant decrease in dissolved oxygen in the wine, a slight decrease in the content of polyphenols and a significant improvement in the antioxidant activity following wine treatment with the product based on chitosan. The applied products had a positive impact on the preservation of the analyzed wines and led to the improvement of the organoleptic properties.

Keywords: *polyphenols, antioxidant activity, chitosan, inactivated yeasts*

Rezumat

Vinul este o sursă importantă de antioxidanți și compuși fenolici. Scopul acestei lucrări a constat în evaluarea impactului pe care adăugarea anumitor adjuvanți îl are asupra îmbunătățirii calității vinurilor din soiurile românești Fetească regală, Fetească neagră și Mamaia. Acești adjuvanți sunt o drojdie inactivată (Longevity Pure Less) și un produs antibacterian pe bază de chitosan obținut din Aspergillius Niger (Bactiless). Au fost urmăriți următorii parametrii: conținutul de polifenoli totali, oxigenul dizolvat din vin, activitatea antioxidantă și proprietățile organoleptice. Pentru comparare au fost folosite vinuri martor tratate doar cu SO_2. Pe parcursul perioadei studiate, s-a observat faptul că produsul pe bază de drojdii inactivate a dus la scăderea semnificativă a oxigenului dizolvat din vin, s-a remarcat o ușoară descreștere a conținutului de polifenoli și îmbunătățirea semnificativă a activității antioxidante în urma tratării vinului cu produsul pe bază de chitosan. Produsele aplicate au avut un impact pozitiv asupra conservării vinurilor analizate și au dus la îmbunătățirea proprietăților organoleptice.

Cuvinte cheie: *polifenoli, activitate antioxidantă, chitosan, drojdii inactivate*

INTRODUCTION

Wine polyphenolic content has been extensively studied regarding the protective action these compounds have against cardiovascular and degenerative diseases (1-6). Their chemical structure allows the neutralization of free radicals (7-10) and their role in inhibiting LDL cholesterol has been demonstrated (11-13). Polyphenols possess anti-inflammatory properties (13-16) and produce vascular relaxation (17,18). These compounds also have a proven role in inhibiting the growth of cancer cells (19-22).

Wine oxidation is a natural and unavoidable process that can have a significant impact on its quality and taste. Exposure to oxygen can have both a positive and a negative effect. Once dissolved, oxygen is essential for the growth and survival of wine microorganisms, as well as for a number of chemical reactions that can affect the stability, sensory characteristics, and resistance of the product over time (23). Oxidation, as long as it is limited and controlled during winemaking operations, is beneficial and improves organoleptic properties (24). Different levels of oxygen exposure can dramatically affect the color of red wines. Gradual exposure to O_2 over several months, for example during aging, can give the wine a softer taste sensation and a more reddish hue. Exposure to oxigen through the bottle cap is also considered beneficial to remove certain sulfidic or "reducing" flavors. Too much O_2, on the other hand, can have detrimental effects on the overall sensory properties of wine (25). Inactivated dry yeast products such as the one used in the present study are derivatives of *Saccharomyces cerevisiae* yeasts pretreated in order to inhibit their fermentative activity. These products are obtained by growing yeasts in a sugar-rich medium, after which they are autolyzed and dried to obtain final powder products. These will contain inactive yeasts, yeast autolysates, yeast extracts, cell fragments and cell walls (26). In recent years, commercial use of such products in wine industry is increasing and, due to their composition, they are recommended for a series of reasons (27), such as the fact that during yeast autolysis multiple bioactive compounds such as peptides, amino acids, glutathione and polysaccharides are released. These substances act as alcoholic and malolactic fermentation promoters, as protective agents by consuming dissolved oxygen from the wine and as organoleptic enhancers (28).

Chitin-glucan (chitosan) based products have strong antioxidant and antimicrobial properties (29-32). These are becoming increasingly popular in winemaking industry due to the downward trend of the legal limit for sulfur dioxide in wines (33). However, it has been reported to have a lower antimicrobial effect compared to sulfur dioxide (34). Although there is evidence of the effect of chitosan on various species of microorganisms in wine (30), its influence on the final aroma and composition remains insuficiently studied.

Despite the fact that many of these products are currently on the market under different names and claim to achieve various wine improvements, scientific information about the chemistry behind their application is still insufficient and the mechanisms responsible for the claimed improvements are not completely clear. Therefore, well-established scientific experiments dedicated to the effects that these products induce in wines are needed to obtain a better understanding of their mechanism of action.

The purpose of the present study consisted in testing two oenological products, one based on inactivated yeasts (*Longevity Pure Lees*), and one based on chitosan (*Bactiless*) on 3 wines from Romanian varieties, one white - Fetească albă and two red - Fetească neagră and Mamaia grown in the Murfatlar viticultural center.

MATERIAL AND METHOD

In order to perform this study, 3 local varieties of grapes for white and red wines were monitored, Fetească albă, Fetească neagră and Mamaia harvested in 2023, the latter being a variety created by the SCDVV Murfatlar research team and authorized to obtain DOC Murfatlar wines. These followed a vinification process after de-stemming and crushing; the grapes from the Fetească albă variety were pressed with a pneumatic press, and the grapes from the red wine varieties (Fetească neagră and Mamaia) were subjected to the maceration-fermentation process on skins for 6 days (for Fetească neagră) and 5 days (for Mamaia), respectively. Afterwards, the obtained wines were pressed, the scheme for obtaining and treating the 3 varieties being shown in Figure 1.

According to the manufacturer's instructions, *Pure Lees Longevity* helps to increase the shelf life and protects the color and aroma, also contributing to the stabilization of colloids. Due to its high oxygen absorption capacity, it minimizes the loss of fruitiness and browning, which increases the shelf life. The wines are perceived as fresher, fruity, with a more complex aroma. It quickly and irreversibly removes up to 1 mg/L O_2 of the dissolved oxygen. The product will continue to capture oxygen until its capacity is exhausted. It can also replace SO_2 as an antioxidant in winemaking that aims to reduce sulfite content, although it is not a direct substitute for it, as it has no antimicrobial activity. It can be added at the end of alcoholic fermentation or during aging, the recommended contact time being between 1 week and up to 9 months.

Bactiless is a non-GMO biopolymer of fungal origin (*Aspergillus niger*) with the role of controlling the population of harmful bacteria in wine. With the help of this product the populations of acetic bacteria and lactic bacteria in wine can be reduced and removed. Bactiless has no effect on yeasts. Its antibacterial action can be increased by combining with SO_2. Sulfiting should not be eliminated when using Bactiless, the product not being a substitute for sulphur. It has no antioxidant or antifungal properties and its use in wine results in a reduction of the number of acetic and lactic bacteria as well as the concentration of sulfur needed for stabilizing wines. It prevents the apparition of acetic acid and biogenic amines in wine by reducing the populations of harmful bacteria, according to the manufacturer's statements.

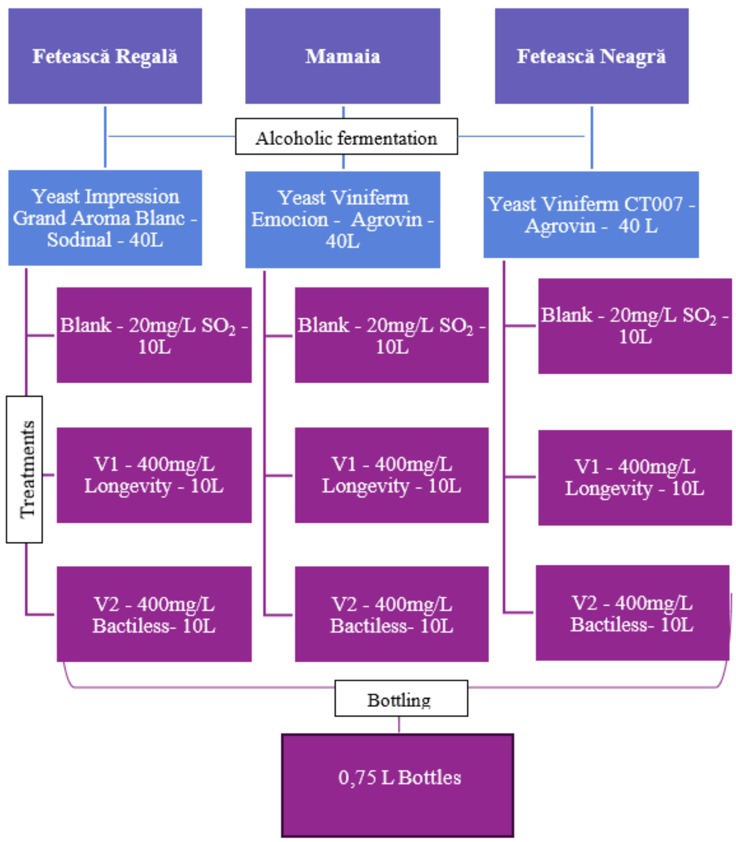


Figure 1. The treatment scheme of the 3 varieties under study / Schema de tratare a celor 3 soiuri studiate

For each variety a control variant was made, treated only with a quantity of 20 mg/L sulfur dioxide and one variant for each oenological product added, respectively 40 g/hl Longevity and respectively 40 g/hl Bactiless. Given the fact that these oenological products can only be administered after conditioning, the variants were vinified in 40-liter vessels with the related yeast variant, being treated later separately, in 10-liter vessels, with the selected oenological products. Later the wines were bottled in 0.75 L capacity bottles and stored in a dark storeroom.

A Thermo Scientific Orion oxygen meter was used to determine the amount of wine dissolved oxygen; in order to quantitatively determine the content of total polyphenols, the Folin-Ciocâlteu method was used, for the content of antioxidants, the DPPH method, and in order to perform the spectrophotometric determinations, a Metertech SP 8001 spectrometer. These determinations were carried out monthly, starting one week from the date of their treatment with the specified products.

The organoleptic examination was carried out at the end of the studied period by a commission organized by the SCDVV Murfatlar research team, which was formed by 4 members. The organoleptic assessment was made in accordance with the modality used by the ONVPV for wine classification in quality categories.

RESULTS AND DISCUSSIONS

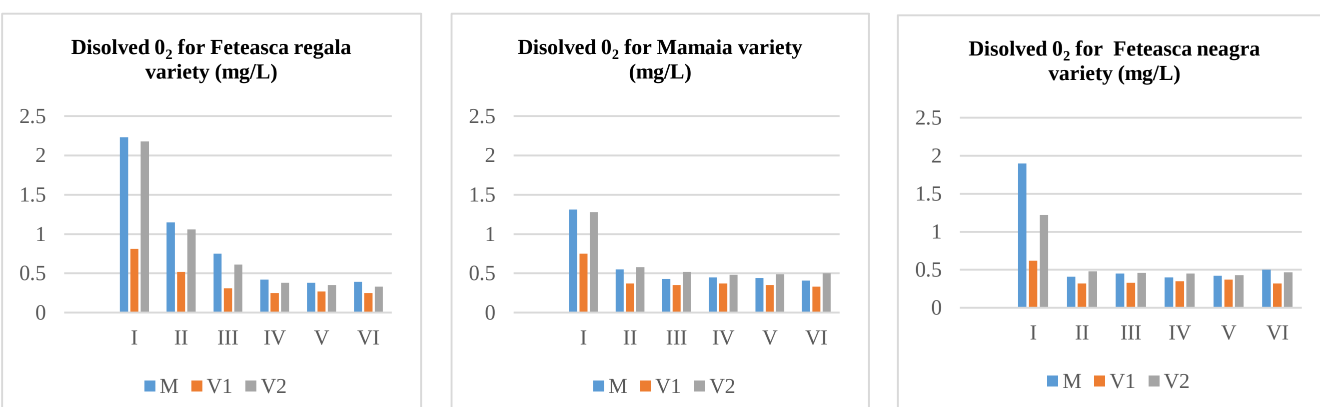
The experimental variants were carried out on 3 varieties of Romanian grapes, Fetească regală, Mamaia and Fetească neagră, for which the grapes were picked at full maturity, based upon the quality indicators established in the specifications for DOC Murfatlar wines. Grape quality at harvest is shown in the Table 1:

Table 1. Grape quality at harvest for the varieties studied, 2023 / Calitatea strugurilor la recoltare pentru soiurile studiate, 2023

Variety/Physico-chemical characteristics	Fetească regală	Mamaia	Fetească neagră
Sugar content (g/L)	215.5	225.7	238.5
Acidity (g/L tartaric acid)	5.35	8.11	5.66
pH	3.464	3.253	3.321

The grapes from the Fetească neagră variety had the highest amount of sugars at harvest time in the conditions of 2023 viticultural year (238.5 g/L), compared to the grapes from the Fetească regală variety that accumulated 215.5 g/L. The total acidity oscillated between 5.35 - 8.11 g/L, higher values being recorded for the Mamaia variety, the quality of the must being suitable for obtaining DOC Murfatlar wines.

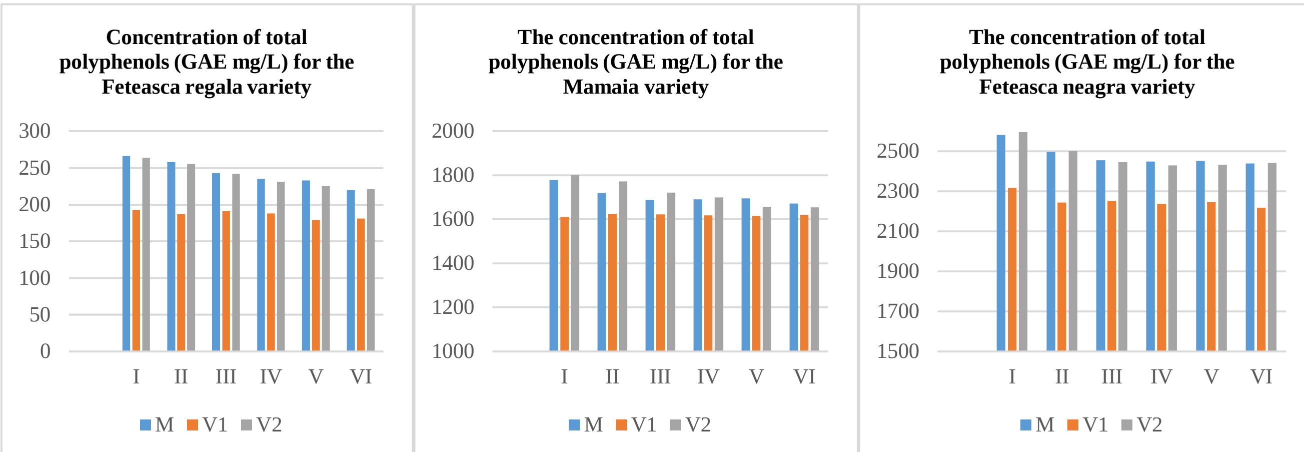
The evolution of **dissolved** wine **oxygen** over time can have a significant impact on its polyphenol content and antioxidant activity. The values measured during the 6 months of study for the analyzed wines are shown in Figure 2, a), b), c). By analyzing the obtained data it can be seen that the highest value of dissolved oxygen at bottling was recorded for the Fetească regală variety (2.23 mg/L), and the lowest for the Mamaia variety (1.3 mg/L). It can be observed that the amount of oxygen gradually decreases in months I, II and III for the white variety, after which it reaches relatively stable values in months IV, V and VI after bottling. For the red varieties, a rapid decrease is observed after the first month of preservation. At the same time, a significant decrease can be observed for variant no. 2, treated with the inactivated yeast based product. The difference between the analyzed variants is approximately 50% at the time of the first set of analyzes (one week after bottling), reaching a reduced level during the final months of the studied period.



a) b) c)

Figure 2. Dissolved oxygen content for the 3 vaieties experimentally treated for 6 months / Conținutul de oxigen dizolvat pentru cele 3 soiuri tratate experimental pe durata a 6 luni

Wine polyphenol content can vary depending on several factors such as: grape variety, the geographical area of production, winemaking techniques and harvesting time. However, in general, wines containing higher concentrations of polyphenols are associated with greater antioxidant activity and potential health benefits. The values obtained for the analyzed wines in terms of polyphenol content are presented in Figure 3 a), b), c). The lowest values for this parameter were obtained for the Fetească regală variety, between 266 and 181 GAE mg/L, as it is normal for a white wine variety. Intermediate values were obtained for the Mamaia variety, between 1801 and 1621 GAE mg/L, and the highest values were obtained for the Fetească neagră variety, between 2595 and 2218 GAE mg/L, a variety with a high polyphenolic potential.

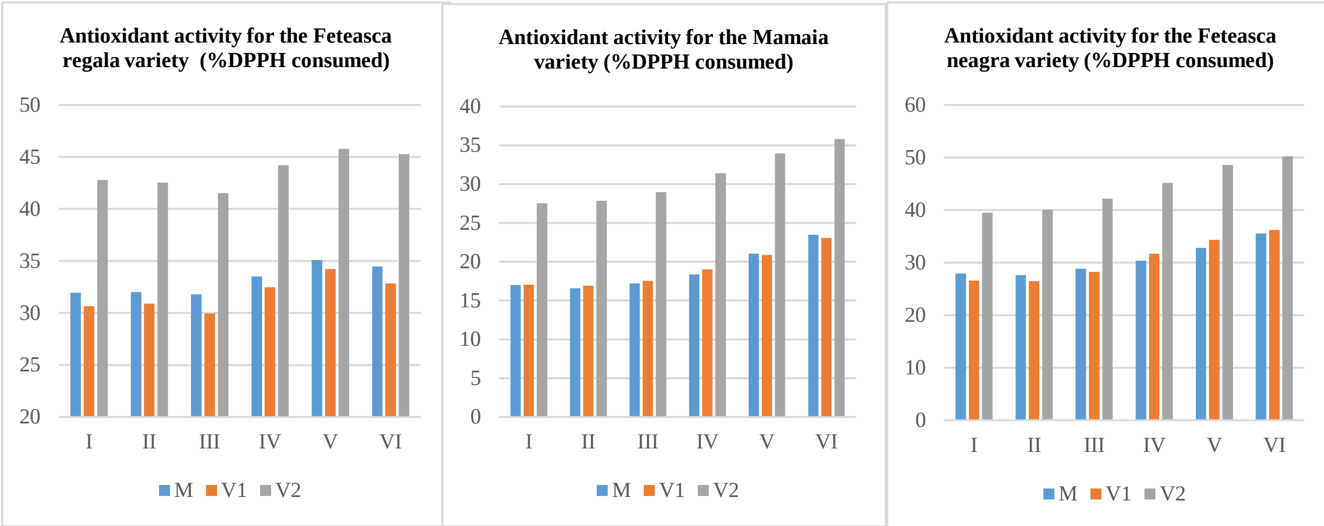


a) **b)** **c)**

Figure 3. Total polyphenolic content for the 3 varieties under study during 6 months / Conținutul de polifenoli totali pentru 3 soiuri studiate pe durata a 6 luni

As can be seen, the addition of the product based on inactivated yeasts led to a significant decrease of the polyphenols content for the white wine (over 25%) and a moderate decrease for the red wines (about 10%). This can be explained by the fact that polyphenols can bind and deposit on the fragments and constituents of cell walls in the utilised product. Also, a moderate decrease in the values obtained for these compounds can be observed, more pronounced in the first months of storage, which coincides with the consumption of dissolved oxygen in the wine.

The evolution of the antioxidant activity of wine over time can be influenced by several factors including: the initial composition of the wine, production process, storage conditions and storage time. This is associated with the presence of compounds such as polyphenols, flavonoids, resveratrol and vitamins, which can neutralize free radicals and protect the wine against oxidative damage. The values obtained for this parameter are illustrated in Figure 4 a), b) and c). It should be noted that for red wines, a dilution of 1:10 was used.



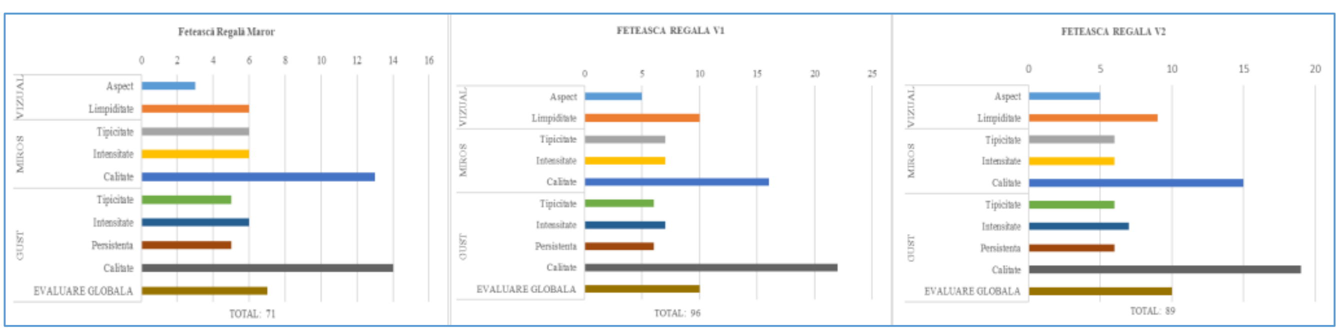
a) b) c)

Figure 4. Antioxidant activity for the 3 varieties (%DPPH consumed). For red wines, a 1:10 dilution was made / Activitatea antioxidantă pentru cele 3 soiuri (%DPPH consumat). Pentru vinurile rosii s-a efectuat diluție 1:10

As expected, the lowest antioxidant activity was obtained for Fetească regală white wine, with values between 30 and 45% DPPH consumed. As can be seen from Figure 4. a), the values for this parameter decreased slightly during the first 3 months of storage, after which in months 4, 5, and 6 they show very slight increases. As can be noted, variant 2 (treated with the antibacterial chitosan product) shows significant increases (approximately 24%) for the antioxidant activity determined based on this assay method due to the antioxidant effect of the product.

Determinations on red wine, carried out at a dilution of 1:10 compared to white wine samples, resulted in DPPH consumption values between 16.5 and 35.8% for the Mamaia variety and between 26.5 and 50,2% for the Fetească neagră variety. It can be observed that the values obtained for this parameter are relatively constant during the first 3 months, after which they show slight increases during months IV, V and VI of analysis. It can also be noted that variant 2, treated with chitosan, shows significant increases compared to the other 2 variants, of approximately 35% for the Mamaia variety, respectively 30% for the Fetească neagră variety. These increases are attributed to the properties of the added product.

Regarding the organoleptic analysis, the results obtained for the Fetească regală variety in the 3 studied variants are presented in Figure 5. a), b) and c). The displayed results are obtained as an average of the 4 qualifications obtained for each parameter.

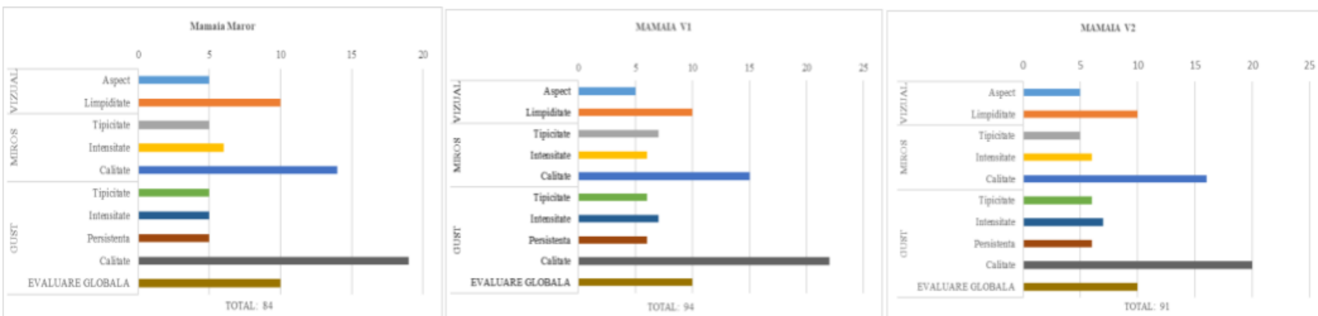


a) b) c)

Figure 5. Sensory evaluation of the 3 variants obtained for the Feteacă regală variety / Evaluarea senzorială a celor 3 variante obținute pentru soiul Feteacă regală

Following sensory analysis and data processing, the control variant scored the lowest with a total of 71 points. The product had a slightly opalescent and slightly oxidized appearance. The best score was obtained by variant 2, with the product based on inactivated yeasts addition, with a total of 96 points. The wine was clear, non-oxidized, with taste and smell specific for the variety. This variant proved to have improved organoleptic characteristics, preserved the fruity notes present in the fresh wine used as a base. As for the taste, a significant improvement was noted in terms of fullness, structure and complexity. Variant 2 treated with the chitosan-based *Bactiless* product was also clear and without an oxidized appearance, but not retaining the complexity of flavors found for variant 1.

Mamaia variety leads to obtaining a red wine of moderate color intensity, with a specific aroma of roses, velvety, full, with a slightly spicy taste, leaving the impression of spices. The values obtained from the organoleptic analysis are shown in Figure 6 a), b) and c).



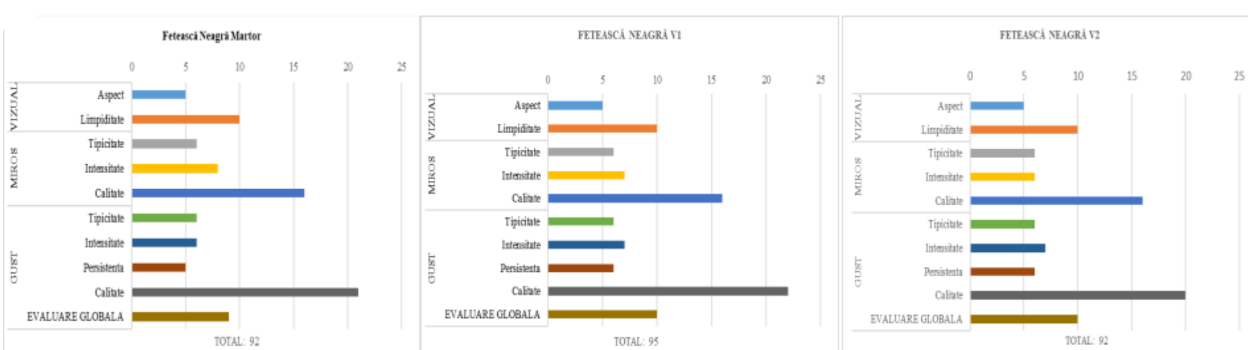
a) **b)** **c)**

Figure 6. The organoleptic evaluation of the 3 variants obtained for Mamaia variety / Evaluarea organoleptică a celor 3 variante obținute pentru soiul Mamaia

Following the organoleptic analysis, the control variant for Mamaia variety scored a total of 84 points. Although the appearance of the control variant was clear, it got lower points for olfactory typicity and taste intensity and persistence. The V1 variant got the highest total with 94 points. This variant proved to have superior organoleptic characteristics, a better intensity of the typical aromas and it preserved taste structure and complexity. Variant V2 treated with the chitosan based product obtained a total close to V1, with a slightly lower score for olfactory typicity and intensity.

Fetească neagră variety is known for its elegant red wines full of character. It leads to wines with rich and complex taste, intense color, distinguished by their aromas of black and red fruits, with fine tannins and a balanced acidity.

Following the organoleptic evaluation the results from Figure 7. a), b) and c) were obtained:



a) **b)** **c)**

Figure 7. Sensory evaluation of the 3 variants obtained for the Fetească neagră variety / Evaluarea senzorială a celor 3 variante obținute pentru soiul Fetească neagră

As can be observed from the presented data, the total obtained for the 3 variants is very close. The variant with the best total points is variant 1, treated with the product based on inactivated yeasts, while the control and variant 2 were rated with the same total points. Variant 1 obtained a better appreciation in terms of olfactory intensity, gustatory intensity and persistence.

From the point of view of the organoleptic evaluation, the product based on inactivated yeasts led to significant improvements on the white wine variety and moderate on the red wine, while the chitosan-based product only had an influence on the appearance and clarity of the wine, without a particular impact on the olfactory and gustatory properties.

CONCLUSIONS

The present study carried out using 3 variants obtained for 3 Romanian varieties by adding a product based on inactivated yeasts (*Longevity Pure Lees*) and a product based on chitosan (*Bactiless*) aimed to highlight how the addition of these oenological products influences certain characteristics and qualitative indicators of the wines. The conclusions are as follows:

1. Regarding the **dissolved oxygen** in wine, the product based on inactivated yeasts considerably decreased the value for this parameter to approximately 50% for all 3 varieties in the first month after treatment. In months IV, V and VI of the study, the differences between the variants became insignificant. The chitosan-based product did not influence this parameter.
2. For **polyphenols content**, the addition of the product based on inactivated yeasts led to a significant decrease in polyphenols content for the white wine (over 25%) and a moderate decrease for red wines (approximately 10%). The chitosan-based product did not influence the values determined for this parameter. A slight decrease was also observed during the storage period in the first months, a period that coincides with the consumption of the dissolved oxygen in the wine.
3. The **antioxidant activity** for variant number 2 treated with the chitosan-based product was higher by 24% for the Feteacă regală variety and by 35 and 30%, respectively, for the Mamaia and Fetească neagră varieties. The product based on inactivated yeasts did not significantly influence this parameter.
4. The **organoleptic properties** were positively influenced by the addition of the two products, especially for white wine. *Longevity Pure Lees* had a significant influence on the preservation of freshness and fruitiness, complexity and taste balance.

Based on these data, it can be concluded that the tested oenological products can significantly influence the chemical and organoleptic characteristics of wine, and understanding these effects can contribute to the optimization of wine production processes. The use of new adjuvants can represent an alternative to replacing the use of traditional additives to prevent the development of oxidative damage in beverages and requires further studies to deepen the understanding of the processes underlying this influence.

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RESEARCH ON THE BEHAVIOR OF COLUMNA AND MAMAIA VINE VARIETIES IN THE CLIMATE CONDITIONS OF NORTH - EAST ROMANIA

CERCETĂRI PRIVIND COMPORTAREA SOIURILOR DE VIŢĂ-DE-VIE COLUMNA ŞI MAMAIA ÎN CONDIŢIILE CLIMATICE DIN NORD-ESTUL ROMÂNIEI

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Abstract
The viticultural assortment that makes up the varietal assembly line for wine grape varieties from our country, was enriched by the creation of new varieties and clones with superior agrobiological and technological properties, increased resistance to the action of biotic and abiotic stress factors. The paper presents the agro-productive potential of the Columna and Mamaia grape varieties created/approved at SCDVV Murfatlar and studied under the eco-pedological conditions of the Iasi vineyard. The conducted research revealed the fact that they favorably assimilated the environmental conditions, a fact demonstrated by the values of the elements of fertility and productivity. The results obtained in the period 2020 - 2022 confirm the ecological plasticity of the varieties studied, a fact that allows the recommendation of introduction in the current zoning and extension in culture in the Copou Iaşi viticultural center.

Keywords: *ecological plasticity, new varieties, wine growing area*

Rezumat
Sortimentul viticol ce alcătuieşte conveierul varietal al soiurilor pentru struguri de vin din ţara noastră, a fost îmbogăţit prin crearea de noi soiuri şi clone cu însuşiri agrobiologice şi tehnologice superioare, rezistenţă sporită la acţiunea factorilor de stres biotici şi abiotici. În lucrare este prezentat potenţialul agroproductiv al soiurilor de viţă-de-vie Columna şi Mamaia create/ omologate la SCDVV Murfatlar şi studiate în condiţiile ecopedologice ale podgoriei Iaşi. Cercetările efectuate au relevat faptul că acestea au asimilat favorabil condiţiile de mediu, fapt demonstrat de valorile elementelor de fertilitate şi productivitate. Rezultatele obţinute în perioada 2020 – 2022 confirmă plasticitatea ecologică a soiurilor studiate, ceea ce indică faptul că sunt bine adaptate şi pot fi extinse în cultură în zona arealului viticol Copou Iaşi.

Cuvinte cheie: *plasticitate ecologică, soiuri noi, areal viticol.*

INTRODUCTION

Improving the structural assortment of traditional vine varieties is possible through viticultural improvement works, concretized by creating new varieties with superior agrobiological and technological characteristics, increased resistance to the action of biotic and abiotic stress factors (Damian Doina, Calistru Gh, 1997; Oprea Şt., Moldovan S. D., 2007). Through directed sexual hybridization works, varieties for table grapes and wine have been obtained for all existing vineyards and viticultural centers. Research on the behavior of varieties in their areas of origin has been carried out by the authors, taking into account different varieties and ecological conditions (Ionescu A., 1988; Ionescu A., Oşlobeanu M., 1994).

Climate change is causing major modifications both in the spatial distribution of vineyard areas and in the favorability of cultivation for grapevine varieties. Recent studies have highlighted the shift of the favorable zone for vine cultivation towards the north of the country, the increased suitability of cultivation for red varieties, as well as changes in the productive potential of varieties (Irimia L. M. et al., 2014, 2018; Zaldea G. et al., 2021). Given these trends and the knowledge of possible negative effects on grapevines, in-depth studies are required regarding the cumulative effect of restrictive environmental factors on the agrobiological and technological characteristics of varieties.

Understanding the behavior of grapevine genotypes in areas other than those where they were created is important, both for complementing the assortment of varieties and for improvement works.

In this paper, the agroproductive potential of the Columna and Mamaia grapevine varieties, created and approved at the SCDVV Murfatlar, is evaluated for introduction and expansion in cultivation under the ecopedological conditions of the Iasi vineyard.

MATERIAL AND METHOD

Columna and Mamaia varieties obtained through sexual hybridization of Pinot gris x Grasă de Cotnari genotypes and respectively from the hybrid combination of Merlot x (Băbească neagră x Muscat Ottonel) varieties were studied during the period 2020 - 2022, compared with Fetească regală, one of the established varieties in the assortment of the Iasi vineyard, and the Arcaş variety created at SCDVV Iasi. The varieties are planted in the ampelographic collection of the reestablished unit in 2013, on a chernozem soil type, with a sculptural plateau aspect with a slope of less than 5%, southwest exposure, with planting distances of 2.2 m between rows and 1.2 m within rows, semi-high training form, bilateral cordon pruning with two-eye canes. The practiced cultivation technology was specific to the studied area, correlated with the evolution of climatic factors.

The research conducted focused on observations and determinations regarding the development of vegetation phenophases, assessment of frost resistance, behavior against pathogenic agents, fertility and productivity elements, evaluation of quantitative and qualitative production expressed by the average number of grapes per trunk, average weight of a grape, production per trunk, must content in sugars, acidity, and the main characteristics of the obtained wines.

RESULTS AND DISCUSSIONS

The climatic factors during the studied period corresponded to years with different conditions. The viticultural center Copou Iasi benefited from a high thermal input, with useful temperatures during the vegetation period ranging from 1374.4 to 1662.0°C, with sunshine hours of 1351.6 to 1524.1, while the volume of precipitation was decreasing (Table 1).

Table 1. The values of the main climatic elements in the period 2020 – 2022 in the Copou Iasi viticultural center / Valorile principalelor elemente climatice în perioada 2020 – 2022 în centrul viticol Copou Iași

Climatic elements analyzed	Multiannual average	2020	2021	2022	Average (2020-2022)
The global heat balance, (∑t°g)	**3168,4**	3420,2	3124,7	3357,1	**3300,7**
Active thermal balance, (∑t°a)	**3048,9**	3312,0	2944,4	3262,2	**3172,9**
Useful heat balance, (∑t°u)	**1386,0**	1662,0	1374,4	1582,2	**1539,5**
Average temperature in July, °C	**21,0**	22,7	23,4	23,2	**23,1**
Average temperature in August,°C	**20,3**	23,5	20,9	22,5	**22,3**
Average temperature in September, °C	**15,6**	19,6	14,7	15,5	**16,6**
The absolute min. temp. in the air,°C	**-27,2**	-8,4	-16,3	-11,6	**-16,3**
The absolute min. temp. at the surface of the soil,°C	**-35,0**	-7,0	-22,1	-13,8	**-22,1**
Average annual temperature T°C	**9,8**	12,0	10,1	11,3	**11,1**
The absolute max. temp. in the air,°C	**42,3**	36,2	34,5	36,5	**36,5**
The absolute max. temp. at the surface of the soil,°C	**66,0**	62,5	61,8	61,4	**62,5**
∑ annual precipitation, mm	**579,6**	547,4	593,4	416,8	**519,2**
∑ precipitation during the vegetation period, mm	**398,1**	300,0	408,8	295,8	**334,9**
∑ hours of insolation during the vegetation period, hours	**1448,2**	1524,1	1351,6	1369,1	**1414,9**
Number of days with maximum temperatures > 30°C	**17,3**	47	31	39	**39**
Duration of the bioactive period, nr. days	**169,0**	169	157	168	**165**
Real heliothermic index (IHr)	**2,0**	2,5	1,9	2,2	**2,2**

The hydrothermal coefficient (CH)	**1,3**	0,9	1,4	0,9	**1,1**
The bioclimatic index of the vine (Ibcv)	**7,1**	9,9	6,2	9,0	**8,4**
Oenoclimatic aptitude index (IAOe)	**4106,1**	4786,1	4137,2	4585,5	**4502,9**
Huglin heliothermic index (IH)	**2095,2**	2323,2	1978,7	2234,5	**2178,8**
Characterization of the year		dry season	a little rainier	excessively dry	

The average temperatures in July, August, and September, the period when the main physiological and biochemical processes occur, were normal and even higher, contributing to the completion of these processes. The absolute minimum air temperatures ranged from -8.4 to -11.6 °C without affecting the vine buds. Summers were very warm with absolute maximum air temperatures exceeding 35°C and surface temperatures over 61°C.

