Scientific Papers. Series B, Horticulture. Vol. LXIX, No. 2, 2025
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

ALTERNATIVE APPROACHES FOR CONTROLLING SOME DISEASES AND PESTS IN GRAPEVINES

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Abstract

The research aimed to test the behavior of the Argessis variety in the organic farming system under the conditions of the Ștefănești Viticultural Center. The study included monitoring the evolution of diseases and pests (Plasmopara viticola, Uncinula necator, Guignardia bidwellii, Eriophyes vitis) during 2024, application of a treatment program adapted to the moment of appearance and intensity of the attacks, as well as evaluating some agrobiological indicators (grapes weight, berry weight, trunk production, sugar content, and must acidity). The results showed that the attacks of mites and downy mildew stopped completely in June after applying treatments with Limocide and Copperfield. In July, black rot settled on the grapes, but was controlled by increasing the dose of Copperfield; the pathogens were no longer present until harvest. Regarding production parameters, the Argessis variety recorded an average grape weight above the values in the specialized literature. The sugar and must acidity levels were within limits close to those reported in the specialized literature. The study demonstrates the efficiency of alternative products to chemical pesticides for ensuring grapevine health and maintaining competitive production parameters.

Key words: *downy mildew, eriophyid mites, black rot of grapevine, Vitis vinifera, grapevine.*

INTRODUCTION

Pesticides play a crucial role in modern agriculture by safeguarding crops from pests and diseases, ensuring food safety. Nevertheless, the use of pesticides in food production has sparked considerable concerns about their potential effects on human health and the environment (Lazarević-Pašti et al., 2025). To be beneficial to human health and the environment, they must be used in moderation and with a full understanding of their categorisation (Pathak et al., 2022).

In the European Union, the number of pollinators has declined significantly in recent decades, with one in three bee and butterfly species in decline, and one in ten such species on the verge of extinction. Pollinators are essential for the functioning of terrestrial ecosystems, human welfare, and food security, as they facilitate the pollination of both wild and cultivated plants. Almost EUR 5.000.000.000 of the Union's annual agricultural production is directly attributable to pollinating insects. Sustainable, resilient and biodiversity-rich agricultural ecosystems are therefore needed to ensure safe, nutritious, and affordable food. Agricultural ecosystems rich in biodiversity increase agricultural resilience to climate change and environmental risks.

One of the practices that has significant multiple benefits for biodiversity protection, ecosystem services, and landscape elements is organic farming (EU Regulation 869, 2022).

Vitis vinifera L. is among the most commercially significant fruit species globally (Romero-Romero et al., 2025) and grapes rank among the most widely consumed fruits worldwide, primarily utilised in the production of juice and wine (Haseeb et al., 2019; Martin et al., 2020).

Pesticides are used in grapevine culture to control pests and diseases (Flamini, 2003). These can have negative impacts on human health and the environment (Metral et al., 2024). Grapevines are susceptible to a range of phytopathogenic diseases throughout their developmental cycle, including downy mildew (*Plasmopara viticola*), powdery mildew (*Uncinula necator*), black rot (*Guignardia bidwellii*), and anthracnose (*Elsinoe ampelina*). The diseases and pests can significantly compromise both the yield and quality of the fruit. In intensive viticultural systems, applying chemical pesticides remains a primary strategy for crop protection, many pathogens and pests can cause severe reductions in productivity and agricultural output (Alsufyani et al., 2024; Syrgabek et al., 2023; Tukenova et al., 2021).

In grape cultivation, the improper or excessive use of pesticides can lead to residue levels that surpass established safety thresholds. These pesticide residues not only pose risks to environmental health but may also compromise the quality of grapes and their derived products, potentially exerting adverse effects on human health (Syrgabek et al., 2022).

Practising organic farming also has a positive impact on the climate (EU Biodiversity Strategy for 2030, 2020), encourages biodiversity, natural biological cycles, and enhances product quality (Dina et al., 2024).

The purpose of this study was to develop a treatment schedule and evaluate the effect of organic products on diseases, pests, and the yield of grapevine plants, providing an alternative to chemical control.