In terms of rainfall, 2021 was "slightly rainier," while 2020 and 2022 were "dry" and "excessively dry," with precipitation amounts during the vegetation period well below normal.

The values of synthetic ecoclimatic indicators, which indicate a certain zonality and have a restrictive character for grapevine cultivation in certain areas, provide a clear picture of the climatic conditions during the studied period. Thus, the following were noted:

– an increase in the real heliothermal index (IHr), from 1.9 to 2.5, ensuring good grape ripening;
– a decrease in the values of the hydrothermal coefficient (CH), due to the recording of increasingly lower amounts of precipitation during the vegetation period;
– an increase in the values of the viticultural bioclimatic index (Ibcv), from 7.1 (multi-year average) to 9.9 in the year 2020, indicating increased heliothermal resources against lower water resources during the vegetation period;
– an increase in the values of the oenoclimatic suitability index (IAOe), from 4106.1 to 4786.1, confirming favorable conditions for white grape varieties in the Copou vineyard area of Iasi and a medium degree of favorability for the production of red wines;
– an increase in the values of the Huglin heliothermal index (IH), from 1978.7 to 2323.2, classifying the vineyard area, for the reference period, in the "temperate" climate class in the year 2021 and "warm temperate" in the years 2020, 2022.

Against this backdrop of climatic conditions, the studied varieties went through all specific phenophases of the active vegetation period. Budburst occurred earlier in dry years, starting from the second decade of April, and later in cold and rainy years, respectively in the first decade of May (Table 2).

Table 2. The phenological spectrum of the studied varieties / Spectrul fenologic al soiurilor studiate

Variety / Soi	**Budburst /** Dezmugurit			**Flowering** / Înflorit			**Veraison / Pârgă**			**Ripe for harvest /** Maturarea de recoltare			**Falling of leaves /** Căderea frunzelor		
	2020	**2021**	**2022**	**2020**	**2021**	**2022**	**2020**	**2021**	**2022**	**2020**	**2021**	**2022**	**2020**	**2021**	**2022**
Varieties for white wines / Soiuri pentru vinuri albe															
Columna	15.IV	04.V	28 IV	10.VI	22.VI	06.VI	10.VIII	18.VIII	08.VIII	21.IX	06.X	23. IX	21.XI	09.XI	09.XI
Fetească regală (control)	15.IV	30.IV	24.IV	08.VI	20.VI	06.VI	06.VIII	16.VIII	05.VIII	24.IX	29.IX	21.IX	21.XI	09.XI	09.XI
Varieties for red wines / Soiuri pentru vinuri roșii															
Mamaia	15.IV	01.V	24.IV	10.VI	21.VI	09.VI	08.VIII	16.VIII	10.VIII	23.IX	08.X	26.IX	21.XI	09.XI	09.XI
Arcaş (control)	19.IV	02. V	02.V	10.VI	22.VI	08.VI	09.VIII	17.VIII	10.VIII	24.IX	17. X	28.IX	21.XI	09.XI	09.XI

In the conditions of the Copou Iasi viticultural center, Columna variety budded with a delay of 4 days compared to the control variety Fetească regală, while Mamaia variety budded with an advance of 4 to 7 days compared to the Arcaş variety.

Flowering occurred approximately at the same time for all varieties, with a difference of 1 to 2 days between them. This phenomenon is frequently encountered in recent years due to the very high temperatures during the flowering period. This phenophase unfolds at an accelerated pace, over a short period, significantly reducing the gap between varieties (varieties flower simultaneously). During the studied period, the flowering of the varieties in the Copou Iasi viticultural center occurred earliest on June 6 and latest on June 22.

The lower temperatures in the year 2021 led to a delay in this phenophase (June 20 - 22). Berry set occurred earliest in the Fetească regală variety, followed by two, respectively four days by the Columna variety. For the black grape varieties, Mamaia and Arcaş, berry set occurred almost simultaneously. For both studied varieties, the technological ripening of the grapes, in the conditions of the Copou vineyard ecosystem, occurred in the last decade of September and the first decade of October.

Examining the winter hardiness characteristics of the studied varieties, as well as their resistance to cryptogamic diseases, it is noted that these are specific to *Vitis vinifera* varieties, being influenced by the evolution of climatic factors (Table 3).

Under conditions of absolute minimum air temperatures mentioned earlier, bud losses remained within normal physiological limits, with Columna and Mamaia varieties standing out with a higher percentage of viable buds compared to the control varieties. Additionally, the response of the genotypes to the action of biotic stress factors (cryptogamic diseases) was very good. Thus, under the application of anti-cryptogamic treatments, the studied varieties showed very good resistance to the main grapevine diseases, being rated 9 on the OIV scale (attack level below 1%).

Table 3. The response of the studied varieties to the biotic and abiotic stress factors / Răspunsul soiurilor studiate la factorii de stres biotici și abiotici

Variety / Soiul	**Frost resistance (% viable buds) /** Rezistența la ger (% muguri viabili)			**Resistance to Downy mildew (OIV note) /** Rezistența la mană (Nota OIV)			**Rezistance to Powdery mildew (OIV note) /** Rezistența la făinare (Nota OIV)			**Resistance to Bunch rot (OIV note) /** Rezistența la putregaiul cenușiu (Nota OIV)		
	2020	**2021**	**2022**	**2020**	**2021**	**2022**	**2020**	**2021**	**2022**	**2020**	**2021**	**2022**
Columna	100	98	100	9	9	9	9	9	9	9	9	9
Fetească regală (control)	78	95	100	9	8	8	9	9	9	9	9	9
Mamaia	100	100	100	9	9	9	9	9	9	9	9	9
Arcaş (control)	91	100	100	9	9	9	9	9	9	9	9	9

Research conducted on the Columna and Mamaia varieties revealed that they adapted favorably to the environmental conditions, as demonstrated by the values of the elements defining the fertility and productivity of a variety (Tables 4 and 5).

Table 4. The main agrobiological and technological characteristics of the variety Columna in comparison with the control variety Fetească regală / Principalele caracteristici agrobiologice și tehnologice ale soiului Comuna în comparație cu soiul martor Fetească regală

Nr. crt.	**Characteristics** / Caracteristici	**Columna**				**Fetească regală**			
		2020	**2021**	**2022**	**Average /** Media	**2020**	**2021**	**2022**	**Average /** Media
1	% of fertile shoots	88	98	88	**91**	95	98	92	**95**
2	The absolute fertility rate	1,4	1,9	1,0	**1,4**	1,6	1,9	1,7	**1,7**
3	The relative fertility rate	1,2	1,8	0,9	**1,3**	1,5	1,9	1,6	**1,7**
4	Absolute productivity index	106	197	48	**117**	100	175	80	**118**
5	Relative productivity index	92	357	43	**164**	96	333	73	**167**
6	Effective production, kg/trunk	3,3	5,5	1,8	**3,5**	3,7	7,4	4,3	**5,1**
7	Calculated production, t/ha	12,5	20,8	6,8	**13,3**	13,9	28,0	16,3	**19,4**
8	The average weight of a grape (g)	75	106	48	**76**	62	90	47	**66**
9	Mass of 100 grains (g)	152	216	128	**165**	128	162	131	**140**
10	Sugar g/L	215	166	236	**206**	191	191	188	**190**
11	Total acidity g/L $C_4H_6O_6$	6,0	8,9	5,3	**6,7**	6,2	8,8	5,5	**6,8**

Table 5. The main agrobiological and technological characteristics of the variety Mamaia, in comparison with the control variety Arcaş / Principalele caracteristici agrobiologice și tehnologice ale soiului Mamaia în comparație cu soiul martor Arcaș

Nr. crt	**Characteristics** / Caracteristici	**Mamaia**				**Arcaş**			
		2020	**2021**	**2022**	**Average** / Media	**2020**	**2021**	**2022**	**Average** / Media
1	% of fertile shoots	85	93	21	**66**	84	54	75	**71**
2	The absolute fertility rate	1,3	1,1	1,0	**1,1**	1,4	1,1	1,4	**1,3**
3	The relative fertility rate	1,1	0,6	0,2	**0,6**	1,1	1,0	1,0	**1,0**
4	Absolute productivity index	233	207	60	**167**	127	132	108	**122**
5	Relative productivity index	198	126	13	**112**	106	127	81	**105**
6	Effective production, kg/trunk	2,9	6,0	0,5	**3,1**	2,1	5,5	4,3	**4,0**
7	Calculated production, t/ha	11,0	22,7	1,9	**11,8**	7,9	20,8	16,3	**15,0**
8	The average weight of a grape (g)	182	153	60	**132**	93	119	79	**97**
9	Mass of 100 grains (g)	200	230	168	**199**	118	130	85	**111**
10	Sugar g/L	197	182	254	**211**	220	182	211	**204**
11	Total acidity g/L $C_4H_6O_6$	5,7	6,0	4,7	**5,5**	6,0	8,2	6,0	**6,7**
12	Anthocyanins mg/L	469	416	110	**332**	894	822	316	**677**
13	The total anthocyanin potential	1461	1048	3298	**1936**	2682	2265	947	**1965**
14	Total polyphenols, g/L gallic acid	1,32	0,22	0,34	**0,62**	1,48	0,22	0,48	**0,73**
15	Total polyphenolic index (TPI)	34,2	17,1	21,1	**24,1**	42,8	18,9	32,1	**31,3**

The percentage of fertile shoots had average values of 91% for Columna, 95% for Fetească regală, and lower values for black varieties, 66% for Mamaia, and 71% for Arcaş. Absolute fertility coefficients were above unity for all varieties, while relative coefficients ranged from 0.2 (Mamaia) to 1.7 (Fetească regală).

Absolute and relative productivity indices, conditioned by the average weight of a grape, had similar values for Columna and Fetească regală, while lower average values were observed for black varieties. The average weight of a grape for Columna variety was 76 g/grape, and for Fetească regală was 66 g/grape, while for the black varieties it was 132 g/grape for Mamaia and 97 g/grape for Arcaş.

During the research period, the production of the varieties was influenced by the action of climatic factors in correlation with the genetic specificity of each variety. Thus, the effective grape production per vine was lower for the studied varieties compared to local varieties. The control variety, Fetească regală, authorized for quality wine production in the Iasi vineyard, averaged 5.1 kg/ trunk in the three years of study, with an effective production of 19.4 t/ha, compared to Columna, which had an average production of 3.5 kg/trunk and 13.3 t/ha.

A similar situation was recorded for the black varieties, where the Arcaş variety achieved a production of 4.0 kg/trunk, corresponding to 15.0 t/ha, and the Mamaia variety achieved 3.1 kg/trunk, corresponding to 11.8 t/ha.

The quality of the production of Columna and Mamaia varieties was superior to the control variety. Thus, the qualitative indices assessed by the content of sugars and acidity of the must highlight accumulations of over 200 g/L in most varieties.

The total acidity of the grape must remained within normal limits, specific to wine varieties, varying from one variety to another, with average values ranging from 5.5 g/L $C_4H_6O_6$ (Mamaia) to 6.7 g/L $C_4H_6O_6$ (Columna). This indicates that the studied varieties are well adapted and can be expanded in cultivation in the Copou Iasi viticultural area.

The superior quality of the grape production was also reflected in the main composition characteristics of the obtained wines (Table 6).

From the analysis of the obtained data, it was found that concerning the climatic conditions of the harvest year and the yields achieved, generally, dry wines resulted, with alcoholic potential ranging from 11.5% vol. (Fetească regală) to 12.7% vol. (Columna). The residual content of reducing sugars was generally below 4 g/L (dry wines). Total acidity presented low values, due to the water deficit during the vegetation period, ranging from 4.50 g/L to 7.5 g/L tartaric acid. The volatile acidity of the analyzed wines was low for white wines and higher for red wines.

Table 6. The main compositional characteristics of the wines / Principalele caracteristici de compoziție ale vinurilor

Nr. crt	**Characteristics** / Caracteristici	**Columna**		**Fetească regală (control) / (martor)**		**Mamaia**		**Arcaş (control) / (martor)**	
		2020	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**
1	Alcohol, %vol.	12,7	9,7	11,5	11.5	12,4	11,0	12,5	13,0
2	Total acidity, g/L $C_4H_6O_6$	5,02	5,0	4,5	7,5	6,90	5.35	5.14	8.42
3	Volatile acidity, g/L CH_3COOH	0,48	0,36	0.58	0.30	1.0	0,26	0.54	0.24
4	Non-reducing extract, g/L	17,0	17,1	14,7	18,0	16.4	22.4	17,6	18,1
5	Reducing sugar, g/L	1,0	1,3	0,5	2,4	6.8	1,5	2.0	2.0
6	pH	3,26	3,03	3.39	3.20	3,47	3,61	3.92	3.02
7	SO_2 free, mg/L	30	20	30	32	55	25	30	23
8	SO_2 total, mg/L	93	86	77	89	143	64	70	90
9	Taste grade	B	B	B	FB	B	FB	B	B

CONCLUSIONS

The fluctuating climatic factors recorded in the Copou Iasi viticultural center during the period 2020 - 2022 allowed the wine grape varieties Columna and Mamaia to go through all specific phenophases of the active vegetation period.

The values of the elements defining the fertility and productivity of a variety revealed that they assimilated favorably to the environmental conditions, and under the application of anti-cryptogamic treatments, they showed very good resistance to the main grapevine diseases, being rated 9 on the OIV scale (attack level below 1%).

In the conditions of the Copou Iasi viticultural center, the quantitative grape production was similar to the known biological potential from the pre-homologation stage, being influenced by the action of climatic factors. The quality of the production, assessed by the average cluster weight, weight of 100 berries, sugar content, and must acidity, recorded higher values for the Columna and Mamaia varieties compared to the control varieties.

The evaluation of the agrobiological and technological potential under specific eco-pedo-climatic conditions confirms the ecological plasticity of the studied varieties. The results regarding production characteristics, quality, and resistance to abiotic and biotic factors, obtained in the three years of study, support the promotion of cultivating the Columna and Mamaia varieties in the area of the Copou Iasi viticultural center.

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DESCRIPTION OF THE NEW GRAPE VARIETIES USING MODERN AMPELOGRAPHIC DESCRIPTORS IN THE WINE PLANTATIONS WITHIN RDSVO DRĂGĂŞANI

DESCRIEREA SOIURILOR NOI DE VIŢĂ-DE-VIE FOLOSIND DESCRIPTORI AMPELOGRAFICI MODERNI ÎN PLANTAŢIILE VITICOLE DIN CADRUL SCDVV DRĂGĂŞANI

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Abstract

In 2022-2023, an ampelographic study was carried out at Research and Development Station for Viticulture and Oenology (RDSVO) Drăgăşani using modern ampelographic descriptors accredited by international bodies in the field. RDSVO Drăgăşani is part of the Drăgăşani vineyard area, the oldest vineyard in Romania, also called the great grandmother of viticulture. The research station is the first research station in the country founded in 1936. The grape varieties studied were 'Crâmpoşie selecţionată', 'Crâmpoşie aromată', 'Vilarom', 'Alutus', 'Novac' and 'Negru de Drăgăşani'. The study was carried out using the OIV, UPOV, Bioversity-IBPGR descriptors, due to the fact that the description of the grape varieties must be done according to the rules developed by the international bodies accredited in this field, in order to avoid confusion and the loss of a valuable genetic fund (Mândrilă, 2010).

Keywords: *varieties, descriptors, genetic background, vineyard, research*

Rezumat

În anul 2022-2023 s-a efectuat un studiu ampelografic la SCDVV Drăgăşani folosind descriptori ampelografici moderni acreditaţi de organismele internaţionale în domeniu. Staţiunea de Cercetare Dezvoltare pentru Viticultură şi Vinificaţie Drăgăşani face parte din arealul podgoriei Drăgăşani, cea mai veche podgorie din România, denumită şi străbunica viticulturii. Staţiunea de cercetare este cea dintâi staţiune de cercetare din ţară fondată în anul 1936. Soiurile luate în studiu au fost 'Crâmpoşie selecţionată', 'Crâmpoşie aromată', 'Vilarom' , 'Alutus', 'Novac' şi 'Negru de Drăgăşani'. Studiul s-a realizat folosind descriptorii OIV, UPOV, Bioversity-IBPGR, datorită faptului că descrierea soiurilor trebuie să se facă după norme elaborate de organismele internaţionale acreditate în acest domeniu, în vederea evitării confuziilor şi pierderii unui fond genetic valoros (Mândrilă, 2010).

Cuvinte cheie: *soiuri viţă-de-vie, descriptori, fond genetic, podgorie, cercetare*

INTRODUCTION

The Research and Development Station for Viticulture and Oenology Drăgăşani is part of the Drăgăşani vineyard area, the oldest vineyard in Romania, also called the great grandmother of viticulture. The research station is the first research station in the country founded in 1936.

The most famous and important grape varieties created at this research station are the table grapes varieties 'Victoria' and 'Azur', the seedless grape variety 'Călina', the grape varieties for white wines 'Crâmpoşie selecţionată' and 'Vilarom' and for red wines the most important are 'Negru de Drăgăşani', 'Novac' and 'Alutus'. Clones of some value for viticulture were also obtained, namely 'Tămăioasă Românească 104 Dg', 'Sauvignon 62 Dg', 'Cabernet Sauvignon 7 Dg' and two rootstock grape varieties - 'Drăgăşani M70' and 'Drăgăşani 57'. The viticultural research station owns an 'Ampelographic Collection', which is a national viticultural heritage, including approximately 300 grape varieties. The existing grape varieties in this collection are autochthonous grape varieties, some even local, with a very good adaptability to the eco-pedological conditions of the vineyard (Popa et al., 2023).

The grape varieties studied were 'Crâmpoşie selecţionată', 'Crâmpoşie aromată', 'Vilarom', 'Alutus', 'Novac' and 'Negru de Drăgăşani'.

MATERIAL AND METHOD

In the plantations of RDSVO Drăgăşani, a study was carried out on modern ampelographic descriptors for grape varieties of certain value in the production of white, red and aromatic wines (Gorjan, 2013).

Currently, for the identification and characterization of cultivated grapevine varieties, or rootstock grape varieties and hybrids, a unique system is used, standardized with ampelographic descriptors: The 3rd edition of *"OIV Descriptor list of grape vine varieties and Vitis species"*, published in 2023.

This standard is recommended for the management of viticultural germplasm collections and regulates the system of scoring and recording the ampelographic characters of the studied varieties. The standard for the description and characterization of the species and varieties of the *Vitis* genus includes 150 descriptors, of which 48 are mandatory (Popescu et al., 2018).

The descriptors analyzed for the grape varieties studied in the year 2023-2024 were: morphological descriptors, namely young shoot, shoot, young leaf, mature leaf, grape, berry; agrobiological descriptors and technological descriptors.

RESULTS AND DISCUSSIONS

According to the OIV ampelographic descriptors, the 'Crâmpoşie selecţionată' grape variety stands out for its strong shoot growth, bunchs production per m^2 and an average amount of sugar content of must. The mature leaf is orbicular, whole or with three lobes, and the shape of the base of the petiolar sinus is U-shaped. The time of bud brust and time of beginning of berry ripening (veraison) is average (Table 1) (Figure 1).

Table 1. Grape variety 'Crâmpoşie selecţionată' / Soiul 'Crâmpoşie selecţionată'

OIV Code / Cod OIV	**Descriptors /** Descriptori	**Character description /** Descrierea caracterului	**Note /** Nota
Young shoot			
001	Young Shoot: aperture of tip	fully open	5
003	Young Shoot: intensity of anthocyanin coloration on prostrate hairs of tip	weak	3
004	Young Shoot: density of prostrate hairs on tip	big	7
Shoot			
006	Shoot: attitude (before tying)	semi-erect	3
007	Shoot: colour of dorsal side of internodes	red	3
008	Shoot: colour of ventral side of internodes	green	1
Young leaf			
051	Young leaf: colour of the upper side of blade (4th leaf)	green- yellowish	1/2
053	Young leaf: density of prostrate hairs between main veins on lower side of blade (4th leaf)	average	5
Mature leaf			
067	Mature leaf: shape of blade	orbicularis	4
068	Mature leaf: number of lobes	whole/three	2
070	Mature leaf: area of anthocyanin coloration of main veins on upper side of blade	absence	1
072	Mature leaf: goffering of blade	low	3
074	Mature leaf: profile of blade in cross section	right	1
076	Mature leaf: shape of teeth	one straight side, one convex	4
079	Mature leaf: degree of opening / overlapping of petiole sinus	open	3

080	Mature leaf: shape of base of petiole sinus	U-shaped	1
081-1	Mature leaf: teeth in the petiole sinus	absent	1
081-2	Mature leaf: petiole sinus base limited by veins	not	1
083-2	Mature leaf: teeth in the upper lateral sinuses	not	1
084	Mature leaf: density of prostrate hairs between the main veins on lower side of blade	average	5
087	Mature leaf: density of erect hairs on main veins on lower side of blade	average	5
094	Mature leaf: depth of upper lateral sinuses	shallow	3
151	Flower: sexual organs	normal development of stamens and gynoecium	3
Bunch			
202	Bunch: length (peduncle excluded)	average	5
204	Bunch: density	average	5
206	Bunch: length of peduncle of primary bunch	short	3
208	Bunch: shape	conical	2
Berry			
220	Berry length	average	5
221	Berry width	average	5
223	Berry: shape	conical	2
225	Berry: colour of skin	yellowish green	1
231	Berry: intensity of the anthocyanin coloration of flesh	absence	1
235	Berry: firmness of flesh	slightly firm	2
236	Berry: particularity of flavor	without	1
241	Berry: formation of seeds	complete	3
Agrobiological descriptors			
301	Time of bud burst	average	5
303	Time of beginning of berry ripening (veraison)	average	5
351	Vigour of shoot growth	strong	7
Technological descriptors			
502	Bunch: single bunch weight	small	3
503	Berry: single berry weight	small	3
504	Yield per m^2	average	5
505	Sugar content of must	average	5
506	Total acidity of must	small	3

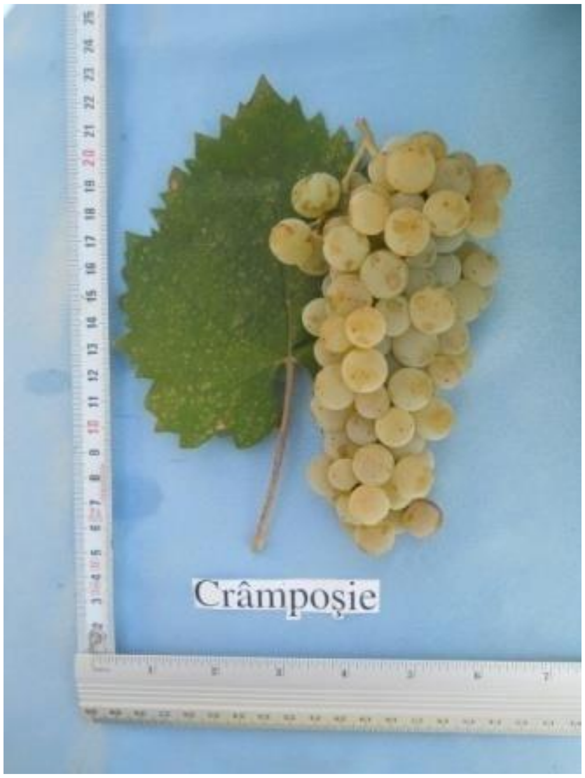

Figure 1. Bunch and leaf, 'Crâmpoşie selecţionată' variety / Strugure şi frunză, soiul 'Crâmpoşie selecţionată'

The variety 'Crâmpoşie aromată' has a mature leaf with three to five lobes, having a pentagonal shape. The attitude (before tying) of the shoot is semi-erect. The shape of the bunch is conical, and the berry has a muscat-type aroma. The production of bunchs per m^2 is high, and the total acidity of the must is low (Table 2) (Figure 2).

Table 2. Grape variety'Crâmpoşie aromată' / Soiul 'Crâmpoşie aromată'

OIV Code/ Cod OIV	**Descriptors /** Descriptori	**Character description /** Descrierea caracterului	**Note /** Nota
Young shoot			
001	Young Shoot: aperture of tip	fully open	5
003	Young Shoot: intensity of anthocyanin coloration on prostrate hairs of tip	low	3
004	Young Shoot: density of prostrate hairs on tip	average	5
Shoot			
006	Shoot: attitude (before tying)	semi-erect	3
007	Shoot: colour of dorsal side of internodes	red	3
008	Shoot: colour of ventral side of internodes	green	1
Young leaf			
051	Young leaf: colour of the upper side of blade (4th leaf)	green- yellowish	1/2
053	Young leaf: density of prostrate hairs between main veins on lower side of blade (4th leaf)	average	5
Mature leaf			
067	Mature leaf: shape of blade	pentagonal	3
068	Mature leaf: number of lobes	three/five	2/3
070	Mature leaf: area of anthocyanin coloration of main veins on upper side of blade	absence	1
072	Mature leaf: goffering of blade	low	3
074	Mature leaf: profile of blade in cross section	Right	1
076	Mature leaf: shape of teeth	one straight side, one convex	4
079	Mature leaf: degree of opening / overlapping of petiole sinus	open	3
080	Mature leaf: shape of base of petiole sinus	U-shaped	1
081-1	Mature leaf: teeth in the petiole sinus	absent	1
081-2	Mature leaf: petiole sinus base limited by veins	not	1
083-2	Mature leaf: teeth in the upper lateral sinuses	not	1
084	Mature leaf: density of prostrate hairs between the main veins on lower side of blade	average	5
087	Mature leaf: density of erect hairs on main veins on lower side of blade	average	5
094	Mature leaf: depth of upper lateral sinuses	shallow	3
151	Flower: sexual organs	normal development of stamens and gynoecium	3
Bunch			
202	Bunch: length (peduncle excluded)	average	5
204	Bunch: density	average	5
206	Bunch: length of peduncle of primary bunch	short	3
208	Bunch: shape	conical	2
Berry			
220	Berry length	average	5
221	Berry width	average	5
223	Berry: shape	conical	2
225	Berry: colour of skin	yellowish green	1
231	Berry: intensity of the anthocyanin coloration of flesh	absence	1
235	Berry: firmness of flesh	slightly firm	2
236	Berry: particularity of flavor	muscat	2
241	Berry: formation of seeds	complete	3
Agrobiological descriptors			
301	Time of bud burst	average	5
303	Time of beginning of berry ripening (veraison)	average	5
351	Vigour of shoot growth	strong	7
Technological descriptors			
502	Bunch: single bunch weight	average	5
503	Berry: single berry weight	average	5
504	Yield per m^2	big	7
505	Sugar content of must	average	5
506	Total acidity of must	small	3

Figure 2. Bunch and leaf, 'Crâmpoşie aromată' variety / Strugure şi frunză, soiul 'Crâmpoşie aromată'

The 'Vilarom' is highlighted by a particular, valuable muscat-type aroma, the length of the bunch (without the peduncle) being long and the vigour of shoot growth being strong. The weight of the bunch and the berry is average, the sugar content of must is low, having a low total acidity of the must (Table 3) (Figure 3).

Table 3. Grape variety 'Vilarom' / Soiul 'Vilarom'

OIV Code/ Cod OIV	**Descriptors /** Descriptori	**Character description /** Descrierea caracterului	**Note /** Nota
	Young shoot		
001	Young Shoot: aperture of tip	completely open	5
003	Young Shoot: intensity of anthocyanin coloration on prostrate hairs of tip	average	5
004	Young Shoot: density of prostrate hairs on tip	average	5
	Shoot		
006	Shoot: attitude (before tying)	semi-erect	3
007	Shoot: colour of dorsal side of internodes	green	1
008	Shoot: colour of ventral side of internodes	green	1
	Young leaf		
051	Young leaf: colour of the upper side of blade (4th leaf)	coppery	4
053	Young leaf: density of prostrate hairs between main veins on lower side of blade (4th leaf)	average	5
	Mature leaf		
067	Mature leaf: shape of blade	cuneiform	2
068	Mature leaf: number of lobes	three/five	2/3
070	Mature leaf: area of anthocyanin coloration of main veins on upper side of blade	absence	1
072	Mature leaf: goffering of blade	low	3
074	Mature leaf: profile of blade in cross section	in V	2
076	Mature leaf: shape of teeth	both sides straight	2
079	Mature leaf: degree of opening / overlapping of petiole sinus	open	3
080	Mature leaf: shape of base of petiole sinus	lyrate	2
081-1	Mature leaf: teeth in the petiole sinus	absent	1
081-2	Mature leaf: petiole sinus base limited by veins	not	1
083-2	Mature leaf: teeth in the upper lateral sinuses	not	1
084	Mature leaf: density of prostrate hairs between the main veins on	very small	1

	lower side of blade		
087	Mature leaf: density of erect hairs on main veins on lower side of blade	big	7
094	Mature leaf: depth of upper lateral sinuses	average	5
151	Flower: sexual organs	normal development of stamens and gynoeciu	3
Bunch			
202	Bunch: length (peduncle excluded)	big	7
204	Bunch: density	medium short	5
206	Bunch: length of peduncle of primary bunch	short	3
208	Bunch: shape	cylindrical-conical	1/2
Berry			
220	Berry length	average	5
221	Berry width	average	5
223	Berry: shape	spherical	2
225	Berry: colour of skin	yellowish green	1
231	Berry: intensity of the anthocyanin coloration of flesh	absence	1
235	Berry: firmness of flesh	very firm	3
236	Berry: particularity of flavor	muscat	2
241	Berry: formation of seeds	complete	3
Agrobiological descriptors			
301	Time of bud burst	average	5
303	Time of beginning of berry ripening (veraison)	average	5
351	Vigour of shoot growth	strong	7
Technological descriptors			
502	Bunch: single bunch weight	average	5
503	Berry: single berry weight	average	5
504	Yield per m^2	average	5
505	Sugar content of must	low	3
506	Total acidity of must	small	3

Figure 3. Bunch and leaf, 'Vilarom' variety / Strugure şi frunză, soiul 'Vilarom'

The variety 'Alutus' shows an average vigour of shoot growth, the time of bud brust and time of beginning of berry ripening (veraison) being also average. The weight of the grape and the berry are medium and the production of grapes per m^2, the sugar content of must and the total acidity of the must are big (Table 4) (Figure 4).

Table 4. Grape variety 'Alutus' / Soiul 'Alutus'

OIV Code/ Cod OIV	**Descriptors /** Descriptori	**Character description /** Descrierea caracterului	**Note /** Nota
Young shoot			
001	Young Shoot: aperture of tip	open	3
003	Young Shoot: intensity of anthocyanin coloration on prostrate hairs of tip	low	3
004	Young Shoot: density of prostrate hairs on tip	very low	1
Shoot			
006	Shoot: attitude (before tying)	semi erect	3
007	Shoot: colour of dorsal side of internodes	green with red stripes	2
008	Shoot: colour of ventral side of internodes	green	1
Young leaf			
051	Young leaf: colour of the upper side of blade (4th leaf)	yellowish green	2
053	Young leaf: density of prostrate hairs between main veins on lower side of blade (4th leaf)	low	3
Mature leaf			
067	Mature leaf: shape of blade	pentagonal	3
068	Mature leaf: number of lobes	five	3
070	Mature leaf: area of anthocyanin coloration of main veins on upper side of blade	until the second bifurcation	4
072	Mature leaf: goffering of blade	low	3
074	Mature leaf: profile of blade in cross section	right	1
076	Mature leaf: shape of teeth	both sides convex	3
079	Mature leaf: degree of opening / overlapping of petiole sinus	open	3
080	Mature leaf: shape of base of petiole sinus	U-shaped	1
081-1	Mature leaf: teeth in the petiole sinus	absent	1
081-2	Mature leaf: petiole sinus base limited by veins	not	1
083-2	Mature leaf: teeth in the upper lateral sinuses	absent	1
084	Mature leaf: density of prostrate hairs between the main veins on lower side of blade	small	3
087	Mature leaf: density of erect hairs on main veins on lower side of blade	small	3
094	Mature leaf: depth of upper lateral sinuses	slightly deep	3
151	Flower: sexual organs	normal development of stamens and gynoecium	3
Bunch			
202	Bunch: length (peduncle excluded)	average	5
204	Bunch: density	compact medium	5
206	Bunch: length of peduncle of primary bunch	very short	1
208	Bunch: shape	conical	2
Berry			
220	Berry length	average	5
221	Berry width	narrow	3
223	Berry: shape	globose	2
225	Berry: colour of skin	dark blue	6
231	Berry: intensity of the anthocyanin coloration of flesh	absence	1
235	Berry: firmness of flesh	soft	1
236	Berry: particularity of flavor	without	1
241	Berry: formation of seeds	complete	3
Agrobiological descriptors			
301	Time of bud burst	average	5
303	Time of beginning of berry ripening (veraison)	average	5
351	Vigour of shoot growth	average	5
Technological descriptors			
502	Bunch: single bunch weight	average	5
503	Berry: single berry weight	average	5
504	Yield per m^2	big	7
505	Sugar content of must	big	7
506	Total acidity of must	big	7

Figure 4. Bunch and leaf, 'Alutus' variety / Strugure şi frunză, soiul 'Alutus'

In the 'Novac' variety we find a dark blue colour of skin, the firmness of flesh being soft. The berry length is medium and the width is narrow. The shape of the bunch is conical. It presents a production of grapes per m^2, a very high sugar content of the must and a high total acidity of the must (Table 5) (Figure 5).

Table 5. Grape variety 'Novac' / Soiul 'Novac'

OIV Code/ Cod OIV	**Descriptors /** Descriptori	**Character description /** Descrierea caracterului	**Note /** Nota
	Young shoot		
001	Young Shoot: aperture of tip	open	3
003	Young Shoot: intensity of anthocyanin coloration on prostrate hairs of tip	low	3
004	Young Shoot: density of prostrate hairs on tip	very low	1
	Shoot		
006	Shoot: attitude (before tying)	semi erect	3
007	Shoot: colour of dorsal side of internodes	green with red stripes	2
008	Shoot: colour of ventral side of internodes	green	1
	Young leaf		
051	Young leaf: colour of the upper side of blade (4th leaf)	yellowish green	2
053	Young leaf: density of prostrate hairs between main veins on lower side of blade (4th leaf)	low	3
	Mature leaf		
067	Mature leaf: shape of blade	orbicular	4
068	Mature leaf: number of lobes	whole/three	1/2
070	Mature leaf: area of anthocyanin coloration of main veins on upper side of blade	until the second bifurcation	4
072	Mature leaf: goffering of blade	low	3
074	Mature leaf: profile of blade in cross section	in V	2
076	Mature leaf: shape of teeth	both sides convex	3
079	Mature leaf: degree of opening / overlapping of petiole sinus	open	3
080	Mature leaf: shape of base of petiole sinus	U-shaped	1
081-1	Mature leaf: teeth in the petiole sinus	absent	1
081-2	Mature leaf: petiole sinus base limited by veins	not	1

083-2	Mature leaf: teeth in the upper lateral sinuses	absent	1
084	Mature leaf: density of prostrate hairs between the main veins on lower side of blade	small	3
087	Mature leaf: density of erect hairs on main veins on lower side of blade	small	3
094	Mature leaf: depth of upper lateral sinuses	slightly deep	3
151	Flower: sexual organs	normal development of stamens and gynoecium	3
Bunch			
202	Bunch: length (peduncle excluded)	average	5
204	Bunch: density	compact medium	5
206	Bunch: length of peduncle of primary bunch	very short	1
208	Bunch: shape	conical	2
Berry			
220	Berry length	average	5
221	Berry width	narrow	3
223	Berry: shape	narrow ellipsoidal	3
225	Berry: colour of skin	dark blue	6
231	Berry: intensity of the anthocyanin coloration of flesh	absence	1
235	Berry: firmness of flesh	soft	1
236	Berry: particularity of flavor	without	1
241	Berry: formation of seeds	complete	3
Agrobiological descriptors			
301	Time of bud burst	average	5
303	Time of beginning of berry ripening (veraison)	average	5
351	Vigour of shoot growth	big	7
Technological descriptors			
502	Bunch: single bunch weight	average	5
503	Berry: single berry weight	average	5
504	Yield per m^2	very big	9
505	Sugar content of must	very big	9
506	Total acidity of must	big	7

Figure 5. Bunch and leaf 'Novac' variety / Strugure şi frunză, soiul 'Novac'

A valuable variety in obtaining quality red wines is the variety 'Negru de Drăgăşani'. It is characterized by the appearance aperture of tip the young shoot is completely open and the attitude (before tying) of the shoot is semi-erect. The skin colour of the berry is dark blue. Production of bunchs per m^2 and the sugar content of must is big. The total acidity of the must is average (Table 6) (Figure 6).

Table 6. Grape variety 'Negru de Drăgăşani' / Soiul 'Negru de Drăgăşani'

Code OIV / Cod OIV	**Descriptors /** Descriptori	**Character description /** Descrierea caracterului	**Note /** Nota
Young shoot			
001	Young Shoot: aperture of tip	fully open	5
003	Young Shoot: intensity of anthocyanin coloration on prostrate hairs of tip	low	3
004	Young Shoot: density of prostrate hairs on tip	very low	1
Shoot			
006	Shoot: attitude (before tying)	semi erect	3
007	Shoot: colour of dorsal side of internodes	green with red stripes	2
008	Shoot: colour of ventral side of internodes	green	1
Young leaf			
051	Young leaf: colour of the upper side of blade (4th leaf)	yellowish green	2
053	Young leaf: density of prostrate hairs between main veins on lower side of blade (4th leaf)	low	3
Mature leaf			
067	Mature leaf: shape of blade	orbicular	4
068	Mature leaf: number of lobes	whole/three	1/2
070	Mature leaf: area of anthocyanin coloration of main veins on upper side of blade	until the second bifurcation	4
072	Mature leaf: goffering of blade	low	3
074	Mature leaf: profile of blade in cross section	right	1
076	Mature leaf: shape of teeth	both sides convex	3
079	Mature leaf: degree of opening / overlapping of petiole sinus	open	3
080	Mature leaf: shape of base of petiole sinus	U-shaped	1
081-1	Mature leaf: teeth in the petiole sinus	absent	1
081-2	Mature leaf: petiole sinus base limited by veins	not	1
083-2	Mature leaf: teeth in the upper lateral sinuses	absent	1
084	Mature leaf: density of prostrate hairs between the main veins on lower side of blade	small	3
087	Mature leaf: density of erect hairs on main veins on lower side of blade	small	3
094	Mature leaf: depth of upper lateral sinuses	slightly deep	3
151	Flower: sexual organs	normal development of stamens and gynoeciu	3
Bunch			
202	Bunch: length (peduncle excluded)	average	5
204	Bunch: density	compact medium	5
206	Bunch: length of peduncle of primary bunch	very short	1
208	Bunch: shape	conical	2
Berry			
220	Berry length	average	5
221	Berry width	narrow	3
223	Berry: shape	narrow ellipsoidal	3
225	Berry: colour of skin	dark blue	6
231	Berry: intensity of the anthocyanin coloration of flesh	absence	1
235	Berry: firmness of flesh	soft	1
236	Berry: particularity of flavor	without	1
241	Berry: formation of seeds	complete	3
Agrobiological descriptors			
301	Time of bud burst	average	5
303	Time of beginning of berry ripening (veraison)	average	5
351	Vigour of shoot growth	big	7
Technological descriptors			
502	Bunch: single bunch weight	average	5
503	Berry: single berry weight	average	5
504	Yield per m^2	big	7
505	Sugar content of must	big	7
506	Total acidity of must	average	5

Figure 6. Bunch and leaf, 'Negru de Drăgăşani' variety / Strugure şi frunză, soiul 'Negru de Drăgăşani'

CONCLUSIONS

The grape varieties studied are varieties with a very good adaptability to the eco-pedological conditions of the Dragăşani vineyard.

We can observe based on the studied descriptors that these grape varieties have medium and high yields and the technological elements are conducive to obtaining quality wines.

Based on these modern descriptors, we can find a very good description in order to easily identify the new grape varieties from all the plantations belonging to the Drăgăşani vineyard based on the morphological, agrobiological and technological descriptors included in the OIV list.

In the future, these descriptions can contribute to the in-depth analysis of all the grape varieties of certain value in the vine plantations.

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THE CONTRIBUTION OF SCIENTIFIC RESEARCH IN THE VITICULTURAL FIELD TO THE REDUCTION OF THE EFFECTS OF CLIMATE CHANGE

CONTRIBUȚIA CERCETĂRII ŞTIINȚIFICE DIN DOMENIUL VITIVINICOL LA REDUCEREA EFECTELOR SCHIMBĂRILOR CLIMATICE

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Abstract
The wine-growing sector is currently facing and will face in the future a tendency of changing the wine-growing climate in the sense of the increase of heliothermic resources against the background of the decrease of water resources. Forecasts made on the basis of predictable climate models highlight the fact that the challenges that the wine industry will face in the next half century will be: the faster development of the vegetative phenophases by the vinifera varieties zoned in different wine growing regions, changes regarding the "favorite" areas for certain varieties, the reduction of the optimal harvesting period for obtaining high-quality wines and the need to pay more attention to the management of water resources, which are still low. Similar to global climate changes, changes in the regime of extreme thermal values were also highlighted in our country, namely: the increase in the annual frequency of tropical days (daily maximum >30°C) and the decrease in the annual frequency of winter days (daily maximum <0°C); the significant increase in the average minimum summer temperature and the maximum winter and summer temperature. For this reason in the last decade, researches have been oriented towards the development of viticultural new technologies adapted to diminish the disruptive effect of climate change (soil maintenance systems, drip irrigation), as well as the introduction into culture of new valuable genotypes, obtained in the last decades by Romanian viticultural research.

Keywords: *viticultural climate, climate changes, grapevine variety, rootstock, soil maintenance systems, drip irrigation*

Rezumat
Sectorul vitivinicol se confruntă în prezent şi se va confrunta şi în viitor cu o tendinţă de modificare a climatului viticol în sensul creşterii resurselor heliotermice pe fondul scăderii resurselor hidrice. Prognozele realizate pe baza modelelor climatice predictibile, evidenţiază faptul că provocările cu care se va confrunta industria vinului în următoarea jumătate de secol vor fi: derularea mai rapidă a fenofazelor vegetative de către soiurile vinifera zonate în diferite regiuni viticole, schimbări în privinţa arealelor „favorite” pentru anumite soiuri, reducerea perioadei optime de recoltare pentru obţinerea vinurilor de înaltă calitate şi necesitatea acordării unei mai mari atenţii în administrarea resurselor de apă care şi în prezent sunt scăzute. Similar cu schimbările climatice la nivel global, s-au evidenţiat şi la noi în ţară schimbări în regimul unor valori termice extreme şi anume: creşterea frecvenţei anuale a zilelor tropicale (maxima zilnică >30°C) şi descreşterea frecvenţei anuale a zilelor de iarnă (maxima zilnică <0°C); creşterea semnificativă a mediei temperaturii minime de vară şi a temperaturii maxime de iarnă şi vară. Din acest motiv în ultimul deceniu cercetarile din domeniul viticol au fost orientate catre elaborarea de noi tehnologii vitivinicole adaptate pentru diminuarea efectului perturbator al schimbărilor climatice(sisteme de întreţinere a solului, irigare prin picurare), precum si introducerea în cultură de noi genotipuri valoroase, obținute în ultimile decenii de cercetarea viticolă românească.

Cuvinte cheie: *climat viticol, schimbări climatice, soiuri de viță-de-vie, portaltoi, sisteme de întreținere a solului, irigare prin picurare*

INTRODUCTION

Climate changes, which are manifested at a global level according to the opinion of specialists, will be increasingly accentuated in the coming decades and will obviously influence the biology of horticultural species, especially the vine (Jones and Webb, 2010; Georgakopoulos et al., 2016, Emadodin et al., 2021). Studies on the evolution of climatic factors have shown a gradual warming trend in the growing season, especially in the phenophase of grape ripening. Also, an increase in the average temperature during the growing season, especially in the months of June, July and August, was observed. At the same time, there is a significant increase in the number of days with temperatures higher than 30°C (Bucur and Dejeu, 2014).

Studies related to the influence of climate change on the vine culture, were mainly carried out in the vineyards of Dobrogea, the south-east of Moldova and the south of the country (Damian, et al., 2022; Dejeu et al., 2008, Ranca, 2008, Bucur et al., 2017; Iliescu et al., 2019, 2020; Dobrei et al., 2015).

In this paper, are presented some new technological solutions applied to the establishment of vine plantations or concerning the technology of vine cultivation, adapted to the current climate changes, which have the effect of reducing their disruptive effect.

MATERIALS AND METHODS

The research was carried out in the period 2010-2022, in the Valea Călugărească viticultural center, from Dealu Mare vineyard.

The experimental studied factors were:

- rootstock varieties, vinifera varieties and clones, concerning their adaptation to the climatic change;
- the soil maintenance system, with the following graduations: black furrow (autumn and spring ploughing, 5 mechanical harrows per interval, 5 manual harrows per row); total mulching with vegetable residues (cereal straws in a layer of 10 cm); partial mulching (interval between rows) with marcs (composted pomace), in a layer of 10 cm and post-emergent application of herbicides per row (2 applications); minimum tillage (autumn ploughing, deep mechanical harrowing in spring, total post-emergent application of herbicides (2-3 applications);
- the fruit load, with the following graduations: the recommended fruit load (considered as control), 80% of the recommended fruit load, 60% of the recommended fruit load;
- irrigation methods, represented by: underground drip irrigation with porous tubes (TUPOREX) and above-ground drip irrigation with T-Type; irrigation with above-ground drip lines and rain collectors and underground irrigation with the help of micro-droppers.

For studying the effects of the experimental factors monofactorial and polifactorial experiments were set up, respecting the norms of experimental techniques.The observations, determinations and analyses carried out were specific to each experience, using standardized methods at the national and international level.

To monitor the influence of the disruptive effect of climate change and that of the experienced technological solutions on the biological and physiological processes involved determinations were made at two representative vegetative phenophases (flowering and veraison) regarding the content of leaves in chlorophyll pigments, the intensity of photosynthesis, respiration and transpiration and the mineral nutrition. Also, the development of the vegetative phenophases, the productivity of the vine and the quality of the grape production were studied.

The intensity of the photosynthesis and respiration processes was determined with the automatic analyzer LCA-4, the results being expressed in μmoles $CO_2/m^2/s$ and the intensity of the transpiration process was determined with the automatic analyzer LCA-4, the results being expressed in mmoles $H_2O/m^2/s$.

Determinations were made also regarding the main microbiological properties of the soil, determining the load of viable germs and the structure of the microbial communities.

RESULTS AND DISCUSSIONS

The analysis of climate change trends with impact on viticulture

The impact of climate change on world viticulture highlights the increase in the average temperature during the vine vegetation period by 1.3°C in the Northern Hemisphere and by only 0.9°C in the Southern Hemisphere. In the summer months, the increase will be 2.5°C to 4.5°C. At the level of the wine-growing regions in Europe, an increase in the average annual temperature by 2.8-4.2°C is forecast until the year 2100. An increase in the frequency of tropical days (with a maximum temperature > 35°C) will be recorded, as well as a variation in precipitation , with oscillations between - 40% and + 40% both at the level of 2050 and for the year 2100, compared to the current level.

The climate scenarios for Romania are in line with the European ones, highlighting the increase in the average annual temperature by 0.5-1.5°C in the period 2020-2029 and by 2.0-5.0°C in the period 2029-2099. The increase of the average of the maximum temperature will be by 5.0-6.0°C in the wine-growing areas in the south of the country, Dobrogea and S-E Moldova, the south of Muntenia and Oltenia and by 4.0-5.0°C in the wine-growing areas of Transylvania and the north of the country. It will also be recorded an increase in the annual frequency of tropical days (daily maximum >35°C) and pronounced droughts for the end of the century, especially in the wine-growing areas of the south and SE of the country.

Although the vine is considered a resistant plant to water stress, prolonged pedological drought can significantly affect the course of physiological and biochemical processes, the course of vegetative phenophases, the state of vegetation of the vine and their productive capacity. It has been registered for more than 15 years, a modification of the phenology of the varieties, respectively the earlier development of the vegetative phenophases (budding, flowering, veraison, ripening) by approximately 2-3 weeks; The ripening of grapes takes place more quickly and in conditions of thermal stress. This leads to a change in the composition of the grapes, namely an increase in sugar content, a decrease in acidity, a change in the phenolic composition (for red wine varieties) and a change in the aromatic profile, especially in white wine varieties.

There is also damage the appearance of the grains in table grape varieties (grain staining, burns, etc.) and a decrease in grape production and an increase in its quality, provided that the water deficit will not be very pronounced.

The impact of climate change on the wine industry is manifested by: changing in the dynamics of grape ripening, changing the physico-chemical composition (sugars, acidity, specific compounds) of the grapes, of the basic nutrients of yeasts and the extractability of oenological compounds from them, changing in the dynamics of alcoholic fermentation and of maceration, modification of the basic composition (alcohol concentration, pH, extract, ash) and specific composition (phenolic compounds, aromas) of raw wines and modification of the dynamics of specific oenological compounds during maturation and aging of wines.

New varieties and clones of fruiting vines and rootstocks with drought resistance

One of the most important aspects regarding the improvement of the competitiveness of the Romanian wine-growing sector is the identification of the most valuable table and wine varieties, which adapted to the recent climate changes, will allow the satisfaction of the market demand, which is strongly oriented towards qualitative and quantitative growth of grape production.

Through long-term studies of germplasm sources, the selection of the most valuable parents and by carrying out a wide range of intra and interspecific sexual hybridizations, a number of 7 grape varieties for table and wine with increased biological resistance have been created in Romania, adapted to the conditions of the ecosystems in which they were created.

For recreational plantations and viticultural areas located outside the consecrated ones, 3 new table grape varieties were created, with resistance to drought, frost and cryptogamic diseases, Argessis (from INCDBH Ștefăneşti) and Mara (from SCDVV Iasi), with medium-sized berries (3.7 g/grain), with a blue-black colored epidermis that achieves high grape production (19 t/ha) and Valeria (from ICDVV Valea Călugărească), a variety with mixed functions that can also be used to produce white wines of table wine, which ensures high productions of 14 t/ha and an accumulations of sugars that allow obtaining wines with an alcoholic potential of 12.7% vol. To obtain table wines, the following varieties were created and approved: Purpuriu (from ICDVV Valea Călugărească), Brumăriu (from SCDVV Blaj), Radames (from SCDVV Blaj) and Rubin (from SCDVV Blaj), which show good resistance to drought, frost and cryptogamic diseases and achieve productions between 15.3-22.9 t/ha. These varieties are suitable for organic vine cultivation in the areas mentioned above (Table 1).

Table 1. Varieties of fruitful vines produced by Romanian viticulture research, with a high degree of adaptability to the impact of climate change / Soiuri de viță-de-vie roditoare realizate de cercetarea viticolă românească,cu grad ridicat de adaptabilitate la impactul schimbărilor climatice

Varieties/ Clones	Unit	Destination	Biological resistances			Production (t/ha)	Sugar (g/L)
			Drought	Frost	Diseases		
Valeria	ICDVV Valea Călugărească	Table grapes/ Wine	Good	Medium	Good	14.9	177
Argessis	INCDBH Ștefănești	Table grapes	Good	Good	Medium	22.1	135
Mara	SCDVV Iasi	Table grapes	Medium-good	Medium-good	Good	18.7	180
Purpuriu	ICDVV Valea Călugărească	Wine	Medium-good	Good	Good	17.5	154
Brumăriu	SCDVV Blaj	Wine	Medium	Very good	Very good	15.3	166
Radames	SCDVV Blaj	Wine	Medium	Good	Good	22.9	180
Rubin	SCDVV Blaj	Wine	Medium	Good	Good	18.0	182

The range of rootstocks was completed with the varieties Precoce (from SCDVV Miniş), Ruvis (from ICDVV Valea Călugărească) and the clones: Ru 140 sel.59 Vl and 41 B sel.6 Vl which show resistance to drought, frost, limestone, downy mildew, powdery mildew, phylloxera radicicola and gallicola (Table 2).

Table 2. Rootstock varieties and clones produced by Romanian viticultural research, with a high degree of adaptability to the impact of climate change / Soiuri şi clone de portaltoi realizate de cercetarea viticolă românească, cu grad ridicat de adaptabilitate la impactul schimbărilor climatice

Varieties/ Clones	Unit	Biological resistances				
		Drought	Frost	Diseases	Phylloxera galicola	$CaCO_3$ activ (%)
Precoce	SCDVV Miniş	Good	Very good	Good	Good	20
Ruvis	ICDVV Valea Călugărească	Medium-good	Very good	Good	Medium	40
Ru 140 sel. 59 Vl	ICDVV Valea Călugărească	Very good	Very good	Very good	Medium	35
41 B sel. 6 Vl	ICDVV Valea Călugărească	Medium-good	Very good	Very good	Medium	35

These biological creations positively influence grape production and its quality in fruitful vine varieties, especially in dry years.

The influence of rootstock on the behavior of vinifera varieties under drought conditions

The drought tolerance of the vinifera varieties can be influenced in an obvious way by the rootstocks from the grafting combination, which can present a greater or lesser capacity to use the water resources of the soil, depending on the development and positioning of their root system.

Rootstock varieties are divided according to drought resistance into: sensitive (Riparia gloire); with medium resistance (Berlandieri x Riparia hybrids); resistant (41B, 1103 P, 140 Ru) (Table 3).

Table 3. Drought resistance of rootstock varieties and clones / Rezistenţa la secetă a soiurilor şi clonelor de portaltoi

High	Medium	Weak	Sensitive
140 Ru, 41 B Sel. Crăciunel 71, 333 E.M., 44-53 M	SO4, Kober 5 BB, Fercal, Sel. Crăciunel 2, Sel. Crăciunel 26, Sel. Drăgăşani 70, Precoce de Miniş, Ruvis, 125 AA	Teleki 8B	Riparia gloire, 1616 C, 3306

The graft x rootstock interaction can induce some differences that change the order above.

Knowing the architecture of the root system and the modifying factors is an important requirement in the correct elaboration of some agrotechnical measures in order to obtain high, constant and quality productions. Research in this direction was carried out at ICDVV Valea Călugărească in a stationary (reddish brown soil) with the Merlot variety grafted on a wide range of rootstocks with a different genetic provenance. Rootstocks belonging to the species Vitis riparia (R G clone 93) were used as well as Berlandieri x Riparia hybrids (8B, 5BB, 2C, SO4-4, 125 AA, 57D, 26C, 71C), Berlandieri x Rupestris (140 Ru) and Vinifera x Berlandieri (41 B).

The root system of the grafting combinations with the Merlot variety presented a differentiated distribution depending on the rootstock used in the grafting combination. Rootstocks 140 Ru and SO 4-4 showed a more uniform and deeper distribution of the root system, as well as the lowest number of necrotic roots, which suggests that these rootstocks showed better resistance to drought (Figure 1).

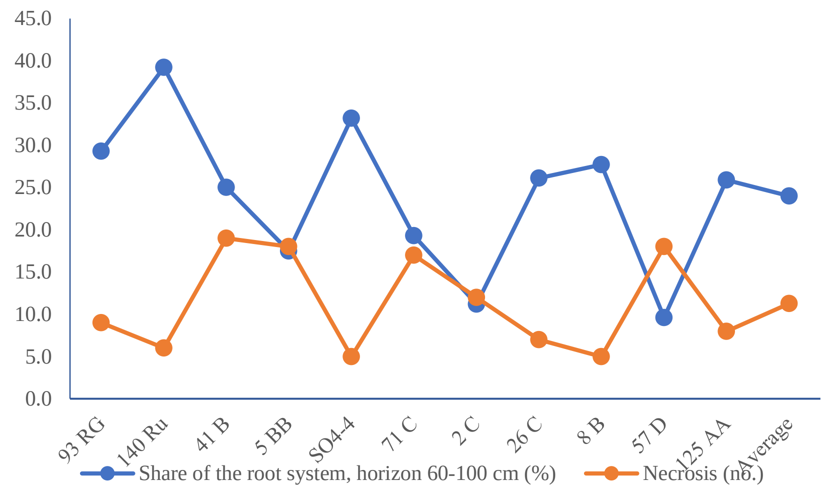

Figure 1. Graft/rootstock interaction on the development of the root system/ Interacţiunea altoi/ portaltoi asupra dezvoltării sistemului radicular

The use of different soil maintenance systems

In the context of climate change the cultivation systems are requested to be reconsidered in accordance with local conditions and the structure of cultures.

The research carried out concerning the influence of different soil maintenance systems on the behavior of some vine varieties at ICDVV Valea Călugărească, in the period 2011-2012, characterized by a deficient water regime during the vine vegetation period (especially 2012) showed as the use as a soil maintenance system of total mulching with plant residues (cereal strows) or partial mulching at intervals with marcs, have contributed to the increase in the productivity of grapevine and implicitly the production of grapes. It is found that the soil maintenance systems by mulching (total or partial) induced a higher humidity in the soil by 2-3 percent, due to the reduction of water losses from the soil through evaporation (Figure 2).

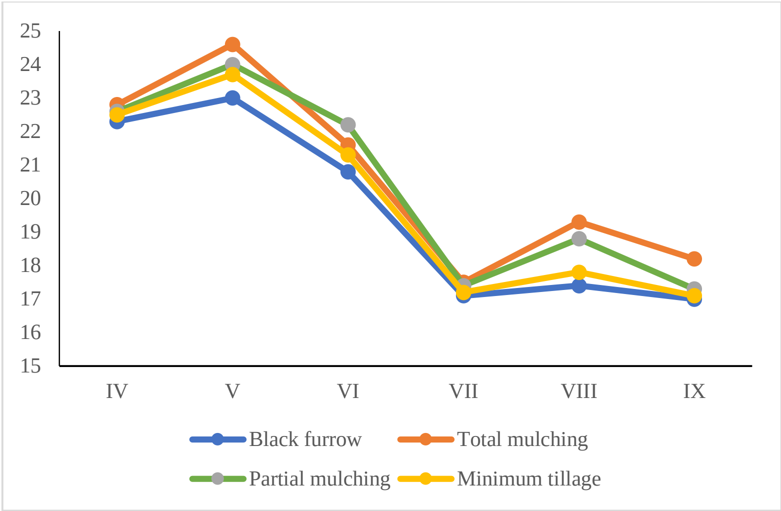

Figure 2. Dynamics of soil moisture during the growing season of vines under the influence of soil maintenance systems (average 0-100cm), (Valea Călugărească viticultural center) / Dinamica umidităţii solului în perioada de vegetaţie a viţei-de-vie sub influenţa sistemelor de intreţinere a solului (media 0 – 100cm), (centrul viticol Valea Călugărească)

A specific characteristic of the experimental period was represented by the very high temperatures recorded in the summer months both in the air, where they frequently exceeded 35ºC, and on the ground surface, where temperatures of 50ºC were frequently recorded. Also, the time interval in which these temperatures were present often exceeded 7-12 days. These changes in the wine-growing climate determined an earlier development of the vegetative phenophases, especially veraison and the ripening of grapes (by approx. 7-14 days), a fact that especially influenced the quality of the grape production. Under these conditions, the physiological and biochemical processes in the plant involved in the edification of grape production and its quality were affected, but the degree of damage was differentiated according to the soil maintenance systems tested (Figure 3).

The changes in the wine-growing climate, as well as the experienced technological solutions in order to reduce or counteract the disruptive effect of climate change, have influenced the intensity of the main physiological and biochemical processes in plant, with repercussions on the phenology of the studied varieties and on the productivity of the vines and on the quality of grape production.

In general, soil maintenance systems by mulching (total or partial) ensured the highest content of chlorophyll pigments in leaves, a higher photosynthetic activity and even a slight reduction in leaf transpiration. The reduction of fruit load by 20 and 40% determined an increase in stomatal conductance values and a reduction in the transpiration process. Regarding plant nutrition with N, P, K, no significant differences induced by the experienced agrotechnical factors were found.

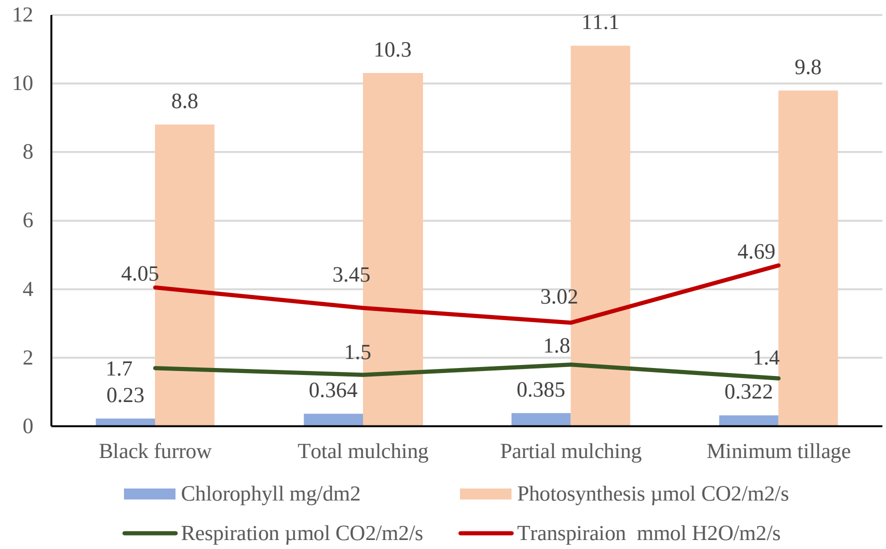

Figure 3. The influence of soil maintenance systems on the physiological processes in plant /
Influenţa sistemelor de întreţinere a solului asupra proceselor fiziologice din plantă

The experimental data obtained clearly highlight the fact that when partial mulching at intervals with marcs and total mulching with plant residues (cereal straws) were used as soil maintenance systems, the microbiological activity of the soil was much more intense than in the case of the others soil maintenance systems. Thus, the total number of viable microorganisms/g soil in the 0-30 cm horizon was 22.06 x 10^6 in the case of partial mulching and 16.83 x 10^6 in the case of total soil mulching, compared to 13.0 x 10^6 in case of soil maintenance through the minimum tillage and only 7.71 x 10^6 in case of soil maintenance as black furrow. The same tendency, less accentuated, was maintained at the depth of 30-60 cm. Also, the fungi/bacteria ratio, which is an indicator of the good functionality of the microbial activity in the soil, had higher values in case of soil maintenance by partial mulching with marcs and by total mulching with plant residues compared to its maintenance as black furrow or through the minimum tillage (Figure 4).

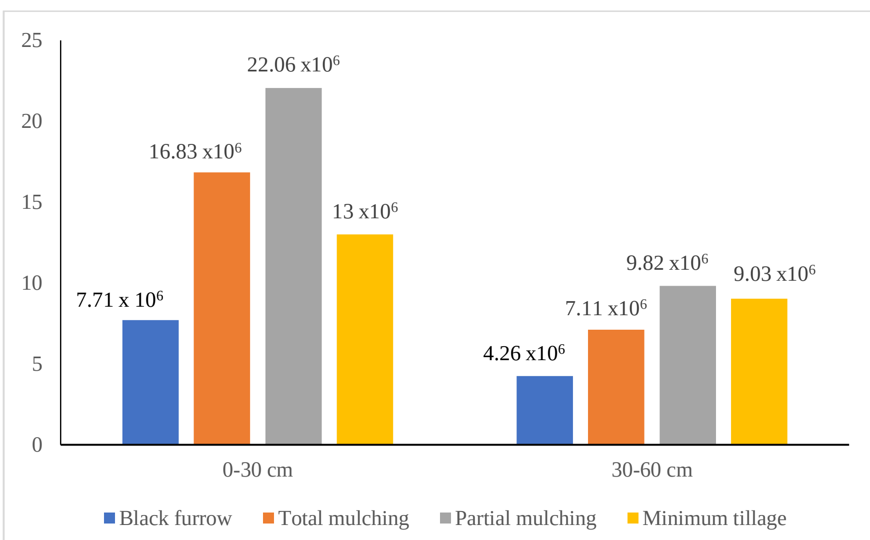

Figure 4. The influence of soil maintenance systems on the soil microbiological activity/
Influenţa sistemelor de întreţinere a solului asupra activitaţii microbiologice a solului

These results can be explained by the fact that in the case of soil maintenance by mulching, the soil humidity was higher throughout the vine vegetation period, especially in the 0-30 cm horizon, a fact that led to the creation of optimal conditions for the development of microorganisms. As part of mulching with marcs, the microorganisms in the soil also benefited from an additional supply of nutrients resulting from the decomposition of pomace, even if it was not incorporated into the soil.

The changes in the physiological and biochemical processes in the plant had an impact on the production of grapes and its quality. Thus, grape yields were higher, in the case of using soil mulching (total or partial), because these maintenance systems ensured a better conservation of water in the soil. The marcs (composted pomace) constituted at the same time an additional complex fertilizer for plants, even if it was not incorporated into the soil (Table 4).

Table 4. Influence of soil maintenance systems and fruit load on grape production/
Influenţa sistemelor de întreţinere a solului şi încărcăturii de rod asupra producţiei de struguri

Soil maintenance systems (A)	Fruit load (B)			Average (A)
	18 buds/vine (control)	15 buds/vine	12 buds/vine	
Black furrow (control)	2.424	2.160	2.108	**2.231**
Total mulching	3.663	2.898	1.817	**2.793 ****
Partial mulching	4.160	2.854	2.424	**3.146 *****
Minimum tillage	4.068	3.231	2.609	**3.303 *****
Average (B)	**3.579**	**2.786 ^{000}**	**2.239 ^{000}**	**2.868**
DL for values A P 5%= 0.37 kg/vine; P 1%= 0.56 kg/ vine; P 0.1%= 0.89 kg/ vine				
DL for values B P 5%= 0.29 kg/ vine; P 1%= 0.41 kg/ vine; P 0.1%= 0.56 kg/ vine				

Regarding the disruptive impact of climate change on the quality of grape production, it manifested itself especially on the acidity of the must, which had very low values, which made the glucoacidimetric index to take high values, well above the optimal values for a quality yield. The acidity of the must decreased slightly and in proportion to the reduction of the fruit load.

The productivity of grape vines, under the conditions of thermo-hydric stress, was positively influenced by the soil maintenance systems through mulching (total or partial), which ensured the highest grape production in all the viticultural studied centers. Decreasing the fruit load by 20 and 40% led to a decrease in grape production, but the differences compared to the control (normal load) were not always being statistically ensured.

Regarding the quality of grape production, the changes in the wine-growing climate led to an increase in the accumulation of sugars in grapes, against the background of a drastic reduction in total acidity.

The experienced technological solutions did not obviously influence the quality of the grape production. Only in case of a decrease in the fruit load, an increase in the sugar content in the grapes was recorded. However, soil maintenance systems through mulching (total or partial) have influenced the technological properties of the grapes, this fact being particularly important for winemakers. One can mention an increase of the values of the grain composition index and of the yield index, a fact that highlights that under conditions of thermal-hydric stress registered in 2012, the grapes obtained in case of using these soil maintenance systems will be richer in must, ensuring a higher efficiency of the vinification process. During the drought, the repeated works applied to the soil have an unfavorable effect because they cause an excessively increase of the non-capillary porosity values, thus favoring the faster loss of water from the soil.

Use of irrigation systems with low water consumption

Although the vine is considered a plant resistant to water stress, prolonged pedological drought can significantly affect the vegetation state of the vine and its productive capacity. In these conditions, irrigation is the only effective solution to ensure a water balance at the level of the soil and the plant, which allows an optimal development of the physiological processes in the plant. The most efficient irrigation method is the drip irrigation, with low water consumption, which ensures a higher irrigation water use coefficient, compared to the classic irrigation methods. This method is especially useful in the phenophases of intense growth of shoots, flowering, formation and growth of berries.

The research carried out at ICDVV Valea Călugărească in the period 1999-2000 (the year 2000 was considered excessively dry) demonstrated that, through irrigation with norms between 1500-2300 m^3/ha, average production increased by 17-90 % (depending on humidity conditions) and a better accumulation of sugars in grapes was highlighted. Irrigation through pipes with built-in drippers (T-TAPE) led to the best results in terms of grape production and quality (Figure 5).

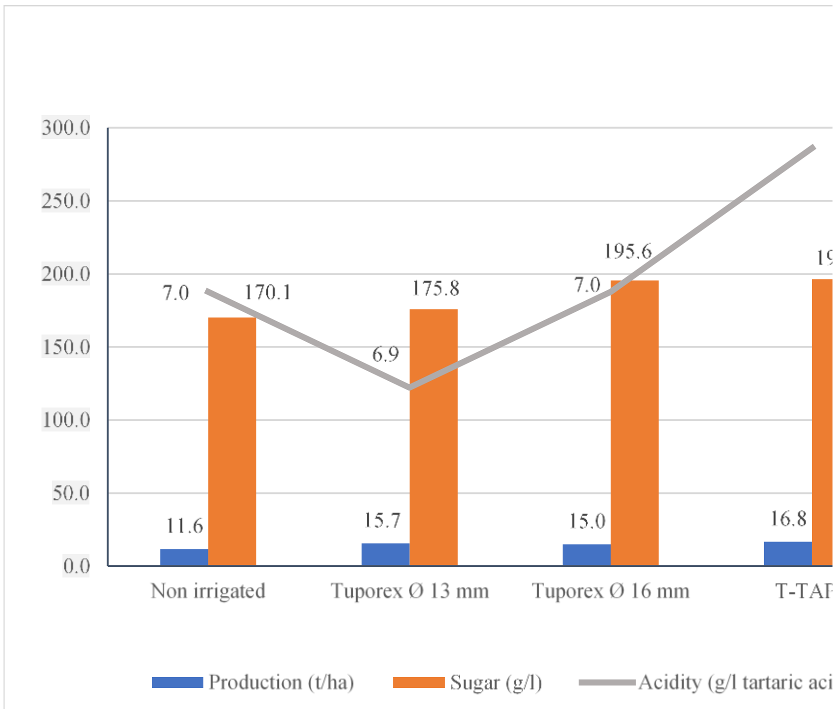

Figure 5. Influence of drip irrigation on grape production and quality /
Influenţa irigaţiei prin picurare asupra producţiei de struguri şi a calităţii acesteia

Also, in 2017, a relatively normal year concerning the hydric conditions, at ICDVV Valea Călugărească two new irrigation systems were tested: one with an above-ground drip line and one with an above-ground drip line and rain collectors placed between the vines. The collectors include a storage vessel with a cover, which ensures the reduction of the evaporation rate of the accumulated water. The geometry of the cover ensures the efficient capture of rain water and condensation, which is then slowly released to the vines, by means of a textile wicks. The experiments were carried out in an experimental plot, set up in a 4 year-old plantation with the variety Tămâioasă românească grafted on SO4-4 rootstock, under the conditions of a preluvosoil. The rainfall regime was normal until the second decade of July. Irrigation started when the soil moisture reached the ceiling of 17%, considered the minimum threshold and was stopped on August 26, even if the level of soil moisture has decreased below the minimum threshold of 17%, considering that the grapes were in the veraison phenophase.