MATERIALS AND METHODS

The study took place at the National Research and Development Institute for Biotechnologies in Horticulture Ştefăneşti - Argeş (INCDBH Ştefăneşti), in a table grape vineyard with the Argessis variety (0.5 ha). The distance between rows is 2.5 m, and between plants/row is 1 m. At the beginning of the vegetation period, a treatment scheme was developed, which was modified throughout the year depending on the appearance and intensity of the attack of grapevine plants' pathogens and pests (Table 1): *P. viticola*, *U. necator*, *G. bidwellii*, and *Eriophyes vitis* (erineum leaf mite).

Throughout the vegetation period, in 2024, the attack of harmful organisms was monitored, and the following products were applied: Flosul (*U. necator*), Limocide (*P. viticola, Eriophyes vitis*), Vitisan (*U. necator, B. cinerea*), Copperfield (*P. viticola, G. bidwelli*), Wuxal ascofol (biostimulant based on seaweed), Wuxal amino (liquid biostimulator based on organic nitrogen), Amargerol essence (organic biostimulator).

Table 1 Treatment schedule

No.	Date	Product and dosage (for 0.5 ha)
1.	04/16/2024	Flosul 1.5 L Limocide 1 L
2.	04/29/2024	Flosul 1.5 L Limocide 1 L Vitisan 2 kg
3.	05/08/2024	Flosul 1.5 L Vitisan 2 kg Copperfield 1 L Wuxal ascofol 1.5 L
4.	05/27/2024	Flosul 2 L Vitisan 2 kg Copperfield 1 L Wuxal amino 1.5 L
5.	06/11/2024	Flosul 2 L Vitisan 2 kg Copperfield 1 L Wuxal amino 1.5 L
6.	06/21/2024	Flosul 2 L Vitisan 2 kg Copperfield 1 L Amargerol 1.5 L
7.	07/05/2024	Flosul 2 L Vitisan 2 kg Copperfield 1 L
8.	07/16/2024	Flosul 2 L Vitisan 2 kg Copperfield 1.25 L Wuxal amino 1.5 L
9.	07/21/2024	Copperfield 1.25 L
10.	07/29/2024	Flosul 2 L Vitisan 2 kg Copperfield 1.25 L Wuxal amino 1.5 L
11.	08/09/2024	Flosul 2 L Vitisan 2 kg Copperfield 1.25 L Wuxal amino 1.5 L

Eriophyid mites and downy mildew produced symptoms only on leaves, and black rot only on grapes. To monitor their attack, the frequency (F), intensity (I), and degree of attack (GA) were determined (Vizitiu et al., 2022).

In order to find out the behaviour of the Argessis variety in an ecological culture, the main agrobiological characteristics were also determined: grape weight, berry weight, the grape production per m^2, sugar, and total acidity of the must. Sugar and acidity were measured with the PAL-BRIACID2 device.

To quantify how the attack of mites and downy mildew evolves after each treatment, the daily means (eq. 1) were compared to a baseline set at the treatment date.

$$m_{p,t,k} = mean\ of\ metric\ k \in \{I, F, GA\} for\ pest\ p\ on\ date\ t$$

Because measurements occur on 08.05.2024, 16.05.2024 and 30.05.2024, two complementary, pre-specified baseline strategies were used:

- Nearest-after (strict): the baseline $b_{p.k.j}$ is the first measurement on or after the treatment date. This is conservative, but for Tx2 (27.05.2024), it sets the baseline at 30.05.2024, which prevents detecting a decrease between 27.05.2024 and 30.05.2024.
- Nearest-before (practical for sparse sampling): the baseline is the last measurement on or before. For Tx2, this uses 16.05.2024 as baseline, allowing the 27.05.2024 → 30.05.2024 change to be quantified.

The first decrease date was calculated according to eq 2:

$$d_{p,k,j} = \min\{t > t_0 : m_{p,t,k} < b_{p,k,j}$$

where t_0 is the baseline date determined by the algorithm.

The attack is considered stopped when the mean meets a predefined threshold θ (eq 3). The value of 0 was used by default; a small $\varepsilon > 0$ can be substituted to define "near-zero" if desired.

$$S_{p,k,j} = \min\{t > \tau_j : m_{p,t,k} \leq \theta\}$$

To assess the efficiency of the treatment for black rot, the Mann-Whitney test was applied by comparing the pre- and post-treatments of I, F, and GA. Before any between-group comparisons, normality was checked (Shapiro–Wilk).

The statistical analysis was implemented using the Python programming language and the following modules: pandas, scikit-learn, and matplotlib.

RESULTS AND DISCUSSIONS

Insect pests inflict substantial damage on global agriculture, leading to significant financial and environmental repercussions (Yactayo-Chang et al., 2020).

Agricultural expansion and intensification at the global level have led to the decline of ecological infrastructures essential for insects, herbaceous plants, and other organisms. Therefore, agriculture is considered a major factor in the biodiversity decline, and initiatives such as the European Green Deal highlight the importance of reducing ecosystem degradation. Among fruit crops, grapevine culture has one of the most intensive agricultural systems with the highest economic importance (Marcelino et al., 2024).

In 2024, eriophyid mites (Figure 1) and downy mildew (Figure 2) first appeared in May. The eriophyid mites attack was stronger than the downy mildew; the latter usually manifested itself by the appearance of 1-2 spots on the upper surface of the leaves, rarely accompanied by fruiting on the underside of the leaves. Nymphs and adults of *E. vitis* settled on the underside of the leaves and fed on their sap, which led to the appearance of swellings on the upper side of the leaves.

Figure 1. Galls produced by eriophyid mites (05/07/2024)

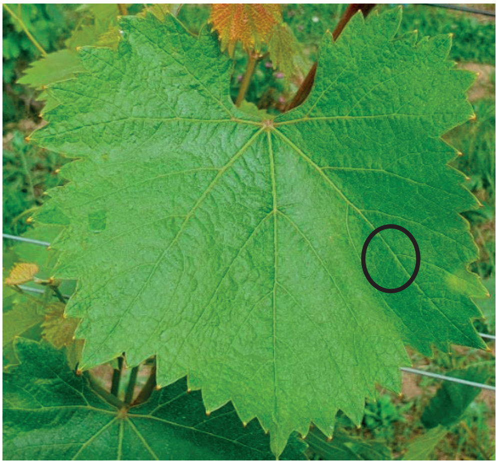

Figure 2. The appearance of the first downy mildew spots

E. vitis is a pest with significant potential to affect plant physiological performance and production quality. Monitoring the attack dynamics by assessing the symptoms frequency and intensity is a fundamental tool for understanding the establishment and evolution of populations on the leaf. The integration of these parameters in the attack degree indicator allows a more precise characterization of the severity of the infestation and the effectiveness of control measures.

The frequency of attack showed a progressive increase in the first half of May, suggesting a rapid establishment of *E. vitis* colonies on the leaves. Subsequently, after applying the treatments on May 8, 2024, and May 27, 2024, a visible decrease in frequency was recorded, indicating the organic products' effectiveness in limiting the spread of the pest (Figure 3).

The intensity of the attack followed the same trend as the frequency: an initial increase, reaching a peak in mid-May, followed by a significant reduction after the application of successive treatments. This dynamic confirms that the interventions were able to reduce not only the number of affected plants, but also the severity of the symptoms (Figure 4).

The degree of attack faithfully reflected the evolution of the other two parameters: a steady increase until severe symptoms appeared, followed by a clear decline after treatments. The data suggest that the applied scheme was able to stop the progression of the attack before it caused economic damage (Figure 5).