The irrigation rate used to fill the water deficit was: 231.25 m^3/ha, in case of the variant with drip irrigation + rain collector and 360.65 m^3/ha, in case of the variant with drip irrigation. The amount of water retained in the rain collectors and slowly released to the vines was estimated at 129.4 m^3/ha.

The intensity of the processes of photosynthesis, transpiration and respiration (average values for the flowering and veraison phenophases) was higher in case of the irrigated variants (Table 5).

Table 5. The influence of irrigation systems on the intensity of the main physiological processes to the Tămâioasă românească variety (2017) / Influenţa sistemelor de irigare asupra intensităţii principalelor procese fiziologice la soiul Tămâioasă românească (2017)

Variants	Physiological processes in plant			
	Pphotosynthesis ($\mu mol\ CO_2/m^2/s$)	Transpiration ($mmol\ H_2O/m^2/s$)	Respiration ($\mu mol\ CO_2/m^2/s$)	Leaves water potential (barr)
Non irrigated	22.42	2.80	1.05	- 6.5
With above-ground drip line	24.85	4.22	2.74	- 3.3
With above-ground drip line and rain collectors	24.56	4.56	3.12	- 3.4

The water potential of leaves, determined at the beginning of September with the Scholander pressure chamber, showed values of -3.3 and -3.4 barr in case of the irrigated variants, meaning a medium water stress level and values of -6.5 barr, in case of the non-irrigated control variant, meaning a high level of water stress. Irrigation, in case of both variants, positively influenced the average weight of the grapes and implicitly the level of grape production but also the sugar content of the must (Table 6).

Table 6. The influence of irrigation systems on the production of the Tămâioasă românească variety (2017) / Influenţa sistemelor de irigare asupra producţiei de struguri la soiul Tămâioasă românească (2017)

Variants	Grape weight g	Number of grapes	Production kg/vine	Sugar g/L	Acidity g/L tartric acid
Non irrigated	168	7.0	1.177	201,0	8.5
With above-ground drip line	202	6.8	1.374*	209,0	8.1
With above-ground drip line and rain collectors	204	6.9	1.408*	209,0	8.1
			DL 5%	DL 1%	DL 0.1%
			0.18	0.25	0.31

The research carried out in the period 2019-2023 in Valea Călugărească wine-growing center, within a plantation with Chardonnay variety, followed the determination of the effect of the application of irrigation norms of: 1102 m^3/ha (2019), 1836 m^3/ha (2020), 698 m^3/ ha (2021), 2196 m^3/ha (2022) and 2225 m^3/ha (2023), which ensured a provision of water at the field capacity level.

The positive effect of irrigation was more pronounced on the production of grapes and on the average weight of a grape, a fact that ensured for the irrigated variants a production increases between 30-65% (on average) and an increases between 26-37% in case of the weight of a grape, compared to the non-irrigated control (Table 7).

Table 7. The influence of irrigation on the quantitative and qualitative production of Chardonnay variety / Influenţa irigarii asupra producţiei cantitative şi calitative de struguri la soiul Chardonnay

Years	Variants	Production t/ha	The grape weight g	Sugar g/L	Acidity g/L tartric acid
2019	Non irrigated	6.8	68.6	182.7	5.2
	Irrigated	8.8	86.4	195.5	4.9
2020	Non irrigated	5.4	72.4	194.5	5.5
	Irrigated	7.5	95.6	217.8	5.0
2021	Non irrigated	7.2	75.8	187.4	6.6
	Irrigated	10.9	101.6	219.3	6.1
2022	Non irrigated	8.0	77.2	196.7	5.5
	Irrigated	13.1	105.8	232.1	5.2
2023	Non irrigated	8.0	78.9	192.7	5.4
	Irrigated	13.2	106.5	237.0	4.9

Regarding the quality of Chardonnay grape production expressed by the sugar content and the total acidity of the must, it should be noted that in case of the irrigated variants, there were increases in the sugar content between 7.0 (2019) and 23% (2023), on the background of a relatively constant must acidity, with decreases of 5.0 (2019) and 9.0% (2023).

CONCLUSIONS

Studies were carried out on the behavior of the new varieties and clones for table and wine and also new rootstocks concerning their adaptability to the climatic change and on some agrotechnical factors that have an important impact on the water regime in soil and on the vegetative growth of vines, respectively the soil maintenance systems, fruit load and irrigation, as solutions to reduce the disruptive effect of climate change in viticulture.

With regard to the resistance of the new varieties to drought, 4 varieties with increased biological resistance, two varieties and two rootstock clones were highlighted, which are recommended for the vineyard areas where they were created or in other areas with similar climate and soil conditions. It was recomended for establishing new vineyards in the Valea Calugareasca wine-growing center, the rootstocks SO4-4 and 140Ru, for red wine varieties.

Regarding the soil maintenance systems, were highlighted the total or partial mulching, which ensured a normal development of the physiological processes, positively influencing the production of grapes and its quality.

The reduction of the fruit load caused a decrease in the production of grapes, parallel to the increase in the content of sugars in the berries and the decrease in the acidity of the must, not being recommended except in case of excessive drought conditions.

Irrigation technological solutions with reduced water consumption had positive effects on the development of physiological processes, microbiological activities of the soil, increasing grape production and quality and are recommended in wine-growing areas prone to drought.

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STAGES IN THE DEVELOPMENT OF RESEARCH IN THE FIELD OF VITICULTURE AND OENOLOGY AT VALEA CĂLUGĂREASCĂ (1950-1967)

ETAPE ÎN DEZVOLTAREA CERCETĂRILOR DIN DOMENIUL VITICULTURII ȘI VINIFICAȚIEI LA VALEA CĂLUGĂREASCĂ (1950-1967)

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Abstract
The paper presents a review of the infrastructure and research activities carried out by the Valea Călugărească Experimental Viticultural Station, in two stages, from its establishment in 1950, until 1957, under the coordination of ICAR and in the period 1958-1967 under the coordination of ICHV. Major investments were made, consisting of: modern laboratories, new experimental plantations, nursery, winemaking complex, etc., which allowed top research to be carried out and exceptional results to be obtained. The practical scientific results were the basis of the recommendations for production. The actions to promote the products obtained from the research activity, by participating in competitions, exhibitions and tastings, have contributed to increasing the research station's visibility. Through the theoretical and practical results obtained, the research station had an important contribution to the modernization of viticulture and winemaking in the Dealu Mare vineyard.

Keywords: *new experimental plantations, nursery, winemaking complex, wines*

Rezumat
Lucrarea prezintă o trecere în revistă a activităților de realizare a infrastructurii şi de cercetare, realizate de Staţiunea Experimentalã Viticolã Valea Călugărească, în două etape, de la înfiinţarea acesteia în anul 1950, până în anul 1957, sub coordonarea ICAR şi în perioada 1958-1967 sub coordonarea ICHV. Au fost realizate investiţii majore, constând în: laboratoare moderne, plantaţii experimentale noi, pepiniera, combinat de vinificaţie etc, care au permis efectuarea de cercetări de vârf şi obţinerea unor rezultate deosebite. Rezultatele ştiinţifice cu caracter practic au stat la baza recomandãrilor pentru producţie. Acţiunile de promovare a produselor obţinute din activitatea de cercetare, prin participarea la concursuri, expoziţii şi degustări efectuate, au contribuit la creşterea vizibilităţii staţiunii. Prin rezultatele teoretice şi practice obţinute, staţiunea a avut o contribuţie importantã la modernizarea viticulturii si vinificaţiei din podgoria Dealu Mare.

Cuvinte cheie: *plantaţii experimentale, pepiniera viticolă, crama, vinuri*

INTRODUCTION

We dedicate this paper to the period 1950-1967, characterized by deep transformations, by the awareness of the important role that scientific research can have in the development of the wine sector, the period that marked the beginning of the great actions taken to modernize viticulture and winemaking in the Dealu Mare vineyard.

We show our gratitude to all those who have made an important contribution to the establishment, consolidation and smooth functioning of the Experimental Viticulture Station Valea Călugărească, transformed with the dates of October 1, 1967 into the Research Institute for Viticulture and Oenology.

RESULTS AND DISCUSSIONS

1. The establishment of the patrimony of the Experimental Viticultural Station Valea Călugărească

1.1. The period 1950-1957

The Experimental Viticultural Station Valea Călugărească was created in 1950 as an experimental center in the massive Dealu Mare vineyard in the Ploiesti region for the purpose of studying various aspects related to the vine culture and wine production. This functioned as an experimental base of the Viticulture Section within the Agronomic Research Institute of Romania (I.C.A.R.), in the period 1950 – 1957.

At its establishment, the station had 3 researchers and a land area of 43 ha, from which 18.5 ha, occupied with vine plantations. The headquarters of the station was in the Crama and Conacul Matac buildings (Figure 1).

Figure 1. The headquarters of the Experimental Vineyard Station Valea Călugărească / Sediul central al Stațiunii Viticole Experimentale Valea Călugărească

In 1952, the area of the resort was completed, through merging, to 97 ha, including "a hillock, open to all exhibitions and meeting the most representative soil conditions of the vineyard".
In 1954, the station was allocated an area of 50 ha, located 4 km away, in Chiţorani, intended for the vine nursery and fodder base.

In order to establish the new wine plantations, extensive works were carried out to combat soil erosion. The anti-erosion landscaped surfaces increased from 2 ha (1953) to 17.5 ha (1956).

In order to combat soil erosion, various measures were also used: the establishment of bushes formed by the following species: cherry, blood cherry and quince and the execution of water drainage works.

Lands with slopes of up to 15-18% required, as anti-erosion measures, in addition to planting the rows in the direction of the level curves, the placement of bollards, made by plowing at the tiller or grassy strips. The grassy strips were created open spaces, with the width equal to the planting distance between the rows. However, landscaping works in the terraces were required on hills with slopes greater than 18-20%. The terraces presented a double advantage, in addition to prevent soil erosion, they offered the possibility of mechanizing the maintenance works in vineyards.

1.2. The period 1957-1967

In 1957, the Reasearch Station became part of the Horti Viticole Research Institute (ICHV). At this moment, the School of Viticulture from Valea Călugăreacă locality, with an area of 41 ha, was annexed to it.

Following the completion of the heritage, the area of the resort reached 233 ha, of which approximately 100 ha are occupied by vineyards.

The Experimental Vineyard Station operated under ICHV from 1957 until September 30, 1967.

In 1960, the station's total area was 418 ha, of which 142 ha were vineyards, which increased to 461 ha, of which 315 are vine plantations and 47 ha are fruit plantations (94% of this area, representing 295 ha, were new plantations, mostly irrigated).

The station had an ampelographic collection consisting of 189 varieties of grafted vines and 49 varieties of rootstocks.

In order to establish new vineyards, the works to combat soil erosion continued. The development of landscaped areas was increased to 82 ha (1960). It goes from the planting system with distances of 1.4 - 1.5 m between rows and 1.2 - 1.3 m per row, to 1.6 - 1.8 m between rows in order to mechanize the works.

The trellis, as a support system for vines, was used with a height of 1.7 - 2.0 m and 4 horizontal wires. In 1967, the station had an area of 1036 ha, divided into 3 bodies: Valea Călugărească (475 ha), Chiţorani (156 ha) and Pietroasa (405 ha).

All the three sections of the station had an independent irrigation system, which provided the irrigation of the surface of about 600 ha, by using sprinkler irrigation (partially, however, it could also be necessary to use the irrigation through furrows).

The systems were of modern design, consisting of buried steel pipe, working under direct pressure from the pumps in case of Chiţorani and Valea Călugărească systems and using the pressure resulting from the fall in case of Pietroasele system.

The irrigation systems from Chiţorani and Valea Călugărească used processed water from the Bucovel brook (Morilor pond), and the system from Pietroasele was based on collecting water by capturing springs and torrents in retention basins.The total water storage capacity through this system was 220,000 m^3.

The vineyard nursery from Chiţorani, with an area of 60 ha, had the possibility of complete irrigation, as a result of the major investments made: boreholes, water collection basin, pumping stations, built of brick with concrete floor and equipped with efficient pumps, network of water supply etc.

One of the first actions undertaken by the ICHV in 1958, with beneficial effects on the station, was the organization of the first national wine competition, from which an edifying picture of the quality level and potential of the Romanian wines could be formed.The success of this competition was so great that was adopted the measure to build a modern winery of 500 wagons at the Valea Călugărească Experimental Winery Station. The construction of the complex began in April 1959.

After the completion of the construction, the complex was equipped with modern equipment for grape processing and wine conditioning, with laboratory equipments (for carrying out the basic analyzes of the wines) and with installations to ensure an adequate climate (temperature and humidity) in the spaces for the aging of wines with the capacity of 100 wagons.

The project was carried out in collaboration with French oenological specialists, the endowment being made with modern equipment imported from France through the CIFAL company.

The winemaking complex had as its destination the processing of grapes and musts in different technological variants, the conditioning, storage and aging of wines and was equipped with a small bottling station.

The winemaking complex was put into operation in the fall of 1959. Through its creation winemaking in Romania entered in a new phase of continuous modernization and adaptation to winemaking practiced in countries with advanced viticulture.
The winemaking plant included the following sections: Primary processing and fermentation; Storage and conditioning of wines; Bottling; Champagne; Wines aging; Byproducts; Laboratories. The processing capacity of the complex was 1,500 t of grapes, for 20 working days. The new wines, after fermentation, were stored in vitrified metal tanks. Their total storage capacity was 10,000 hl. Aspects from the Primary Processing-Fermentation and Storage-Conditioning sections are shown in Figure 2.

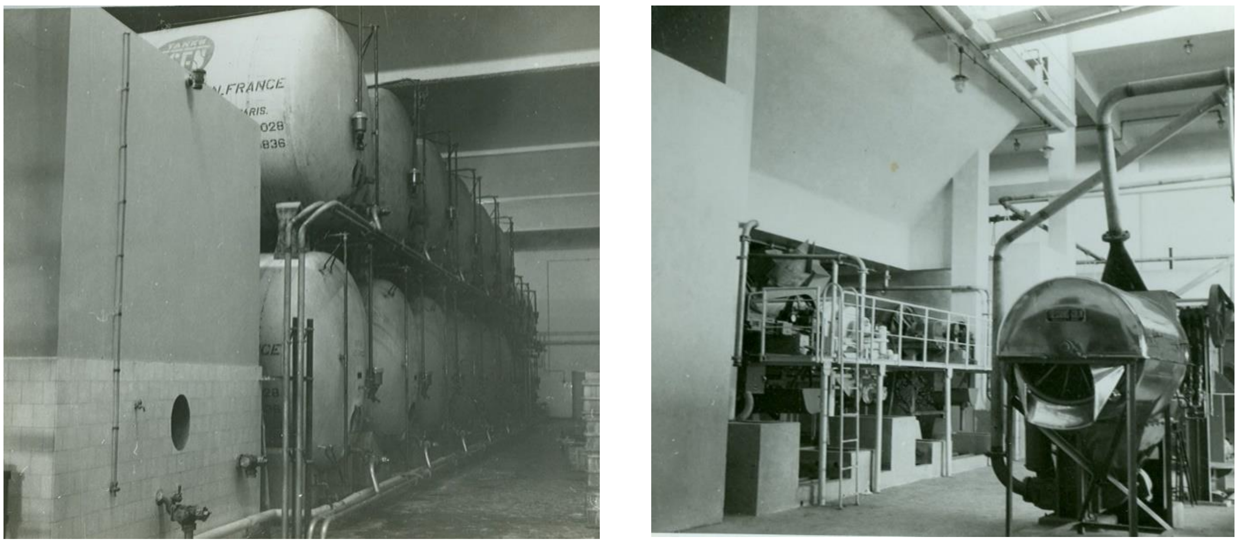

Figure 2. Aspects of the winemaking complex, equipped with modern machinery of French origin / Aspecte din complexul de vinificație, cu echipamente moderne de origine franceză

Within the Winemaking Complex, the entire quantity of grapes obtained in the research station was processed, preparing assorted wines and wines from pure varieties, highly appreciated by consumers from abroad. Of the total amount of wine produced, about 80%, wines from pure varieties were used for export.

In the period 1958-1959, a viticultural complex for grafting and forcing vines was built at the Chiţorani section of the Experimental Viticulture Station. Its production capacity was 1,500,000 grafted vines annually (Figure 3).

It was composed by the following compartments: the room for grafting and stratification of grafted cuttings (equipped with grafting machines and boxes for handling grafted cuttings), 3 rooms for forcing the cuttings, provided with a heating and humidification system, basins for moistening the eyes of grafts and rootstock cuttings for grafting, warehouse for keeping the biological material and a technological laboratory for quality control of the biological material used for grafting.

In 1964, it was built a cold storage for table grapes preservation with a total volume of 597 cubic meters, which could hold 8-10 wagons of table grapes. The storage warehouse was built with 4 isothermal compartments

The cooling plant operated with direct expansion of ammonia and had five cold-generating aerotherms with a total cooling surface of 141 m^2.

The air in the warehouse is homogenized with the help of fans placed in air heaters that generate cold. The regulation of the temperature and relative humidity of the air was done automatically. Sulphitation was done from a central station that ensured the quantitative and controllable distribution of gaseous sulfur dioxide in each room. The grapes were packed for entering the warehouse in 8-10 kg boxes. Before being introduced into the storage compartments, the table grapes were pre-cooled for about 12 hours, depending on their temperature.

Research work was carried out in 4 laboratories: Laboratory of biology and vine improvement; Laboratory of viticultural agrotechnics; Plant protection laboratory and Winemaking technology and biochemistry laboratory. Within these laboratories, 13 researchers carried out their research activity, who approached a number of 81 experiences.

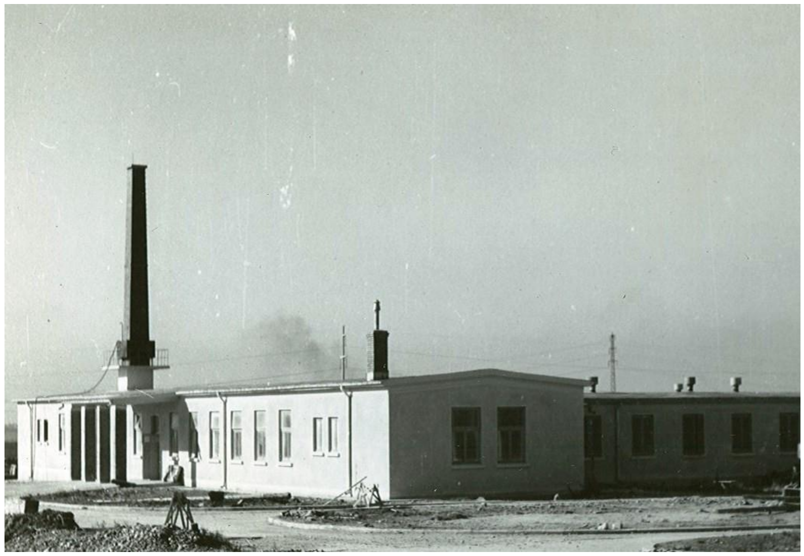

Figure 3. The grafting and forcing complex of the vine / Complexul de altoire și forțare a vițelor

For the study of the climatic conditions, observations were made with the help of the 5 own meteorological stations and the 5 mobile stations. Based on the recorded meteorological data, was created a warning system to combat downy mildew for 5600 ha of wine plantations. Aspect with the main platform of the Valea Călugărească agrometeorological station is reproduced in Figure 4.

Figure 4. View of the main platform of the Valea Călugărească agrometeorological station / Vedere a platformei principale a stației agrometeorologice a stațiunii Valea Călugărească

2. Achievements obtained in the research activity

In the field of grapevine improvement, research was carried out focused on the problem of studying the varieties of fruit-bearing vines and rootstocks from the domestic and global assortment and their improvement through the application of selection and the creation of new varieties.

The main objectives of the breeding activity were to increase the productivity and quality of the varieties and to improve their properties of resistance to diseases, pests and adverse climatic conditions.

In order to study the behavior of the old fruit-bearing vine varieties, starting from 1949, the biological material was prepared and an ampelographic collection was established with over 300 fruit-bearing vine varieties.

Sexual hybridization works were carried out, using different combinations. In 1959, a number of 7131 new hybrid seedlings were obtained, representing 96 combinations.

The behavior of the fruiting varieties found in the ampelographic collection from Bucharest was analyzed in comparison with the results obtained based on the study of 150 grafted varieties and on own roots found in the collection from Valea Călugărească. The production of grapes was much higher in the grafted varieties compared to the non-grafted ones, and the content of grapes in sugars and acidity was higher in the grafted varieties compared to the non-grafted ones.

Since 1960, the behavior of a number of 24 vinifera varieties in comparative cultures has been followed.

In the period 1963 - 1965, a study was carried out regarding the establishment of the comparative value of the table grape varieties cultivated in different ecologogeographical conditions. In this case 9 table grape varieties were studied: Perla de Csaba, Regina vilor, Cardinal, Chasselas doré, Muscat de Hamburg, Afuz-Ali, Alphonse Lavallée, Black Horn and Italia.

The researches in the field of viticultural agrotechnics has addressed a wide range of aspects with reference to the establishing and maintaining of the vine plantations. The researches were oriented to the technological solutions of an intensive type of viticulture with great economic efficiency, based on the expansion of mechanization and the use of fertilizers.

Considering the requirements imposed by mechanization and the conditions under which viticulture can be practiced, two planting distances were recommended:

- the distance of 3 m between rows (which can reach 3.40 m in some conditions) for uniform lands with slopes up to 14% and for wide terraces, with fertile soils, arranged on slopes up to 20%, both for high and low forms of vine management.
- the distance of 2.20 m between rows for land with slopes between 14-24%, arranged in terraces, for culture with semi-high or classic forms of vine management.

The vineyards where the planting distances of 3 m were adopted were more accessible to mechanization with universal tractors, and those with the distance of 2.20 m can be worked by using vineyard tractors

In the period 1953-1957, research was carried out regarding the assignment of an additional fruit load to dry cutting, with 150% (50.4 eyes per vine, distributed over 4 fruit links), 200% (59 eyes per vine, distributed over 5 fruit links) and 250% (73 eyes per vine distributed over 6 fruit links), compared to the control variant (38 eyes per vine, distributed over 3 fruit links). Based on the results obtained, it was recommended to leave 50-60 eyes/vine, respectively 255,000 - 306,000 eyes per hectare, to ensure a production of 15,000 - 17,000 kg of grapes per hectare (Băjescu şi colab., 1958- 1959).

Concerning the vine cultivation in high forms, the studies undertaken at Valea Călugărească and at the other experimental stations led to the development of a complete technology, with the indication of solutions for the establishment of plantations, the realization of management forms, the maintenance of young and fruiting plantations. In plantations with high management and large distances between rows, the cost price of grapes decreases by 8 - 36% compared to classic plantations, and the consumption of manual labor is reduced from 210 - 230 Z.O. per ha at 120 - 130 Z.O. per ha, with the possibility of decreasing to 60 - 70 Z.O. per ha by introducing mechanized harvesting and by carrying out control treatments with a helicopter.

Starting from 1962-1963, experimental plantations with tall forms were established. For this purpose, both national and foreign varieties were used, such as: Tămâaoasa românească, Fetească de Ardeal, Muscat Ottonel, Riesling italian, Cabernet Sauvignon, Merlot, Afuz-Ali, as well as valuable varieties recently introduced in the country, such as: Italy, Cardinal, Regina Puglia, Muscat d'Adda, Delizia di Vaprio, Ohanez, etc.

The preliminary results have shown that the tall forms capitalize to a great extent the production potential of the varieties and ensure significant increases in yield compared to low mixed cutting. The increase in production of the Cabernet Sauvignon variety was 31 - 83%, respectively 1,984 - 8,810 kg grapes/ha.

For the continuous increase of viticultural production and the reduction of the cost price, it was of particular interest to introduce the tall forms in vineyards that benefit from favorable pedoclimatic conditions (Popa şi colab., 1966), especially in the culture of the varieties for table grapes. The most indicated forms are the Trentino pergola, Sylvoz and Lenz Moser.

The research carried out in the field of vine nutrition aimed to establish the dosages, the periods and the way of fertilizer (organic and mineral) administration.

The first study on "extra-radicular feeding of the vine in order to establish the number of sprayings, the optimal application period and the influence of nutritional elements on the grape harvest", was carried out in the period 1957-1958. The experiment achieved using a 8-year-old Pinot gris variety, grafted on Kober 5 BB, cultivated on a reddish-brown forest soil, loamy-clay, indicated that by applying extraradicular fertilizers, a positive effect on vegetative growth was found. The increase in shoot length was higher by up to 36%, the weight of wood removed during cutting up to 950 kg/ha, the weight of 100 grains, up to 14% and the weight of grapes by 17% (Băjescu şi colab., 1958-1959).

The degree of nutrient supply of the soils on the territory of the research station was determined. They had "an average supply level in humus from 1.6 to 2.6%, from poor to medium in total nitrogen (0.60-0.12%) and medium in nitric nitrogen. They were well supplied with total phosphorus 0.15%. However, due to the neutral and slightly alkaline reaction and the high content of carbonates, phosphorus in these soils is found in the form of basic phosphates, which is reflected in the relatively low content of phosphorus easily assimilated by plants (between 2.5 and 12 mg/100 g soil).

The research carried out in the irrigation of vine plantations, aimed to establish the irrigation regime, in relation to the type of soil, relief and variety, improving the method of forecasting and warning in the application of irrigation etc.

In the years 1959-1963, experiments were made with different watering rates and fertilizer doses, to see to what extent irrigation can influence the increase in grape production. It was found that between July and September, more or less intense dry periods, 1-2 irrigations with 700-900 m^3/ha each were necessary to be applied, this period corresponding to the veraison. Taking into account the requirements of sloping lands arranged in terraces, it was used for irrigation sprinklers with a short stream and slow rain to allow water to infiltrate into the soil and not cause puddles and leaks, or to break the young organs of the vines..The effect of irrigation, supplemented with fertilizers, was highlighted in the large productions achieved year after year, whose maximum absolute values reached 18,000 - 20,000 kg of grapes/ha recorded in the irrigated variants, compared to the maximum amount of 15,000 kg of grapes/ha obtained in the non-irrigated variants. The production quality estimated by the sugar content of the must did not change through irrigation, instead the acidity increased by 10-20% more than in the non-irrigated variants, which for the Valea Călugărească vineyard, recognized by the lack of acidity of the musts, presented a special importance in terms of quality and economy. Supplementing soil moisture through irrigation intensified the physiological processes of the assimilating apparatus of the vine, which makes the plant synthesize and accumulate more reserve substances, thus increasing resistance to frost and drought (Mihalache şi Laszlo, 1966).

By using the irrigation system created in Valea Călugărească as an experimental model, it was found that there is a possibility of introducing irrigation on the terraced slope lands as well.

The research in the field of vine protection aimed at improving the forecasting and warning methods of treatments, the knowledge of the biology of the main pathogenic agents and the establishment of solutions to combat some diseases and pests that are important for the Dealul Mare vineyard. Studies have been carried out on the problem of combating downy mildew, powdery mildew, gray rot of bunches, molds that cause damage in the production of viticultural planting material, phylloxera gallicola in case of rootstocks and vine mites.

Experiments related to the preservation of table grapes were carried out in the research station starting from 1965. It was found that the preservation of grapes in cold conditions, at a temperature of 0 – 2^{o}C, by maintaining a relative humidity of 92 - 95% and by the execution of repeated sulfiting, with the use of polyethylene film packaging, allows to extend the consumption period of the grapes by 3 - 4 months. It has been established that, in addition to the characteristics of the variety, the success of conservation is largely influenced by climate conditions, soil, the location of the plantations and the health of the harvest.

In the field of winemaking, research has been directed towards solving the important problems of wine technology, chemistry and microbiology.

In a first stage, the technological properties of grapes as a raw material for winemaking were studied and the establishment of the direction of production and the types of wine that can be made in the Dealul Mare vineyard was followed.

The research undertaken during the years 1951-1959 had the aim of "specifying the optimal dates of harvesting, in relation to the types of wine required and classifying the studied varieties in ripening periods, according to the environmental conditions of the vineyard" (Taraş şi colab., 1959 – 1960).

In the new conditions created by the construction of the modern winemaking complex, a series of important problems for oenological practice were pursued and solved, with results widely disseminated in the production sector, among which one can mention:

- establishing the regime of the use of SO_2 to ensure antioxidant protection of must and wine, under the conditions of using industrial winemaking lines;
- establishing the working parameters and operating regime for the equipements used in the modern winemaking complex;
- specifying the means of increasing the extract content of white wines by applying appropriate technological procedures in the stage of primary winemaking;
- establishing the thermal regime of must fermentation for the production of white wines with superior compositional and taste-olfactory properties;
- specifying the conditions that ensure the optimal development of the maceration-fermentation process during red winemaking;
- indicating the advantages of using closed tanks with automatic recirculation (Ducellier - Isman type) for the production of quality red wines;
- highlighting the technological possibilities offered by the process of carbonic maceration and thermo-winemaking in the production of red wines.

The results of these researches were presented as a synthesis in the paper "*Scientific research in support of production*", which was primarily addressed to specialists with higher and medium training from the winemaking production units.

Increasing the internal and international visibility of the Experimental Research Station
Participation in wine and table grape competitions

The Experimental Research Station Valea Călugăreascăt has participated in numerous domestic and intern ationational wine competitions.

At the 2nd Republican Wine Competition, organized by the Superior Council of Agriculture, in February 1963 in Bucharest, the station has participated with the following samples: Riesling (1962), Clairette (1960) in the category of dry wines, red blended wine (1960), Merlot (1958, 1959 and 1960), Cabernet Sauvignon (1958 and 1960), in the dry red wine category, Fetească albă (1960), Pinot gris (1958), Riesling (1960), Sauvignon (1958) in the demisec and sweet white wines category, Fetească neagră (1960) in the demisec and sweet red wines category, demisec champagne (2 samples) in the Romanian Champagne category and Viniac (1961) in the Brandy category.

In 1958 and 1963, at the 2 republican wine competitions, the station won 24 gold medals and 10 silver medals.

Between 1959-1966, he participated in 16 international wine competitions organized in 7 countries: Austria, Bulgaria, Czechoslovakia, Yugoslavia, France, USSR, Hungary, where he won 39 gold and 20 silver medals.

The red wines of Experimental Viticultural Station Valea Călugărească have always prevailed and won well-deserved appreciation at the international competitions in which they participated in confrontation with the best wines of the world.

In the period 1964-1966, at the republican contests for table grapes, the Experimental Viticultural Station obtained 33 gold medals, 7 silver medals, 6 of the medals being obtained for grapes kept in refrigerators until January.

In the golden book of the Experimental Viticultural Station Valea Călugărească, numerous messages of admiration for the achievements and for the special wines tasted are mentioned.

During the period 1957-1967, 261 delegations were received from the country, but especially from abroad. Among the prominent foreign guests who visited the research station, one can mention: Italo Cosmo, renowned viticultural expert, professor and former director of the Experimental Institute for Viticulture and Oenology Conegliano (28.05.1964), M.R. Protin, Director General of the International Office of Vine and Wine, (19.10.1965), Professor Robert Sweet from Cornell University, Itacha, USA (11.10.1967) etc.

Following the outstanding results obtained in the period 1950-1967, as well as the need for more effective coordination of research activity at the national level, the Experimental Viticultural Station Valea Călugărească was transformed, starting October 1, 1967, into the Research Institute for Viticulture and Oenology (ICVV) Valea Călugărească, "*the first republican scientific unit that established its headquarters in the heart of the most famous vineyard in the country, managing to concentrate all its forces at its workplace since the beginning of its establishment*" as stated by Professor Gherasim Constantinescu, the first general director of the institute (1967-1969). The unit had and still has the role "*to resume the ancestral aspirations and the practice of advanced and anonymous winegrowers, accumulated over millennia and to promote viticulture and winemaking on a new level of development*".

CONCLUSIONS

In the period 1950-1967, major investments were made to develop the research activity in the field of viticulture and oenology to bring it up to international standards. The great scientific results obtained at Experimental Viticultural Station Valea Călugărească and the promotional actions have contributed to increase the visibility of the unit at national level and abroad.

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CLIMATIC CHARACTERIZATION OF THE VITICULTURAL YEAR 2023 AT SCDVV BLAJ

CARACTERIZAREA CLIMATICĂ A ANULUI VITICOL 2023 LA SCDVV BLAJ

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Abstract
This paper presents the agrometeorological peculiarities of the vintage year 2023 in Blaj viticultural center. In order to assess the potential of the agroclimatic resources available in this area, we used data recorded by the weather station located in the vineyards belonging to the Research and Development Station for Viticulture and Oenology Blaj. The climatic characterization of the year 2023 is based on the analysis of several thermal, hydric and heliothermic indicators registered between November 1, 2022 and October 31, 2023. Also, the risk factors corresponding to the growth and development processes of the grapevine were assessed. In general, the 2023 vintage was characterized as a warm year. The average annual temperature was 0.9 °C higher than the annual average temperature recorded in the reference period between 1990 and 2021. The winter period was mild, there was no risk of winter frost, the absolute minimum of -14.8 °C being recorded in February. The spring of the year2023 was slightly colder than in the reference period, with the frequency of spring frost being 16%. The summer period recorded maximum temperatures between 32.2 and 36.5 °C, in July and August, the frequency of drought exceeding 50%. Autumn was warmer than the reference period, with the first negative temperature being recorded on October 17, 2023.

Keywords: *grapevine, climatic indicators, risk factors*

Rezumat
Lucrarea prezintă particularitățile agrometeorologice ale anului viticol cuprins între 1 noiembrie 2022 și 31 octombrie 2023 și constă în analiza parametrilor meteorologici caracteristici culturii viței- de -vie din centrul viticol Blaj. În vederea evaluării potențialului resurselor agroclimatice disponibile în această zonă s-au luat în considerare datele înregistrate de stația meteo amplasată în plantațiile viticole ale Stațiunii de Cercetare-Dezvoltare pentru Viticultură și Vinificație Blaj. Pe baza indicatorilor termici, hidrici și heliotermici analizați s-a identificat frecvența apariției factorilor de risc care corespund cu parcurgerea proceselor de creștere și dezvoltare ale viței- de- vie. Anul viticol 2023 a fost unul călduros, temperatura medie anuală fiind cu 0.9 °C mai ridicată decât media anuală de referință calculată pe perioada 1990-2021. Temperaturile din perioada de iarnă au fost destul de ridicate cu o minimă absolută de -14.8 °C, înregistrată în luna februarie, neexistând riscul înghețului de iarnă. Primăvara anului 2023 a fost ușor mai rece decât în perioada de referință, frecvența de apariției înghețului de primăvară fiind de 16%. Perioada estivală a înregistrat temperaturi maxime cuprinse între 32.2 și 36.5 °C, în lunile iulie și august, frecvența apariției secetei depășind 50%. Toamna a fost mai călduroasă decât cea din perioada de referință, primele temperaturi negative înregistrându-se pe 17 octombrie 2023.

Cuvinte cheie: *viță-de-vie, indicatori climatici, factori de risc*

INTRODUCTION

Blaj viticultural center, located at the intersection of the geographic coordinates 46°11` north latitude and 23°55` east longitude, is one of the five viticultural centers of the prestigious Târnave vineyard, known and appreciated for its quality wines with specific flavor and a good sugar/acidity balance. Viticulture has been practiced here since antiquity, perpetuating and developing ever since the migration of people during the feudal period up to now (Chedea et al., 2021).

Climate is an essential part of the terroir system. Climatic conditions play a decisive role on the cultivation of grapevine from the geographical suitability to the effects on yield and quality. Over time, various climate parameters were used to delimit the boundaries of wine regions and to develop legal frameworks that are still present in the current definition of wine regions across the European Union (Schultz & Jones, 2010). The knowledge and rational use of the climatic conditions is an imperative requirement for the distribution, specialization and efficient organization of grapevine production. Individual climate factors affecting grape growth, production, and wine quality include solar radiation, average temperatures, extreme temperatures (including winter freezes, spring and fall frosts, and summer heat stress), heat accumulation, ripening period temperatures, wind, precipitation, humidity, and soil water balance characteristics (Jones, 2018).

Solar radiation is the main source of energy received by the soil surface and grapevines use both the caloric energy and the light energy of it (Ropan et al., 2023; Țârdea & Dejeu, 1995). Throughout the growth stages of the grapevine, the amount of insolation is important for maintaining the proper levels of photosynthesis (Mullins et al., 1992).