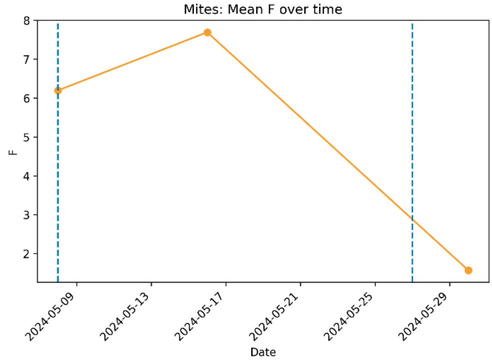

Figure 3. Evolution of the eriophyid mites frequency attacks in May 2024

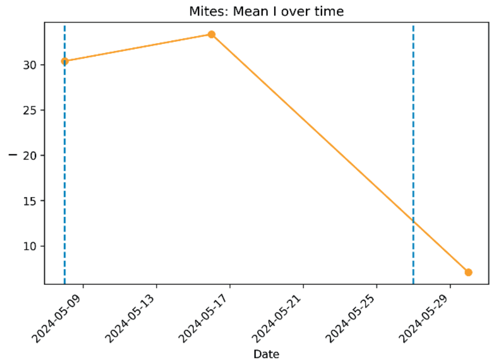

Figure 4. Evolution of the eriophyid mites intensity attacks in May 2024

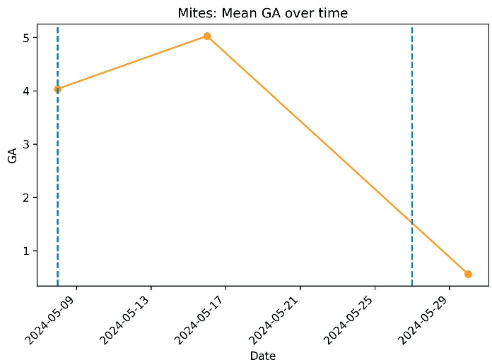

Figure 5. Evolution of the eriophyid mites degree of attacks in May 2024

Downy mildew is a disease that reduces grapevine yield (Voiculescu et al., 2021). Therefore, monitoring the attack evolution caused by *P. viticola* is essential for understanding the infection pressure and for substantiating protection strategies. The analysis of the frequency and intensity of symptoms, as well as the degree of attack, made it possible to capture both the dynamics of disease occurrence and the severity of leaf manifestations, providing a comprehensive picture of infection evolution and treatment effectiveness.

At the beginning of May (May 9, 2024), the frequency was 0.19%, but the infection spread rapidly until May 17, 2024, when it reached 0.26%. After this date, the frequency of *P. viticola* infection decreased steadily to 0.13% (May 29, 2024), indicating a reduction in pathogen spread (Figure 6).

The intensity of downy mildew showed high values at the beginning of May (4.2%), remaining at the same level until May 17, 2024. In the following period, a sharp decrease was observed, reaching 1.2% by the end of the month (May 29, 2024), which reflects a considerable reduction in symptom severity in the vineyard plantation (Figure 7).

The values of the degree of attack remained relatively constant in the first half of May (0.041%), but after May 17, 2024, they recorded a significant decline, reaching 0.011% on May 29, 2024. This trend suggests a reduction in the epidemiological pressure exerted by *P. viticola* in the second part of May (Figure 8).

These results indicate that the applied organic products limited the development of primary infections and prevented the occurrence of secondary ones, ensuring adequate protection of the grape and grapevine canopy.

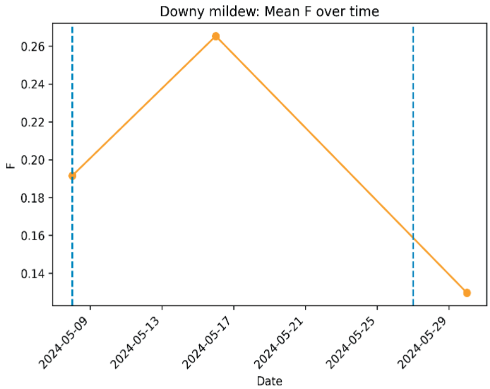

Figure 6. Evolution of downy mildew frequency attack in May 2024

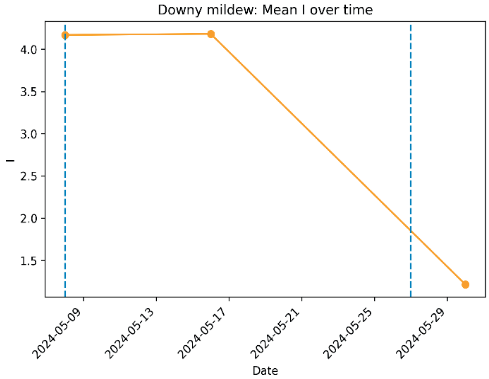

Figure 7. Evolution of downy mildew intensity attack in May 2024

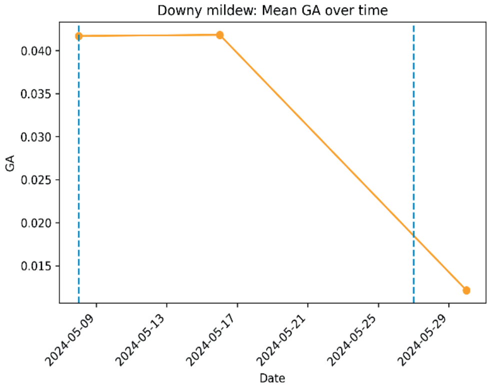

Figure 8. Evolution of downy mildew frequency attack in May 2024

From the beginning of June until the end of the growing season, mites and downy mildew were no longer present in the vineyard.

In July, black rot appeared on the grapes (Figure 9). After the appearance of this pathogen, the Copperfield dose was increased from 1.0 l/0.5 ha to 1.25 l/0.5 ha. To monitor this pathogen, the frequency, intensity, and degree of attack were determined before increasing the Copperfield product dose (July 15, 2024), but also after the application of treatments with this increased dose (July 28, 2024). Increasing the Copperfield product dose led to the attack stopping after the second treatment. Since the Shapiro-Wilk test showed that the data were not normally distributed, the Mann-Whitney U test (a non-parametric alternative to the t-test) was used.

Thus, after interpreting the data using the Mann-Whitney U test, it was found that, monitoring the same grapes, no significant differences between the determinations in terms of frequency, intensity, and degree of attack of the black rot were observed between 12.07.2025 and 27.07.2025 (Table 2). Black rot was monitored until the grapes were harvested, during which time the absence of pathogen-specific manifestations was noted. Therefore, the increased dose of the Copperfield product stopped the attack of black rot.
No other grapevine diseases were present on the grapevine plants until grape harvest.

Table 2. Statistical analysis of the black rot evolution on Argessis grapes

F	I	GA
Mann-Whitney value = 837.500, p = 0.455	Mann-Whitney value = 1010.000, p = 0.460	Mann-Whitney value = 914.500, p = 0.935

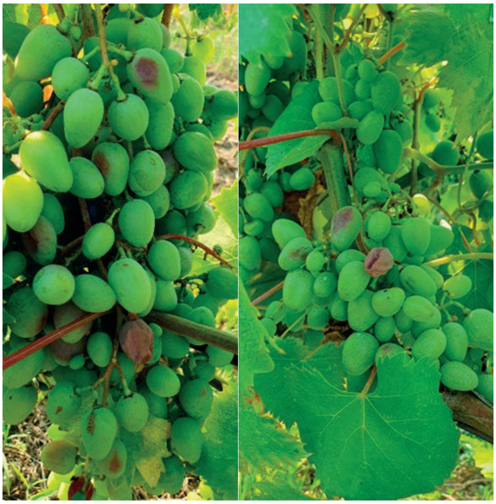

Figure 9. Argessis cultivar affected by black rot (July 2024)