Higher values of solar radiation accelerate the process of budbreak, flowering and ripening of the grapes. Also, higher levels of insolation may extend the vegetation period, having a positive influence on the maturation of the wood and the winter hardiness of the vines (Ropan et al., 2023).

The most critical stages are during the development of the berries, starting at bloom and continuing through the harvest. During bloom, high amounts of insolation result in effective plant tissue differentiation into flowers. Low levels of insolation during the blooming phenophase can lead to the failure of grapes to develop after flowering and can also reduce fertility for the next season by impacting the differentiation of inflorescence primordia in the buds (Jones, 2018). During the ripening phenophase, insolation contributes to the anthocyanin development, and the amount of sugar in the grapes, thus influencing the wine's potential alcohol content (Jones & Davis, 2000; Jones, 2018). A decrease in global radiation can reduce the concentration in sugars and increase the total acidity (Ropan et al., 2023).

Air temperature is a critical aspect of viticulture influencing the varietal adaptation to specific regions or sites and also because of the major influence on the growth stages, grape ripening and fruit quality (Țârdea & Dejeu 1995; Jerzy, 2008; Schultz & Jones, 2010; Ropan et al., 2023). Although grapevine varieties are cultivated in numerous climates worldwide, they ultimately have relatively narrow climate zones for optimum growth, productivity and quality (Mosedale et al., 2016; Jones, 2018). Early maturing varieties perform better in cool climates with relatively short growing seasons, while later maturing varieties require warmer and longer growing seasons. Varieties that are best suited to a cool climate tend to produce wines having a lower alcohol content, crisp acidity, a lighter body, and typically bright fruit flavors. In contrast, those from hot climates tend to have a higher alcohol content, soft acidity, a fuller body, and more dark or lush fruit flavors (Jones, 2018).

Grapevine is a relatively demanding plant in terms of heat. It is cultivated in areas with an average annual temperature higher than 9 ˚C, quality products being obtained when it exceeds 10 ˚C. The general thermal environment for grapevines has numerous influences, which can be positive or detrimental, depending on the timing of plant growth. Negative influences typically come from extremes but can also come from prolonged periods of average temperatures that are below normal during growth stages such as bloom. Positive influences include prolonged temperatures above 10 ˚C that can initiate plant growth in the spring and temperatures that influence overall heat accumulation, which can drive ripening potential (Jones, 2018).

The average temperature of the warmest month (July or August) with values that exceed 17-18 ˚C, indicates the existence of favorable conditions for the production of white wines for current consumption and sparkling wines. At values above 19 ˚C superior quality wines may be obtained, and above 21 ˚C superior quality wines with designation of origin. The success of the cultivation of late-ripening table grape varieties is ensured when the average temperature in the warmest month exceeds 22 ˚C (Țârdea & Dejeu, 1995). A temperature of 25-30 ˚C is considered optimal for the activity of photosynthesis. Levels below 6 ˚C and above 40 ˚C determine the stagnation of the photosynthesis process. Also, the optimal temperature for the blooming phenophase is 20-25 ˚C, levels below 15 ˚C leading to the failure of grapes to develop after flowering (Țârdea & Dejeu, 1995).

During late summer and early autumn, big differences between daytime and nighttime temperatures contribute to increased sugar and tannin production in the grapes (Ristic et al., 2007). Lower autumn temperatures, allow a better balance of sugar and acidity, as well as an increase in flavour and aroma constituents in the grapes (Ramos & Martínez de Toda, 2020). During winter months, minimum temperature thresholds are important: temperatures below -20 ˚C can cause injury to most *V. vinifera* cultivars, and temperatures below -12 ˚C before mid November can result in freeze damage, particularly to the primary buds. Severe damage can occur at temperatures below -25 ˚C (Colibaba et al., 2024). Effective chilling units (cold temperatures) are necessary for uniform budbreak. Grapevine hardiness increases through the winter and temperatures below -9 ˚C in late November and early December can increase grape production by preventing grapevine deacclimation (Colibaba et al., 2024). At the other end of the spectrum of temperature, prolonged periods of higher than 35 ˚C can induce heat stress of the grapevine and lead to premature véraison, a possible abscising of the berries, partial or total failure of flavor ripening (Jones, 2018; Mullins et al., 1992).

Factors such as ambient atmospheric moisture (humidity), local rainfall rate, duration, frequency and timing, soil water holding capacity, and evapotranspiration rates are all important aspects for the growth and productive balance of grapevines, fruit quality, fruit yield, and disease pressure (Jones 2018).

Atmospheric humidity is very important in regulating the evaporative demands put on the grapevines and the occurrence of fungal diseases (Comșa et al., 2022; Jones, 2018). Over the course of the season, relative humidity is lowest during the summer and highest during the winter registering higher values in the morning, when temperatures are lower, and lower levels during the maximum heating of the day. In extreme cases, water stress resulting from low relative humidity can lead to leaf loss, severe reductions in vine metabolism, and fruit damage or loss (Jones, 2018; Mullins et al., 1992). Even moderate periods of moisture stress can substantially reduce the relative level of photosynthesis, resulting in lower fruit yields and quality (Jones, 2018; Jones & Davis, 2000). High levels of atmospheric humidity allow various fungal problems to develop (Jones, 2018).

The occurrence of rain during critical growth stages can lead to devastating effects. Although ample precipitation during the early vegetative stage is beneficial to initial growth, during blooming it can reduce or retard flowering; during berries development it can enhance the occurrence of fungal diseases; and during maturation it can increase the fungus occurrence and growth, and also severely limit the yield and quality (Jones, 2018; Mullins et al., 1992).

Extreme meteorological events, such as thunderstorms and hail, are highly detrimental to the grapevine cultivation. Both events can severely damage the leaves, tendrils, and berries during growth and if they occur during maturation can split the grapes, causing oxidation, premature fermentation, and a severe reduction in volume and quality of the yield (Jones, 2018; Mira de Orduña, 2010).

Recent changes in the climate have significant implications for the grapevine growth and wine composition (Schultz & Jones, 2010). A better understanding of what grapevine cultivars and wines are produced, where and how could be beneficial for the viticulture in the future. This paper presents the agrometeorological peculiarities of the vintage year 2023 in Blaj viticultural center in order to assess the potential of the agroclimatic resources available in this area.

MATERIALS AND METHODS

The study was focused on establishing the agrometeorological peculiarities of the vintage year 2023 in close link to the developmental stages (phenophases) of the grapevine. The monitoring of the climate factors with major impact on grapevine cultivation was carried out by recording and processing the daily climate data between the period November 1, 2022 and October 31, 2023. The weather data were recorded by a Adcon telemetry GmbH weather station, from the grapevine plantation located within the premises of the Research Station for Viticulture and Oenology Blaj, at the following coordinates 46º 17' 27.85" Northen latitude and 23º 93' 38.33" Est longitude.

The basic evaluation of the thermal resources was made by analyzing thermic indicators such as monthly average temperatures, monthly absolute maximum temperatures, monthly absolute minimum temperatures and the global, active and useful thermal balance from the growing season. The global thermal balance **(∑t°G)** represents the sum of the average daily temperatures from the vegetation period. The active thermal balance **(∑t°A)** represents the sum of the average daily temperatures higher than 10 ˚C. The useful thermal balance **(∑t°U)** represents the sum of the difference between daily average temperatures higher than 10 ˚C and the biological threshold for starting grapevine vegetation (10 ˚C) (Oșlobeanu et al., 1991; Țârdea & Dejeu, 1995; Răcoare et al., 2022). Based on the daily temperature records, the frequency of risk factors such as frost and drought were also assessed.

Monthly precipitations regimes and monthly relative humidity were used as hydric indicators for the evaluation of the hydric resources and the monthly sunlight hours was used as indicator for the heliothermic resources.

All the analyzed parameters were compared with the multiannual values from the reference period between 1990-2021.

RESULTS AND DISCUSSIONS

The viticultural year 2023 starts in November 2022 after the leaf fall of the 2022 vintage when the grapevine enters dormancy period. As a last month of autumn, November 2022 was a mild one, generally favorable for the vernalization process of the grapevines. Minimum temperatures ranged between -3.61 and 7.29 ˚C, maximum temperatures ranged between 2.85 and 18.10 ˚C which led to a monthly average temperature of 5.7 ˚C, slightly warmer than the reference period. November 2022 was characterized by higher levels of relative humidity and precipitations than usually and the fourteen days of rain have significantly reduced the sunlight hours (Table 1).

The 2022-2023 winter season was characterized by a higher than normal air temperature regime. In the first part of February 2023, cold weather prevailed. The absolute minimum winter temperature was -14.8 ˚C (recorded in February) therefore no winter frost risk was recorded for the viticultural year 2023 (Table 1 and Table 2). The absolute maximum winter temperature was 15.6 ˚C and it was recorded in December 2022. No negative monthly average temperatures were recorded for the winter season of the 2023 viticultural year in Blaj vineyards. Higher amounts of precipitations were recorded in January, but higher relative humidity was recorded for December 2022. Low levels of sunlight were recorded in December 2022 and January 2023 (Tabel 1). Under these agrometeorological conditions, the specific maintenance works corresponding to the dormant stage, took place in good conditions, excepting the days with precipitation.

In the spring season of 2023, there was an alternation of thermally normal days, with periods when the weather was colder than usual. Absolute minimum temperatures ranged between -6.8 and 4.0 ˚C, a 16% frequency of spring frost being registered in March (Table 1 and Table 2). The absolute maximum temperature reached 27.5 ˚C, recorded in May. March was warmer that the refence period, the monthly average temperatures exciding the monthly average temperature of the reference period meanwhile April and May registered lower monthly average temperatures that the reference period (Table 1). Atmospheric instability was accentuated and manifested mostly by light rains but heavy rains were also recorded accompanied by electrical discharges and wind intensifications. Significantly higher amounts of precipitations, than the reference period, were recorded in April meanwhile significantly lower amounts of precipitations were recorded in May 2023 than the average amounts of precipitations from the May months of the reference period (Table 1). Lower levels than the reference period of relative humidity were recorded throughout the whole spring season. However, more hours of sunlight were registered in the spring of 2023 than in the springs of the reference period.

Table 1. Climatic conditions of the viticultural year 2023 recorded at SCDVV Blaj //
Condiții climatice ale anului viticol 2023 înregistrate la SCDVV Blaj

Month / Climatic Parameter		Nov. 2022	Dec. 2022	Jan. 2023	Feb. 2023	Mar. 2023	Apr. 2023	May 2023	Jun. 2023	Jul. 2023	Aug. 2023	Sept. 2023	Oct. 2023	Total
Temperature [°C]	Monthly Average	5.7	2.3	3.3	1.1	6.9	9.1	15.8	19.2	21.9	21.9	18.5	12.8	**11.5**
	Reference	4.7	-0.3	-1.6	0.9	5.5	11.2	16.0	19.6	21.2	21.0	16.0	10.7	10.4
	Absolute Maximum	18.1	15.6	14.7	14.3	22.3	21.3	27.5	32.2	34.5	36.5	31.1	29.7	**36.5**
	Absolute Minimum	-3.6	-9.3	-4.7	-14.8	-6.8	-1.4	4.0	9.7	8.1	9.1	7.3	-1.9	**-14.8**
∑t°G [°C]	Registered value	-	-	-	-	-	198.7	490.0	575.8	680.2	679.2	553.6	397.9	**3649.2**
	Reference	-	-	-	-	-	301.7	486.1	586.4	654.8	652.5	487.1	284.6	3453.1
∑t°A [°C]	Registered value	-	-	-	-	-	164.8	490.0	575.8	680.2	679.2	553.6	363.6	**3517.5**
	Reference	-	-	-	-	-	240.6	478.7	587.4	659.1	651.7	469.8	224.4	3311.6
∑t°U [°C]	Registered value	-	-	-	-	-	24.8	180.0	275.8	370.2	369.2	253.6	103.6	**1577.5**
	Reference	-	-	-	-	-	64.0	183.7	287.1	345.9	345.0	180.5	57.7	1463.8
Precipitations [mm]	Registered value	58.6	18.2	41.6	39.2	27.4	75.4	34.8	93.4	72.4	68.6	27.6	13.0	**570.2**
	Reference	35.9	33.9	24.3	22.2	29.3	52.8	76.3	97.4	88.3	60.9	54.2	45.6	621.1
	Difference	22.7	-15.7	17.3	17.0	-1.9	22.6	-41.5	-4.0	-15.9	7.7	-26.6	-32.6	**-50.9**
	Days with >1 mm/m^2	9	5	11	8	5	9	6	10	10	6	6	3	**88**
	Days with >5 mm/m^2	3	0	2	2	2	6	2	6	4	5	1	1	**34**
	Days with>10mm/m^2	2	0	0	1	1	4	1	5	3	2	1	0	**20**
RH [%]	Registered value	93.9	91.2	89.2	80.7	67.2	73.7	66.9	79.6	76.2	74	76	74.5	**78.6**
	Reference	88.3	92.7	91.0	86.6	79.9	76.9	77.1	79	79.8	80.5	82.6	84.4	83.2
Sunlight [hours]	Registered value	39	41	30	109	203	207	264	268	298	277	249	152	**2137**
	Reference	109	52	62	100	159	189	229	250	264	241	173	143	**1971**

Table 2. Risk factors frequency in the viticultural year 2023 recorded at SCDVV Blaj //
Frecvența apariției factorilor de risc în anul viticol 2023 la SCDVV Blaj

Risk/stress factor	Critical level	Month	Days with critical levels/month	Risk factor frequency (%)
Winter frost	Minimum temperature < **-15°C**	December	0	0
		January	0	0
		February	0	0
Late spring frost	Minimum temperature < **-2°C**	March	5	16
		April	0	0
		May	0	0
Drought	Maximum temperature > **30°C**	June	3	10
		July	18	58
		August	17	55
		September	3	10

The beginning of the grapevine vegetation period, at SCDVV Blaj in 2023, was recorded in April 13th. Less thermal resources were available for grapevine bud burst in 2023 than the average thermal resources from the reference period, all of the thermal balances, calculated for this period (the rest of April 2023), being significantly smaller. In May, however, the thermal resources were slightly more abundant than those of the reference period (Table 1). By the end of April all of the grapevine cultivars have passed through the bud development stage, the BBCH 05-09 being recorded from April 18th to April 28. By the end of May, all the grapevine cultivars from SCDVV Blaj have gone through the leaf development stage, shoot growth, inflorescence emerge and development (Table 3.) in good and normal conditions without negative meteorological interferences. Also, in the days with no precipitations, the meteorological conditions were generally favorable for fertilization, application of herbicides, weeding and other phytosanitary treatments.

Table 3. The unfolding of the grapevine phenophases at SCDVV Blaj in 2023 //
Desfășurarea fenofazelor viței de vie la SCDVV Blaj în anul 2023

Crt. No.	Developmental stage BBCH scale	Viticultural year 2023
1	*Beginning of bud swelling* **01**	April 13th
2	*Bud development* **05-09**	April 18th - April 28th
3	*Leaf development* **10-15**	May 2nd - May 10th
4	*Inflorescence emerges* **51-57**	May 10th - May 29th
5	*Flowering* **65**	June 6th- June 20th
6	*Fruit development* **71-79**	June 20th – July 13th
7	*Veraison* **81-85**	August 20th - August 23rd
8	*Harvest* **89**	September 15th – October 10th
9	*Senescence* **91** **93-97**	October 10th - October 17th October 17th – November 1st

The summer of 2023 was quite normal at SCDVV Blaj. The monthly average temperatures ranged between 19.2 ˚C and 21.9 ˚C. As showed in Table 1, we had a slightly colder June and slightly warmer July and August, compared to the reference period of 1990-2021. The absolute minimum temperatures ranged between 8.1 ˚C and 9.7 ˚C and the absolute maximum temperatures ranged between 32.2 ˚C and 36.5 ˚C. July and August registered a more than 50 % frequency of drought, eighteen day of July and seventeen days of August recording temperatures greater than 30 ˚C. Even so, no pedological drought was recorded in the grapevine plantation at SCDVV Blaj for the viticultural year 2023. Optimal thermal resources were available during the whole summer season for a normal development of the grapevines, slightly lower values of the useful thermal balance than the reference period were noticed in June and slightly higher values were recorded in July and August.

Regarding the precipitations regime, June was the rainiest month of the season and of the whole year, 21 days being rainy days. At SCDVV Blaj, significantly higher amounts of precipitations than the reference period were recorded in June 2023. Heavy rains along with lower temperatures were recorded during the flowering phenophase and that lead to an abnormal fruit set for most of the cultivars. In July and August at SCDVV Blaj, optimum amounts of precipitations were registered.

The heliothermic resources of the summer season of 2023 were more abundant than the ones from the reference period. The most hours of sunlight were recorded in July and August during the development and ripening of the grapes which lead to optimal sugar levels and normal aroma development for all the cultivars from SCDVV Blaj.

Generally, the fall of 2023 was a mild one, characterized by higher thermal resources than in the reference period, lower amount of precipitations and relative humidity, and higher heliothermic resources (Table 1). At the beginning of September 2023 there was a hail event recorded at SCDVV Blaj, which could compromise the harvest by splitting the grapes, causing oxidation, premature fermentation, and a severe reduction in volume and quality of the yield. Appropriate treatment was administrated the next day so no significant damage was registered. The maturation of the grapes took place under optimal conditions and the harvest began at September 15 th, after complete ripening. The harvest of 2023 was a good one, higher production than normal was achieved, the grapes kept an optimal sugar acidity balance and high quality white wines were obtained.

Figure 1. Aspects regarding the 2023 harvest at SCDVV Blaj // Aspecte privind recolta anului 2023 la SCDVV Blaj

The vegetation period has ended in October 17th (Tabel 2), when the first negative temperatures were recorded. The absolute minimum temperature of -1.88 ˚C was recorded in October 18th (Tabel 1) and just 4 days recorded significant amount of precipitations, therefore the autumn agricultural works were carried out in good conditions.

Overall, in the Blaj viticultural center, a reduction of the amplitude between the maximum and minimum temperatures was observed for the viticultural year 2023 compared to the reference period between 1990 and 2021 (Figure 2). Also, higher average temperatures were observed during the grapevine dormancy period (Figure 2). The average temperature of the whole 2023 viticultural year was 0.9 ˚C higher than the reference period, the maximum temperature of 36.5 ˚C was recorded in August and the minimum of -14.8 ˚C was recorded in February.

The thermal resources available during the viticultural year 2023 excided the ones available in the reference period. The global thermal balance reached 3649.2 ˚C, the active thermal balance reached 3517.5 ˚C and the useful thermal balance reached 1577.5 ˚C (Table 1), all being quite high, characteristic for warm years in this area.

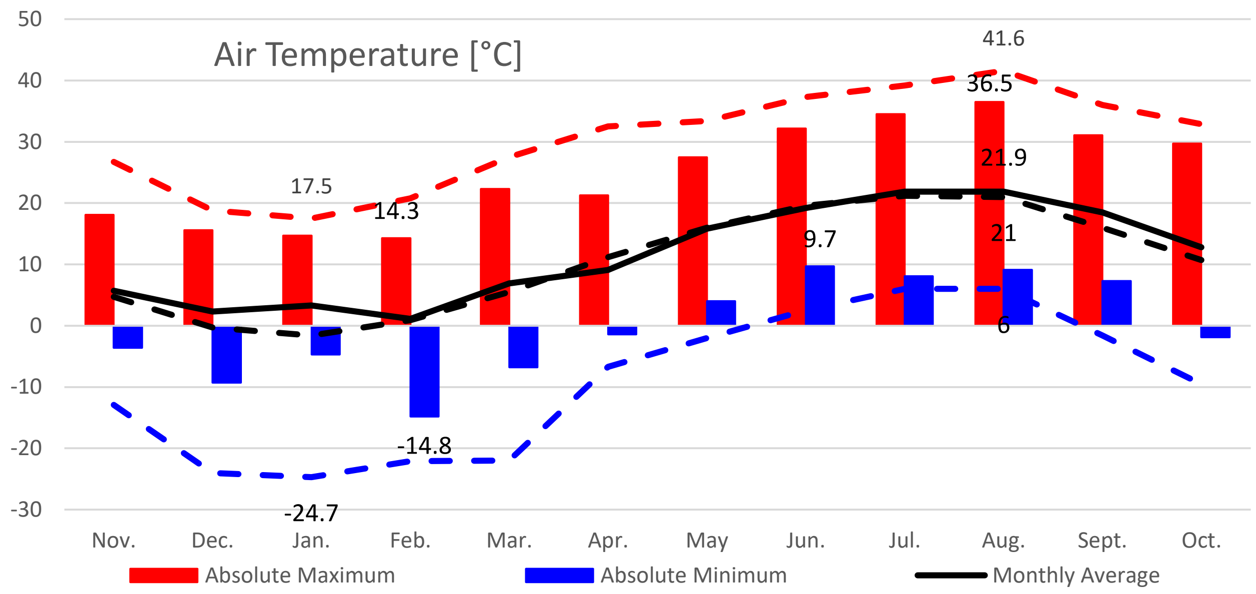

Figure 2. Graphical representation of the air temperatures recorded at SCDVV Blaj grapevine plantation // Reprezentare graphică a temperaturilor înregistrate în plantațiile viticole ale SCDVV Blaj

The whole viticultural year 2023 summed up 570.2 mm of precipitations, of which 385.2 were registered during the vegetation period. A deficit of 50.9 mm precipitations was noted during 2023 vintage compared to the reference period (Figure 3). In all of the studied months, most days recorded light rain. Most of the heavy rains occurred in June during the flowering phenophase and in the month of high demands (July and August). This amount covered the grapevines necessities. At SCDVV Blaj during the viticultural year 2023 we did not registered pedological drought.

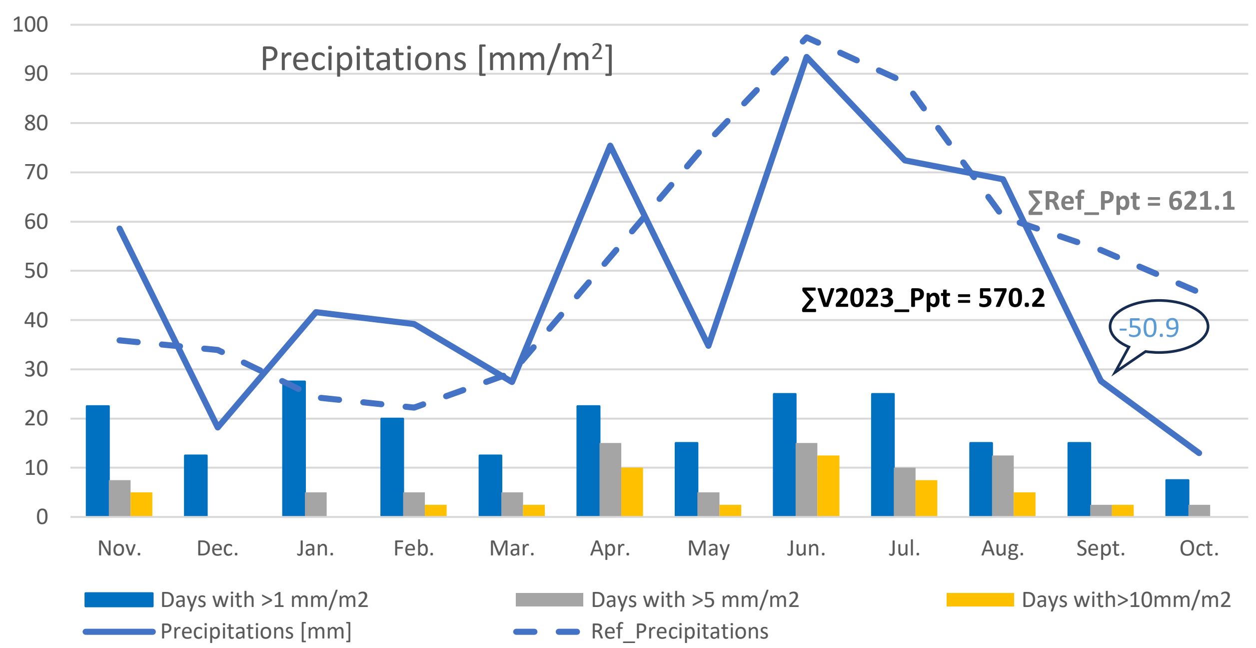

Figure 3. Graphical representation of the pluviometric regime recorded at SCDVV Blaj grapevine plantation // Reprezentare grafică a regimului pluviometric înregistrat în plantațiile viticole ale SCDVV Blaj

Also, throughout the viticultural year 2023 the relative humidity levels were lower than the reference period, registering an annual average of 78.6 % (Tabel 1). At the same time more hours of sunlight (2137) were recorded over the viticultural year 2023, compared to 1971, durig the reference period.

Similar results regarding the annual climatic conditions are reported in literature by Zaldea et al., (2022), Răcoare et al., (2022), Chedea et al., (2021); Iliescu et al., (2019) for Târnave vineyard area.

CONCLUSIONS

Grape varieties are grown in ideal ecological conditions in their areas with ,,Denomination of Controlled Origin" (DOC), conditions highlighted by a complex sum of optimal soil, terrain and climate features, all combined to produce the best growing conditions for high vintage quality (Colibaba et al., 2024). The values of the main climatic elements recorded in the viticultural year 2023 at SCDVV Blaj indicate the existence of such favorable conditions for most of the grapevine cultivars, especially for the white and rose ones.

The period of active vegetation in 2023, at SCDVV Blaj, summed up, 187 days, in which 3517 ˚C of active temperature, 1577.5 ˚C of useful temperature, 2137 hours of effective insolation and 385.2 mm of precipitation were achieved. Climatic changes are obvious at SCDVV Blaj. When compared to the reference period (1990-2021), an increase by 0.9 ˚C of the average annual temperature was observed. Lower levels of maximum temperatures were noted in all of the studied months at the same time with higher levels of minimum temperatures. Also, an increase of the thermal resources of almost 300˚C along with an increase of the heliothermic resources was observed for the vegetation period. There are also recorded decreases in precipitations (-50.9 mm/m^2) alongside with lower levels of relative humidity. These changes may lead to some differences regarding the progression of the grapevine phenophases.

The 2022-2023 winter season was characterized by a higher than normal air temperature regime. The coldest weather prevailed in the first part of February 2023. No winter frost risk was recorded for the viticultural year 2023 at SCDVV Blaj. In the spring season of 2023, there was an alternation of thermally normal days, with periods when the weather was colder than usual. No monthly average negative temperatures were registered for the winter or spring seasons of the viticultural year 2023 but five days of minimum negative temperatures below -2 ˚C were registered in March, therefore a 16% risk of late spring frost was noted. June was a cold and rainy month. July and August registered more than 58% and 55% risk of drought, more than half of the days recording temperatures higher than 30 ˚C. The soil water supply was ensured by the amount of precipitations fallen in this period, so no pedological drought was noted. The fall of 2023 was a mild one, characterized by higher thermal resources than in the reference period, lower amount of precipitations and relative humidity, and higher heliothermic resources. One extreme climatic event occurred in September 3rd, a hail event at Crăciunelu de Jos, but no significant damage was recorded because of the prompt treatment intervention and careful monitorization of the grapevine plantation.

Under this climatic conditions and resources, the harvest of 2023 at SCDVV Blaj was a good one. In the viticultural year 2023 was achieved a higher production than normal, the grapes kept an optimal sugar acidity balance and high quality white wines were obtained.

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PRUNING AND TECHNOLOGICAL INTERVENTIONS IN GREEN IN THE VINEYARDS, PRIORITY IN FIGHTING FUNGAL DISEASES

TĂIERILE DE RODIRE ȘI INTERVENȚIILE TEHNOLOGICE ÎN VERDE LA VIȚA DE VIE, PRIORITATE ÎN COMBATEREA BOLILOR FUNGICE

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Abstract
Organic viticulture, promoting integrated cultural techniques, offers the possibility of obtaining, in established vineyards, harvests of high-quality grapes intended for producing excellent wines. With the major influence of ecological factors, climate and soil, on the quantity and quality of grape and wine production. The basic technological interventions - the load of buds left at the bud pruning, summer works (weeding, leaf pruning and growing tip removing), induce economic effects by reducing the number of treatments for fungal diseases of vines during the vegetation. Addressing also economic and quality engineering aspects, the research has been conducted between 2019-2022 in the Miniș-Măderat vineyard, with the aim of establishing the above-mentioned technological solution.

Key words: *viticulture, green works, fungal diseases, grapes quality*

Rezumat
Viticultura ecologică promovând tehnici culturale specifice, oferă posibilitatea obținerii în podgoriile consacrate, a recoltelor de struguri de calitate superioară destinate producerii vinurilor DOC. Pe fondul influenței majore exercitată de factorii ecologici, climă și sol, asupra cantității și calității producției de struguri și vinuri de calitate, intervențiile tehnologice de bază – încărcătura de ochi lăsată la tăierea de rodire, lucrările în verde (plivit, desfrunzit și cârnit), induc efecte economice. Aceste efecte se răsfrâng asupra reducerii numărului de tratamente pentru bolile fungice ale viței de vie în perioada de vegetație. Abordând și aspecte de inginerie economică și de calitate, cercetările au fost efectuate în perioada 2019-2022 în Podgoria Miniș-Măderat, având ca obiectiv testarea soluției tehnologice amintită mai sus.

Cuvinte cheie: *viticultura, boli fungice, struguri*

INTRODUCTION

Due to the diversity of soil and climatic conditions in which vines are grown, as well as the biological characteristics of the different varieties, it is not possible to develop a universally valid cultivation technology for this plant.

Organic viticulture, using specific cultivation techniques, makes it possible in the Miniș - Măderat vineyards to produce high-quality grapes and wines. The new, balanced technologies, aim to integrate chemical and mechanical means without negative consequences, while enhancing the role of biotechnologies (Dejeu, 1997).

Cultivation technologies must be applied differently, depending on the cultivated variety, the ecological conditions of each wine-growing area, the specific climatic conditions of each year, taking into account the destination of production, financial possibilities, the logistics of each wine-growing holding and the principles of organic viticulture, so that the negative impact on the environment and on wine products is minimized. In recent years, in addition to the already known factors (climatic disturbances, increased inputs, soil and variety), cultivation technologies have had to take account of a new problem, at least for Romania - the lack of labour and, consequently, the increase in labour costs. In the new socio-economic context, the only way to make cultivation technologies more efficient is to increase mechanization. At the same time, it is imperative that new technological models in viticulture should aim to reduce the fertilization and stopping the deterioration of the soil's physico-chemical properties. (Dobrei, 2024).

Given the major influence that genetic (variety/rootstock) and ecological (climate, soil) factors have on the quantity and quality of grape and wine production, the basic technological interventions - bud load and pruning type, mechanical green work, the number of interventions (phytosanitary treatments) carried out preventively, only upon warning and therefore with the reduction of expenses per hectare, is a major objective in order to maximize production efficiency.

Recent research has shown that the dependence of grape and wine quality on the genetic and ecological factors that condition it is particularly complex and variable, especially when other biosynthesis compounds (polyphenols, anthocyanins) are taken into account in addition to the accumulation of sugars in the berries, which are important for defining it, thus confirming earlier research carried out in the country and abroad (Macici, 1993).

MATERIAL AND METHOD

Addressing aspects of economic engineering with clear quality trends, the research was conducted in Podgoria Minis - Măderat, Minis Viticultural Centre, with the aim of establishing the integrated technological solution - pruning, mechanical works in vegetation, differentiated phytosanitary treatments according to the ecological offer of the each variety and the vineyard area intended for the production of quality wines.

The research was carried out between 2019 and 2022 on the next vineyards (table 1):

- In the experimental plantation of the Research and Development Station for Viticulture and Oenology Miniș, established in 2005, with the Cadarcă variety, grafted on the rootstock Kober 5BB, with planting distances of 2.5/0.9 m.
- In the plantation located in the Covăsânț, established in 2011, with the variety Pinot noir, grafted on the SO4 rootstock, with planting distances of 2,5/0,9 m.

Table 1. Identifying data of the plantations where the studies were carried out / Date de identificare a plantațiilor unde s-au desfășurat cercetările

Variety	Location	Soil type	Types of grapevine pruning	Bud load	No. Of plants. /Ha	Growing season precipitation	Mechanical works in green
Pinot noir	Plaiul Covăsânț	Red brown vertic	Guyot	24/plant	4444	300 mm	Leaf removal x 2 Shoot removal
Cadarcă	Plaiul Ghioroc SCDVV Miniș	Regosol	Guyot	26/plant	4444	300 mm	Leaf removal x 2 Shoot removal

For observations and determinations, 20 stumps of each variety have been selected, with an approximately uniform development.

The following determinations were made: phenological development of the varieties under study, elements of fertility, growth vigour, resistance to heat stress, biological resistance of the varieties to the main diseases of the vine and chemical composition of the must at harvest.

RESULTS AND DISCUSSIONS

Analysing the specific ecoclimatic conditions of the period under study compared with the multiannual values, an increase in the thermal regime and a slight fluctuation in the water regime were observed. Precipitation is unevenly distributed, usually by heavy downpours alternating with long dry periods (Table 2).

Table 2. The main climatic elements of the growing season (May - July 2019-2022) in the conditions of the vineyard Miniș-Măderat, Miniș viticultural center / Principalele elemente climatice din perioada de vegetație (mai – iulie 2019-2022) în condițiile podgoriei Miniș-Măderat, centrul viticol Miniș

Month / Climatic Parameters		Year 2019		
		May	**June**	**July**
Temperature (°C)	Monthly Average	16,2	25,83	24,13
	Multiannual	16,6	19,4	21,0
	Absolute Maximum	33,5	35,0	37,0
	Multiannual	30,4	32,8	33,6
	Absolute minimum	10,8	21,13	17,77
	Multiannual	5,8	8,7	11,70
Precipitations (mm)	Recorded Value	214,0	143,0	49,0
	Multiannual	66,7	96,6	72,2
No. of days with precipitations	>1mm/m^2	10	8	2
		Year 2020		
Temperature (°C)	Monthly average	15,6	20,5	23,03
	Multiannual	16,6	19,4	21,0
	Absolute Maximum	31,0	34,0	36,0
	Multiannual	30,4	32,8	33,6
	Absolute minimum	6,0	7,0	12,0
	Multiannual	5,8	8,7	11,7
Precipitations (mm)	Recorded Value	33,0	222,0	147,0
	Multiannual	66,7	96,6	72,2
No. of days with precipitations	>1mm/m^2	14	15	10
		Year 2021		
Temperature (°C)	Monthly average	15,74	22,5	27,47
	Multiannual	16,6	19,4	21,0
	Absolute Maximum	30,0	40,0	39,0
	Multiannual	30,4	32,8	33,6
	Absolute Minimum	4,0	8,0	16,0
	Multiannual	5,8	8,7	11,7
Precipitations (mm)	Recorded Value	92,0	70,0	100,0
	Multiannual	66,7	96,6	72,2
No. of days with precipitations	>1mm/m^2	13	7	10
		Year 2022		
Temperature (°C)	Monthly average	18,42	24,4	25,5
	Multiannual	16,6	19,4	21,0
	Absolute Maximum	30	38,9	41,4
	Multiannual	30,4	32,8	33,6
	Absolute Minimum	6,0	10,6	9,2
	Multiannual	5,8	8,7	11,7
Precipitations (mm)	Recorded value	70,0	31,3	22,0
	Multiannual	66,7	96,6	72,2
No. of days with precipitations	>1mm/m^2	7	7	3

The highest biological resistance of the two studied varieties to the diseases manifested was in 2022, thus in the climatic conditions of this year, when the anticryptogamic treatments could be applied at the optimal times, the studied varieties showed very good resistance.

During the growing season of the 2020 viticultural year, specifically in May, June and July, 402 Liters of precipitation fell (number of days with precipitation: 39), 167 Liters above the multiannual average. The monthly average temperatures exceeded the multiannual values (in June there was an average monthly temperature 1.0 ºC above the multiannual value and in July 2.3 ºC above the multiannual value). The level of precipitation in May, June and July associated with high temperatures caused a high infection pressure, these diseases were also favoured by luxuriant growth that led to shoot crowding.

The results of the observations on the behaviour of the studied varieties under the specific climatic conditions of the study years 2019-2022 proved that the studied grapevine ecosystems are vulnerable to these changes due to significant increases in extreme positive temperatures in conjunction with increases in precipitations.