Black rot is among the most difficult diseases to control in organic vineyards, as *G. bidwellii* shows low sensitivity to copper-based treatments (Jones & McManus, 2017).
Alternative products such as Limoncide (based on citrus extracts), Flosul (based on micronized sulfur), and Vitisan (potassium hydrogen carbonate) are increasingly used in organic agriculture and viticulture due to their preventive and curative action against fungal pathogens, offering a sustainable option to reduce the use of conventional synthetic fungicides. For example, Limocide has demonstrated high efficacy against the fungi responsible for crown rot in dessert bananas (Kouame et al., 2025); Flosul can be used to control grapevine powdery mildew (Wicks et al., 2003); Vitisan, applied together with Bas foliar Aktiv, had a satisfactory effect against grape powdery mildew (Žežlina et al., 2010).
The climate data for the 2023-2024 wine-growing period (Figure 10) show significant deviations from the multiannual average (1979–2018). The average monthly temperature recorded higher values almost throughout the year, with important positive deviations in February (+5.62°C) and in the June-August period (+2.76-3.55°C). These differences confirm the climate warming trend reported in other European wine-growing regions, where acceleration of phenophases, reduction of ripening time, and possible imbalances between technological and phenolic ripening of grapes were observed (Jones et al., 2005; van Leeuwen & Darriet, 2016).
The rainfall regime showed high variability, with surpluses in November 2023 (+42.92%) and September 2024 (+149.00%), but with accentuated deficits in May (-73.73%), June (-79.04%), July (-48.18%) and August (-89.45%). This uneven distribution of precipitation is characteristic of the intensification of extreme climatic phenomena (Schultz, 2016) and can generate risks of water stress during the critical period of berries development, but also excess water in other stages, with possible consequences on the quality of production and on the pressure of cryptogamic diseases (Palliotti et al., 2014).

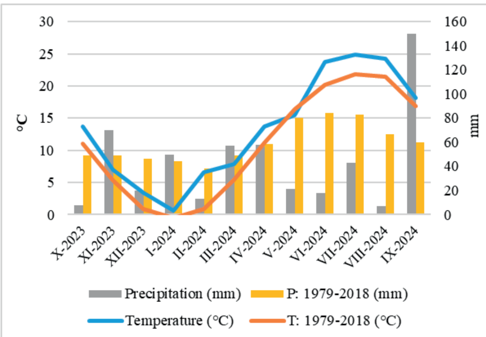

Figure 10. Evolution of the main climatic factors

Overall, the results confirm the major impact of climate change on viticulture, highlighting the need to adapt technologies through more efficient management of water resources (localized irrigation, mulching), the use of varieties and rootstocks resistant to abiotic stress, and adjusting the calendar of green works, as recommended by other researchers (Ollat et al., 2017; Santos et al., 2020).

In addition to the fungicidal and insecticidal activity, the following agrobiological indicators were also determined: grape weight, berry weight, grape production per m^2, sugar amount from the must, and total acidity of the must (H_2SO_4). In order to carry out these determinations, the grapes were harvested (Figure 11) and processed on 25.09.2024.

Figure 11. Argessis grapes at harvest time (25.09.2024)

Argessis table grapes showed a very good evolution (Figure 9), averaging 491.31 g, which is 18.67% higher than the values found in the specialised literature. However, the average weight of a berry was 5.34 g, representing 17.44% less than the values from the specialised literature (Table 3).

Table 3. Main agrobiological characteristics of the Argessis variety

Descriptor	Average in the demonstration plot	Average after Glăman et al., 2018*
Grape weight	491.31 g	414 g
Berry weight	5.34 g	6.5 g
Grape production per m^2	4.78 kg/trunk	-
Sugar amount from the must	146.67 g/l	150 g/l
Total acidity of the must (H_2SO_4)	3.43 g/l	3.8 g/L

CONCLUSIONS

The organic products and biostimulants tested (Flosul, Limocide, Vitisan, Copperfield, Wuxal, Amargerol) were highly effective in controlling mites, downy mildew, and black rot.

Mites and downy mildew had a stronger spread in the first half of May, but their attack was stopped due to the ecological products applied.

Increasing the dose of Copperfield led to the complete stoppage of the black rot attack, confirmed by monitoring during the growing season and by the statistical tests applied.

Argessis cultivar has demonstrated good tolerance to the main diseases and, as a result, good adaptation to the organic farming system, with satisfactory production and quality parameters comparable to data from the specialized literature.

The results highlight the potential of using alternative products to chemical pesticides in viticulture, thereby contributing to reducing the environmental impact and improving the sustainability of agriculture.

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