Under the ecoclimatic conditions during the study period, the following determinations were made:

✓ Phenological spectrum

Table 3. The phenological evolution of the studied varieties (average 2019-2022) / Evoluția fenologică a soiurilor luate în studiu (media 2019-2022)

Variety	Bud removal		Bloom		Veraison		Ripeness	
	Data	BTU (ºC)	Data	BTU (ºC)	Data	BTU (ºC)	Data	BTU (ºC)
Pinot noir	25 IV	31	23 V	168	10 VIII	1332,5	25 VIII	1544,5
Cadarcă	21 V	154	20 V	153	5 VIII	1247,5	20 VIII	1485,1

✓ Elements of fertility

Table 4. The main fertility characteristics of the varieties under study (average 2019-2022) / Principalele caracteristici de fertilitate ale soiurilor luate în studio (media 2019-2022)

Variety	Total no. of shoots per plant	No. of fertile shoots per plant	Coefficient of fertile shoots (FS) %	No. of blooms	Fertility coefficients	
					Cfr	Cfa
Pinot noir	26	17	65,4	30	1,15	1,76
Cadarcă	30	22	73,3	34	1,13	1,54

✓ Growth vigor

Table 5. The amount of wood removed on prunning for the studied varieties (average 2019-2022) / Cantitatea de lemn eliminată la tăiere la soiurile luate în studio (media 2019-2022)

Variety	The amount of wood removed on prunning /plant (g)		
	Total, of which:	Annul	Multiannual
Pinot noir	700	620	80
Cadarcă	1200	970	230

Table 6. Vegetative growth of the varieties considered (average 2019-2022) / Creșterile vegetative la soiurile luate în studiu (media 2019-2022)

Variety	No. shoots/plant	Length of the Shoots (cm)			Shoot growth vigor (OIV 351)
		Maximum	Minimum	Average	
Pinot noir	26	115	50	80	Average (5)
Cadarcă	30	150	30	70	High (7)

✓ Resistance to thermal stress

Table 7. Effect of frost on studied genotypes (average 2019-2022) / Comportarea la ger a genotipurilor studiate (media 2019-2022)

No.	Variety	Absolute minimum Temperature, °C		% Bud viability		
		Air	Soil	Primary	Secundary	Total
1	Pinot noir	-12	-12	92	6	98
2	Cadarcă			98	2	100

Table 8. Response of genotypes under study to drought (average 2019-2022) / Comportarea genotipurilor luate în studiu la fenomenul de secetă (media 2019-2022)

Variety	Grade OIV 403	Rating
Pinot noir	5	Good
Cadarcă	5	Good

✓ Biological resistance of varieties to the main grapevine diseases

Table 9. Degree of resistance to the main grapevine diseases / Gradul de rezistență la principalele boli ale viței de vie

Variety	Resistance to downy mildew (*Plasmopara viticola*)		Resistance to powdery mildew (*Uncinula necator*)		Resistance to grey mould (*Botritis cinerea)*	
	Leaf OIV 452	Grape OIV 452	Leaf OIV 452	Grape OIV 452	Leaf OIV 452	Grape OIV 452
Pinot noir	Good (7)	Good (7)	Average (5)	Average (5)	Weak (3)	Weak (3)
Cadarcă	Weak (3)	Weak (3)	Weak (3)	Weak (3)	Average (5)	Average (5)

✓ Chemical composition of grape must at harvest

Table 10. Chemical composition of grape must at harvest (average 2019-2022) / Compoziția chimică a mustului de struguri la recoltare (media 2019-2022)

Variety	SUGAR		ACIDITY		Glucoacidimetric index
	Must Temp. (ºC)	Sugar level (g/l)	Value of Tartaric Acid (g/l)	Value of Sulfuric Acid(g/l)	
Pinot noir	20	221	6,4	4,16	53
Cadarcă	20	204	7,3	4,75	43

The quantity and quality of the fruit is harmonized by pruning to maintain a normal vegetative balance of the vine stumps. By limiting production to a constant level, vigour is increased and the quality of the fruit substantially improved. In the cultivation technology of plantations intended for the production of quality wines, the balancing of the factors involved in the ecosystem must contribute to the production of quality wines by avoiding nutritional stress caused by major nutrients in the soil.

Vine-growing technology based on the theoretical acceptance of the existence of an inverse relationship between quantity and quality, the rules for obtaining quality wines (DOC, PDO), limits production to 8-10 t/ha, using appropriate technical means: low load of berries at the bud break (20-30 buds/plant).

CONCLUSIONS

1. The eye load and the type of shoot pruning in the two varieties according to the ecological offer, by green-working technology, guarantee the reduction of the number of fungal phytosanitary treatments and the quantity and quality of the grapes.
2. The highest biological resistance of the two studied varieties to the diseases manifested was in the year 2022, so in the climatic conditions of this year, when the anticryptogamic treatments could be applied at the optimal times, the studied varieties showed very good resistance.
3. The lowest biological resistance of the two studied varieties was in the year 2020, when the level of rainfall in May, June and July associated with high temperatures, caused a high pressure of infections, these diseases were also influenced by the luxuriant growths that led to shoot crowding.
4. In grapevine plantations, intended for the production of high-quality wines; in order to harmonize the quantity and quality of the fruit, it is recommended to limit production by carrying out rational pruning, in line with the intensification of green work and the organic offer.

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THE MAIN COMPOSITION CHARACTERISTICS OF GRAPES FROM THE WHITE AND SEMI-AROMATIC VARIETIES

PRINCIPALELE CARACTERISTICI DE COMPOZIȚIE ALE STRUGURILOR DIN SOIURILE ALBE ȘI SEMIAROMATE

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Abstract

The studies were carried out at the Research and Development Station for Viticulture and Oenology Drăgășani and aimed to study certain varieties of Romanian and foreign white grapes grown in the eco-pedo-climatic conditions of the Drăgășani vineyard, Vâlcea county. The researches that are the subject of this paper were carried out during the wine years 2019, 2020 and 2021 on the technological potential of varieties for white and aromatic wines: 'Crâmpoşie selecționată', 'Sauvignon', 'Crâmpoşie aromată' and 'Tămâioasă românească'. In all 3 wine years, during which the research was carried out, starting with the onset of the leafy phenophase, identified by soaking the berries, according to the methodologies developed by the Research and Development Institute for Viticulture and Oenology, the grapes growth and ripening process were monitored. For this purpose, for all the varieties studied in the Drăgășani vineyard, 500-700 grapes were taken into account at each reference calendar date, accurately determining their weight and comparring to 100 berries. In the must of the 500-700 berries, the relative contents in carbohydrates (g/l) and acidity (g/l in H_2SO_4) have been determined by appropriate methods. For the first time, the newly created variety at RDSVO Drăgășani, the elite obtained from the sexual hybridization between 'Crâmpoşie selecționată' and 'Muscat de Hamburg'.

Keywords: *vineyard, grapes, full maturity, acidity, polyphenols.*

Rezumat

Studiile au fost efectuate la Stațiunea de Cercetare Dezvoltare pentru Viticultură și Vinificașie Drăgășani si au avut drept scop studierea anumitor soiuri de struguri românești și străine, albe cultivate în condițiile eco-pedo-climatece ale podgoriei Drăgășani, județul Vâlcea. Cercetările care fac obiectul lucrării de faţă s-au desfăşurat în perioada anilor viticoli 2019, 2020 şi 2021 asupra potenţialului tehnologic al soiurilor pentru vinuri albe și aromate: 'Crâmpoșie selecționată', 'Sauvignon', 'Crâmpoșie aromată' și 'Tămâioasă românească'. În toţi cei 3 ani viticoli, pe parcursul cărora s-au efectuat cercetările, începând cu declanşarea fenofazei de pârgă, identificată prin înmuierea boabelor, s-a procedat, conform metodologiilor elaborate de Institutul Cercetare-Dezvoltare pentru Viticultură şi Vinificaţie, la urmărirea procesului de creştere şi maturare a strugurilor. În acest scop, pentru toate soiurile luate în studiu cantonate în podgoria vâlceană Drăgășani au fost luate în considerare 500-700 boabe de struguri, la fiecare dată calendaristică de referinţă, determinându-se cu precizie, greutatea lor şi raportându-se la 100 boabe. În mustul celor 500-700 boabe s-au determinat, prin metode adecvate, conţinuturile relative în glucide (g/l) şi în aciditate (g/l în H_2SO_4). Pentru prima data a fost luată în studiu pentru analiza soiul nou creat la SCDVV Drăgășani, elita obținută din hibridarea sexuată dintre 'Crâmpoșie selecționată' și 'Muscat de Hamburg'.

Cuvinte cheie: *podgorie, struguri, maturitate deplina, aciditate, polifenoli.*

INTRODUCTION

Uvological researches and studies, carried out with modern technical means and by highly professional specialists, focused on the following: general histological structure of grapes, chemical constituents of bunches and berries components (skins, core, seeds), physicomechanical structure of grapes and definition of technological indices, based on quantitative and numerical values of uvological components.

The histological structure of the constituent parts of grapes has been thoroughly studied, especially by using the electron microscope. Research has focused, in particular, on the knowledge of the constituent elements of the grain: cuticle, epidermis, hypodermis, mesocarp and endocarp (Blanke, 1990;). In addition to the theoretical importance of this way of expressing the main constituents of grapes, the wine industry also benefits from a real criterion regarding the establishment on scientific bases of the moment when the largest quantity of carbohydrates is achieved in grape production compared to the conventional unit of area and implicitly the establishment of the harvest date. In general, there is a parallelism between the evolution of carbohydrate content per 100 grains and the weight of 100 grains. A more conclusive parallelism, however, exists between this absolute content and the evolution of the relative sugar content. Up to the leaf, although the weight of the berries increases continuously, sudden decreases in the relative sugar content, expressed in g/l, cause them to fall correspondingly.

Between leafing and full maturity, in all cases there are increases in sugar expressed at the biological unit, but these increases, in most varieties and years, do not have a uniform character, depending on how the weight of the berries evolves and the relative sugar content (Gheorghita, 1973).

MATERIAL AND METHOD

For the analysis of the productivity and quality components of grapes and of the composition components of wines, the official methods recommended by OIV – Paris were used.

1. Determination of sugar content of grapes

The sugar content of grapes was determined refractometrically with the Zeiss hand refractometer, a method based on the principle of refraction of light rays. After adjusting the apparatus, the dry matter in the wort is determined. After correcting the dry matter content, proceed to determining the sugar must content by means of a special table or by applying the formula:

% sugar = (N x 4.25) : 4 – 2.5

where:

N = dry matter content read and corrected; 4.25 = ratio between the density of wort and its refractive index; 2.5 = % content of must in other soluble organic substances (other than sugars).

The result is g sugar per 100 ml of wort.

2. Determination of total acidity in must and wine

The acidity of must and wine is titrimetrically determined by neutralizing the acids in a specified quantity of must or wine with an alkaline solution of known titre. On the basis of the quantity of basic solution used for titration, calculate the acidity of the must or wine.

x = (n x f x 0.0075) x 100 g/l tartaric acid

x = (n x f x 0.0049) x 100 g/l sulphuric acid

n-number of milliliters of NaOH alkaline solution, N/10 used for titration

f-correction factor of the alkaline solution

0.0075 and 0.0049 are the quantities in grams of tartaric or sulphuric acid per 1 ml of N/10 solution.

The titratable acidity of must or wine shall be expressed in grams of sulphuric acid or tartaric acid per 1 litre.

RESULTS AND DISCUSSIONS

For the variety 'Crâmpoșie selecționată', the main composition characteristics of the grapes at full maturity and technological maturity are quantified in Table 1 and Table). High production variety, achieved at full maturity, carbohydrate contents between 153 g/l and 155 g/l, with an average of 152.66 g/l. In relation to carbohydrate contents, carbohydrate contents did not fall below 4.0 g/l (in H_2SO_4) and recorded levels below 5.0 g/l (4.85 g/l). Within the acidity of grapes, tartaric acid accounted for just over 54% on average. Total polyphenols and tannins showed varying levels between 1.61 g/kg berries and 1.74 g/kg berries and between 1.40 and 1.50 g/kg grains, respectively, found in averages of 1.68 g/kg grains and 1.45 g/kg grains, respectively. For both total polyphenols and tannins, the highest contents were recorded in the excessively hot and strongly sunny year – 2020.

At technological maturity or harvest, depending on the wine year, carbohydrates were between 172 g/l and 189 g/l, corresponding to alcoholic degrees of 10 to 11 % vol. In terms of carbohydrate parameter, 2019 proved to be the best and 2020 the weakest, due to heavy rainfall in September. At this phenophase, acidity ranged from 4.01 g/l to 4.25 g/l, with an average of 4.12 g/l (in H_2SO_4), in which tartaric acid occupied over 63%. Polyphenol and tannin contents decreased from full maturity on average over the experimental period by approximately 16% and 12.0%, respectively.

Table 1. The main compositional parameters of 'Crâmpoşie selecţionată' grapes - at full maturity /
Principalii parametrii de compoziţie ai strugurilor de 'Crâmpoşie selecţionată - la maturitatea deplină

Year / Anul viticol	**Full maturity /** Maturitatea deplină							
	Glucides g/l Glucide g/l	**Acidity g/l H_2SO_4** Aciditate g/l H_2SO_4	**Tartric acid /** Acid tartric		**Other acids /** Alţi acizi		**Total polyphenols g/kg** Polifenoli totali g/kg	**Tannin g/kg** Tanin g/kg
			g/l	**%**	**g/l**	**%**		
2019	155	4.85	2.95	60.82	1.90	39.17	1.69	1.47
2020	150	4.65	2.40	51.61	2.25	48.39	1.74	1.50
2021	153	4.30	2.18	51.90	2.02	48.10	1.61	1.40
Average / Media	**152.66**	**4.56**	**2.51**	**54.77**	**2.05**	**45.22**	**1.68**	**1.45**

Table 2. The main compositional parameters of 'Crâmpoşie selecţionată' grapes - at technological maturity /
Principalii parametrii de compoziţie ai strugurilor de 'Crâmpoşie selecţionată' - la maturitatea tehnologică

Year / Anul viticol	**Technological maturity /** Maturitatea tehnologică							
	Glucides g/l Glucide g/l	**Acidity g/l H_2SO_4** Aciditate g/l H_2SO_4	**Tartric acid /** Acid tartric		**Other acids /** Alţi acizi		**Total polyphenols g/kg** Polifenoli totali g/kg	**Tannin g/kg** Tanin g/kg
			g/l	**%**	**g/l**	**%**		
2019	189	4.25	2.70	63.52	1.55	36.48	1.49	1.29
2020	172	4.01	2.52	61.46	1.58	38.54	1.36	1.29
2021	181	4.10	2.64	65.83	1.37	34.17	1.38	1.25
Average / Media	**180.66**	**4.12**	**2.62**	**63.60**	**1.50**	**36.40**	**1.41**	**1.27**

For the variety 'Sauvignon', the basic compositional parameters whose levels are quantified in Tables 3 and 4 are enlightening in relation to the conditions imposed on high-brand wines. The results fully confirm those obtained in older research (Budan, 1966), as well as those of recent studies (Stoica, 2003; Nicolaescu, 2007).

At full maturity, in the case of the highest yield at the conventional unit of area (ha), the grapes incorporated: carbohydrates with contents between 192.2 g/l and 200.4 g/l, with an average of 196.36

g/l and acidity between 5.15 g/l and 5.75 g/l, with an average of 5.40 g/l (expressed as H_2SO_4). To these essential oenological quantities are added the contents of total polyphenols and tannins, collected in the media, during the experimental period, of 2.61 g/kg berries and 2.37 g/kg berries respectively.

Table 3. The main compositional parameters of 'Sauvignon'grapes - at full maturity / Principalii parametrii de compoziție ai strugurilor de 'Sauvignon'- la maturitatea deplină

Year / Anul viticol	**Full maturity /** Maturitatea deplină							
	Glucides, g/l, Glucide, g/l	**Acidity g/l H_2SO_4** Aciditate g/l H_2SO_4	**Tartric acid /** Acid tartric		**Other acids /** Alți acizi		**Total polyphenols g/kg ,** Polifenoli totali g/kg	**Tannin g/kg,** Tanin g/kg
			g/l	**%**	**g/l**	**%**		
2019	196.5	5.15	3.17	61.55	1.98	38.45	2.61	2.32
2020	192.2	5.75	3.39	58.95	2.36	41.05	2.47	2.18
2021	200.4	5.30	3.25	61.32	2.05	38.68	2.75	2.61
Average Media	**196.36**	**5.40**	**3.27**	**60.66**	**2.13**	**39.34**	**2.61**	**2.37**

At technological maturity, generally positioned in the second decade of September, carbohydrate contents between 220.3 g/l and 229.3 g/l were recorded, from which, certainly, by applying appropriate biotechnological measures, semi-dry or even semi-sweet, semi-aromatic wines of high quality can be obtained. In the presence of these carbohydrate contents, the acidity in the grapes was between 4.24 g/l and 4.52 g/l, in which tartaric acid occupied proportions between 65.45% and 67.21% in excessively hot years (2020 and 2021) and 64.15% in 2019.

Table 4. The main compositional parameters of 'Sauvignon'grapes - at technological maturity / Principalii parametrii de compoziție ai strugurilor de 'Sauvignon'- la maturitatea tehnologică

Year / Anul viticol	**Technological maturity /** Maturitatea tehnologică							
	Glucides g/l Glucide g/l	**Acidity g/l H_2SO_4** Aciditate g/l H_2SO_4	**Tartric acid /** Acid tartric		**Other acids /** Alți acizi		**Total polyphenols g / kg** Polifenoli totali g/kg	**Tanin g/kg** Tanin g/kg
			g/l	**%**	**g/l**	**%**		
2019	220.3	4.52	2.90	64.15	1.62	35.85	2.25	2.03
2020	218.9	4.24	2.85	67.21	1.39	32.79	2.07	1.96
2021	229.3	4.40	2.88	65.45	1.52	34.55	2.23	2.01
Average / Media	**222.83**	**4.38**	**2.87**	**65.27**	**1.51**	**34.73**	**2.18**	**2.00**

Total polyphenols and tannins have seen considerable reductions between full maturity and technological maturity. The decreases between the two phases evolved, on average over the experimental duration, from 2.61 g/kg berries to 2.18 g/kg berries for total polyphenols and from 2.37 g/kg berries to 2.00 g/kg berries for tannin content. However, the polyphenol content at harvest time is important, signifying the attention to be paid to the maceration vinification of semi-aromatic grapes.

For the grapes of the elite 'Crâmpoșie aromată' obtained from selected 'Crâmpoşie × Muscat de Hamburg', the data given in Table 5 and Table 6, representing the values of the main characteristics of grapes at full maturity and technological maturity, are certain arguments regarding its technological value, manifested in the Drăgăşani vineyard.

At full maturity, depending on the conditions of the wine years, the carbohydrate contents oscillated between 152.8 g/l (in 2020) and 160 g/l (in 2021 - very good wine year). This variability, quite important, is found in the average carbohydrate of 156.4 g/l., a value close to the 'Crâmpoșie selecționată'.

Table 5. The main compositional parameters of 'Crâmpoșie aromată' grapes - at full maturity /
Principalii parametrii de compoziție ai strugurilor de 'Crâmpoșie aromată' - la maturitatea deplină

Year / Anul viticol	**Full maturity /** Maturitatea deplină							
	Glucides g/l Glucide g/l	**Acidity g/l H_2SO_4** Aciditate g/l H_2SO_4	**Tartric acid /** Acid tartric		**Other acids /** Alți acizi		**Total polyphenols g/kg** Polifenoli totali g/kg	**Tanin g / kg** Tanin g/kg
			g/l	**%**	**g/l**	**%**		
2019	156.4	4.96	2.94	59.27	2.02	40.73	1.75	1.51
2020	152.8	4.75	2.69	56.63	2.06	43.37	1.65	1.42
2021	160.0	4.88	2.89	59.22	1.99	40.78	1.85	1.50
Average / Media	**156.4**	**4.86**	**2.84**	**58.37**	**2.02**	**41.62**	**1.75**	**1.47**

Table 6. The main compositional parameters of 'Crâmpoșie aromată' grapes - at technological maturity /
Principalii parametrii de compoziție ai strugurilor de 'Crâmpoșie aromată' - la maturitatea tehnologică

Year / Anul viticol	**Technological maturity /** Maturitatea tehnologică							
	Glucides g/l Glucide g/l	**Acidity g/l H_2SO_4** Aciditate g/l H_2SO_4	**Tartric acid /** Acid tartric		**Other acids /** Alți acizi		**Total polyphenols g/kg** Polifenoli totali g/kg	**Tanin g / kg** Tanin g/kg
			g/l	**%**	**g/l**	**%**		
2019	192.7	4.46	2.75	61.65	1.71	38.35	1.55	1.39
2020	187.5	4.08	2.32	56.86	1.76	43.14	1.49	1.32
2021	200.1	4.41	2.66	60.31	1.75	39.69	1.48	1.40
Average / Media	**193.4**	**4.31**	**2.57**	**60.27**	**1.74**	**39.73**	**1.50**	**1.37**

Even in hot years, after the fallow phenophase, the acidity goes through a slow decrease, so that at full maturity its contents do not fall below 4.7 g/l (in H_2SO_4). Within the acidity, tartaric acid occupies proportions with pronounced variability, depending on the climatic conditions of the wine-growing years, between 56.63% and 59.27%, with an average of 58.37%. For total polyphenols and tannin, the contents are lower, compared to those of 'Crâmpoșie selecționată' grapes. As averages, the phenolic constituents represent 1.75 g/kg for total polyphenols and 1.47 g/kg for tannin.

At technological maturity (located as a moment between 25 and 30.IX), even in the less favorable years in terms of climate, the carbohydrate content can reach levels around 190 g/l, from which at least 11 %vol results alcohol. In good or very good wine years, the carbohydrate content can reach around 200 g/l, without the acidity falling below 4.40 g/l. Between full and technological maturity, the acidity decreases mainly due to the combustion of malic acid, so that at harvest tartaric acid occupies 60.27% of the total acidity.

Compared to full maturity, total polyphenols decreased from 1.75 g/kg to 1.50 g/kg, and tannins from 1.47 g/kg to 1.37 g/kg. Between full and technological maturity, the acidity decreases mainly due to the combustion of malic acid, so that at harvest tartaric acid occupies 60.27% of the total acidity.

Compared to full maturity, total polyphenols decreased from 1.75 g/kg berries to 1.50 g/kg berries, and tannins from 1.47 g/kg to 1.37 g/kg.

For the 'Tămâioasă românească' variety, the main constituents of the grapes at full and technological maturity (Table 7 and Table 8), confirm, once again, the close connection between its oenological potential and the Drăgăşani vineyard. Currently, alongside the 'Tămâioasă românească 104 Dg' variety that was obtained in 1982 from the traditional biotype, with cylindrical-conical grapes, with larger, more aromatic berries, with smaller yields and with golden-yellow berries at advanced ripening, there are quite a few to spread and the biotype with branched grapes, with smaller berries, but more productive. The results reflect, in general, the current situation regarding the proportions of the two biotypes in the vineyard plantations.

At full maturity, the carbohydrates in the grapes did not drop below 190 g/l and reached insignificantly above 200 g/l, under the conditions of preserving important acidity contents in the berries, between 5.28 g/l and 5.61 g/l, with an average of 5.41 g/l (expressed in H_2SO_4).

Tartaric acid represents, on average, 59.60% of the acidity of the grapes, and the polyphenol contents are important, even exceeding 3.0 g/kg, with an average of 2.96 g/kg for total polyphenols and contents included between 2.68 g/kg and 2.80 g/kg, found on average 2.73 g/kg for tannin content.

Table 7. The main compositional parameters of 'Tămâioasă românească' grapes - at full maturity /
Principalii parametrii de compoziţie ai strugurilor de 'Tămâioasă românească' - la maturitatea deplină

Year / Anul viticol	**Full maturity /** Maturitatea deplină							
	Glucides g/l Glucide g/l	**Acidity g/l H_2SO_4** Aciditate g/l H_2SO_4	**Tartric acid /** Acid tartric		**Other acids /** Alţi acizi		**Total polyphenols g/kg** Polifenoli totali g/kg	**Tanin g / kg of berries** Tanin g/kg boabe
			g/l	**%**	**g/l**	**%**		
2019	198.7	5.35	3.15	58.87	2.20	41.13	2.94	2.73
2020	191.7	5.61	3.34	59.53	2.27	40.47	3.05	2.80
2021	202.3	5.28	3.19	60.41	2.09	39.59	2.91	2.68
Media / Average	**197.56**	**5.41**	**3.22**	**59.60**	**2.18**	**40.39**	**2.96**	**2.73**

Table 8. The main compositional parameters of 'Tămâioasă românească' grapes - at technological maturity /
Principalii parametrii de compoziţie ai strugurilor 'Tămâioasă românească' - la maturitatea tehnologică

Year / Anul viticol	**Technological maturity /** Maturitatea tehnologică							
	Glucides g/l Glucide g/l	**Acidity g/l H_2SO_4** Aciditate g/l H_2SO_4	**Tartric acid /** Acid tartric		**Other acids /** Alţi acizi		**Total polyphenols g/kg** Polifenoli totali g/kg	**Tanin g/kg** Tanin g/kg
			g/l	**%**	**g/l**	**%**		
2019	225.8	4.45	2.58	57.97	1.87	42.03	2.70	2.53
2020	219.7	4.24	2.36	55.66	1.88	44.34	2.67	2.49
2021	230.2	4.31	2.62	60.78	1.69	39.22	2.56	2.45
Media / Average	**225.23**	**4.33**	**2.52**	**58.13**	**1.67**	**36.8**	**2.64**	**2.49**

At technological maturity, in relation to the climatic conditions of the wine-growing years, the carbohydrate content of grapes recorded levels between 219.7 g/l and 230.2 g/l, from which through total yeast metabolism (dry fermentation) can result alcoholic degrees between the limits of 12.8 – 12.9 %vol and 13.1 – 13.3 %vol.

By conducting the alcoholic fermentation up to approximately 12.0 %vol alcohol and keeping 15.0 - 20.0 g/l of carbohydrates unfermented, natural semi-sweet wines can be obtained without sugar corrections, with a natural acidity of over 4.3 g/l (in H_2SO_4), in which tartaric acid represents almost 60%.

Between full maturity and technological maturity, total polyphenols and tannins, as averages at the level of the experimental duration, decreased from 2.96 g/kg berries to 2.64 g/kg berries and respectively from 2.73 g/kg berry to 2.49 g/kg berry. In this case, the reductions are 10% in total polyphenol content and 7.5% in tannin content. Considering the contents of phenolic compounds, when picking the grapes, as in the case of the 'Sauvignon' variety and the elite 'Crâmposie aromată (Crâmposie selecționată x Muscat de Hamburg) ', the maceration process in order to extract the terpenic aromas must be conducted with the utmost care, so that the profile variety-specific terpenic not to be compromised by the shades of hardness imprinted by polyphenols.

CONCLUSIONS

In general, the quality parameters of the grapes and those of productivity and yield, for the same area and viticultural year, are essential attributes of the genetic nature of each variety, and for one and the same variety, their levels differ, at the different phenophases, depending on the climatic conditions of the production years.

Both the quality characteristics of the grapes, as well as the elements of productivity and yield, on the entire assortment for white, semi-aromatic, aromatic wines, meet the most advantageous levels in years with a good supply of water from the previous year, with a normal pluviometric regime, accompanied by a thermal regime and one of superior insolation, from the active period of the vine, as was the year 2021.

In all varieties for wines in the higher categories, in general, the compositional parameters of the grapes reach the levels corresponding to the targeted types 10 – 15 days after full maturity.

All the grape varieties analyzed are suitable for cultivation in all the wine-growing areas of the country, in order to vinify and obtain wines of superior quality.

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RESEARCH ON THE INFLUENCE OF INCREASING BIODIVERSITY IN VINEYARDS ON THE HEALTH STATUS OF PLANTS

CERCETĂRI PRIVIND INFLUENȚA CREȘTERII BIODIVERSITĂȚII ÎN PLANTAȚIILE VITICOLE ASUPRA STĂRII DE SĂNĂTATE A PLANTELOR

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Abstract
Within the Era-NET Core Organic - ALL project (Agroecology Living Labs for the promotion of robust and resistant organic production systems) in the period 2022-2023 in Murfatlar, an innovative system of organic vine cultivation was experimented, aiming that by increasing the biodiversity of the viticultural ecosystem to improve the health of the plants. The degree of plant attack by the main pathogenic and harmful fungi was monitored, phytosanitary treatments being carried out only upon warning. In this way, the frequency of treatments was reduced by up to 40%. They were comparatively evaluated. the innovative system of increasing biodiversity compared to the classic one, in the ecological vineyard from Murfatlar. The impact of intercropping on vineyards is a variable factor that largely depends on the climatic evolution and the area where the vineyard is located. It should not be overlooked that intercropping can compete for resources with vines, both for water and nutrient uptake.

Keywords: *organic viticulture, sustainability, cover crops, diseases and pests evolution*

Rezumat
În cadrul proiectului Era-NET Core Organic - ALL (Agroecology Living Labs pentru promovarea sistemelor de producție organice robuste și rezistente) în perioada 2022-2023 la Murfatlar, a fost experimentat un sistem inovator de cultivare ecologică a viței-de- vie, vizând ca prin creșterea biodiversității ecosistemului viticol să se amelioreze starea de sanatate a plantelor. A fost monitorizat gradul de atac al plantelor cu principalele ciuperci patogene şi dăunători, efectuându-se tratamente fitosanitare doar la avertizare. În acest fel, frecvența tratamentelor a fost redusă cu până la 40%. Au fost evaluate comparativ. sistemul inovator de creştere a biodiversităţii faţă de cel clasic, in plantaţia ecologică de la Murfatlar. Impactul culturilor intercalate asupra plantațiilor viticole este un factor variabil care depinde in mare masură de evoluția climatică şi de zona în care se află via. Nu trebuie trecut cu vederea faptul că cultura intercalată poate concura pentru resurse cu vița-de-vie, atât pentru absorbția de apă, cât și de nutrienți.

Cuvinte cheie: *viticultură ecologică, sustenabilitate, culturi intercalate, evoluţia bolilor şi dăunătorilor*

INTRODUCTION

The concept of ALL - "Agroecological Living Labs" (living agroecological laboratories) is materialized through an initiative recently launched by the European Commission with the aim of accelerating the transition from conventional agricultural systems to sustainable ones, with the help of research in the field (https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en). In this way, the premises are created for the realization of candidate European partnerships in the field of food, bioeconomy, natural resources, agriculture and the environment within the Horizon Europe program (https://ec.europa.eu/eip/agriculture/en).

The application of the concept of agroecological system in farms can support the transfer towards resilient agricultural systems, more closely related to the environment and society, which can provide sufficient, safe, nutritious and accessible food, also rewarding the efforts of farmers https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/european-partnerships-horizon-europe/food-bioeconomy-natural-resources-agriculture-and-environment_en).

Through such partnerships, a network of living laboratories and research infrastructures can be created and supported that will accelerate the transition to organic farming in Europe by providing innovative technologies, techniques and products applicable on plots for long-term experimentation or demonstration, specific to the area, involving as many interested parties as possible, including farmers, the academic and administrative environment, input suppliers, etc. Their priority is to provide validated solutions that support farmers in understanding and implementing agroecological practices to obtain a positive economic, environmental and social impact (Strategy, U. B., 2018).

Agroecological partnerships can be a powerful tool for addressing climate, biodiversity, environmental, economic and social challenges facing the world. The potential of agroecology to reduce the use of pesticides, fertilizers and antimicrobials should be emphasized. Last but not the least, agroecology is one of the types of agricultural practices that the future common agricultural policy in Europe could support financially through the so-called eco-schemes (https://enoll.org/).

One of the functions of living labs is to accelerate innovation and the adoption of sustainable practices by engaging farmers and other stakeholders in the joint development of solutions to problems they face in their locality or region, taking into account the specificity of agricultural systems and their environment.

Experiments must be coupled with research efforts to increase understanding of the long-term evolution of ecosystems and the effects of adopted agroecological practices (https://enoll.org/network/living-labs/).

In this context, in the coordination of ARAD - the Romanian Association for Sustainable Agriculture, through the ERA-Net ALL-Organic project with the title: Agroecological laboratories for the promotion of robust and resistant organic production systems, at the Research and Development Station for Viticulture and Oenology Murfatlar was established a demonstrative plot cultivated in an ecological system where new methods of increasing the biodiversity of vineyards were applied, with the aim of better controlling the evolution of diseases and pests.

MATERIALS AND METHODS

The study was carried out during the viticultural year 2022-2023 at the Research and Development Station for Viticulture and Oenology Murfatlar, situated in the center of the Dobrogean Plateau, 20 km west of the Black sea and 30 km east of the Danube River (44°10’36’’N; 28°25’22’’E) (Chelcea et al., 2016). The viticultural area is compries of 183 ha of land. The study focused on two experimental plots. Each plot was focused on two varieties. The first variety is Columna, patented in 1985, which is a variety of medium to large vigor. It ensures constant yields of 7-8 tons per hectare and an average accumulation of sugars in the must (200-220 g/L), but with a relatively high acidity of 5.5-6.5 g/L H_2SO_4. The unique manner of shoot growth, in the form of a curtain, allows for cultivation in an organic system. The other variety is Fetească neagră, with a vigorous growth and early ripening, the grape yield is 3.076 kg per vine reaches 11.5 tons per hectare, achieving 4.6 g/L H_2SO_4 total acidity and 221 g/L sugar (Pîrcălabu et al., 2020). In the study, three experimental variants were developed gruped by type of tehnology that was applied:

V 1: Sowed wildflower mix on intervals, mowed after flowering, where more than 20 species of flowers were used. The list of plants include species: *Festuca spp.*, *Poa spp.*, *Agrostis capillaris*, *Dactylis glomerata; Onobrychis viciifolia*, *Trifolium spp.,* etc (Figure 1)

V 2: Natural flora left on intervals mowed after the second half of June. The list of species is based on native flora of the Murfatlar region. It includes the following important species: *Chenopodium album; Amaranthus retroflexus; Bassia scoparia; Centaurea cyanus; Xantium strumarium; Convolvulus arvensis; Acer rubrum; Calendula officinalis; Lamium amplexicaule; Anethum graveolens* etc (Figure 2).

V 3: Bare soil on interrows.

Figure 1. V 1 - Sowed wildflower mix on Intervals / *V 1- Amestec flori de câmp*

Figure 2. V 2 – Natural flora left on intervals / *V 2 – Floră spontană pe interval*

To monitor the climatic elements, the weather station (iMetos 3.3), located in the center of the vineyard, was used. For a better characterization of the heliothermal and hydric resources during the studied period, synthetic ecological indicators were calculated: the real heliothermal index (J. Branas et al., 1946); the hydrothermal coefficient (Gh. Selianinov, 1936); the bioclimatic index of grapevine (Gh. Constantinescu et al., 1936); and the oenoclimatic suitability index (Şt. Teodorescu, 1977), the annual aridity index De Martonne (1926), and the Huglin heat sum index (Huglin, 1978).

For pests and diseases, visual observations were conducted to investigate vine diseases in this study. Grapevines were thoroughly inspected within the vineyard for signs of disease, including leaf discoloration, wilting, presence of lesions, and other visible symptoms. These observations were made at regular intervals throughout the growing season to track disease progression and assess overall vine health. The study focused to observe the evolution of the following grapevine diseases: Downy mildew (*Plasmopara viticola*), Powdery mildew (*Uncinula necator*), and Gray mold (*Botrytis cinerea*):

Downy mildew - Average temperatures fall within the development limits of the fungus *Plasmopara viticola*, in the second half of April and the first decade of May. Infections from the oospores that have survived over winter represent the primary infection, occurring from mid-April to June. Infections resulting from the conidia formed from primary infections are called secondary infections and can be numerous, reaching 50-60 in some years. In the Murfatlar wine-growing center, strong downy mildew infections occur during the intensive shoot growth phase. In recent years, the most virulent attacks have been recorded in years with high precipitation during the vegetation period. The intensity of attacks is reflected in the number of treatments applied, being higher in years with abundant precipitation, reaching 9-10 treatments. (Dina et al., 2023).

Powdery Mildew - The disease is caused by the fungus *Uncinula necator* and is considered, alongside Downy Mildew and Gray Mold, one of the most damaging grapevine diseases. From spring to autumn, Powdery Mildew affects all green organs: leaves, shoots, inflorescences, clusters, and berries. The most damaging attack is on the berries, which can be affected in various stages of development. The berries are covered with characteristic powdery white fuzz, the skin often cracks under the pressure of the pulp, juice leaks out. The resulting grapes are sour, and the resulting wine is weak and lacks bouquet. In the Murfatlar wine-growing center, the most powerful attack occurs during grape berry formation, causing significant damage. (Mirică, 1986).

Gray Mold caused by the fungus *Botrytis cinerea*, has devastating effects in years with abundant precipitation, where phytosanitary protection has not been correctly applied. Starting from entering the veraison stage, the berries are affected by gray mold, with the infection progressing and infecting the entire cluster. In rainy conditions and high atmospheric humidity, the berries crack, and a gray mold develops on their surface, while under drought conditions with low atmospheric humidity, as in this year, the berries can become raisined. Optimal infection conditions occur when the temperature is between 15-20°C and there is water on the berries or atmospheric humidity is 90%.

To reduce or combat the effects of diseases, complex treatments against downy mildew, powdery mildew, and gray mold are simultaneously applied within vineyards. (Ranca et al., 2013).

Pests in grapevines encompass a range of organisms, including insects, pathogens, and weeds, which negatively impact the vitality, growth, and productivity of grapevine plants. These organisms can cause substantial damage to various plant parts, such as leaves, shoots, clusters, and roots, through feeding, transmission of diseases, or competition for resources. The most dangerous that cause significant problems is: *Lobesia botrana* (European grapevine moth), (Varela et al., 2010). In the Murfatlar vineyard, the grape moth is consistently the most significant pest of the grapevine, causing damage of up to 30-40% of the harvest annually and further promoting the development of grey mold, especially in the third generation. Combatting the grape moth is challenging due to the irregularity of attacks, the brief vulnerability of larvae, as well as the need to protect clusters throughout the entire egg hatching period. In order to assess the attack degree, pheromone traps designed specifically for *Lobesia botrana* were utilized in this research. Each trap contained a lure emitting the female sex pheromone to attract male moths. Positioned strategically within the vineyard canopy, these traps were equipped with sticky surfaces or containers to capture the attracted insects. Regular maintenance and monitoring ensured optimal trap performance, with data collected on trapped moths and environmental conditions to evaluate efficacy.

RESULTS AND DISSCUSIONS

The viticultural year 2022-2023 was characterized by high heliothermal availabilities, expressed through monthly average temperatures (°C) and a thermal balance (∑°C) higher than the multi-year average values.

In the viticultural year 2022-2023, the monthly average temperature was above the climatological normal by 3.3°C. The monthly average temperature recorded until October 31, 2023, was 14.8°C compared to the normal monthly average of 11.5°C for a typical year.

The climate record shows that positive deviations from the normal monthly values ranged between 0,3°C and 5,5°C. The largest difference during the dormant period was recorded in January, with 5,5°C more (6,0°C compared to 0,5°C), while during the growing season, the largest difference was recorded in September, 4,6°C higher than the climatological norm for that month (22,2°C compared to 17,6°C as seen. The absolute minimum temperatures during the winter period reached -9,8°C (February 10, 2023).

The overall thermal balance in the viticultural year 2022-2023 was 779,8°C above the climatological normal for this period (November 1, 2022 - October 31, 2023), totaling 4097,5°C, due to the monthly thermal surplus recorded both in the cold season and during the growing period.

The active and effective thermal balances exceeded the specific values for a normal year during this period. The annual active thermal balance totaled 4795,3°C, with 994,1°C more than the active thermal balance for a normal year within this interval of 3801,2°C, while the useful thermal balance for this period totaled 2398,3°C compared to the normal value of 1747,3°C, that is 651°C more than the normal active thermal balance for this interval.

The temperature range of this year was 29,3°C, given by an absolute maximum temperature of 39,1°C (on July 26, 2023), and an absolute minimum of -9,8°C recorded on February 10, 2023. During the growing season, the active thermal balance totaled 3806,3°C, compared to the normal value specific to this period – 3272,1°C, while the useful thermal balance totaled 2066,3°C compared to 1615,6°C as seen in Table 1.

Table 1. The Evolution of Temperatures - Recorded Data in the wine year 2022-2023 *// Evoluția temperaturilor – date înregistrate în anul viticol 2022-2023*

Year	Month	Monthly mean temperature		Maximum absolute temp.	Minimum absolute temp.	Sum of temperatures					
						Global		Active		Effective	
		Normal	2021-2022			Normal	2021-2022	Normal	2021-2022	Normal	2021-2022
2022	XI	7.2	10.0	13.0	-0.5	228.1	300.7	134.9	195.4	34.9	45.4
2022	XII	2.3	5.0	19.1	-5.6	255.1	155.1	24.2	41.5	3.4	11.5
2023	I	0.5	6.0	19.6	-5.8	4.1	185.9	2.6	51.0	0.0	11.0
2023	II	1.3	3.8	19.9	**-9.8**	62.6	106.4	14.7	60.2	2.7	10.2
2023	III	4.2	8.1	20.5	-6.3	125.6	249.9	41.3	111.4	9.3	24.4
2023	IV	10.5	10.8	20.3	-1.9	369.7	324.3	219.8	251.3	53.8	41.3
2023	V	16.2	17.4	29.7	1.5	513.7	541.2	513.7	541.2	203.7	231.2
2023	VI	20.4	22.8	33.6	7.9	620.1	683.9	620.1	683.9	328.1	383.9
2023	VII	22.6	26.8	**39.1**	13.4	726.3	830.8	726.3	830.8	416.3	520.8
2023	VIII	22.6	26.9	**36.9**	11.5	671.0	834.5	671.0	834.5	361.0	524.5
2023	IX	17.6	22.2	31.4	8.6	521.2	664.6	521.2	664.6	252.7	364.6
2023	X	12	17.4	32.9	0.0	373.1	539.3	311.4	529.5	81.4	229.5
Sum/year						**4470.6**	**5416.6**	**3801.2**	**4795.3**	**1747.3**	**2398.3**
Mean/month		**11.5**	**14.8**	**39.1**	**-9.8**						

The rainfall deficit was 318.1 mm compared to 405,8 mm. This quantity accumulated from 97 rains > 0.1 mm, including 17 > 5.0 mm and 9 > 10.0 mm (useful rains). The recorded precipitation amounts were unevenly distributed and were below the multi-year average during most months of the growing season, except for April when quantities of 99.5 mm were recorded, compared to 33.5 mm. The largest deficit was recorded in September, amounting to 41.4 mm (only 0,3 mm was recorded compared to 41.6 mm specific to a normal year for this month). The total precipitation recorded during the growing season was 170.9 mm compared to 245.7 mm, the multi-year average.

The relative air humidity remained high compared to the multi-year average (75.4% compared to 72.4%, the normal value), while sunshine, assessed by the number of hours of sunlight, was lower than normal limits, with 232.8 hours less due to the high number of overcast days (1925.5 hours compared to 2158.3 hours for the period 01.11.2022-30.09.2023). The wind speed was above the multi-year average, recording 3.2 m/s compared to 2.7 m/s as seen in Table 2.

Table 2. Precipitations, air humidity, insolation and wind speed – registered data in viticultural year 2022-2023 /
Precipitații, umiditate aer, insolația și viteza vântului – date înregistrate in anul viticol 2022-2023

Year	Month	Precipitations (mm)		Days with rains			Higroscopicity %		Insolation (hours)		Wind speed m/s	
		Normal	2021-2022	>0.1	>5	>10	Normal	2021-2022	Normal	2021-2022	Normal	2021-2022
2022	XI	40.4	39.5	10	4	1	82.0	92.2	87.2	66.50	3.1	2.7
2022	XII	34.0	20.3	11	0	0	85.0	93.7	66.1	48.90	2.6	2.8
2023	I	31.0	45.2	11	3	2	83.0	93.2	63.5	54.10	3.9	3.9
2023	II	33.0	10.8	8	0	0	81.0	83.3	84.8	116.0	3.1	3.0
2023	III	21.7	23.6	13	1	0	75.0	82.8	111.7	161.0	2.8	3.3
2023	IV	33.5	99.5	13	7	3	72.0	85.8	160.7	159.8	3.1	3.2
2023	V	50.2	11.4	8	1	0	68.0	73.4	261.8	227.3	2.6	3.3
2023	VI	53.2	28.4	7	1	1	65.0	64.8	314.5	227.5	2.6	2.0
2023	VII	35.6	27.8	8	0	2	60.0	57.6	305.5	227.6	2.1	3.5
2023	VIII	31.6	3.6	3	0	0	60.0	58.7	305.5	225.5	2.1	3.8
2023	IX	41.6	0.2	1	0	0	68.0	59.5	221.0	244.1	1.6	2.9
2023	X	30.2	7.8	4	0	0	70	59.4	176.0	167.1	2.4	4.2
Sum /Year		**436.0**	**318.1**	**97**	**17**	**9**			**2158.3**	**1925.5**		
Mean/Month							**72.4**	**75.4**			**2.7**	**3.2**

Concerning the synthetic ecological indicators, the real heliothermal index (IHr), from November 2022 to September 2023, was 3.6, indicating optimal conditions for grape ripening. The hydrothermal coefficient (CH) in our country ranges between 0.7 and 1.8. Normal values for the hydrothermal coefficient range from 1 to 1.9 and allow for quality production. Values above 3 indicate excess moisture and lack of warmth, while values between 0.6 and 0.7 require vineyard irrigation. In the Murfatlar region, the multi-year average hydrothermal coefficient is 0.7, but this year it was 0.4, requiring water deficit supplementation through irrigation. The bioclimatic index of the vine (Ibcv) exhibits pronounced variation across Romania, from 4.0 in the northern vineyards to 15.0 in the south. Lower values indicate reduced heliothermal resources against higher hydric resources and vice versa. For the year 2022-2023, this index was 13.9, indicating optimal heliothermal resources for grape production. The oenoclimatic aptitude index (IAOe) shows certain zonality in Romanian viticulture, with values increasing from cooler climates (3700) to warmer climates (5250.7). For this year, the index recorded a value of 5197.2, indicating favorable conditions for producing red wines. The annual aridity index by Martonne had a value of 13.3, placing the viticultural center of Murfatlar in a semi-arid (steppe) climate conducive to vine cultivation. The Huglin heat sum index (or Huglin index, respectively) is calculated by summing the temperatures above the threshold of 10°C from the beginning of April to the end of September. Each grape variety requires a specific amount of heat to be successfully cultivated in a particular area in the long term. For the viticultural year 2022-2023, the value within this interval was 2191.0, demonstrating optimal conditions for grapevine cultivation, especially for varieties intended for red wine production in warm climates.

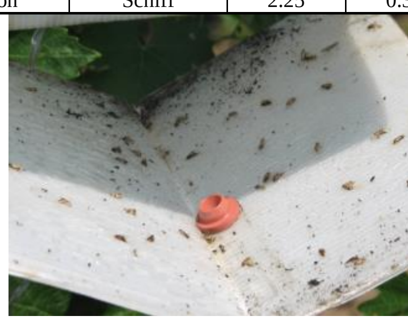
These fluctuations in precipitation, coupled with changes in humidity and wind intensity, likely influenced the prevalence of diseases and pests in the grapevine ecosystem. Moreover, fluctuations in sunshine hours and wind speed further contributed to the dynamic environmental conditions experienced by grapevines, potentially affecting their susceptibility to pests such as *Lobesia botrana*. Additionally, fluctuations in maximum and minimum absolute temperatures further highlighted the range of conditions experienced by grapevines during this period.

The monitoring process uncovered a spectrum of infestation intensities, showcasing a nuanced range from as low as 0.31% to a peak of 2.25%, indicative of the dynamic nature of pest activity across various phases of vine growth and within different grape cultivars as seen in Table 3. Throughout the monitoring period of the year 2023, a systematic approach was adopted, utilizing traps baited with Atra Bot pheromones. This method served as a reliable and consistent means of pest surveillance, offering insights into the population dynamics and distribution of the grape moth across the vineyard. A control measure was implemented consistently across all observations. The application of Laser 240 SC at a dosage of 0.200 l/ha emerged as a robust intervention strategy against grape moth infestation.

Table 3. Pest monitoring, attack intensity and attack degree regarding *Lobesia botrana* in 2023 //*Monitorizarea dăunătorului Lobesia botrana - intensitatea atacului și gradul de atac in 2023*

Plant Species/ Cultivated Variety	Area (ha)	Vegetative Phase and Date of Pest Observation	Pest (Common Name/ Scientific Name)	Attack Intensity (%)	Attack Degree (%)	Pest Monitoring Method	Pest Control Method	Part of Plant Used for Human/ Animal Consumption
Vitis vinifera/ Columna	2.39	Before flowering	Grape moth *Lobesia botrana* Den et Schiff	1.73	0.31	Traps with Atra Bot pheromones	Laser 240 SC 0.200 l/ha	Fruit - grapes
Vitis vinifera/ Fetească neagră	0.86	Before flowering	Grape moth *Lobesia botrana* Den et Schiff	0.31	0.18	Traps with Atra Bot pheromones	Laser 240 SC 0.200 l/ha	Fruit - grapes
Vitis vinifera/ Columna	2.39	After flowering	Grape moth *Lobesia botrana* Den et Schiff	1.70	0.18	Traps with Atra Bot pheromones	Laser 240 SC 0.200 l/ha	Fruit - grapes
Vitis vinifera/ Fetească neagră	0.86	After flowering	Grape moth *Lobesia botrana* Den et Schiff	1.76	0.22	Traps with Atra Bot pheromones	Laser 240 SC 0.200 l/ha	Fruit - grapes
Vitis vinifera/ Columna	2.39	Veraison	Grape moth *Lobesia botrana* Den et Schiff	1.58	0.15	Traps with Atra Bot pheromones	Traps with Atra Bot pheromones	Fruit - grapes
Vitis vinifera/ Fetească neagră	0.86	Veraison	Grape moth *Lobesia botrana* Den et Schiff	2.25	0.39	Traps with Atra Bot pheromones	Traps with Atra Bot pheromones	Fruit - grapes

Botrytis cinerea traps



Furthermore, the research analyzed pest infestation data across different growth phases of grapevines. Attack intensities varied, ranging from 2.2% to 11.32% for Downy Mildew and from 0.1% to 1.44% for Gray Mold. Similarly, attack grades fluctuated, with Downy Mildew ranging from 0.07% to 1.02% and Gray Mold from 0.17% to 1.44% as observed in Table 4. Notably, Kocide 2000 W consistently exhibited efficacy against Downy Mildew, while Zytron and Cuproxat flowable demonstrated effectiveness against Gray Mold across different growth stages.

Table 4. Disease monitoring and control, attack intensity, and attack degree regarding the diseases caused by *Plasmopara viticola*, *Unciunula necator* and *Botrytis cinerea* in 2023 //*Monitorizarea și controlul bolilor, intensitatea atacului, gradul de atac al patogenilor Plasmopara viticola, Unciunula necator și Botrytis cinerea în anul 2023*

Growth Phase and Date of Pest Observation	Pest (Common Name)	Attack Intensity (%)	Attack Grade (%)	Pest Monitoring Method	Pest Control Method
Shoots 15-20 cm	*Downy Mildew*	2.2	0.1	Field Observations, Meteorological Station Alerts	Kocide 2000 W (copper hydroxide 53.8%) 1.5kg/ha
Shoots 15-20 cm	*Downy Mildew*	2.98	0.3	Field Observations, Meteorological Station Alerts	Kocide 2000 W (copper hydroxide 53.8%) 1.5kg/ha
Pre-flowering	*Downy Mildew*	0.56-	0.07-	Field Observations, Meteorological Station Alerts	Kocide 2000 W (copper hydroxide 53.8%) 1.5kg/ha
Pre-flowering	*Downy Mildew*	-	-	Field Observations, Meteorological Station Alerts	Kocide 2000 W (copper hydroxide 53.8%) 1.5kg/ha
Post-flowering	*Downy Mildew*	1.89	0.20	Field Observations, Meteorological Station Alerts	Kocide 2000 W (copper hydroxide 53.8%) 1.5kg/ha
Post-flowering	*Downy Mildew*	10.6	1.02	Field Observations, Meteorological Station Alerts	Kocide 2000 W (copper hydroxide 53.8%) 1.5kg/ha
Post-flowering	*Gray Mold*	11.32	0.86	Field Observations, Meteorological Station Alerts	Zytron (20% citrus seed extract) 1.5 l/ha
Berry development (veraison)	*Downy Mildew*	-	-	Field Observations, Meteorological Station Alerts	-
Berry ripening	*Powdery Mildew*	10.6	1.02	Field Observations, Meteorological Station Alerts	Mycrothiol Special (80% sulfur) 3 kg/ha
Berry ripening	*Gray Mold*	10.00	0.56	Field Observations, Meteorological Station Alerts	Zytron (20% citrus seed extract) 1.5 l/ha
Berry compactness	*Downy Mildew*	3.48	0.22	Field Observations, Meteorological Station Alerts	Cuproxat flowable (copper from copper sulfate tribasic) 1.5 l/ha
Berry compactness	*Downy Mildew*	-	-	Field Observations, Meteorological Station Alerts	Cuproxat flowable (copper from copper sulfate tribasic) 1.5 l/ha
Entering veraison	*Downy Mildew*	2.04	0.30	Field Observations, Meteorological Station Alerts	Cuproxat flowable (copper from copper sulfate tribasic) 1.5 l/ha
Entering veraison	*Powdery Mildew*	6.0	0.78	Field Observations, Meteorological Station Alerts	Kumulus DF (80% sulfur), 3 kg/ha
Entering veraison	*Gray Mold*	11.32	0.86	Field Observations, Meteorological Station Alerts	Zytron (20% citrus seed extract), 1.5 l/ha
Entering veraison	*Powdery Mildew*	6.0	0.58	Field Observations, Meteorological Station Alerts	Mycrothiol Special (80% sulfur), 3 kg/ha
Entering veraison	*Gray Mold*	11.25	1.44	Field Observations, Meteorological Station Alerts	Zytron (20% citrus seed extract), 1.5 l/ha

Powdery Mildew emerged late in 2023, affecting the grape berry compacting phase and early ripening phase, with an attack rate of 0.48% on Columna grapes and 0.68% on Fetească neagră grapes. Concurrently, during the first half of June, *Downy Mildew* intensified post-flowering and early berry development, recording rates of 1.4% on Columna and 1.8% on Fetească neagră grapes.

Throughout the year, all grape varieties faced susceptibility to *Gray Mold*, notably evident from late August. The intensity heightened in mid-September, coinciding with morning humidity levels of 90-100%. Attack rates ranged from 0.4% on Columna grapes to 0.9% on Fetească neagră grapes.

Regarding the yield data from 2022-2023 across experimental variants (V1, V2, and V3) for Fetească neagră and Columna grape varieties: all variants witnessed a notable increase in yield for both grape varieties, with V3 consistently yielding the highest production. For Fetească neagră, V3 yielded 2.40 kg per vine, and for Columna, V3 yielded 2.22 kg per vine. However, despite challenges from *Downy Mildew*, *Powdery Mildew*, and *Gray Mold*, the yield remained relatively stable across all experimental variants. While V3 had a greater yield, both V1 and V2 had almost a similar yield to V3, indicating that using flower mixes (V1) or maintaining natural flora with mowing intervals (V2) may increase biodiversity and contribute to natural pest and disease control without affecting yield, highlighted in Table 5.

Table 5: Average grape yield (Kg/vine) for Fetească neagra and Columna varieties across experimental variants in 2022 and 2023 //*Producția medie (kg/ha)la soiurile Fetească neagră și Columna per variante experimentale*

Year	Variety	Area (ha)	Experimental Variant	Average Yield (Kg/vine)
2022	Fetească neagră	0.86	V1	2.24
			V2	2.36
			V3	2.40
	Columna	2.39	V1	2.20
			V2	2.20
			V3	2.22
2023	Fetească neagră	0.86	V1	1.22
			V2	1.22
			V3	1.22
	Columna	2.39	V1	1.30
			V2	1.28
			V3	1.30

CONCLUSIONS

Temperature trends and Thermal balance: The viticultural year 2022-2023 experienced significantly higher temperatures compared to historical averages, with monthly averages exceeding the norm by 3,3°C. This led to an overall thermal surplus of 779.8°C, indicative of optimal conditions for grape ripening. The active and effective thermal balances surpassed those of a normal year, promoting quality grape production.

Precipitation and Water management: Despite a rainfall deficit of 318.1 mm, unevenly distributed precipitation and below-average rainfall during the growing season were observed. This necessitated supplemental irrigation, especially in regions like Murfatlar where the hydrothermal coefficient dropped to 0.4, highlighting the need for water management strategies to mitigate drought stress.

Environmental influences on Pest activity: fluctuations in humidity, wind intensity, and sunshine hours influenced the prevalence of diseases and pests, notably *Lobesia botrana* and various mildews. Effective pest surveillance and control measures were implemented, utilizing pheromone traps and targeted chemical interventions to manage infestations and minimize crop losses.

Yield and Biodiversity: despite pest pressures, all experimental variants exhibited increased grape yields, with variant V3 consistently outperforming others. Maintaining biodiversity through flower mixes or natural flora management (variants V1 and V2) demonstrated potential for natural pest and disease control without compromising yield, indicating the importance of ecological approaches in viticulture.

Varietal performance and Climate adaptation: varieties like Fetească neagră and Columna exhibited resilience to environmental stressors, maintaining stable yields despite disease challenges. Climate indices such as the oenoclimatic aptitude index (IAOe) and Huglin heat sum index further underscored the suitability of the climate for grape cultivation, particularly for red wine production.

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ESTABLISHING THE MOST APPROPRIATE METHODS OF PLACEMENT OF EXPERIENCES IN THE VINE NURSERY

STABILIREA CELOR MAI CORESPUNZĂTOAREA METODE DE AȘEZARE A EXPERIENȚELOR ÎN ȘCOALA DE VIȚE

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Abstract
The research was carried out during the 2023 wine year, in the vine nursery of the Research and Development Station for Viticulture and Oenology Drăgășani. The object of study of this paper is the improvement of the experimental technique in the vine nursery. Scientific research is a field of great complexity and importance based on a high level of professionalism that widens the area of coverage and scientific knowledge. The indisputable paradox of science is that with the expansion of knowledge, the number of enigmas or unknown elements that need to be clarified also increases. The objectives of scientific research in general and agro-biological research in particular are changing, in a continuous dynamic, dependent on the evolution of the material base and the demands of society. Scientific research in the field of plant culture is very complex due to the multitude of problems as a result of existing biodiversity within species and genera, specific culture technologies, the environment or the ecological habitus. In order to contribute to the development of applied biological sciences (in the present case of plant culture), scientific experimentation must extend its methods from observations and experiments to theoretical elaborations (theories) with practical value in which mathematical statistics has a considerable role.

Keywords: *experimental plot, experimental variants, repetitions of the experience*

Rezumat
Cercetările s-au efectuat pe perioada anului viticol 2023 în pepiniera Stațiuni de Cercetare Dezvoltare pentru Viticultura și Vinificație Drăgășani. Obiectul de studiu al aceste lucrări îl constituie îmbunătățirea tehnicii experimentale în școala de vițe altoite. Cercetarea ştiinţifică este un domeniu de mare complexitate şi importanţă bazat pe un înalt profesionalism care lărgeşte aria de cuprindere şi cunoaştere ştiinţifică. Paradoxul de necontestat al ştiinţei este că odată cu lărgirea cunoaşterii creşte şi numărul enigmelor sau al elementelor necunoscute care necesită a fi lămurite. Obiectivele cercetării ştiinţifice în general şi a celei agro-bologice în special sunt schimbătoare, într-o continuă dinamică, dependentă de evoluţia bazei materiale şi de pretenţiile societăţii. Cercetarea ştiinţifică din domeniul culturii plantelor este foarte complexă datorită multitudinii de probleme ca urmare a biodiversităţii existente în cadrul speciilor şi genurilor, a tehnologiilor specifice de cultură, a mediului sau habitusului ecologic. Pentru a contribui la dezvoltarea ştiinţelor biologice aplicative (în cazul de faţă al culturii plantelor) experimentarea ştiinţifică trebuie să-şi extindă metodele de la observaţii şi experimentări la elaborării teoretice (teorii)cu valoare practică în care statistica matematică are un rol considerabil.

Cuvinte cheie: *lot experimental, variante experimentale, repetiții ale experientei*

INTRODUCTION

With the aim of obtaining the most different distribution of variants on the surface of the experimental field, some researchers (Behrens, 1956) propose a directed (fair) randomization based on the following criteria: avoiding, as much as possible, diagonal touching of plots occupied by the same variant; reduction of pairs of variants in the sense that the variants that are adjacent in one repetition are no longer placed next to each other except rarely in the other repetitions; each variant must be present only once in the same column. This fair distribution is disputed, because it introduces subjectivity to a certain extent in the distribution of the variants and makes the error calculation inapplicable, which requires that the variants be distributed according to the law of probability, strictly at random.

The production differences of the plots in the experimental field are mainly caused by the action of three factors: the experimental variant, the non-uniformity of the soil fertility and the accidental errors. The different methods of laying out the experiments are intended to allow the separation of the effect of these three factors, thus making it possible to establish the real value of each experimental variant. In this sense, it is very important to separate from the total error, the variations due to the unevenness of the soil. The different methods of setting up the experiments, depending on the way the parcels are grouped, allow the calculation and elimination of the errors due to the unevenness of the soil from the obtained results.

The method of placing in randomized blocks, which has the plots grouped in one direction, allows simple control of the influence of soil fertility from one block to another in this direction. The square and Latin rectangle layout methods, which have the parcels grouped in two perpendicular directions, allow a double control of the influence of soil fertility, horizontally in the direction of the blocks and vertically in the direction of the columns.

MATERIAL AND METHOD

The surest means of reducing the influence of large production variations from plot to plot is the use of an optimal number of plots with the same treatment, i.e. repetitions and vines in the elementary plot of a suitable number of variants and a technique of statistical calculation.

In order to obtain the production data necessary for the application of the analysis, an experimental plot of 10,000 grafted cuttings of the Negru de Drăgășani/Kober 5 BB variety was created. These plots were divided into 10 blocks of 60, respectively 50 elementary plots. In each elementary plot, 100 grafted cuttings were planted on a single portion of the plot.

To obtain the production data necessary for the application of variant analysis, they have. Establishing the resistance to the attacks of diseases and pests is done according to the frequency and intensity of the attack. The respective determinations are made at the moment of maximum intensity of the attack and can also be expressed by assigning grades from 1 to 9. The frequency of the attack (F %) represents the number of attacked plants in the plot (n) in relation to the total number of plants analyzed (N), or the number of attacked organs of the plant (n) relative to the total number of analyzed organs (N) and is calculated with the formula:

$$F = n/N \times 100$$

Attack intensity (I %) represents the percentage in which a plant or its organ is attacked, or the production loss recorded by a plant or plots. The intensity of the attack can be expressed both qualitatively and quantitatively. The qualitative estimate of the intensity of the attack is made according to the formula:

$$I\% = \sum(i \times f)/n,$$

in which: I - the percentage of the attack on the plant or organ; f - the number of plants or organs that present a certain percentage of attack; n - the total number of plants or organs attacked. The quantitative estimate of the intensity of the attack, respectively of the production loss recorded by the plant or plot is calculated with the formula:

$$I\% = (1-b/a) \times 100,$$

in which: a – the production of the unattacked plant or plot; b – the production of the attacked plant or plot. Based on the values of the frequency (F %) and the intensity of the attack (I %), the degree of damage (Gd) is calculated, with the formulas:

$$Gd\% = F \times 1/100; \text{ or } Gd\% = \sum(i \times f/N)$$

The resistance to falling or breaking of the stem is appreciated by assigning marks from 0 to 9, depending on the percentage of fallen plants (in general, in species cultivated in dense rows) or of plants in which the stems broke (in species cultivated in rare cases).

In order to establish the most appropriate methods of placing the experiences, the following indicators were determined through statistical calculations applied to the scheme with hypothetical variants:

- the minimum amount of production to count on
- the optimal number of grafted vines to be planted in an elementary plot

In order to establish the most appropriate methods of placing schemes with hypothetical variants, which must be counted on in order to have as many chances as possible of obtaining vine that must be planted in an elementary plot.

The statistical method adopted to achieve these objectives, the most used and the most recommended were analyzed in this way.

In order to estimate the minimum production increments that must be obtained depending on their types and the size of the elementary parcels, some new statistical indicators were compared to x and Dl, which were called tests the fact that in the statistical calculation scheme, to establish s2E, a SPV is subtracted, which in the hypothetical variants is not due to treatments but to errors. Because of them, the amplitudes of the variants result, the bigger the errors are. Therefore, if a treatment were to overlap the hypothetical variant with the lowest value or one of the variants with values lower than x, the production increments established compared to a variant without any treatment (control) with values above the average or possibly with the highest value, they will not stand out unless they exceed a certain value. However, if the control overlaps the hypothetical variant with the lowest value, unreal increases stand out, especially in cases where some treatments with reduced effects coincidentally overlap one of the variants with high initial values. Starting from s2V, a new index was calculated - to compensate for the amplitude of the variants - called CA for short. For this purpose, the recommended formulas were used to calculate its and Dl. To establish the t-values with the help of the tables, the GLs corresponding to the number of variants in the analyzed scheme were taken into consideration.

The formulas adopted are: $sV=\sqrt{(2s^2 V)/n}$; $CA=sV\times t$.

From the summation of CA and Dl α results the test a. So $\alpha=CA+Dl$. what must be calculated in an experiment in order to have a chance of obtaining real differences compared to the control, is calculated with the help of the β test, according to the formula: $\beta=1/2CA+Dl+\bar{x}'$, in which $\bar{x}'$ = the average of the increments calculated for each individual variant.

(x) what would result if the treatments were applied, because the differences.

RESULTS AND DISCUSSIONS

The minimum amount of production that must be counted for significant differences.

As can be seen from Tables 1 and 2, in order to have as many chances as possible for the variant with the lowest initial value, but which was 0 significant difference compared to the variant with the highest initial value in the hypothesis that it will count only on 0 increase in production equal to the value of the test α which in the example taken is of 12.6% (Table 1), but on an increase equal to the value of the test α., respectively of 14.8% (Table 2).

The latter condition is necessary for a probability $=(100\times1)/v$,, which in the given example is equal to 10. It therefore means that in a, it should not come out. In 90% of cases, however, it is sufficient for the increase to be identical, even if it were applied to elementary plots with potential expected duction must be at least equal to the test value β.

So it turns out that testing with the help of the a and β tests is a method of placing experiences in the vine nursery.

Table 1. Synthesis of results after application in Latin square 10x10 / Sinteza rezultatelor după aplicarea în pătrat latin 10x10

The order number of the variants depending on the production / Nr. de ordine al variantelor in funcție de producție	**Hypothetical variants /** Variante ipotetice	**Production (vine yield) /** Productia (randament vițe)	$\bar{d}$	**The meaning of the differences /** Semnificatia diferentelor	**The value of the surcharges applied /** Valoarea majorarilor aplicate
I	V_5	68,80	+	-	0
II	V_3	67,90	+	-	4,83
III	V_7	67,30	+	-	4
IV	V_1	67,12	+	-	6
V	V_6	67,12	+	-	3
-	$\bar{x}$	66,67	-	-	5,2
VI	V_{10}	66,10	-	-	6
VII	V_2	65,67	-	-	7
VIII	V_8	66,23	-	-	5
IX	V_4	64,80	-	-	7
X	V_9	65,40	-	-	7,5

Dl 5% = 4,2   Dl 1% = 5,6
CA 5% = 4,0   Dl 0,1% = 7,3
α = 8,2 $\bar{x} = \sum \pm \bar{d} = 5,2$
α relatively, reported to V_4 = 12,6%
α relatively, reported to $\bar{x}$ = 12,3%

Table 2. Synthesis of results after settling in latin square / Sinteza rezultatelor după așezarea în pătrat latin 10x10

The order number of the variants depending on the production / Nr. de ordine al variantelor in funcție de prod	**Hypothetical variants /** Variante ipotetice	**Production (vine yield)** Producția (randament vițe)	$\bar{d}$	**The meaning of the differences /** Semnificația diferențelor	**The value of the surcharges applied /** Valoarea majorărilor aplicate
I	V_5	68,80	+ 2,20	-	0
II	V_3	67,90	+1,30	-	6,0
III	V_7	67,30	+0,70	-	3
IV	V_1	67,12	+0,50	-	3
V	V_6	67,12	+0,50	-	6
-	$\bar{x}$	66,60	-	-	5,2
VI	V_{10}	66,10	-0,50	-	5
VII	V_2	66,10	-0,60	-	6
VIII	V_8	66,00	-1,00	-	5,4
IX	V_4	65,30	-1,30	-	8
X	V_9	64,80	-1,80	-	9,6

Dl 5% = 5,6   Dl 1% = 4,2
CA 5% = 4,0   Dl 0,1% = 7,3
α = 9,6 $\bar{x} = \sum \pm \bar{d} = 5,2$
α relatively, reported to V_4 = 14,8 %
α relatively, reported to $\bar{x}$ = 14,4 %

The optimal number of grafted cuttings to be planted in an elementary plot.

As can be seen from Table 3 with the results obtained at the Research and Development Station for Viticulture and Oenology Drăgășani, the optimal number of grafted cuttings to be planted in one of the α test is in the Latin squares 10x10 and 8x8 of 500 pcs.

It turned out that they are not acceptable for experience in vine nursery in the elementary plot.

In the blocks with a large number of repetitions, such as the 12x10 rectangle types, it can be deduced that for verification experiments, in the elementary plot, 700 grafted cuttings would be planted, the times are almost reduced.

Because for the organization of the experiences in this category, there are also the other indicators, it was established taking into account this condition.

Mentions that in the 10x10 square with 700 grafted cuttings plot. Moreover, and by extrapolation, using the series of analyzes with the plot of 600 grafted cuttings with soil, it turned out that in order to obtain low values of the a and C test, 500 grafted cuttings are needed in the elementary plot, and to make it mandatory that this plot to be 700 grafted cuttings,production pores very difficult or even impossible to obtain. country as being optimal, it becomes useless, the Latin squares 8x8 and 10x10 with 700 grafted cuttings in the elementary plot from reference values, for all other methods and types of methods of the production increments that can be obtained by applying fertilizers.

Therefore, it follows that both for the experiments without isolations and for the settlement methods (Latin squares 10x10 and 8x8) the optimal number of grafted cuttings in the plot - for which isolations are necessary.

Table 3. The influence of the number of grafted cuttings from the elementary plot without isolation on the test α values depending on the placement method and the number of variants and repetitions / Influența numărului de vițe altoite din parcela elementară fară izolare asupra valorilor testului α in funcție de metoda de așezare și numărul variantelor și al repetițiilor

Type of placement method / Tipul metodei de așezare	**No. of grafted cuttings in the elementary plot (hundreds) /** Nr de vițe din parcela elementară (sute)	**No. of analyzes performed /** Nr. de analize efectuate	x^{-}	**Ca 5%**	**Dl 5 %**	**A**
				% in relation to x- / % în raport cu x^{-}		
Latin square / Pătrat latin						
10x10	1	5	66,60	15,55	11,53	27,07
	2	3	67,01	9,35	8,92	18,26
	3	14	66,82	7,76	7,43	15,14
	4	4	66,30	6,31	7,57	13,87
	5	16	66,78	6,55	5,93	12,45
	6	8	66,81	7,26	6,30	13,57
	7	5	66,78	7,67	6,48	14,15
8x8	1	8	66,17	11,22	16,43	27,65
	3	12	66,53	7,69	7,74	15,42
	5	12	67,30	6,41	6,03	12,44
	7	20	67,61	6,55	5,75	12,29
5x5	1	6	65,93	22,20	17,79	40,41
	3	4	65,64	10,12	11,50	21,62
	5	4	66,60	12,06	8,56	20,63
	7	4	66,80	9,22	8,12	17,34
	10	4		10,61	7,41	18,00
Latin rectangles / Dreptunghiuri latine						
20x10	1	1	65,79	7,222	13,39	20,61
	3	1	66,81	9,08	9,20	18,27
12x6	3	8	66,45	11,23	9,12	20,35
	5	8	67,04	9,37	8,52	17,98
20x5	3	2	66,80	13,86	15,05	28,91
15x5	3	2	66,08	10,82	11,53	22,34
	4	2	66,69	13,31	9,78	23,10
10x5	3	8	66,41	12,04	10,69	22,73
	5	8	66,79	10,11	10,43	20,54
8x4	3	4	65,43	16,13	17,38	33,51
	5	4	64,99	14,05	11,09	25,15
Block / Blocuri						
12x10	5	2	66,80	6,73	7,86	14,58

5x10	5	4	66,59	8,11	7,84	15,94
12x5		1	63,32	15,77	23,46	39,27
6x5		1	67,10	12,80	11,62	24,52
		1	66,73	10,60	12,96	23,55
6x4		2	66,15	14,31	14,31	28,60
5x4		5	64,60	19,57	20,54	40,12

CONCLUSIONS

The following conclusions can be drawn from the results of the statistical analyzes presented in this paper:

- the most appropriate methods of placing the experimental variants are Latin squares with a maximum of 12 variants and a minimum of 8.
- in order to be able to count with the greatest certainty on the experimental results, an experiment must be repeated in the same year at least 3-4 times.
- in order to obtain the most correct results for the safety of obtaining some differences, the production increments must be at least equal to the test values α.

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THE INFLUENCE OF CLIMATE CHANGE ON THE PHENOLOGICAL DEVELOPMENT OF GRAPEVINE VARIETIES IN THE ASSORTMENT OF THE IASI VINEYARD

INFLUENŢA SCHIMBĂRILOR CLIMATICE ASUPRA DESFĂŞURĂRII SPECTRULUI FENOLOGIC LA SOIURILE DE VIŢĂ-DE-VIE DIN SORTIMENTUL PODGORIEI IAŞI

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Abstract
In recent decades, a trend of modification in the evolution of climatic factors has been observed, making it increasingly difficult to accurately predict the onset of vegetative phenophases in grapevines. Establishing and continuously updating climate and phenological databases constitute a starting point for issuing possible scenarios in the context of climate change, as well as an important stage in optimizing the zoning of grapevines. The paper presents climatic data from the viticultural ecosystem of the Iasi vineyard recorded between 2000 and 2023, based on which a series of bioclimatic indices and coefficients were calculated, as well as their influence on the development of vegetative phenophases and the productive potential of the main grapevine varieties in the assortment. The dynamic analysis of the phenological spectrum, closely correlated with the evolution of specific climatic factors in the Iasi vineyard, has highlighted that it was conditioned both by the level and action of climatic factors and by the hereditary specificity of the cultivated varieties. The increase in temperature values (annual average temperature, average temperature in the first and second decades of June, average temperature in July, etc.) has led to the advancement of the onset of phenophases and the shortening of their duration, especially in drought years.

Keywords: *climate change, phenology, grapevine*

Rezumat
În ultimiile decenii s-a constatat o tendinţă de modificare în evoluţia factorilor climatici, ceea ce face tot mai dificilă prognozarea exactă a momentului declanşării fenofazelor de vegetaţie la viţa-de-vie. Realizarea şi actualizarea permanentă a bazelor de date climatice şi a celor fenologice, constituie un punct de plecarea în emiterea unor scenarii posibile în contextul schimbărilor climatice, precum şi o etapă importantă în optimizarea zonării viţei-de-vie. În lucrare sunt prezentate datele climatice din ecosistemul viticol al podgoriei Iaşi înregistrate în perioada 2000 – 2023, pe baza cărora s-au calculat o serie de indici şi coeficienţi bioclimatici, precum şi influenţa asupra desfăşurării fenofazelor de vegetaţie şi a potenţialului productiv la principalele soiuri de viţă-de-vie din sortiment. Analiza în dinamică a spectrului fenologic, în strânsă corelaţie cu evoluţia factorilor climatici specifici podgoriei Iaşi, a evidenţiat faptul că acesta a fost condiţionat atât de nivelul şi acţiunea factorilor climatici cât şi de specificul ereditar al soiurilor cultivate. Creşterea valorilor temperaturilor (temperatura medie anuală, temperatura medie din decadele I şi II ale lunii iunie, temperatura medie din luna iulie, etc.), a determinat devansarea momentului declanşării fenofazelor şi scurtarea duratei de derulare a acestora, cu precădere în anii secetoşi.

Cuvinte cheie: *schimbări climatice, fenologie, viţă-de-vie*

INTRODUCTION

Climate change, currently manifesting globally, according to expert opinion, will be increasingly pronounced in the coming decades and will clearly influence the biology of horticultural species, especially grapevine. As a result, significant changes will occur in the zoning of grapevine varieties and rootstocks (Condei et al., 2017).

In recent times, the existence of climate databases, as well as the use of phenological observations, both concerning climate change and various fields of activity (agriculture, viticulture), has become of great importance (Sparks et al., 2000; Scheifinger et al., 2002). A long-term study of the dynamics of vegetative phenophases in close correlation with environmental conditions is one of the best ways to quantify climate change (Duchêne et al., 2010; Jones GV et al., 2010; Schultz H.R et al., 2010; Tomasi D. et al., 2011; Sadras and Moran, 2012; Biasi R. et al., 2019).

In the last decades, the effects of climate change have been increasingly felt in Romania, through increased incidence of frost, drought, and floods, generating a negative impact on crop productivity and reducing the biodiversity of fauna and flora. A particularly notable trend is the increase in average temperature during the growing season, especially in June, July, and August, and the number of days with temperatures above 30°C (Bucur G. M. and Dejeu L. 2014; Chiriac Cristina, 2007; Dobrei A.G. et al., 2015; Irimia L.M. et al., 2017; Nistor E. et al., 2019, etc.). Pluviometrically, there is a trend of decreasing annual precipitation amounts and a change in distribution during the growing season (Dumitrescu A et al., 2015). Recent studies also point to a shift in the favorable growing zone of grapevine cultivation towards the north of the country, an increase in the suitability of red varieties for cultivation in certain areas sometimes to the detriment of white ones, and changes in the productive potential of varieties (Irimia L.M., et al., 2014, 2017, 2018).

In this context, the aim of this study is to highlight the climate changes of the past 24 years recorded in the Copou viticultural ecosystem, Iasi vineyard, namely the increase in average annual temperature, decrease in precipitation regime, increase in the frequency of drought years, and the impact on the phenological spectrum of grapevine varieties in the assortment.

MATERIALS AND METHOD

To study the impact of climate change on the development of vegetative phenophases in case of 15 grapevine genotypes for table and wine grapes, predominantly cultivated in the Copou-Iași viticultural center, climatic and phenological data recorded over the past 24 years (2000 - 2023) were analyzed.

For recording phenological stages such as budburst, flowering, berry set, and grape ripening, the BBCH scale was used (Lorenz et al., 1994), and the climatic analysis was based on a series of daily meteorological parameters (temperatures, precipitation) recorded at the weather station of the Iasi County Directorate for Agriculture and Rural Development (SCDVV Iasi) located in the northern part of the municipality of Iasi, at an altitude of 191 m, 47°12'18" north latitude, and 27°32'04" east longitude. The analyzed period aimed at a series of homogeneous data, based on which a series of multi-year bioclimatic coefficients and indicators used in viticulture were calculated: thermal coefficient (CT), hydrothermal coefficient (CH), Martonne aridity index (IDM), precipitation coefficient (CP), real heliothermal index (IHr), grapevine bioclimatic index (Ibcv), oenoclimatic suitability index (IAOe), and Huglin heliothermal index (IH).

REZULTS AND DISCUSSIONS

The climatic factors in the ecosystem directly influence vegetative development, as well as the quantity and quality of production. Climatic analysis over the past 24 years indicates an *average annual temperature* (Ta°C) of 10.6°C, with a maximum value of 12.2°C in 2023 and a minimum of 9.5°C in the years 2001 and 2003, with significant warming observed mainly in winter and summer seasons (Table 1).

The average temperature in the first and second decades of June (Tmed dec. I_II June°C), an important factor in triggering, intensity, and duration of flowering, averaged 20.0°C, with a minimum of 16.9°C in 2006 and a maximum of 22.8°C in 2007.

The average temperature in the warmest month, July (Tmed July°C), which is a criterion for assessing conditions for improving grape quality, averaged 22.4°C, with a trend of increase in recent years reaching a maximum value of 25.4°C in 2012, favoring the accumulation of high concentrations of sugars, aromas, color, phenolic substances, etc.

T*he average maximum temperatures in August (Med. Tmax August, °C)* constitute a restrictive factor only when exceeding 34.0°C. In our country's conditions, they range between 24.5°C and 30.0°C (Oşlobeanu M., et al., 1991). In Iasi, the average value over the past 24 years has been 28.5°C, with a maximum of 31.9°C in 2023 and a minimum of 25.0°C in 2007.

Table 1. The values of the main climatic elements in the Iaşi vineyard region (2000 – 2023) / Valorile principalelor elemente climatice din podgoria Iaşi (2000 – 2023)

Year	T_a,°C	Tmed dec. I_II June, ° C	T_{med} Iuly, °C	T_{med} August,°C	T_{med} September, °C	Med. T_{max} August, °C	No. days Tmax>30°	Pa, mm	Pv, mm	Ir growing season, hours	DPV, days
2000	11.0	19.9	21.9	22.3	14.2	31.1	48	399.7	269.2	1593.1	174
2001	9.5	17.6	22.1	21.4	15.5	29.4	31	748.0	533.2	1512.9	187
2002	10.3	18.3	23.0	20.2	14.9	25.9	18	602.3	432.0	1416.1	185
2003	9.5	21.9	21.2	21.2	15.1	27.6	31	485.4	293.5	1603.2	175
2004	10.0	18.8	21.5	19.8	15.0	25.6	9	593.5	386.1	1467.0	174
2005	9.8	17.9	21.6	20.5	16.6	27.1	20	646.1	433.9	1461.2	170
2006	9.6	16.9	21.5	21.0	16.2	26.8	28	500.2	341.5	1491.6	178
2007	11.5	22.8	25.0	22.0	15.3	25.0	60	523.5	283.6	1491.3	165
2008	10.9	19.1	20.9	21.6	14.7	28.7	21	707.3	532.5	1350.6	167
2009	10.9	20.5	23.1	21.2	17.6	27.5	34	493.7	214.0	1521.7	182
2010	10.0	21.6	22.9	23.4	15.0	29.7	34	674.3	419.9	1336.7	169
2011	9.8	20.7	22.1	20.9	17.8	26.8	20	493.1	390.8	1472.4	173
2012	10.4	22.2	25.4	22.6	18.6	29.3	55	535.9	287.1	1499.1	175
2013	10.3	19.5	20.5	21.2	14.2	27.3	14	656.1	501.1	1426.1	167
2014	10.3	18.8	21.5	21.6	16.9	28.5	22	618.0	377.1	1405.2	189
2015	11.5	21.9	23.6	23.5	18.9	30.3	50	365.5	180.6	1513.3	174
2016	11.0	18.9	23.1	21.8	18.5	29.1	53	646.8	333.8	1513.1	175
2017	10.8	20.3	21.8	22.8	17.1	29.8	39	546.6	293.4	1580.4	180
2018	10.6	21.8	21.2	22.9	16.7	29.7	34	727.8	450.8	1504.1	180
2019	11.6	22.3	21.5	22.5	17.4	29.5	46	478.7	323.4	1482.3	165
2020	12.0	20.0	22.7	23.5	19.6	30.5	47	547.4	300.0	1524.1	169
2021	10.1	17.6	23.4	20.9	14.7	27.6	31	593.4	408.8	1351.6	157
2022	11.3	21.4	23.2	22.5	15.5	44.6	39	416.8	295.8	1369.1	168
2023	12.2	19.6	23.0	24.6	19.9	31.9	43	509.1	349.3	1417.8	180
Average	**10.6**	**20.0**	**22.4**	**21.9**	**16.5**	**28.5**	**34.5**	**562.9**	**359.6**	**1471.0**	**174**

The sum of sunshine hours during the growing season (Ir in the growing season, hours), under normal ecoclimatic conditions, in the vineyards and viticultural centers of our country ranges between 1200 and 1600 hours. Values below 1200 hours are considered restrictive. This parameter recorded an average value of 1471.0 hours, with a maximum of 1603.2 hours in 2003 and a minimum of 1336.7 hours in 2010.

The duration of the bioactive period (DPV, days), when the average daily temperature is higher than 10°C in the interval from April 1st to September 30th, has a minimum of 160 days in our country's conditions. In the analyzed period, this averaged 174 days and ranged between 157 and 189 days.

Another vegetation factor influencing grapevine growth and development is humidity. Excessive rainfall negatively affects the flowering phase, leading to frequent phenomena of millerandage and shot berries, reducing the percentage of fruit set. In the berry ripening phase, excessive rain can lead to berry cracking.

During periods of precipitation deficit, shoot growth is slowed, berries remain small and wither, and both quantitative and qualitative yields are reduced. In recent years, there has been a reduction in precipitation volume, especially during the growing season, and a very uneven distribution of rainfall. In the studied period, the lowest quantity was 180.6 mm in 2015, and the highest was 533.2 mm in 2001.

High temperatures and drought resulting from climate change have also significantly modified multi-year bioclimatic coefficients and indicators, directly correlated with the average annual temperature, active thermal balance (Σ tºa), useful thermal balance (Σ tºu), actual insolation, total annual precipitation, and precipitation during the growing season (Table 2).

The assessment of the thermal resources of a vineyard or the requirements of a grapevine variety can be done through the sum of temperature degrees (thermal balances), which can be calculated for the entire growing season or for a specific phenophase, as the sum of temperature necessary to complete that phenophase. Thus, *the global thermal balance (Σtºg)* for the period 2000 - 2023 had an average value of 3323.4°C, indicating that in the Copou-Iasi viticultural center, conditions for grape ripening until maturity epochs V and VI are ensured.

Table 2. The values of the main synthetic bioclimatic indicators in the Iasi vineyard (2000 – 2023) / Valorile principalilor indicatori cu caracter sintetic din podgoria Iași (2000 – 2023)

Year	∑t°g	∑t°a	∑t°u	CT	CH	Iar_{DM}	CP	IHr	Ibcv	IAOe	IH
2000	3329.5	3268.4	1528.4	18.8	0.8	19	1.5	2.4	11.1	4842.3	2298.3
2001	3129.4	2984.1	1316.1	16.0	1.8	38	2.9	2.0	4.5	4231.8	2006.9
2002	3232.7	3133.4	1403.4	16.9	1.4	30	2.3	2.1	5.6	4367.0	2017.4
2003	3325.8	3241.7	1561.7	18.5	0.9	25	1.7	2.5	10.1	4828.4	2215.7
2004	3099.9	3038.4	1298.4	17.5	1.3	30	2.2	1.9	6.6	4369.3	1900.4
2005	3156.2	3063.4	1363.4	18.0	1.4	33	2.6	2.0	6.1	4340.7	1998.6
2006	3188.8	3108.4	1378.4	17.5	1.1	25	1.9	2.1	7.6	4508.5	2018.3
2007	3493.3	3342.2	1692.2	20.3	0.8	24	1.7	2.5	10.6	4799.9	2406.1
2008	3169.4	3039.7	1369.7	18.2	1.7	34	3.2	1.8	4.6	4107.8	1994.0
2009	3397.5	3305.9	1575.9	18.2	0.6	24	1.2	2.4	12.9	4863.6	2229.3
2010	3349.2	3287.7	1527.7	19.5	1.3	34	2.5	2.0	6.2	4454.5	2113.7
2011	3259.8	3130.8	1490.8	18.1	1.2	25	2.3	2.2	6.8	4462.4	2098.3
2012	3652.8	3596.3	1856.3	20.6	0.8	26	1.6	2.8	10.7	5058.2	2541.0
2013	3253.9	3147.1	1467.1	18.8	1.6	32	3.0	2.1	5.4	4322.1	2059.0
2014	3219.0	3076.7	1426.7	16.3	1.2	31	2.0	2.0	7.0	4354.8	2103.0
2015	3488.6	3378.1	1728.1	19.4	0.5	17	1.0	2.6	16.3	4960.8	2406.0
2016	3455.8	3390.6	1630.6	19.4	1.0	31	1.9	2.5	8.8	4819.9	2322.0
2017	3335.8	3216.9	1566.9	17.9	0.9	26	1.6	2.5	9.6	4753.9	2237.0
2018	3535.3	3465.5	1715.5	19.3	1.3	35	2.6	2.6	6.4	4768.8	2408.4
2019	3361.1	3229.5	1579.5	19.6	1.0	22	2.0	2.3	8.9	4638.4	2247.7
2020	3420.2	3312.0	1662.0	19.6	0.9	25	1.8	2.5	9.9	4786.1	2323.2
2021	3124.7	2944.4	1374.4	18.8	1.4	30	2.6	1.9	6.2	4137.2	1978.7
2022	3357.1	3262.2	1582.2	19.4	0.9	20	1.8	2.2	9.0	4585.5	2234.5
2023	3425.5	3273.5	1673.5	18.2	1.1	23	1.9	2.4	8.3	4592.0	2330.6
Average	**3323.4**	**3218.2**	**1532,0**	**18.5**	**1.2**	**27.4**	**2.1**	**2.3**	**8.3**	**4581.4**	**2187.0**

The active thermal balance (∑tºa), considered as the biological threshold for grapevine growth, for the period 2000 - 2023 had an average value of 3218.2°C. *The useful thermal balance (∑tºu)* averaged 1532.0°C. These values indicate that in the Copou-Iasi viticultural center, late-ripening varieties can be cultivated.

The thermal coefficient (CT) showed an increasing trend in recent years (from 16.0 in 2001 to 20.6 in 2012). The values of the thermal coefficient increase directly proportional to the sum of active temperature degrees.

The hydrothermal coefficient (CH) reached a minimum value of 0.5 in 2015 and a maximum value of 1.8 in 2001. The trend of this coefficient is decreasing due to the recording of increasingly lower amounts of precipitation during the growing season. Values below 0.8 of the hydrothermal coefficient justify the necessity of irrigation in vineyards.

The De Martone aridity index (Iar DM) had a minimum value of 17 in 2015 and a maximum of

38 in 2001, indicating that in the Copou-Iasi viticultural center, during the period 2000 - 2023, there were both years classified as "semi-arid climate" and years with "semi-humid" and "humid" climates. *The precipitation coefficient (CP)* recorded an average value of 2.1, with a minimum of 1.0 in 2015 and a maximum of 3.2 in 2008.

The real heliothermal index (IHr) showed an increasing trend during the analyzed period, ranging between 1.8 and 2.8. The increase in these values reflects an increase in heliothermal resources (light and temperature), allowing late-ripening grape varieties to mature.

The grapevine bioclimatic index (Ibcv) in vineyards in our country shows a pronounced variation from a value of 4.0 in northern vineyards to a value of 15.0 in the south. In the analyzed period, this index averaged 8.3, ranging between 4.5 (2001) and 16.3 (2015).

The oenoclimatic suitability index (IAOe) averaged 4581.4 over the last 24 years, predominantly classifying the Iaşi vineyard area for obtaining white and red wines with geographical indication, and in some years, for quality wines with designation of origin.

The Huglin heliothermal index (IH), in the Copou-Iasi viticultural center area, had an average value of 2187.0 during the analyzed period, falling into the "warm temperate climate" class.

The values of synthetic indicators from the Copou-Iasi viticultural center indicate a favorable area for grape cultivation, balanced, with very good favorability for cultivating quality white and red wine varieties.

Observations made during the period 2000 - 2023 regarding the development of vegetative phenophases undergone by the main varieties in the assortment, in direct relation to climatic factors, highlight that they were conditioned by their level and action, as well as by the genetic specificity of the varieties.

Knowing the budburst timing is important in zoning works for grapevine varieties, thus avoiding placing early budding varieties in areas with a high frequency of spring frosts, which, in the temperate continental climate conditions, occur until the end of May. For representative varieties in the assortment of the Iasi vineyard, budburst occurred from the second decade of April to the first decade of May. It occurred earliest on April 10, 2016, for the Fetească albă variety and latest for Cabernet Sauvignon on May 7, 2011 (Table 3).

Table 3. The development of vegetation phenophases in the Iasi vineyard (average of the years 2000 - 2023) / Derularea fenofazelor de vegetatie in podgoria Iași (media anilor 2000 – 2023)

Genotype / Genotip	**The vegetation phenophases /** Fenofaza de vegetație			
	Budburst / Dezmugurit	**Flowering /** Înflorit	**Veraison /** Pârgă	**Ripening /** Maturitate deplină
Aligoté	11.IV – 30.IV	22.V – 20. VI	25.VII – 16.VIII	09.IX – 08.X
Fetească albă	10.IV – 04.V	21.V – 18. VI	21.VII – 15.VIII	02.IX – 29.IX
Fetească regală	11.IV – 01.V	23.V – 20. VI	24.VII – 23.VIII	05.IX – 08.X
Sauvignon blanc	12.IV – 04.V	25.V – 21. VI	25.VII – 19.VIII	05.IX – 08.X
Chardonnay	11.IV – 02.V	23.V – 20. VI	25.VII – 16.VIII	04.IX – 06.X
Muscat Ottonel	12.IV – 02.V	24.V – 22. VI	20.VII – 21.VIII	07.IX – 05.X
Cabernet Sauvignon	17.IV – 07.V	25.V – 22. VI	29.VII – 28.VIII	10.IX – 18.X
Chasselas doré	11.IV – 02.V	25.V – 21. VI	20.VII – 14.VIII	05.IX – 30.IX
Gelu	10.IV – 01.V	24.V – 22. VI	09.VII – 06.VIII	15.VIII – 07.IX
Golia	13.IV – 04.V	25.V – 22. VI	25.VII – 24.VIII	05.IX – 07.X
Arcaş	13.IV – 04.V	24.V – 22. VI	29.VII – 29.VIII	07.IX – 17.X
Mara	13.IV – 04.V	23.V – 18. VI	16.VII – 25.VIII	07.IX – 08.X
Busuioacă de Bohotin cl. 5 Iş	11.IV – 02.V	24.V – 21. VI	22.VII – 23.VIII	05.IX – 10.X
Frâncuşă 14 Iş	10.IV – 01.V	24.V – 23. VI	24.VII – 24.VIII	04.IX – 08.X
Fetească regală 1 Iş	11.IV – 30.IV	23.V – 20. VI	24.VII – 16.VIII	04.IX – 29.IX
Average of the years 2000 – 2023	**10.IV – 07.V**	**21.V – 23.VI**	**09.VII – 29.VIII**	**15.VIII – 18.X**

The useful thermal balance that conditioned the budburst phenophase varied from year to year, with average values of 29.5°C for white varieties and up to 52.2°C for red varieties (Table 4).

Table 4. The evolution of budburst and flowering phenophases from the period 2000 – 2023 / Evoluția derulării fenofazelor de dezmugurit și înflorit din perioada 2000 – 2023

Year / Anul	**Budburst /** Dezmugurit				**Flowering /** Înflorit			
	White varieties / Soiuri albe		**Red varieties /** Soiuri roșii		**White varieties /** Soiuri albe		**Red varieties /** Soiuri roșii	
	Date / Data	**Σ t°useful /** Σ t°utilă	**Date /** Data	**Σ t°useful /** Σ t°utilă	**Date /** Data	**Σ t°useful /** Σ t°utilă	**Date /** Data	**Σ t°useful /** Σ t°utilă
2000	17-Apr	47.4	20-Apr	73.3	27-May	279.9	30-May	292.3
2001	21-Apr	25.4	26-Apr	34.0	9-Jun	230.0	17-Jun	295.4
2002	24-Apr	32.1	30-Apr	50.8	2-Jun	282.9	9-Jun	300.6
2003	29-Apr	30.9	4-May	74.9	3-Jun	374.7	9-Jun	397.6
2004	23-Apr	26.8	27-Apr	35.8	10-Jun	263.0	16-Jun	318.8
2005	23-Apr	30.3	28-Apr	39.0	15-Jun	304.8	19-Jun	338.8
2006	25-Apr	39.9	29-Apr	50.3	13-Jun	249.5	18-Jun	280.9
2007	12-Apr	18.4	28-Apr	30.3	2-Jun	330.3	5-Jun	345.0
2008	14-Apr	25.5	22-Apr	45.6	7-Jun	253.3	12-Jun	286.4
2009	21-Apr	40.8	25-Apr	41.1	2-Jun	242.7	7-Jun	287.5
2010	25-Apr	19.5	30-Apr	33.2	6-Jun	278.9	11-Jun	335.2
2011	28-Apr	34.5	7-May	53.9	5-Jun	270.6	8-Jun	290.4
2012	25-Apr	63.2	2-May	147.9	25-May	257.6	6-Jun	269.0
2013	22-Apr	23.9	27-Apr	68.2	21-May	283.4	30-May	295.7
2014	20-Apr	18.6	27-Apr	47.2	4-Jun	248.9	8-Jun	261.5
2015	21-Apr	27.7	27-Apr	55.4	3-Jun	299.5	9-Jun	344.5
2016	10-Apr	42.9	17-Apr	74.1	2-Jun	255.4	7-Jun	260.8
2017	12-Apr	19.0	27-Apr	31.7	2-Jun	250.8	7-Jun	298.3
2018	14-Apr	60.1	21-Apr	95.5	21-May	267.4	26-May	289.6
2019	22-Apr	15.0	29-Apr	48.7	7-Jun	292.2	11-Jun	308.6
2020	13-Apr	18.7	28-Apr	31.6	8-Jun	243.0	10-Jun	256.6
2021	29-Apr	14.5	30-Apr	18.8	20-Jun	317.7	21-Jun	330.5
2022	21-Apr	28,5	2-May	58,5	4-Jun	279,6	8-Jun	293,5
2023	21-Apr	4,2	27-Apr	13,3	8-Jun	285,7	11-Jun	311,9
X	-	**29,5**	-	**52,2**	-	**276,7**	-	**303.7**

In recent years, due to the increase in air temperature values, there has been a trend of delaying the budburst and shortening its duration. Thus, in drought years, implicitly those with milder winters, budburst occurred in the first and second decades of April (2000, 2007, 2008, 2016, 2017, 2018, and 2020).

For the flowering to occur, grapevine varieties need a certain amount of warmth, with the minimum level for flower opening being 15°C, and the optimum being 25...26°C. High temperatures, above 30°C, around the flowering period, accelerate this phenophase, occurring rapidly over a short period, significantly reducing the gap between varieties (varieties bloom simultaneously). Lower temperatures spread out the flowering over a longer period, extending the duration of the phenophase. Multi-year phenological observations conducted on varieties in the assortment attest that flowering began as early as the end of May in the years: 2000, 2012, 2013, and 2018, while in other years, it occurred in the first and second decades of June (Table 4).

It has been noticed that within the same variety, flowering can last between 6 and 12 days, with the sum of useful temperatures required for the onset of flowering averaging 276.7°C for white varieties and 303.7°C for red ones. There is also a trend of advancement in this phenophase due to increasingly higher air temperatures and a shortening of its duration. Regarding the analyzed varieties, the earliest flowering occurred for the Fetească albă variety on May 21 in 2013 and 2018, followed by Fetească regală and Aligoté. The latest flowering occurred on June 20, 2021, simultaneously for all varieties.

In the Copou-Iasi viticultural center, grape veraison occurred between July 20 (2013) and August 10 (2005) from 2000 to 2023, lasting between 5 and 19 days depending on the variety and year. In drought years, veraison started earlier, in the last decade of July (2003, 2004, 2007, 2009, 2010, 2012, 2013, 2017, and 2018), and occurred over a shorter period, with the latest veraison in the first decade of August (Table 5). The useful thermal balance that conditioned the veraison phenophase ranged from 665.6°C to 740.6°C.

Table 5. The evolution of veraison and ripening phenophases from the period 2000 – 2023 / Evoluția fenofazelor de pârgă și de maturitate deplină în perioada 2000 – 2023

Year / Anul	**Budburst /** Dezmugurit				**Flowering /** Înflorit			
	White varieties / Soiuri albe		**Red varieties /** Soiuri roșii		**White varieties /** Soiuri albe		**Red varieties /** Soiuri roșii	
	Date	**Σ t°useful**	**Date**	**Σ t°useful**	**Date**	**Σ t°useful**	**Date**	**Σ t°useful**
2000	5-Aug	744.1	16-Aug	853.3	17-Sep	433.5	25-Sep	304.2
2001	6-Aug	627.7	24-Aug	778.9	17-Sep	386.6	25-Sep	224.3
2002	1-Aug	697.8	5-Aug	713.1	10-Sep	388.7	28-Sep	400.9
2003	27-Jul	608.5	10-Aug	681.9	14-Sep	455.8	23-Sep	368.6
2004	28-Jul	519.0	6-Aug	551.2	20-Sep	450.5	6-Oct	410.9
2005	10-Aug	618.4	28-Aug	753.6	10-Sep	289.3	30-Sep	232.0
2006	5-Aug	628.1	15-Aug	694.6	20-Sep	403.5	3-Oct	372.3
2007	23-iul	708.9	29-iul	767.0	3-Sep	512.7	16-Sep	484.6
2008	2-Aug	611.7	8-Aug	628.7	15-Sep	458.7	10-Oct	437.5
2009	29-Jul	691.2	5-Aug	740.9	9-Sep	446.9	30-Sep	506.9
2010	25-Jul	589.7	1-Aug	608.9	9-Sep	523.6	16-Sep	477.0
2011	2-Aug	631.7	8-Aug	659.7	20-Sep	497.1	26-Sep	467.1
2012	23-Jul	752.3	1-Aug	804.8	2-Sep	546.7	10-Sep	473.7
2013	20-iul	564.7	31-iul	631.5	10-Sep	528.7	17-Sep	446.1
2014	3-Aug	633.3	12-Aug	718.5	22-Sep	513.3	30-Sep	399.5
2015	4-Aug	768.4	14-Aug	862.3	12-Sep	483.5	23-Sep	426.1
2016	5-Aug	792.1	15-Aug	862.1	10-Sep	419.1	27-Sep	426.5
2017	31-Jul	686.2	12-Aug	816.4	11-Sep	500.5	29-Sep	420.5
2018	21-Jul	665.2	6-Aug	806.8	13-Sep	628.3	3-Oct	530.7
2019	2-Aug	683.3	11-Aug	734.9	13-Sep	500.5	4-Oct	508.5
2020	6-Aug	729.8	9-Aug	751.3	21-Sept	495.8	24-Sep	448.9
2021	6-Aug	608.4	17-Aug	751.6	27-Sept	290,6	18-Oct	271.1
2022	2-Aug	739,9	10-Aug	793,9	21-Sept	493,5	28-Sep	420,1
2023	3-Aug	674,4	16-Aug	808,7	21-Sept	581,5	7-Oct	578,7
X	-	**665,6**	-	**740,6**	-	**467,9**	-	**418,2**

Due to the high air temperatures, the large number of days with maximum temperatures exceeding 30°C in July and August (e.g., 60 days in 2007), and the soil water deficit, there was a clear trend of advancement in the veraison phase.

Grape ripening progressed depending on the variety and climatic conditions. Varieties from the Iasi vineyard assortment reached full ripeness earliest in the first decade of September (Fetească albă and Fetească regală) and latest in the first decade of October (Cabernet Sauvignon and Arcaş). The year 2021 stands out when the varieties ripened about 10 days later than the multi-year average. The useful thermal balance that conditioned the ripening phenophase ranged from 418.2°C to 467.9°C.

Climate change also leads to changes in the productive potential of varieties (Figure 1).

Thus, during the analyzed period, the high temperatures combined with the soil water deficit unfavorably influenced the vegetative state of the vines and consequently, grape yields, which fluctuated from one year to another. The varieties in the assortment achieved yields below their productive potential in the years 2005, 2007, 2008, 2010, 2012, and 2015.

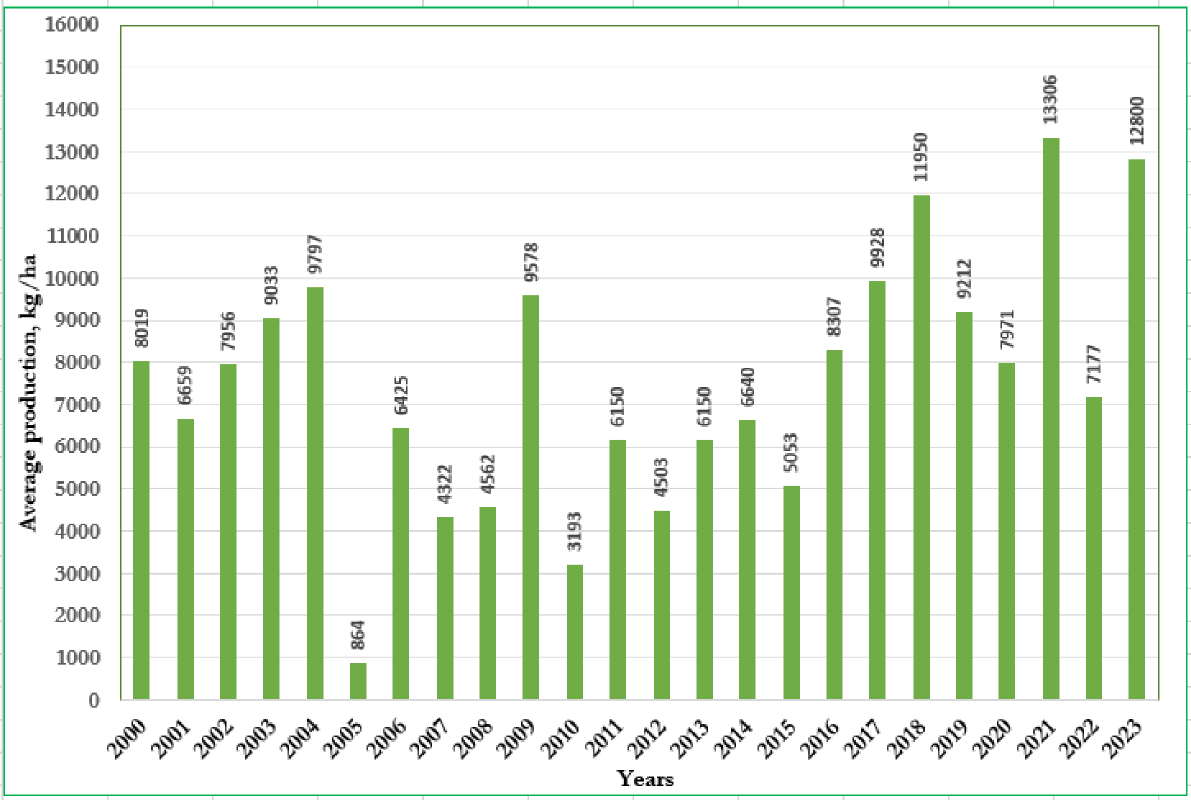

Figure 1. Average grape yield (kg/ha), during the period 2000 – 2023 (mean value for all the varieties) / Producția medie de struguri (kg/ha), în perioada 2000 – 2023 (valoare medie pentru toate soiurile)

CONCLUSIONS

Realizing and continually updating climate and phenological databases constitute an important step in optimizing vineyard zoning, as well as a starting point for issuing possible scenarios in the context of climate change.

The climatic analysis of the last 24 years indicates an increase in the average annual temperature which is up to 10.6°C, with a maximum value of 12.2°C in 2023 and a minimum of 9.5°C in the years 2001 and 2003, compared to the multi-year average of 9.8°C. Significant warming has been observed, especially in winter and summer. The values of synthetic ecological indicators from the Copou-Iaşi viticultural center indicate a favorable area for grapevine cultivation, balanced, with very good suitability for quality white wine varieties and moderate suitability for red wine varieties.

Multi-year phenological observations conducted on the varieties from the assortment show that in drought years, implicitly those with milder winters, budburst occurred in the second decade of April, flowering earliest at the end of May, and in other years, flowering was in the first and second decades of June. Similarly, grape veraison started in the last decade of July, full ripeness earliest in the first decade of September, and until the first decade of October. An exception was the year 2021 when the varieties ripened approximately 10 days later than the multi-year average.

The influence of climatic factors has directly affected grape yields in drought years, with yields well below the biological potential of the varieties cultivated in the Copou-Iasi viticultural center.

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